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## 1 **Abstract**

2 There is increasing appreciation of the benefits associated with exposure to natural  
3 environments. However, most of the evidence relates to green space with much less on blue  
4 space. Drawing on data from a British survey of adults, we describe the characteristics of  
5 visits to blue space and investigate whether the benefits reported in studies of green space -  
6 physical activity, social interaction, and psychological benefits – are evident with respect to  
7 blue space. We also examine the importance of nature to people’s visits to blue space and  
8 investigate the sociodemographic predictors of visit frequency and location, the benefits  
9 received, and the importance of nature to the visit. Social interaction and psychological  
10 benefits were the most important benefits obtained from visiting blue space. Socioeconomic  
11 status was a predictor of both frequency and location of visits and was also associated with  
12 identifying social interaction as the most important benefit. Respondents who reported  
13 psychological benefits as the most important benefit were more likely to find nature very  
14 important to their visit. The importance of nature in underpinning these benefits was  
15 relatively greater for older people compared with younger people. These findings highlight  
16 the social and psychological benefits obtained from visits to blue space, and provide new  
17 evidence on the importance of the natural environment in underpinning these benefits and  
18 enriching people’s lives.

## 19 **1. Introduction**

20 Exposure to the natural environment can have a range of social and psychological benefits  
21 and contribute to physical and mental health (Gascon et al., 2016; van den Berg et al., 2015).  
22 This paper will investigate the benefits associated with visiting a specific environment type,  
23 freshwater blue space. Research has concentrated on green space, with studies tending to  
24 focus on the quantity of green space in people’s living environment (van den Berg et al.,

25 2015). A range of health benefits have been associated with living in a greener  
26 neighbourhood, including better perceived general health (de Vries, van Dillen,  
27 Groenewegen, & Spreeuwenberg, 2013), mental health (Richardson, Pearce, Mitchell, &  
28 Kingham, 2013), happiness (van Herzele & de Vries, 2011), lower rates of cardiovascular  
29 disease (Richardson et al., 2013), and lower death rates (van den Berg et al., 2015; Villeneuve  
30 et al., 2012).

### 31 1.1 Mechanisms by which the environment affects health and associated benefits

32 A number of mechanisms have been proposed to explain the association between green space  
33 and health (Kuo, 2015). Many relate to environmental conditions, for example improvements  
34 in air quality and microclimate regulation, resulting from the presence of green spaces in the  
35 living environment (Kuo, 2015). In terms of people's visits to green spaces, three main  
36 mechanisms have been suggested which link activities in these areas to specific health-related  
37 benefits (de Vries et al., 2013; Hartig, Mitchell, de Vries, & Frumkin, 2014).

38 (i) Green spaces give people an area in which to be physically active, and people may  
39 also be more likely to exercise in these environments as they are aesthetically pleasing  
40 (de Vries et al., 2013; Maas, Verheij, Spreeuwenberg, & Groenewegen, 2008;  
41 Richardson et al., 2013). This provides a health benefit of physical activity.

42 (ii) Green spaces provide people with a space in which they can socialise with family and  
43 friends (de Vries et al., 2013). This provides a health benefit through social  
44 interaction.

45 (iii) Green spaces facilitate relaxation, mental restoration and stress reduction (de Vries et  
46 al., 2013; van Herzele & de Vries, 2011). They therefore provide psychological  
47 benefits for health.

48 Of the three mechanisms and associated benefits, a review of the literature suggests the role  
49 of green space in facilitating relaxation and stress reduction (psychological benefits) appears  
50 to be most important in explaining the green space-health relationship (Hartig et al., 2014).  
51 Visiting green space more frequently has been associated with achieving the recommended  
52 amount of physical activity (Flowers, Freeman, & Gladwell, 2016), but physical activity does  
53 not appear to mediate the association between green space and health (Hartig et al., 2014).  
54 There is some evidence that socialising (social interaction benefits) may also be a mediator;  
55 for example, de Vries et al., (2013) found that perceived social cohesion and stress reduction  
56 mediated the relationship between streetscape greenery and health, but there are a limited  
57 number of studies which have investigated this (Hartig et al., 2014).

58 Whilst research has concentrated on the provision of green space and its proximity to the  
59 dwelling, recent studies have investigated the importance of the quality of this green space in  
60 providing benefits (Dallimer et al., 2012; van den Berg et al., 2015). Quality can refer to both  
61 the amenity value of green space, such as the maintenance and the provision of paths and  
62 other facilities including benches and play areas, or its biological attributes, for example the  
63 presence of wildlife or the biodiversity of the space (Lovell, Wheeler, Higgins, Irvine, &  
64 Depledge, 2014; van den Berg et al., 2015).

65 With respect to amenity value, studies suggest that residents in neighbourhoods in which  
66 green spaces have more amenities have better mental health (de Vries et al., 2013; Francis,  
67 Wood, Knuiman, & Giles-Corti, 2012). Regarding the biological quality of the space,  
68 evidence indicates that, although the general public are fairly poor at accurately gauging the  
69 biodiversity of green space, the biodiversity they perceive is associated with their mental  
70 well-being (Dallimer et al., 2012). Studies have also found a link between objective measures  
71 of biodiversity, particularly plant and bird communities, and better mental well-being (Fuller,  
72 Irvine, Devine-Wright, Warren, & Gaston, 2007; Luck, Davidson, Boxall, & Smallbone,

73 2011). The majority of studies have focused on the psychological benefits of experiencing  
74 biodiversity but there is some evidence of increased physical activity in more biodiverse  
75 environments (Lovell et al., 2014).

76 The benefits obtained from natural environments may also depend on the type of natural  
77 environment (Hartig et al., 2014; Wheeler et al., 2015). Freshwater blue spaces - areas of  
78 standing or running water, such as rivers, lakes, and canals – are one type of environment  
79 which has been identified as needing further research (Foley & Kistemann, 2015; White et  
80 al., 2010). Our study aims to address this need by investigating the benefits of visiting  
81 freshwater environments.

## 82 1.2 Blue space, health and well-being

83 Qualitative studies have highlighted the value that people place on both freshwater and  
84 coastal blue spaces: water is associated with psychological benefits as well as having  
85 aesthetic value, providing a place for recreation and physical activity (Foley & Kistemann,  
86 2015; Völker & Kistemann, 2011). However, a recent scoping review found that quantitative  
87 studies of the relationship between freshwater blue space and health are scarce (Gascon,  
88 Triguero-Mas, Martínez, & Dadvand, 2015).

89 Studies from the UK and the Netherlands have shown that freshwater blue space availability  
90 is associated with better psychological and general health (de Vries, Verheij, Groenewegen,  
91 & Spreeuwenberg, 2003; Wheeler et al., 2015), and, using a validated mental health scale,  
92 lower prevalence of mood and anxiety disorders (de Vries et al., 2016). There is some  
93 evidence that the distance of blue space from the home may affect this association, with water  
94 more than 1km from the home having a positive health effect but water less than 1km having  
95 a negative effect (de Vries et al., 2003).

96 One problem that studies of freshwater blue space have encountered is that of scale.  
97 Compared to green space, blue space is small in area and forms less than 2% of land cover in  
98 the UK (Gascon et al., 2015; White, Alcock, Wheeler, & Depledge, 2013). In comparison,  
99 Richardson & Mitchell, (2010) found the average area covered by green space in urban areas  
100 in the UK is 46.2%. This makes it difficult to determine any effect blue spaces may have on  
101 health and well-being in large-scale studies and has often led to the inclusion of freshwater  
102 blue space with green space in analyses (Gidlow, Randall, Gillman, Smith, & Jones, 2016;  
103 Triguero-Mas et al., 2015).

104 The coastal environment covers a much larger area and, as a result, there is a greater range of  
105 evidence relating to health benefits of coastal blue space. Living near the coast has been  
106 found to be positively associated with both general and mental health in studies using cross-  
107 sectional and longitudinal survey data (Wheeler, White, Stahl-Timmins, & Depledge, 2012;  
108 White, Alcock, et al., 2013), and higher proportions of visible coastal blue space have been  
109 linked with lower rates of psychological distress (Nutsford, Pearson, Kingham, & Reitsma,  
110 2016).

111 Studies in England investigating coastal blue space and health have used data from the  
112 Monitor for Engagement with the Natural Environment (MENE) survey. Running since 2009,  
113 the MENE survey collects data on visits to the natural environment, asking participants to  
114 concentrate specifically on their last visit and their activities, motivations, and attitudes to  
115 visiting natural spaces (Natural England, 2015a).

116 Evidence from the survey indicates that visits to the coast are perceived to be more  
117 restorative than visits to other natural spaces, such as urban parks and playing fields, and that  
118 people living nearer the coast are more likely to meet physical activity guidelines (White,  
119 Pahl, Ashbullby, Herbert, & Depledge, 2013; White, Wheeler, Herbert, Alcock, & Depledge,

120 2014). However, the questions asked in the MENE survey limit the scope of the analyses  
121 which can be undertaken. The survey does not have a question which includes all three  
122 benefits - physical activity, social interaction, and psychological benefits – as outcomes of the  
123 visit.

124 We found only one study which has explored whether the mechanisms affecting green space  
125 and health also apply to blue space. Triguero-Mas et al. (2015) found no relationship between  
126 freshwater or coastal blue space and health but did find that access to these blue spaces was  
127 associated with increased social interaction.

128 Existing studies of both freshwater and coastal blue space and health have considered the  
129 contribution of social factors, including age, gender, socioeconomic status, household  
130 composition, and urbanity ( de Vries et al., 2016; Triguero-Mas et al., 2015). The green space  
131 literature also indicates that factors such as socioeconomic status (Mitchell & Popham, 2008),  
132 age and gender (Astell-Burt, Mitchell, & Hartig, 2014; Richardson & Mitchell, 2010),  
133 influence the relationship between the natural environment and health.

134 Our study investigates whether the benefits associated with the mechanisms thought to  
135 mediate the green space-health relationship are evident in people's visits to freshwater blue  
136 space. The pathways between time spent in blue space and these benefits are represented in  
137 Figure 1. We considered sociodemographic factors known to influence the relationship  
138 between the natural environment and health and their effect on the characteristics of visits to  
139 blue space, the benefits people received from their visit, and the value people placed on  
140 nature when visiting blue space (Fig. 1).

### 141 1.3 Study objectives

142 We had three objectives: (i) to describe the characteristics – frequency and location - of visits  
143 to freshwater blue space; (ii) to investigate which benefits identified in studies of green space

144 are evident for blue space; and (iii) to examine the importance of nature in enhancing the  
145 benefits derived from visits to blue space.

## 146 **2. Methods**

### 147 2.1 Sample

148 Our cross-sectional study was based on the Office for National Statistics (ONS) Opinions and  
149 Lifestyle survey, a British survey containing standard socio-demographic questions, together  
150 with modules commissioned by government organisations, academic institutions, and  
151 charities. Modules are designed with the Opinions and Lifestyle survey team to meet ONS  
152 quality standards. Data access is governed by the ONS Code of Practice, Protocol on Data  
153 Access and Confidentiality and Microdata Release Procedure (UK Statistics Authority,  
154 2009).

155 The survey covers Great Britain, excluding the Isles of Scilly and the Scottish Highlands and  
156 Islands and is based on a random probability sample of private households stratified by  
157 region and socio-demographic profile (ONS, 2014). Each month, 2010 addresses are selected  
158 and one person over 16 in each household is designated as a respondent for the address  
159 (ONS, n.d.). Trained interviewers conduct face-to-face interviews, interviewing only the  
160 selected respondent at the address, and returning at least 8 times to each address at different  
161 times of the day and week to achieve as many responses as possible. Response rates are  
162 typically between 50% and 60% (ONS, n.d.). The survey runs for eight months of the year;  
163 we commissioned a module in the May 2015 survey for which the response rate was 56%,  
164 resulting in a sample of 1043.

165 The sampling structure of the survey, selecting first households and then one individual  
166 within a household, means that the likelihood of an individual being chosen for the survey  
167 differs depending on household size (individuals living alone in a household are certain to be



168 selected if their household is selected; individuals in a family of four in a household only  
169 have a 25% chance of selection if their household is selected). As household size may vary  
170 based on other demographics, this has the potential to bias results. In addition, some groups  
171 are less likely to agree to respond to the survey than others. These factors mean that  
172 weighting is required to make the gathered sample representative of the general population.  
173 The ONS provides an individual analysis weight for each case which accounts likelihood of  
174 selection and non-response bias. In calculating percentages of individuals choosing each  
175 option to a question, raw response numbers were multiplied by the weighting to make them  
176 nationally representative (ONS, n.d.).

## 177 2.2 Survey questions

178 To address our three objectives, our module asked four questions relating to people's visits to  
179 freshwater blue spaces. These were defined for study participants as 'areas such as rivers,  
180 canals and lakes and their immediate surroundings, including river paths, canal paths and  
181 lakeside walks' and therefore excluded coastal blue spaces such as beaches.

182 We based our questions on those asked by the MENE survey to enable us to compare our  
183 data on visits to blue spaces to information from the MENE survey on visits to other natural  
184 environments. The MENE survey asks respondents to think about their last visit to a natural  
185 environment. We used the same format as we considered respondents would give clearer  
186 answers than if asked about visits to blue spaces in general. We also adapted some of the  
187 MENE questions to provide data on the mechanisms affecting the blue space-health  
188 relationship and the importance of nature to visits to blue space.

189 The first question asked the respondent how often they visit blue spaces, with possible  
190 answers being: every day; once a week; once a month; once every few months; two or three  
191 times a year; once a year or less; never visit. Respondents who answered 'never visit' were

192 asked no further questions from our module. Respondents who had visited blue space were  
193 then asked to think about their last visit to a blue space and report the location of this visit  
194 (either countryside or built up area).

195 To investigate mechanisms, we asked respondents to indicate the single most important  
196 benefit they experienced during their last visit to a blue space, the options being: exercise or  
197 keeping fit; spending time with friends or family; relaxation or stress reduction. Respondents  
198 were also given the option of answering 'other' in which case they were asked to describe the  
199 benefit.

200 The final question asked respondents to assess the importance of nature in enhancing their  
201 visit, with options being: very important; quite important; not important; not at all important.

## 202 2.3 Variables

203 Sociodemographic and health information was collected as part of the ONS survey. We used  
204 data on factors that other studies have found to be related to green and blue space use as  
205 predictor variables in our analyses. These factors were: age; gender; household composition  
206 (cohabiting status, number of dependent children); socioeconomic status (highest educational  
207 qualification); car ownership; health status (limiting long-standing illness); and urbanity of  
208 the respondent's dwelling, with 'urban' being defined as more than more than 10,000 people  
209 in the settlement and 'not urban' as less than 10,000 (Table 1).

## 210 2.4 Statistical analyses

211 For some questions, numbers for certain responses were small, requiring response categories  
212 to be merged to allow robust statistical analysis (Table 2). For frequency of visits, responses  
213 were combined to form three categories: frequently ( $\geq$  once a month), infrequently ( $<$  once a  
214 month), and never visit. For the importance of nature to the visit, the majority of respondents  
215 answered 'very important' so this was considered the appropriate category for comparison

216 and ‘quite important’, ‘not important’, and ‘not at all important’ were merged into one group  
217 ‘less important’.

218 A logistic regression model was run to examine the sociodemographic and health factors  
219 predicting whether respondents visited blue space frequently or not frequently (infrequently  
220 or never). Pearson Chi-squared tests were used to determine if there were differences in the  
221 sociodemographic and health profiles of those who visited blue space (frequently or  
222 infrequently) and those who never visited.

223 Users who had never visited a blue space (n=158) were then excluded from further analyses.

224 Logistic regression models were used to investigate the association between the  
225 sociodemographic and health factors and each outcome: visit location; visit benefits; and the  
226 importance of nature to the visit.

227 A logistic regression model was run to predict the sociodemographic and health factors  
228 associated with the location of the respondents’ last visit to a blue space (built-up area or  
229 countryside).

230 A multinomial logistic regression model was run for visit benefits, to investigate the  
231 sociodemographic and health predictors of selecting ‘exercise or keeping fit’, ‘spending time  
232 with family or friends’, or ‘other’ rather than ‘relaxation and stress reduction’.

233 The sociodemographic and health predictors of the importance of nature in enhancing the  
234 respondent’s last visit to a blue space were investigated; reporting that nature was very  
235 important rather than less important was modelled.

236 Finally, a second multinomial logistic regression model was run to identify sociodemographic  
237 and health factors associated with choosing ‘exercise or keeping fit’, ‘spending time with  
238 family or friends’, or ‘other’ rather than ‘relaxation and stress reduction’. The importance of

239 nature was added as a predictor to determine whether the likelihood of choosing a particular  
240 benefit was associated with the importance placed on nature during the visit.

241 Statistical analyses were carried out in SPSS Version 22. Nagelkerke's  $R^2$  is displayed to  
242 indicate the goodness of fit of the model. Results are presented as adjusted odds ratios (OR)  
243 (OR calculated taking into account the effects of all the other variables in the model) with  
244 95% confidence intervals (CI) (these are Wald CI and relate to the adjusted odds-ratios  
245 estimated by SPSS in the logistic regressions). Only variables which were significant  
246 predictors in the multivariable models are displayed in the paper, the full models are available  
247 in the supplementary information.

### 248 **3. Results**

249 Table 1 describes our study sample.

#### 250 3.1 Frequency of visits and location of last visit to freshwater blue space

251 Half (50%) of respondents visited blue space frequently ( $\geq$  once a month) although 15% had  
252 never visited a blue space (Table 2). Those who had never visited blue space were  
253 significantly different to those who had in age, cohabiting status, number of dependent  
254 children, car ownership, level of higher education, and long-term limiting illness (Table 3).

255 Table 3 describes the social profile of people who never visited blue space; 37% were 65 and  
256 over and 42% had no educational qualifications.

257 Of those who had visited blue space, a larger proportion (54%) had visited a built-up area on  
258 their last visit to a blue space than had been to the countryside (46%).

259 Both the frequency of visits and the location of a respondents' last visit were predicted by  
260 their personal and social circumstances. Compared to people with a degree, people with  
261 below degree level qualifications were less likely to visit a blue space frequently (OR 0.71,

262 CI 0.51-0.98). People were more likely to visit blue spaces frequently if they lived in a rural  
263 area than a built up area (OR 3.01, CI 1.91-4.76) (Table 4).

264 People with a degree were more likely to have visited a blue space in an urban area on their  
265 last visit to blue space than those with other (OR 0.53, CI 0.32-0.88) or no qualifications (OR  
266 0.52, CI 0.32-0.86; Table 5). Those who did not own a car were also more likely to have  
267 visited a blue space in an urban area on their last trip to a blue space than those who owned a  
268 car (OR 1.73, CI 1.16-2.57), as were respondents who lived in an urban area rather than a  
269 rural area (Table 5).

### 270 3.2 Perceived benefits received from visits to freshwater blue space

271 Most people reported that spending time with friends or family (33%) or psychological  
272 benefits (40%) was the single most important benefit they received most from their visit, 17%  
273 identified exercise or keeping fit whilst 10% responded 'other' (Table 2). Respondents who  
274 choose 'other' referred mostly to using blue space for a specific activity such as walking with  
275 friends, fishing, dog walking, or as a route to another activity such as work. Other benefits  
276 discussed included enjoying the fresh air and seeing wildlife. There were no  
277 sociodemographic or health factors which predicted selecting other as the most important  
278 visit benefit (Table 3 in the supplement).

279 Health status was a predictor of choosing physical activity as a visit benefit. Respondents  
280 who did not have a limiting long term illness were more likely to report physical activity than  
281 psychological benefits as the most important benefit received from their last visit to blue  
282 space (OR 2.49, CI 1.36-4.54) (Table 6).

283 Socioeconomic circumstances were a predictor of choosing social interaction as a visit  
284 benefit. Compared to respondents with a degree, those with no qualifications were nearly

285 twice as likely to identify spending time with family or friends than psychological benefits  
286 (OR 1.97, CI 1.09-3.57) as the key benefit of their visit to blue space (Table 6).

287 Household composition was also a predictor. Compared to respondents with children, those  
288 without children were less likely to report social interaction than psychological benefits (OR  
289 0.40, CI 0.27-0.59) as the most important benefit of their visit to blue space (Table 6).

290 Finally, those aged 65 and over were less likely to report socialising as the single most  
291 important benefit of their visit compared to young adults (OR 0.34, CI 0.14-0.80, Table 6).

### 292 3.3 Importance of nature on visits to freshwater blue space

293 The majority (57%) of respondents considered nature very important to their most recent visit  
294 to a blue space (Table 2).

295 Table 7 describes the social patterning of those who found nature very important. Women  
296 were more likely than men to value nature (OR 1.28, CI 1.05-1.82). The likelihood of finding  
297 nature important increased with age; compared to those aged 16-24, those aged 45-64 were  
298 over twice as likely (OR 2.43, CI 1.31-4.51) and those aged 65 and older were over three  
299 times as likely (OR 3.48, CI 1.70-7.11) to find nature very important. Socioeconomic status  
300 was also a predictor. Compared to people with a degree or equivalent, those with no  
301 qualifications were less likely to find nature important (OR 0.55, CI 0.34-0.90).

302 The likelihood of selecting different visit benefits differed depending on how important the  
303 respondent found nature to their visit (Table 8). Respondents who found nature less important  
304 were more likely to select exercise (OR 2.80, CI 1.83-4.28) or spending time with family and  
305 friends (OR 1.69, CI 1.21-2.37) than psychological benefits as the most important benefit of  
306 their visit in comparison to those who found nature very important.

307 When the importance of nature was included in the model, both gender and cohabiting status  
308 became predictors of identifying physical activity as the most important benefit of the visit.  
309 Women were more likely to select physical activity than psychological benefits as the single  
310 most important benefit of their visit compared to men (OR 1.51, CI 1.01 – 2.26). Single  
311 respondents were less likely to report exercise than psychological benefits as the most  
312 important benefit of their visit compared to those who were married (OR 0.48, CI 0.24 –  
313 0.98).

#### 314 **4. Discussion**

##### 315 4.1 Frequency and location of visits to freshwater blue space

316 While the majority of respondents visited a blue space at least monthly, access to blue space  
317 was socially patterned. Socioeconomic status and living in an urban area were predictors of  
318 both the frequency and location of visits to blue space whilst car ownership was also a  
319 predictor of visit location.

320 Evidence on the importance of accessibility to natural spaces is varied. Most visits to green  
321 spaces are to those closest to the home but, whilst White et al. (2013) found that people living  
322 nearer the coast are more likely to visit than people who live further away, frequency of visits  
323 to specific landscape features such as forests, beaches, or lakes appears to be less affected by  
324 distance (Schipperijn et al., 2010). Our results suggest area of residence is a predictor of visit  
325 frequency and location. Users from urban areas were more likely to visit blue space in a built-  
326 up area while respondents from rural areas, with perhaps more access to blue space, visited  
327 more frequently. As those without a car were less likely to go to rural blue spaces, the  
328 individual's ability to access the space also appears to be a factor affecting visit frequency  
329 and location.

330

## 331 4.2 Perceived benefits received from visits to freshwater blue space

332 The main benefits people identified as receiving from their visits to blue space were social  
333 interaction and psychological benefits (Table 2). Social disadvantage was associated with  
334 increased odds of identifying social interaction as the most important benefit as was  
335 household composition. Age was an additional predictor: older respondents were less likely  
336 to identify spending time with family or friends as the most important benefit of their visit  
337 than younger respondents. Health status was a predictor of reporting physical activity as the  
338 most important visit benefit.

339 We asked our respondents to identify the most important benefit they felt they received from  
340 visiting blue space. Our results are similar to findings from green space studies, where social  
341 interaction and psychological benefits have been identified as particularly important (de Vries  
342 et al., 2013; Hartig et al., 2014).

343 These results differed from the MENE survey which, in 2014-15, found that almost half of  
344 people visited the natural environment for health and exercise whilst 29% reported their  
345 motivation for visiting was ‘to relax and unwind’ (Natural England, 2015b). This may be  
346 because MENE asks respondents about their reasons for visiting rather than the benefits  
347 resulting from their visit; people’s intentions before visiting may not be the same as the  
348 outcome of the visit (Natural England, 2015a). MENE also asks about a range of natural  
349 environments, not just blue and green space, so it may be indicative of differences in the use  
350 and benefits received from these spaces.

351 People may access different benefits from natural environments simultaneously (Hartig et al.,  
352 2014). For example, some respondents who answered ‘other’ identified ‘walking with a  
353 friend’ as a benefit, which could provide physical activity and social interaction benefits. It  
354 should also be noted that many answers in the ‘other’ category were recreational pursuits,



355 which can provide benefits in themselves (Völker & Kistemann, 2013). Although people  
356 identified these activities as the most important benefit of their visit, most could be placed in  
357 one of the three categories provided, for example, dog walking as physical activity.

358 An individual's socio-demographic characteristics affected the benefits they felt they  
359 received from visiting the space. We found that respondents who were older and who had a  
360 limiting long-term illness were more likely to report psychological benefits as the single most  
361 important benefit they received from visiting blue space. Both are user groups who may have  
362 problems with mobility and accessing blue space, so provision of these spaces with  
363 appropriate amenities, such as paths and benches to allow ease of access and use, is essential  
364 to enable them to derive these benefits (Finlay, Franke, McKay, & Sims-Gould, 2015;  
365 Schipperijn, Stigsdotter, Randrup, & Troelsen, 2010).

366 Socioeconomic status was a predictor of identifying social interaction as the single most  
367 important benefit received from visiting blue space. Studies of green and blue space have  
368 suggested that these areas may moderate some of the effects of socioeconomic inequality on  
369 health (Mitchell & Popham, 2008; Wheeler et al., 2012). This may be because people from  
370 different socioeconomic groups are using these spaces in different ways and therefore gaining  
371 different benefits from them. This is supported by research on relational encounters which  
372 suggests that the benefits people receive from natural spaces are a result of interaction  
373 between individuals and the wider socio-environmental setting (Conradson, 2005).

374 For some people, or in some situations, visiting a natural space may not be beneficial due to  
375 the interaction or relationship of the individual with the environment (Plane & Klodawsky,  
376 2013). We found that one in six people never visited blue space; many of these respondents  
377 were elderly or in poor socioeconomic circumstances. They may not access these spaces  
378 because they are physically unable or due to time or financial limitations, but in some cases,

379 it may be because blue spaces are perceived negatively as unhealthy places for them (Finlay  
380 et al., 2015; Plane & Klodawsky, 2013). More deprived neighbourhoods often have less  
381 access to natural spaces, and those that are present are more likely to be of poor quality  
382 (Mitchell & Popham, 2008; Rigolon, 2016), so these groups may have both fewer  
383 opportunities and little incentive to visit these spaces. As these respondents do not visit blue  
384 space, they are unable to access any benefits from spending time there.

#### 385 4.3 Importance of nature on visits to freshwater blue space

386 The majority of our respondents found nature to be very important to their visit. Current  
387 evidence regarding the impact of water quality on recreational visits to blue space is mixed.  
388 Some research has found that people are more likely to choose to visit blue spaces with good  
389 water quality (Doi, Atano, Egishi, & Anada, 2013), however, work by Ziv et al. (2016)  
390 suggests that water quality does not affect whether people use blue spaces for recreation.  
391 These differences may reflect variation in people's perceptions of what is natural, as nature is  
392 regarded differently by different people, and is even situation-dependent, with people  
393 expecting spaces to be more or less managed depending on whether they are rural or urban  
394 (Cooper, Crase, & Maybery, 2017).

395 There is some research indicating that people prefer the natural environment to have a degree  
396 of naturalness rather than being excessively managed, a view that seems to be stronger in  
397 women than men (Lindemann-Matthies & Bose, 2007; Southon, Jorgensen, Dunnett, Hoyle,  
398 & Evans, 2017; Strumse, 1994). This preference for nature may be a factor in why people in  
399 rural areas were more likely to visit blue space frequently; more extensively modified by  
400 human activity, blue spaces in urban areas are less likely to 'look natural' (Wild, Bernet,  
401 Westling, & Lerner, 2011).

402 Valuing nature showed social patterning: respondents who were female, older and socially  
403 advantaged were more likely to regard nature as very important to their last visit to blue  
404 space. This is in line with studies of pro-environmental behaviours which found that people  
405 engaging in these behaviours tend to be older and female although a recent meta-analysis of  
406 nature connectedness found no effects of age or gender (Capaldi, Dopko, & Zelenski, 2014).

407 Our results suggest that finding nature important when visiting blue space increases the  
408 likelihood of identifying psychological benefits as the main benefit of the visit. This may be  
409 indicative of the respondents' own biases – those who value nature highly may be more likely  
410 to gain psychological benefits from their visit. However, research on visits to green space  
411 indicates that there is a link between biodiversity and the psychological benefits of the space  
412 (Fuller et al., 2007), and that spaces with higher actual and perceived biodiversity are more  
413 restorative than those with less biodiversity (Carrus et al., 2015; Hoyle, Hitchmough, &  
414 Jorgensen, 2017). A review of the health benefits of blue spaces also highlights the  
415 significance of features related to quality such as the movement, colour, and clarity of water  
416 to users (Völker & Kistemann, 2011), so the nature present in blue space may be important in  
417 providing psychological benefits.

#### 418 4.4 Limitations and further work

419 Because our study formed part of a wider national survey, we were able to include a wide  
420 range of sociodemographic factors in our analysis, and use established measures of  
421 socioeconomic position (based on education), health status and household composition.

422 However, some limitations of our study should be noted. The low pseudo- $R^2$  values indicate  
423 that there is a large amount of variation not explained by the models, probably due to  
424 unmeasured factors, and the cross-sectional nature of the study meant that conclusions could  
425 not be drawn about causality. We were therefore unable to investigate whether the perceived

426 benefits of visits to blue space mediated potential health effects of exposure to blue space. In  
427 addition, like other studies of the benefits of exposure to natural environments, our study  
428 relied on self-reported measures. Thus, although freshwater blue space was defined, there  
429 may be differences in people's perception and recall of visits to areas such as rivers, canals  
430 and their surroundings. However, to explain the social differences we found in frequency,  
431 location and benefits of visits to blue space, such perceptual and memory differences would  
432 need to be socially patterned. We consider this unlikely.

433 Our study adds to evidence in an area where research is limited and is one of the first to  
434 examine whether the perceived benefits of spending time in green space were also evident for  
435 blue space (Triguero-Mas et al., 2015). Our findings suggest visits to freshwater blue space  
436 are important for users; their potential contribution to mental health and well-being requires  
437 further investigation and comparison with the benefits provided by coastal blue spaces to  
438 determine whether different types of blue space provide similar benefits.

#### 439 4.5 Relevance for policy and planning

440 There is increasing policy recognition of the societal benefits of the natural environment,  
441 from the acknowledgment of the need for a biodiverse natural environment to meet social  
442 needs in the Welsh Well-being of Future Generations Act (2015) to the promotion of green  
443 spaces for exercise by Natural England (Natural England, 2009; Natural Resources Wales,  
444 2015).

445 Our study indicates the importance of the natural environment beyond green space, showing  
446 that different groups of people experience a range of benefits from freshwater blue space. For  
447 example, we found that younger and older people derive different benefits, as do those in  
448 urban and rural areas. Evidence on such patterns can help inform local and national strategies  
449 to promote the use of public blue space; encouraging the use of freshwater blue spaces could

450 both prevent overuse of coastal environments and allow people who do not live on or near the  
451 coast access to the benefits of blue environments.

452 Importantly, we found that one in six adults does not visit blue space. The social patterning of  
453 visiting blue space infrequently or not at all suggests inequalities in access to blue space –  
454 and therefore to the benefits that exposure to these spaces may provide.

455 Our findings also indicate the importance of protecting and improving blue space,  
456 particularly in urban areas. Whilst many are heavily modified or culverted, urban blue spaces  
457 often exist within urban green spaces or are present where green space has been erased  
458 through urbanisation (Völker, Matros, & Claßen, 2016; Wild et al., 2011). There are an  
459 increasing number of projects which aim to restore urban rivers including success stories  
460 such as that of the river Quaggy in London where restoration has improved the local  
461 environment and increased use by residents (Chartered Institution of Water and  
462 Environmental Management, 2012; The River Restoration Centre, 2009).

463 Blue spaces deserve consideration in urban planning as areas which can benefit people and  
464 support nature. To ensure the provision of good quality blue spaces for use by urban  
465 populations, the catchments upstream of settlements need management to ensure the quality  
466 of the water downstream (Neale & Moffett, 2016). Urban planners should also ensure that  
467 local communities are engaged with restoration projects, particularly in the planning stages,  
468 so that spaces are designed with their support and to meet their needs (Smith et al., 2016).

## 469 **5. Conclusions**

470 In our study, the majority of people had visited a freshwater blue space in the last year; these  
471 visits were split almost equally between urban and rural areas. The frequency and location of  
472 an individual's visits to blue space were socially patterned, and determined by people's  
473 circumstances and access to the space, whether due to car ownership or their urban location.

474 Freshwater blue spaces were perceived as important primarily as areas for social interaction  
475 and psychological benefits. This is consistent with evidence from the green space-health  
476 literature which has identified social interaction and psychological benefits as key  
477 mechanisms through which green space benefits health. Those who were most socially  
478 disadvantaged (as proxied by having no educational qualifications) were more likely to report  
479 social interaction as the primary benefit, pointing to the role that blue space could play in  
480 supporting social engagement and improving wellbeing among those at greatest risk of poor  
481 health. However, as noted above, we found marked social inequalities in use of blue space;  
482 the most socially disadvantaged groups were least likely to report visiting a blue space  
483 frequently.

484 The majority of people considered nature very important to their visit, with women and those  
485 aged 45 and over attaching greater importance to nature than men and younger adults. People  
486 who considered nature very important to their visit were more likely to identify psychological  
487 benefits as the most important benefit of their visit. This suggests that the quality of the blue  
488 space may be integral to the benefits that people derive and points to potential synergies  
489 between protecting natural habitats and promoting public health.

490 The findings of our study are relevant to the design of natural spaces for use by local  
491 populations as well as more broadly for social and environmental policies. The factors related  
492 to people's use of these spaces, particularly socioeconomic and health status, need to be  
493 addressed to ensure that access to blue spaces benefits everyone and does not contribute to  
494 widening socioeconomic inequalities.

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**Table 1 Social profile of the sample (n = 1043)**

	N	Weighted %
<b>Gender</b>		
Male	468	44.9
Female	575	55.1
<b>Age</b>		
16 to 24	116	11.1
25 to 44	338	32.4
45 to 64	349	33.5
65 and over	239	23.0
<b>Cohabiting status</b>		
Married/cohabiting	636	61.0
Single	238	22.8
Widowed	63	6.0
Divorced/separated	106	10.2
<b>Dependent children</b>		
Yes	386	37.0
No	657	63.0
<b>Car ownership</b>		
Yes	835	80.1
No	208	19.9
<b>Level of higher education</b>		
Degree or equivalent	298	28.6
Below degree level	439	42.1
Other qualifications	122	11.7
None	184	17.6
<b>Limiting long-term illness</b>		
Yes	211	56.2
No	188	43.8
<b>Urbanity</b>		
Urban	894	85.7
Not urban	149	14.3

**Table 2 Visits to blue space (n=1040)**

	N	Weighted %
Frequency of visits		
Frequently ( $\geq$ once a month)	520	50.0
Infrequently (<once a month)	362	34.8
Never	158	15.2
Missing	3	
Location of visits		
Built-up area	402	45.6
Countryside	479	54.4
Missing <sup>1</sup>	161	
Visit benefits		
Exercise or keeping fit	151	17.1
Spending time with family or friends	292	33.2
Psychological benefits	349	39.6
Other	89	10.1
Missing <sup>1</sup>	161	
Importance of nature		
Very important	500	56.7
Less important	382	43.3
Missing <sup>1</sup>	161	

<sup>1</sup>includes respondents who have never visited a blue space

**Table 3 Social profile of respondents who never visited a blue space (n=158), who had visited a blue space (n=885), and differences in sociodemographic and health factors between these two groups (\* marks variables for which the difference is significant)**

	Never visited		Visited		X <sup>2</sup>	p-value <sup>1</sup>
	N	Weighted %	N	Weighted %		
Gender						
Male	64	40.5	404	45.6	2.59	0.108
Female	94	59.5	481	54.4		
Age*						
16 to 24	18	11.5	98	11.1	33.46	<0.01
25 to 44	37	23.6	301	34.0		
45 to 64	44	28.0	305	34.5		
65 and over	58	36.9	181	20.5		
Cohabiting status*						
Married/cohabiting	71	44.9	565	63.8	31.62	<0.01
Single	45	28.5	193	21.8		
Widowed	21	13.3	42	4.7		
Divorced/separated	21	13.3	85	9.6		
Dependent children*						
Yes	53	33.5	333	37.6	5.14	0.023
No	105	66.5	552	62.4		
Car ownership*						
Yes	97	61.8	738	83.3	65.13	<0.01
No	60	38.2	148	16.7		
Level of higher education*						
Degree or equivalent	19	12.1	279	31.5	96.67	<0.01
Below degree level	49	31.2	390	44.0		
Other qualifications	23	14.6	99	11.2		
None	66	42.0	118	13.3		
Limiting long term illness*						
Yes	62	39.2	149	61.8	47.74	<0.01
No	96	60.8	92	38.2		
Urbanity						
Yes	142	89.9	752	85.0	3.80	0.051
No	16	10.1	133	15.0		

<sup>1</sup>p-values based on Pearson Chi-squared tests

**Table 4 Logistic regression analysis estimates for visiting a blue space frequently ( $\geq$ once a month) rather than infrequently or never (pseudo- $R^2 = 0.05$ )**

	Frequency	
	Adjusted OR <sup>1</sup>	95% CI
Level of higher education		
Degree or equivalent	1	
Below degree level	0.71	0.51-0.98
Other qualifications	0.91	0.56-1.46
None	0.66	0.43-1.02
Urbanity		
Urban	1	
Not urban	3.01	1.91-4.76

<sup>1</sup> adjusted for gender, age, cohabiting status, number of dependent children, and car ownership



**Table 5 Logistic regression analysis estimates for visiting a blue space in a built-up area rather than the countryside, excluding respondents who have never visited a blue space (pseudo- $R^2 = 0.10$ )**

	Adjusted OR <sup>1</sup>	95% CI
Level of higher education		
Degree or equivalent	1	
Below degree level	0.73	0.52-1.02
Other qualifications	0.53	0.32-0.88
None	0.52	0.32-0.86
Car ownership		
Yes	1	
No	1.73	1.16-2.57
Urbanity		
Urban	1	
Not urban	0.23	0.14-0.37

<sup>1</sup>adjusted for gender, age, cohabiting status, number of dependent children, and long-term limiting illness

**Table 6 Multinomial logistic regression analysis estimates for the most important benefit received on the respondents' last visit to blue space (compared with psychological benefits), excluding respondents who have never visited a blue space (pseudo-R<sup>2</sup> = 0.17)**

	Exercise or physical activity		Spending time with family or friends	
	Adjusted OR <sup>1</sup>	95% CI	Adjusted OR <sup>2</sup>	95% CI
<b>Age</b>				
16 to 24			1	
25 to 44			0.86	0.44-1.67
45 to 64			0.48	0.23-1.00
65 and over			0.34	0.14-0.80
<b>Dependent children</b>				
Yes			1	
No			0.40	0.27-0.59
<b>Level of higher education</b>				
Degree or equivalent			1	
Below degree level			1.35	0.91-2.02
Other qualifications			0.76	0.41-1.43
None			1.97	1.09-3.57
<b>Limiting long term illness</b>				
Yes	1			
No	2.49	1.36-4.54		

<sup>1</sup> adjusted for gender, age, cohabiting status, number of dependent children, car ownership, level of higher education, urbanity

<sup>2</sup> adjusted for gender, cohabiting status, car ownership, limiting long-term illness, urbanity

**Table 7 Logistic regression analysis estimates for whether people found nature to be very important when visiting a blue space, excluding respondents who have never visited a blue space (pseudo-R<sup>2</sup> = 0.06)**

	Adjusted OR <sup>1</sup>	95% CI
Gender		
Male	1	
Female	1.38	1.05-1.82
Age		
16 to 24	1	
25 to 44	1.54	0.87-2.71
45 to 64	2.43	1.31-4.51
65 and over	3.48	1.70-7.11
Level of higher education		
Degree or equivalent	1	
Below degree level	0.79	0.57-1.10
Other qualifications	1.07	0.65-1.76
None	0.55	0.34-0.90

<sup>1</sup> adjusted for cohabiting status, number of dependent children, car ownership, limiting long-term illness, urbanity

**Table 8 Multinomial logistic regression analysis estimates for the most important benefit received on the respondents' last visit to blue space (compared with psychological benefits), excluding respondents who have never visited a blue space (pseudo-R<sup>2</sup> = 0.20)**

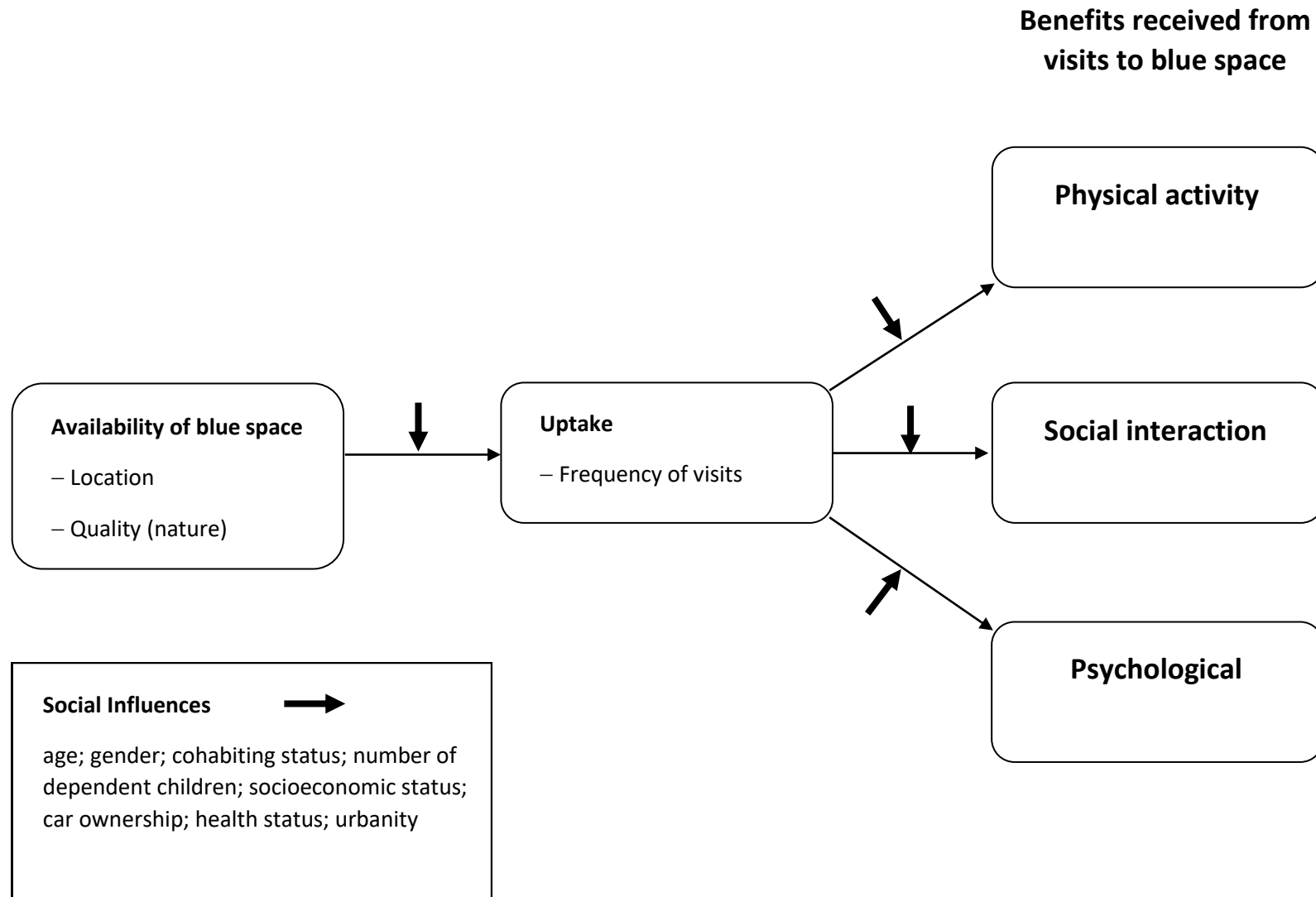
	Exercise or physical activity		Spending time with family or friends	
	Adjusted OR <sup>1</sup>	95% CI	Adjusted OR <sup>2</sup>	95% CI
<b>Gender</b>				
Male	1			
Female	1.51	1.01-2.26		
<b>Age</b>				
16 to 24			1	
25 to 44			0.82	0.42-1.61
45 to 64			0.44	0.21-0.92
65 and over			0.30	0.12-0.71
<b>Cohabiting status</b>				
Married/cohabiting	1			
Single	0.48	0.24-0.98		
Widowed	1.57	0.65-3.79		
Divorced/separated	0.75	0.38-1.48		
<b>Dependent children</b>				
Yes			1	
No			0.41	0.28-0.61
<b>Level of higher education</b>				
Degree or equivalent			1	
Below degree level			1.39	0.93-2.08
Other qualifications			0.78	0.41-1.47
None			2.10	1.16-3.82
<b>Limiting long term illness</b>				
No	1			
Yes	2.66	1.45-4.89		
<b>Importance of nature</b>				
Very important	1		1	
Less important	2.80	1.83-4.28	1.69	1.21-2.37

<sup>1</sup> adjusted for age, number of dependent children, level of higher education, car ownership, urbanity

<sup>2</sup> adjusted for gender, cohabiting status, car ownership, limiting long-term illness, urbanity

**List of figures**

**Figure 1** Conceptual model showing the benefits obtained from visiting blue space and possible influences on the relationship, adapted from Hartig et al. (2014).



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