

# Journal Pre-proof

Restoration in mental health after visiting urban green spaces, who is most affected?  
Comparison between good/poor mental health in four European cities

Alessia Grigoletto, Stefania Toselli, Wilma Zijlema, Sandra Marquez, Margarita Triguero-Mas, Christopher Gidlow, Regina Grazuleviciene, Magdalena Van de Berg, Hanneke Kruize, Jolanda Maas, Mark J. Nieuwenhuijsen

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**Credit author statement**

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1 **Restoration in mental health after visiting urban green spaces, who is most**  
2 **affected? Comparison between good/poor mental health in four European cities**

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## Abstract

Several mechanisms have been proposed to explain the association between green space and health, and one of these is the restoration theory, based on the idea that it is possible to increase mental health and decrease stress visiting a natural environment. The aims of the present study were to understand what activities are most related to restoration and if these are the same for people with poorer and better mental health. A questionnaire was administered in four European cities and data about restoration outcomes, type of activity carried out in green spaces and mental health were collected and analyzed. A cross sectional design was used and total of 3134 respondents participated to the questionnaire. The restoration experience was measured with the restoration outcome score, and the mental health was evaluated with a subscale related to mental health of the Medical Outcome Short Form. Participants were divided in two groups according to mental health score. A multiple regression analysis was performed to investigate the association between mental health, type of activity and restoration. The cities showed a similar trend in the association between restoration and type of activity performed in green environment. People with poorer mental health seem to be more sensitive to the positive effect of visiting the green environment and restoration was more evident in these people than in those with better mental health. At the same time, the type of activity was less evident in people with better mental health, and they seemed to be less influenced by the visiting of green space. Green prescription is important for the entire population: people with poorer mental health could have important restorative effects and people with better mental health could continue to protect their well-being using green space.

Keywords: activity, green space, mental health, restoration theory

74 Declaration of competing interest

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

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78 Ethical approval was obtained for all study populations, and all participants signed an informed consent.

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## 107 1. Introduction

108 There is increasing interest in the use of green spaces and in its connection with human health. This is  
 109 particularly important considering the growing urbanization; in fact, it is expected that by 2030 three out of  
 110 five people worldwide will live in an urban area (*World Urbanization Prospects - Population Division - United*  
 111 *Nations*, 2018). Cities are usually relatively nature-poor due to the great range of competing land-use (Lin et  
 112 al., 2014) or, are areas in which urban natural spaces face considerable development pressure (Jim, 2004). The  
 113 natural outdoor environments might help to reduce the negative impacts of some factors (such as air, and noise  
 114 pollution) which characterize urban settings (Basagaña et al., 2011; Hoek et al., 2013; Selander et al., 2009;  
 115 Shanahan et al., 2015; Wolf & Robbins, 2015). In addition, the exposure to, and the interaction with nature  
 116 have a role in long-lasting psychological benefits (Kaplan & Kaplan, 1989 ; Sacker & Cable, 2006; Ulrich et  
 117 al., 1991). Several mechanisms are used to explain the beneficial effects of natural environment on health,  
 118 probably there are multiple and potentially synergistic (Hartig et al., 2003). They are: (a) Attention Restoration  
 119 theory, as a stress reduction, (b) opportunity to perform physical activity by promoting leisure walking,  
 120 walking through the space when running errands, active place and sports (Dzhambov & Dimitrova, 2014;  
 121 Sallis et al., 2016; Shanahan et al., 2015; Wolf & Robbins, 2015), (c) enhancement of social interaction and  
 122 improved social cohesion in the community (de la Barrera et al., 2016; Koohsari et al., 2015; Lachowycz &  
 123 Jones, 2013), (d) mitigation of exposure to potentially harmful environment , such as noise or air pollution  
 124 (Hartig et al., 2003; Nieuwenhuijsen, , et al., 2014), (e) stimulation of development in children and stimulation  
 125 of personal development and a sense of purpose (Hartig et al., 2003; Ministerie van Volksgezondheid, 2004),  
 126 (f) improved functioning of the immune system (Egorov et al., 2017).

127 In this study, we decided to focus on restoration theory. Attention Restoration Theory has been proposed to  
 128 explain the mental health benefits of exposure to the natural environment, and it is one of the less studied  
 129 meachnism to explain this relationship. In particular, Attention Restoration Theory affirms that the benefits of  
 130 interaction with nature are due to cognitive benefits, and effortless charms (Kaplan & Kaplan 1989). The  
 131 theory identifies four qualities that contribute to a restorative experience: fascination, extent, being away, and  
 132 compatibility (Kaplan & Kaplan, 1989), which are described as person-environment interaction ( Kaplan,  
 133 2001). Fascination means that there is something in the surroundings that capture one's attention in a non-  
 134 exhaustive, restorative way (Kaplan & Kaplan, 1989). Extent implies that the environment should have  
 135 coherent scope such that one feels like being in a whole other world (Kaplan & Kaplan 1989). Then, being  
 136 away indicates to be mentally detached from everyday worries and problems (Kaplan & Kaplan, 1989).  
 137 Finally, compatibility is linked to the environment match with person's current needs to support restoration  
 138 (Kaplan & Kaplan, 1989). From this explanation, it would be better if people had an active role in the  
 139 restoration process, to facilitate the experiences, than to be a passive recipient of some pre-determinant  
 140 restorative insights (Kaplan & Kaplan, 1989; Kaplan, 2001). Restoration could proceed when the person-  
 141 environment interaction helps to gain psychological or geographical distance from usual context, immersion  
 142 in a coherent physical or conceptual environment, and attention without effort (. Korpela et al., 2008). This  
 143 theory is based on the idea that it is possible to improve mental health by counteracting stress and increasing  
 144 the ability to focus and concentrate. Emerging evidence around improvements in the cardiovascular and  
 145 respiratory system is promising and provides some basis for observations linking better health with time spent  
 146 in nature. Type and quality of the environment has been linked to the degree of connection with nature and the  
 147 psychological effects on individuals (Kaplan & Kaplan, 1989). The restoration outcomes score (ROS) was  
 148 developed based on Attention Restoration Theory by Korpela & Ylén . (Korpela & Ylén, 2009) to measure  
 149 restoration outcome in adults after exposure to nature (Hartig et al., 1998; Staats et al., 2003). ROS is based  
 150 on the theory that exposure to nature helps individuals relax, increases physical activity, eliminates unwanted  
 151 thoughts and improves attention and vitality (Kaplan & Kaplan, 1989). The ROS comprises items which cover  
 152 relaxation and calmness, attention restoration, clearing one's thoughts, subjective vitality, and self-confidence.  
 153 There are several studies which used the Restoration Attention Theory, but the results are not conclusive. Some  
 154 studies focused more on the time of exposure, and they found positive effects from exposure time ranging from  
 155 40 seconds to 55 minutes (Berman et al., 2008; Berto, 2005; K. E. Lee et al., 2015; Pilotti et al., 2015). Lin et  
 156 al. (2014) found that focusing on natural features enhance attention and restoration. A similar effect on

157 improved restoration has been shown over longer period in interventions studies (Duvall, 2011; Lymeus et al.,  
158 2018). The two studies suggested that to be engage in walking in natural environment was linked to be expertise  
159 less frustration at the end of the study, and to have a day-to-day replenishment of cognitive resources. Despite  
160 the evidence, in our knowledge, no previous study analyzed restoration linked to different types of activities,  
161 such as relaxing or play with children. In addition, no previous studies have assessed the association between  
162 restoration and amental health. For this reason, the aims of the present study were to answer the following  
163 questions:

164 a) Which activities carried out in green space are most related to restoration?

165 b) Are these activities the same for people with poor and good mental health?

166 Since different activities may have direct effects on emotional states, it is possible that one or more of them  
167 will have a greater impact on restoration. Data analysis were gathered as part of the Positive Health Effects of  
168 the Natural Outdoor Environment in Typical Populations in different Regions in Europe (PHENOTYPE)  
169 project that aimed to investigate the influence of the natural outdoor environment on human health and well-  
170 being (Nieuwenhuijsen et al., 2014). The questionnaire to calculate the restoration was collected in a large  
171 sample of adults in four European cities using a large comparable approach.

## 172 2. Methods

### 173 2.1 Study design

174 A cross-sectional design was used. An extensive description of the study design can be found in  
175 Nieuwenhuijsen et al. (2014). This study was based on adults who participated to the PHENOTYPE project.  
176 Data were collected in four European cities: Barcelona (Spain), Doetinchem (the Netherlands), Kaunas  
177 (Lithuania) and Stoke-on-Trent (the United Kingdom) (Nieuwenhuijsen, et al., 2014). The four cities offer  
178 diverse study areas in terms of size, population density, climate and land cover (Smith et al., 2017). Barcelona,  
179 the largest city (1.6 million inhabitants) is a densely built city (population density 16000 inhabitants/km<sup>2</sup>) and  
180 has a Mediterranean climate. Doetinchem, the smallest city, (56000 inhabitants) has a much lower population  
181 density (706 inhabitants/km<sup>2</sup>) and has a moderate maritime climate. Kaunas (319000 inhabitants) has a humid  
182 continental climate and has a population density of 2046 inhabitants/km<sup>2</sup>. Stoke-on-Trent (363000 inhabitants)  
183 has a population density of 1194 inhabitants/km<sup>2</sup> and has a moderate maritime climate. Greenness and access  
184 to natural environment varies per city. In general, Doetinchem being the greenest city with the best natural  
185 environment access, and Barcelona the least green city with poorest natural environment access (Smith et al.,  
186 2017). Survey data were collected from residents of 30 neighborhoods per city. These neighborhoods were  
187 selected on the basis of their variability in socioeconomic status and access to the natural environment. A  
188 random sample of 30-35 adults (age range 18-75 years) in each neighborhood was invited to participate in the  
189 survey. Response rates were 46.9% in Barcelona, 8.4% in Doetinchem, 21.3% in Kaunas, and 36.9% in Stoke-  
190 on-Trent. The final sample contained approximately 1000 respondents per city. Data were collected by means  
191 of a face-to-face questionnaire administered at respondents' residences during May-November 2013. In  
192 Kaunas (Lithuania), data were collected using a postal questionnaire. The study was conducted in accordance  
193 with the Declaration of Helsinki. Ethical approvals were obtained from the relevant bodies of each institution  
194 and all respondents provided written informed consent before taking part.

### 195 2.2 Collection of study population data

196 A face-to-face questionnaire survey was used to collect the study population data. Most questions were  
197 derived from existing and validated indices and others were tailored to the specific objectives of the  
198 PHENOTYPE study. The survey was developed in English and then translated into Dutch, Spanish, and  
199 Lithuanian. The questionnaire was developed as an oral interview of 30-60 minutes. All the questions used in  
200 the present analysis referred to the green space most used and visited by participant, identified by asking  
201 participants to "please list the name, location and approximate distance from your home of the green/blue  
202 environment that you visit or use most often".

### 203 2.3 Restorative outcomes score

204 Restorative experiences were measured with the ROS (Korpela & Ylén, 2009). The scale includes  
 205 nine items. According to previous measures and findings on restorative outcomes (Hartig et al., 1998; Staats  
 206 et al., 2003), three items reflect attention restoration ('I feel calmer', 'I feel restored and relaxed', 'I get new  
 207 enthusiasm and energy for my everyday routines'). One item reflects attention restoration ('My concentration  
 208 and alertness clearly increase'), two items reflect clearing one's thoughts ('I forget everyday worries', 'My  
 209 thoughts are cleared and clarified'), other two items reflect subjective vitality ('I gain vitality', 'I get trust for  
 210 each new day') and the last one item reflected self-confidence ('My self-confidence improves'). The response  
 211 scale included not at all, a little, somewhat, much and very much.

### 212 2.4 Type of activity

213 The type of activities and the frequency with which they were carried out were used as independent  
 214 variables. The question, which referred to the most often visited green space, was: "How often do you use the  
 215 natural environment you visit most often for the following activities?" The activities proposed were: "walking,  
 216 cycling or doing sport", "picnic", "meeting family or friends", "walk or play with children", "experiencing  
 217 tranquility" and "personal relaxation". For every activity, the frequency indicators included never, seldom,  
 218 sometimes, often and very often.

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### 221 2.5 Mental health

222 Mental health was used as a possible modifier in the relationship between restoration and the type of  
 223 activity. This variable was assessed with the Medical Outcome Study Short Form (SF-36) mental health  
 224 subscale (van den Berg et al., 2016a; Ware 2000; Ware & Sherbourne, 1992). The SF-36 mental health subscale  
 225 is a validated and widely used questionnaire to assess mental wellbeing. In the present study we used the  
 226 subscale of mental health, which is composed by five questions about how the respondent felt in the last four  
 227 weeks. The questions are: Have you been a very nervous person? Have you felt so down in the dumps nothing  
 228 could cheer you up? Have you felt calm and peaceful? Have you felt downhearted and blue? Have you been a  
 229 happy person? The possible answers were six: all of the time, most of the time, a good part of the time, some  
 230 of the time, a little of the time and none of the time. A sum score was calculated by summing all items together.  
 231 If two out of five items were missing, these missing values were replaced by the average of other items. If  
 232 more than two items were missing, no sum score was calculated. Then, summed scores were transformed into  
 233 a scale from 0 to 100, according to guidelines (Ware 2000; Ware & Sherbourne, 1992). Higher scores reflect  
 234 better mental health. The subscale has been shown to be a reliable and valid measure of mental health (Ware  
 235 2000). Finally, the median of the combined sample was considered as a discriminant for dividing people of the  
 236 entire sample with poorer and better mental health.

### 237 2.6 Covariates

238 Based on previous literature, some a priori covariates were selected: gender (Rossi et al., 2015; Sallis  
 239 et al., 2016; Toohey et al., 2013), age (Rossi et al., 2015; Sallis et al., 2016; Toohey et al., 2013), education  
 240 completed (Rossi et al., 2015; Sallis et al., 2016; Toohey et al., 2013), marital status (van den Berg et al.,  
 241 2016a), living with children (van den Berg et al., 2016a) and neighborhood socioeconomic status (SES). In  
 242 addition, the appeal of the place, the length of stay and the frequency of the visits to the environment that  
 243 participants visit or use most often (the frequency indicators were seldom or never, once per month, 2/3 time  
 244 a month, once per week, 2/3 time per week, every day) were also considered as covariates.

### 245 2.7 Statistical analysis

246 Descriptive statistics were used to characterize the study population and are shown for the pooled sample  
 247 and by city. Depending on the type of variables, the one-way ANOVA, chi-squared test and the Kruskal-



248 Wallis test were performed to see the difference in variance by city of residence. The aims of the present study  
 249 were double: understand which activities carried out in green space are most related to restoration and  
 250 understand if these activities are the same for people with ‘poorer and better mental health’. So, to investigate  
 251 these association a multiple regression analysis was performed. The multiple regression was performed twice.  
 252 The first time the entire population was considered together, then, the model was adjusted for the covariates  
 253 described previously, and finally,, the population was stratified by mental health. As the PHENOTYPE study  
 254 was designed to include cities with regional, social, and cultural differences, also the city-specific multilevel  
 255 was analyzed. Analyses were based on a part of the complete cases. The total sample was 3599, but our sample  
 256 was 3134 because we chose to exclude people that did not answer at all the questions about the kind of activity  
 257 done in the green urban space or they did not indicate if they had a most visited place. All the analyses were  
 258 performed in STATA 14.2 (StataCorp, 2015).

### 259 3. Results

#### 260 3.1 Population characteristics

261 Table 1 shows the sociodemographic characteristics for the combined sample and for each city. The  
 262 sample consisted of 3134 respondents from the four cities (Barcelona n=848, Doetinchem n=833, Kaunas  
 263 n=739, Stoke-on-Trent n=714). Respondents had a mean age of 51.67 (SD 15.81), but it differed among the  
 264 cities. In all the cities, the percentage of women was higher than the percentage of men. Stoke-on-Trent  
 265 represented an exception because women and men were equally represented (357 women and 357 men).

266 The participants of the different cities showed remarkable differences in each socio demographic  
 267 characteristics considered (p-value <0.001). The majority of the participants had a high education (50.98% in  
 268 the combined sample) and the results were similar among the cities, except for Stoke-on-Trent, in which the  
 269 62.48% of participants had a medium education level. People from Doetinchem and Stoke-on-Trent had the  
 270 better financial situation: 52.78% in Doetinchem and 51.16% in Stoke-on-Trent said that they were  
 271 “comfortable”. Instead, in Kaunas, only the 23% were “comfortable”, but at the same time Kaunas showed the  
 272 lowest percentage of people that “cannot make ends meet” (4.69%). Due to these differences, subsequent  
 273 analyses were always carried out for the combined sample and then separately for each city.

#### 274 3.2 Covariates and type of activity

276 Table 2 shows the descriptive characteristics for the covariates and of the type of activities. The Chi-  
 277 squared test showed statistically significant differences between the cities in all the covariates and type of  
 278 activities.

279 The largest part of the participants visited the green space for one or two hours (38.84%) and two/three  
 280 times per week (28.78%). It is possible to notice that no one from Barcelona, Doetinchem and Stoke-on-Trent  
 281 said to visit the green urban space “seldom or never” and a very small percentage (2.65%) reported staying in  
 282 the natural environment for less than 10 minutes. The participation in the activities differed across cities.

283 “Sport” had the highest percentage of the answer “often” in the combined sample, and for the same  
 284 answer it achieved the 47.30% in Doetinchem. “Picnic” was the least practiced activity (63.88 % of the answer  
 285 ‘never’ in the frequency indicators), in particular this happened in Doetinchem (78.39% of the answer ‘never’  
 286 in the frequency indicators); the lowest percentage of never was (26.52) in Kaunas. Participants from  
 287 Doetinchem and Stoke-on-Trent showed the lowest percentage for the answer “never” (52.22 and 43.84%  
 288 respectively) for the activity “Meet family/friends”, while people from Kaunas presented the highest  
 289 percentage. In the combined sample “Walk and play with children” the answer ‘never’ had a highest  
 290 percentage. And regards “Tranquility”, it had a higher percentage of answers “sometimes” for the combined  
 291 sample (35.16%) than “personal relaxing” (24.25%). People from Stoke-on-Trent had a higher percentage of  
 292 answers “never” (39.98%) or the item “personal relaxing” than people from Kaunas (10.96%).

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### 295 3.3 Restoration and mental health

296 Table 3 shows the median score of restoration score and the median score of mental health, for the  
 297 combined sample and for each city separately. The Kruskal-Wallis test was performed and statistically  
 298 significant differences were found both for the restoration and the mental score among the results of the cities.  
 299 People from Doetinchem showed the higher statistically significant score of mental health while people from  
 300 Barcelona and Kaunas the lowest. On the contrary, respondents from Doetinchem had the lowest score of  
 301 restoration (11) and those from Stoke-on-Trent the highest (21).

### 302 3.4 Relationship between restoration and the type of activity

303 The combined sample and city-specific samples showed different associations between the restoration  
 304 and the type of activity (Table 4). In the combined sample, the activities linked to the social cohesion (“picnic”  
 305 and “meeting family/friends”) and to the reduction of stress (“tranquility” and “personal relaxing”) were  
 306 associated with higher restoration. In particular, “Picnic” and “meet family or friends” presented a high  
 307 significant association ( $p < 0.001$ ) for all the frequency indicators. Considering the results of the cities  
 308 individually, several differences emerged.

309 In Barcelona sample no statistically significant association was observed between restoration and  
 310 “sport”, “meet family or friends” or “walk and play with children”. Indeed, a significant association ( $p < 0.05$ )  
 311 were observed with “picnic” (with seldom and often), “tranquility” (from sometimes to very often) and  
 312 “personal relaxing” (for all the frequency indicators).

313 In Doetinchem sample a significant association ( $p < 0.05$ ) was observed with “sport” (for often and  
 314 very often), “picnic” (for seldom and very often), “tranquility” (from sometimes to very often) and “personal  
 315 relaxing” (for often and very often).

316 In Kaunas sample the highest number of statistically significant associations were observed. In fact,  
 317 there were significant association ( $p < 0.05$ ) for all the type of activities. “Picnic” showed a statistically  
 318 significant association for all the frequency indicators, while “sport”, “meet family or friends” and “personal  
 319 relaxing” presented statistically significant association for the three frequency indicators sometimes, often,  
 320 very often. Finally, “walk and play with children” recorded statically significant association for two frequency  
 321 indicators (sometimes and very often) and “tranquility” for only one frequency indicator (very often).

322 In Stoke-on-Trent sample no statistically significant association was shown with the activity “sport”  
 323 but a significant association ( $p < 0.05$ ) was observed from seldom to very often for “meet family or friends”.  
 324 Instead, “tranquility” and “personal relaxing” presented statistically significant associations only for three  
 325 frequency indicators (sometimes, often and very often).

326 Table 4 showed the results of the multiple regression. “Never” was the comparison group.

### 327 3.5 Multiple regression and stratification by mental health

328 Table 5 presents the results of the multiple regression performed for all the population of the combined  
 329 sample and of the four cities. In Appendix A it is possible to see the tables for the multiple regression stratified  
 330 by mental health.

#### 331 3.5.1 Combined sample

332 In the combined sample a significant association ( $p < 0.05$ ) was observed for all the different kinds of  
 333 activities for the poorer mental health (Table 5). “Sport” presented a high association ( $p < 0.001$ ) for the  
 334 frequency indicators often and very often. “Picnic” and “walk and play with children” had a significant  
 335 association ( $p < 0.05$ ) for all the frequency indicators. Finally, “meet family or friends”, “tranquility” and  
 336 “personal relaxing” showed a high association ( $p < 0.001$ ) for three frequency indicators, from sometimes to  
 337 very often.

338 The situation was different when we considered the subsample categorized as ‘better mental health’. In  
339 this group, there were no statistically significant associations linking restoration score with “sport” and “walk  
340 and play with children”. “Picnic” presented an association with all the frequency indicators, from 1.78 of  
341 seldom (95%CI 0.75, 2.80) to 5.76 of very often (95%CI 3.53, 7.99).

#### 342 3.5.2 Barcelona

343 Barcelona had a similar trend to the combined sample (Table 6 Appendix A). The association between the  
344 type of activity and mental restoration was more apparent in the subsample categorized as ‘poorer mental  
345 health’ compared to the ‘better mental health’ subsample. For those with poorer mental health, activities related  
346 to the reduction of stress (“tranquility” and “personal relaxing”) were associated with higher restoration scores.  
347 In the ‘better mental health’ subsample, only the activity “tranquility” was associated with higher restoration  
348 scores.

#### 349 3.5.3 Doetichem

350 Doetinchem had more people with a better mental health (523) than those with poorer mental health (267).  
351 The association between the type of activity and mental health was more apparent in the ‘poorer mental health’  
352 subsample (Table 7 Appendix A). For people with ‘poorer mental health’, the activities “sport”, “and  
353 “tranquility” were associated with higher restoration score. Meanwhile, in the ‘better mental health’ subsample  
354 the activities related to the reduction of stress (“tranquility” and “personal relaxing”) were associated with  
355 higher restoration score.

#### 356 3.5.4 Kaunas

357 Participants from Kaunas showed big differences between who had poorer and who had better mental  
358 health (Table 8 Appendix A). In fact, the subsample with ‘poorer mental health’ presented a more apparent  
359 association between the type of activity and mental health. For those people, the activities “picnic”, “meet  
360 family or friends”, “walk and play with children” and “tranquility” were associated with higher restoration  
361 score. For the ‘better mental health’ subsample, only the activities “picnic” and “personal relaxing” were  
362 associated with higher restoration score,

#### 363 3.5.5 Stoke-on-Trent

364 People from Stoke-on-Trent with ‘poorer mental health’ showed a more apparent association between the  
365 type of activities and mental health. In fact, for this subsample, the activities “meet family or friends”,  
366 “tranquility” and “personal relaxing” were associated with a higher restoration score. For the ‘better mental  
367 health’ subsample, the activity “walk and play with children” was negatively associated with mental health for  
368 the frequency indicator seldom and sometimes.

### 369 4. Discussion

370 The goal of the present study was to investigate restoration after visiting green urban space in people with  
371 better and poorer mental health and explore mental health as a potential effect modifier. We found that the  
372 activities “picnic”, “meet family or friends”, “tranquility” and “personal relaxing” in urban space were  
373 associated with restoration. These associations varied between the four cities. For examples, participants from  
374 Kaunas showed the highest number of statistically significant association between restoration and the different  
375 type of activity. Participants from Barcelona presented statistically significant association between the social  
376 activities and ROS. Indeed, people from Doetichem showed statically significant association for the activities  
377 linked to relaxation (“tranquility” and “personal relaxation”). Finally, association between the type of activity  
378 and restoration varied according to the participants’ mental health. In general, participants with poorer mental  
379 health showed more significant associations and for more frequency indicators than participants with better  
380 mental health. It is possible that people with better mental health need to spend less time in green space, due  
381 to their mental health conditions, and this less time is enough for them to continue to have a good mental

382 health. At the same time, it is possible that people with poorer mental health need to spend more time, and to  
383 practice a larger variety of activities to have the same restorative effects of people with better mental health.

384 We found a statistically significant association between the restoration and the kind of activity carried out  
385 in the urban green space and statistically significant differences between the four cities involved in the study.  
386 For example,

#### 387 4.1 Combined sample

388 In the combined sample, the activities linked to the social cohesion (“Picnic” and “meeting family or  
389 friends”) and to the relaxation (“tranquility” and “personal relaxing”) showed statistically significant  
390 association with the ROS after visiting the green urban space. In particular, “Picnic” and “meet family or  
391 friends” presented statistically significant association for all the frequency indicators, for people with poorer  
392 mental health. This could mean that activities related to socialization and social cohesion definitely affect  
393 restoration, even if these activities are performed infrequently. This is in line with previous studies that suggest  
394 natural environments may promote positive social interactions (Kuo et al., 1998; Maas et al., 2009). In addition,  
395 social interaction and the improvement of social cohesion in the community is one of the different types of  
396 mechanisms proposed to explain the beneficial effects of the green environment (de la Barrera et al., 2016;  
397 Hong et al., 2018; Koohsari et al., 2015; Lachowycz & Jones, 2013). Our findings for the combined sample  
398 was in line with previous studies (van den Berg et al., 2016b; White et al., 2013) which showed a higher vitality  
399 and restoration in persons that went to green space with companions. Instead, activities more linked to the  
400 relaxation suggest that the frequency was more important than the activity in and of itself. Previous studies  
401 have shown that short-term exposure to forests, urban parks, gardens and other natural environments reduces  
402 stress and depressive symptoms, restores attention fatigue, increases self-reported positive emotions and  
403 improves self-esteem, mood and perceived mental and physical health (Aerts et al., 2018; Bosch, 2017; W. Y.  
404 Chen & Jim, 2008; I. Lee et al., 2017). These results are important because they highlight the importance of  
405 how people perceive the use and the benefits of the green space. It could be a “safe place” in which people can  
406 stay and relax without other problems or thoughts. In conclusion, for people with poorer mental health seem  
407 that is not so important the type of activity done in the green urban space. The most effective aspect is the use  
408 of this kind of environment.

409 Regarding people with better mental health, “walk and play with children” did not show a strong  
410 association with the restorative score. This is in line with other studies. In particular, White et al. (2013) found  
411 that being with children was associated with lower restoration than being alone. The presence of children  
412 tended to reduce the extent of restoration experienced. While spending time with children may have many  
413 benefits, it is not necessarily a relaxing/restorative activity (White & Dolan, 2009). The feeling of restoration  
414 remained lower also for visits to the playing field, even without the presence of children (White et al., 2013).  
415 The activity “sport” showed a statistically significant association only for the frequency indicator very often.  
416 Korpela et al. (2008) found that physical activity was among the potential determinants of the restorative  
417 experiences (Korpela et al., 2008), but White et al. (2013) found that doing sport was not better than simply  
418 walking for the levels of restoration (White et al., 2013). Even if the beneficial effects of the physical activity  
419 are well established, with strong evidence of the relative reduction of risk of mortality, it is not a factor known  
420 to facilitate restoration experience. Korpela et al. (2014) in their study presented the importance of  
421 experiencing calmness, getting new spirit and vitality, forgetting everyday worries and gaining faith in  
422 tomorrow during nature-based recreation (Korpela et al., 2014). According to our data, the sport practice helps  
423 to do this only if people do it very often.

424 Looking at the results of the cities individually which differed in characteristics that can influence the  
425 restoration, the mental health and the attitude towards green urban spaces key, several differences emerged. It  
426 is important remember that the four European cities offer diverse study areas in terms of size, population  
427 density, climate, and land cover, that could have influenced the results of the study (Kruize et al., 2020; Smith  
428 et al., 2017). Barcelona was the largest city (1.6 million inhabitants), and it is also the densely built city, with

429 a population density of 16000 inhabitants/km<sup>2</sup>. Due to these conditions, Barcelona is also the city with poorest  
430 natural environment access and has the longest distance from the green urban space for the citizens. These  
431 aspects could influence the use and the perception that dwellers have of the natural environment. Instead,  
432 Doetinchem is the smallest city, with 56000 inhabitants and a population density of 706 inhabitants/km<sup>2</sup> but is  
433 the greenest city with the best natural environment access. In the study by Kruize et al. (2020), authors analyzed  
434 several differences in the use and presence of natural environment and green urban space in the four cities.  
435 They found that almost 90% of participants from Stoke-on-Trent and Doetinchem had their own garden, while  
436 in Barcelona only the 10.4% of participants had a garden. The 62.1% of people from Kaunas had a balcony or  
437 patio, and the 42.4% had a communal garden to use. In addition, in Kaunas, more than half of the people owned  
438 a dog, which was a far higher proportion than in the other cities, and which may stimulate people to use the  
439 green urban spaces. The 28.1% of people from Barcelona had a leisure time elsewhere or were usually to spent  
440 weekend elsewhere, and this data could influence the use and the perception of green urban spaces. In addition,  
441 also the climate could influence the use and the perception of green urban space (Ho et al., 2022). Highest and  
442 lowest temperature could discourage the use of natural environments. For example, Barcelona has a dry  
443 climate, with mild and wet winters, relatively warm and dry summers, and generally with long periods of  
444 sunshine throughout most of the years (Rodríguez Algeciras & Matzarakis, 2016). Long periods of sunshine  
445 could improve the possibility to use the green urban space, but at the same time, the hot temperature or the wet  
446 winters could discourage people to go outdoors to pass their leisure time,

447 Below there are the results discussed depending on the city. 4.2 Barcelona

448 Participants from Barcelona showed no statistically significant association between the ROS and “sport”,  
449 “meet family or friends” or “walking and play with children”. This can be related with the characteristics of  
450 the city itself. In fact, Barcelona was the largest city, and it is a densely built city (population density 1600  
451 inhabitants/km<sup>2</sup>). In addition, Barcelona is the least green city and has the longest distance from the most used  
452 green space for the citizens. Maybe for these reasons people prefer to meet family and friends or to do sport in  
453 other kinds of places, such as bars or non-natural open space, such as squares. In Barcelona the satisfaction  
454 with the quality and amount of the green space was lower than the other cities (Kruize et al., 2020). But at the  
455 same time, the restoration score showed a statistically significant association with the activities of “tranquility”  
456 and “personal relaxing”. This can be due to the fact that Barcelona is the busiest city, so people’s restoration  
457 could be really benefited from being able to escape from the busy Barcelona urban life. For this reason, green  
458 spaces in the city, even if they are not particularly appreciated, were used to relax and they significantly  
459 influence the restoration experience.

460 4.3 Doetinchem

461 Doetinchem was the smallest and greenest city (56000 inhabitants), with the best access to green space and,  
462 in addition, with the joint highest percentage of daily visits (37.8%, as Kaunas). Maybe for this wide/large  
463 exposure to green urban space, Doetinchem participants had the lowest score of restoration (11.22, SD 7.15).  
464 People from Doetinchem could have a greater habit to use and to see the green space and so they do not feel  
465 as restored as the participants from other cities after visiting this kind of environment. This could be fact that  
466 everyone had a quite high access to urban green space, and this could reduce the opportunity to see differences  
467 in restoration between people. In Doetinchem a statistically significant association was observed with the  
468 activity “sport” and “personal relaxing” carried out both “often” and “very often” This could mean that these  
469 two kinds of activities influence restoration scores, but only when they are done consistently. This is in  
470 accordance with Korpela et al. (2009), which reported that the physical activity and natural experiences were  
471 among the potential determinants of the restorative experiences ( Korpela & Ylén, 2009). Due to the bigger  
472 amount of green in the city, people could have more possibility to perform outdoor physical activity or to relax.

473 4.4 Kaunas

474 People from Kaunas reported the joint highest percentage of daily visits to green urban space (37.8%, as  
475 Doetinchem). This could be linked to the higher sensitivity of the residents of most Northern countries: they  
476 usually paid more attention to community parks and to increase awareness to people to use them (Chen et al.,  
477 2020). For example, in Denmark a nationwide survey suggested that 43.0% of adults visit green space every  
478 day and 91.5% of them visit green space at least once a week (Schipperijn et al., 2010).

#### 479 4.5 Stoke-on-Trent

480 People from Stoke-on-Trent had the lowest percentage (14.6%) of daily visits, and they also visited green  
481 space further away in the city and outside the city less frequently than people from the other cities. At the same  
482 time, people from this city have the highest restoration score (20.19, SD 8.74). Apparently, people who visit  
483 green spaces more frequently for activities get notable restoration benefit compared with those who do not.  
484 However, people from Stoke-on-Trent could have a bigger passive or today exposure through which they could  
485 get restoration benefits. This is in line with the results of the combined sample.

#### 486 4.6 Stratification for mental health

487 Mental health was used as a modifier of the relationship between the restoration and the type of activity  
488 carried out in the green urban spaces. Several studies showed beneficial association between the natural  
489 outdoor environment exposure and mental health (Astell-Burt et al., 2014; Carter & Horwitz, 2014; de Vries  
490 et al., 2013; McEachan et al., 2016; van Dillen et al., 2012). They found that population mental health could  
491 benefit from environmental interventions aiming to increase public contact with natural environment  
492 (Triguero-Mas et al., 2017). A study found that the use of green space generates mental health benefits  
493 regardless of the level of intensity, duration or type of the green activity undertaken (Pretty et al., 2007). This  
494 could be an important aspect, and it could be in line with the results of the present study. In fact, looking at the  
495 stratification for the mental health score, there were some differences between people with a better and a poorer  
496 mental health. People with poorer mental health showed more statistically significant association and for more  
497 frequency indicators between the kind of activity done in the green urban space and the restoration score. In  
498 the combined sample all the kinds of activity presented statistically significant and a positive coefficients.  
499 Participants with poorer mental health from the different cities showed some differences in the relationship  
500 between the kind of activities and the ROS, but they presented a similar trend. In general, people with poorer  
501 mental health showed more significant associations and for more activity than people with good mental health.  
502 The combined sample showed no significant association for two kinds of activity (sports and walk and play  
503 with children) encouraging the idea that it does not matter the activity that people done in green spaces, but  
504 the important thing is their use. Regarding these results, it seems that every kind of activity done by people  
505 with poorer mental health influences the score of restoration. It could mean that people with poorer mental  
506 health were more sensitive to the effects of using the green urban space and so they could be more sensitive  
507 also to the feeling of restoration after visiting a green urban space. Several studies have found positive effects  
508 of green prescription, in which health professional carried out different types of activities in forest or other  
509 kind of natural environment, to help people with mental health problems or psychiatric disorder (Nordh et al.,  
510 2009; Pretty et al., 2007; Sahlin et al., 2015). It seems that more mentally fragile subjects could have more  
511 beneficial effects due to the contact with green urban space or natural environment. A possible explanation of  
512 this result could be link to the rumination (Bratman et al., 2015). Rumination could be define as a prolonged  
513 and often maladaptive attentional focus on the cause and consequences of emotions, most often negative  
514 emotion (Nolen-Hoeksema, 1991). It has been shown that rumination predict the onset of depressive episodes,  
515 as well as other mental disorders (Nolen-Hoeksema, 1991, 2000). On the contrary, positive or neutral  
516 distraction has been shown to decrease rumination if the distraction is engrossing to maintain the shift of  
517 attention into the distracting stimuli (Nolen-Hoeksema et al., 2008). So, it could be that people with better  
518 mental health have the tendency to have less rumination than people with poorer mental health. Or also, people  
519 with better mental health could have a more immediate effect when they visit green urban space, and for this  
520 reason they need less time in this type of environment.

521 5. These aspects are not so clear, even because usually the population with mental health problems  
522 disorders or problems were analyzed. Instead, the sample of the present study had generally a medium  
523 level of mental health. Further studies to understand better this relationship are needed. Conclusion

524 We found a statistically significant association between restoration and the activities linked to the social  
525 cohesion (as “picnic”) and the reduction of stress (as “personal relaxation”) in the combined sample. In  
526 addition, we found statistically significant differences between the four cities. The four cities showed different  
527 frequencies of statistically significant association, but they had the same trend. In fact, in all the cities people  
528 with poorer mental health showed more statistically significant associations with the kind of activity performed  
529 in the green urban space; they seem to be more sensitive to the positive effect of visiting the green environment.  
530 On the contrary, people with better mental health seem to be less influenced by the visiting of green urban  
531 space, maybe due to their mental health situation. Therefore, the green prescription will be important for all  
532 the people, especially those with poorer mental health. Green prescription means have advice from health  
533 professional to be more active, and improve diet, which is strongly linked to nature-based activities, such as  
534 local walking for health scheme, community gardening, and food-growing projects. In addition, this type of  
535 activities could also carry out in forest or other kind of natural environment, and they are important for the  
536 psychological treatments, as an alternative or a supplement medical treatment of mental health problems or  
537 psychiatric disorder. At the same time, people with better mental health have to continue to use this kind of  
538 environment in order to protect their well-being. Overall, these analyses support the evidence that green urban  
539 spaces have an important influence in the creation and in the maintenance of mental health.

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Table 1. Description of the sociodemographic characteristics of the participants in a cross-sectional sample of 3134 adults in four European cities and divided by the four cities.

	Combined sample	Barcelona	Doetinchem	Kaunas	Stoke-on-Trent	P value
N	3134	848	833	739	714	
Age (years: median, IQR)	52 [16]	44 [16]	56 [12]	61 [13]	45 [16]	<0.001
<b>Gender</b>						<0.001
Male N (%)	1406(44.86)	399(47.05)	360(43.22)	290(39.24)	357 (50.00)	
Female N (%)	1728(55.14)	449(52.95)	473(56.78)	449(60.76)	357 (50.00)	
<i>Missing N</i>	0	0	0	0	0	
<b>Education level</b>						<0.001
Low N (%)	174(5.58)	118(13.96)	8(0.96)	12(1.62)	36 (5.14)	
Medium N (%)	1354(43.44)	327(38.70)	394(47.36)	195(26.39)	438(62.48)	
High N (%)	1589(50.98)	400(47.34)	430(51.68)	532(71.99)	227(32.38)	
<i>Missing N</i>	17	3	1	0	13	
<b>Income</b>						<0.001
Low N (%)	959(30.60)	300(35.38)	262(31.45)	180(24.36)	217(30.39)	
Medium N (%)	1192(38.03)	277(32.67)	326(39.14)	348(47.09)	241(33.75)	
High N (%)	983(31.37)	271(31.96)	245(29.41)	211(28.55)	256(35.85)	
<i>Missing N</i>	0	0	0	0	0	
<b>Money situation</b>						<0.001
Cannot make ends meet N (%)	306(10.39)	100(12.30)	141(17.11)	31(4.69)	34(5.26)	
Have enough to get along N (%)	1431(48.59)	417(51.29)	254(30.83)	478(72.31)	282(43.59)	
Comfortable N (%)	1208(41.02)	296(36.41)	429(52.06)	152(23.00)	331(51.16)	
<i>Missing N</i>	189	35	9	78	67	
<b>Family composition</b>						<0.001
Alone N (%)	507(16.24)	58(6.87)	189(22.69)	131(17.77)	129(18.22)	
With partner without children N (%)	1081(34.63)	202(23.93)	379(45.50)	291(39.48)	209(29.52)	
With children younger than 12 years N (%)	507(16.24)	172(20.38)	125(15.01)	37(5.02)	173(24.44)	
With children older than 12 years N (%)	515(16.50)	109(12.91)	126(15.13)	161(21.85)	119(16.81)	
Other N (%)	512(16.40)	303(35.90)	14(1.68)	117(15.88)	78(11.02)	
<i>Missing N</i>	12	4	0	2	6	

Marital status						<0.001
Married/registered together N (%)	2022(64.93)	536(63.81)	544(65.38)	497(67.25)	445(63.30)	
Living apart together N (%)	151(4.85)	18(2.14)	71(8.53)	25(3.38)	37(5.26)	
Divorced/separated N (%)	941(30.22)	286(34.05)	217(26.08)	217(29.36)	221(31.44)	
<i>Missing N</i>	20	8	1	0	11	

P-value refers to one way ANOVA for the age variable and refers to chi-squared test for the other variables.

Table 2. Descriptive characteristics in a cross-sectional sample of 3134 adults in four European cities and divided by the four cities for the functionality of the place, the length of stay, the frequency of the visits, and the kind of activity. People were asked to think and answer questions about the green space they most used and visited. The quality and functionality of the green space were calculated using the question about the appeal of the place (seven items evaluated from 1 to 5), and about the importance of the presence of some features (seven items evaluated from 1 to 5).

	Combined sample	Barcelona	Doetinchem	Kaunas	Stoke-on-Trent	P value
N	3134	848	833	739	714	
Quality of the place	32.02±4.92	30.79±5.46	33.91±4.01	30.90±4.97	32.50±4.35	<0.001
<i>Missing N</i>	46	7	25	0	14	
Functionality of the place	12.07±2.04	11.91±2.26	12.55±1.82	11.84±2.04	11.99±1.94	<0.001
<i>Missing N</i>	45	8	20	0	17	
Length of stay						<0.001
Less than 10 minutes N (%)	83(2.65)	29(3.42)	28(3.36)	9(1.22)	17(2.39)	
11 to 30 minutes N (%)	356(11.37)	83(9.80)	136(16.33)	58(7.85)	79(11.10)	
30 minutes to 1 hour N (%)	816(26.06)	194(22.90)	267(32.05)	173(23.41)	182(25.56)	
1 to 2 hours N (%)	1216(38.84)	372(43.92)	294(35.29)	232(31.39)	318(44.66)	
2 hours or more N (%)	660(21.08)	169(19.95)	108(12.97)	267(36.13)	116(16.29)	
<i>Missing N</i>	3	1	0	0	2	
Frequency of visits						<0.001
Seldom or never N (%)	19(0.61)	-	-	19(2.57)	-	
Once per month N (%)	334(10.68)	82(9.70)	89(10.68)	73(9.88)	90(12.68)	
2-3 time a month N (%)	611(19.54)	148(17.51)	172(20.65)	149(20.16)	142(20.00)	
Once per week N (%)	569(18.20)	156(18.46)	145(17.41)	150(20.30)	118(16.62)	
2-3 time per week N (%)	900(28.78)	239(28.28)	242(29.05)	200(27.06)	219(30.85)	
Every day N (%)	694(22.19)	220(26.04)	185(22.21)	148(20.03)	141(19.86)	

<i>Missing N (%)</i>	7	3	0	0	4	
<b>Sport</b>						<0.001
Never N (%)	252(8.04)	120(14.15)	11(1.32)	39(5.28)	82(11.48)	
Seldom N (%)	183(5.84)	51(6.01)	15(1.80)	73(9.88)	44(6.16)	
Sometimes N (%)	604(19.27)	143(16.86)	57(6.84)	212(28.69)	192(26.89)	
Often N (%)	1203(38.39)	283(33.37)	394(47.30)	292(39.51)	234(32.77)	
Very often N (%)	892(28.46)	251(29.60)	356(42.74)	123(16.64)	162(22.69)	
<i>Missing N</i>	0	0	0	0	0	
<b>Picnic</b>						<0.001
Never N (%)	2002(63.88)	660(77.83)	653(78.39)	196(26.52)	493(69.05)	
Seldom N (%)	443(14.14)	89(10.50)	94(11.28)	176(23.82)	84(11.76)	
Sometimes N (%)	451(14.39)	67(7.90)	56(6.73)	231(31.26)	84(11.76)	
Often N (%)	165(5.23)	18(2.12)	19(2.28)	95(12.86)	33(4.62)	
Very often N (%)	73(2.33)	14(1.65)	11(1.32)	41(5.55)	7(0.98)	
<i>Missing N</i>	0	0	0	0	0	
<b>Meet family/friends</b>						<0.001
Never N (%)	1059(33.79)	230(27.12)	435(52.22)	81(10.96)	313(43.84)	
Seldom N (%)	474(15.12)	89(10.50)	128(15.37)	160(21.65)	97(13.59)	
Sometimes N (%)	870(27.76)	219(25.83)	148(17.77)	301(40.73)	202(28.29)	
Often N (%)	520(16.59)	210(24.76)	94(11.28)	137(18.54)	79(11.06)	
Very often N (%)	211(6.73)	100(11.79)	28(3.36)	60(8.12)	23(3.22)	
<i>Missing N</i>	0	0	0	0	0	
<b>Walk or play with children</b>						<0.001
Never N (%)	987(31.49)	292(34.43)	307(36.85)	140(18.94)	248(34.73)	
Seldom N (%)	343(10.94)	84(9.91)	93(11.16)	118(15.97)	48(6.72)	
Sometimes N (%)	729(23.26)	145(17.10)	162(19.45)	243(32.88)	179(25.07)	
Often N (%)	687(21.92)	190(22.41)	167(20.05)	171(23.14)	159(22.27)	
Very often N (%)	388(12.38)	137(16.16)	104(12.48)	67(9.07)	80(11.20)	
<i>Missing N</i>	0	0	0	0	0	
<b>Tranquillity</b>						<0.001
Never N (%)	365(11.65)	103(12.15)	52(6.24)	28(3.79)	182(25.49)	
Seldom N (%)	266(8.49)	104(12.26)	48(5.76)	50(6.77)	64(8.96)	
Sometimes N (%)	798(25.46)	207(24.41)	137(16.45)	253(34.24)	201(28.15)	
Often N (%)	1102(35.16)	279(32.90)	345(41.42)	280(37.89)	198(27.73)	

Very often N (%)	603(19.24)	155(18.28)	251(30.13)	128(17.32)	69(9.66)
<i>Missing N</i>	0	0	0	0	0
Personal relaxing					
Never N (%)	844(26.93)	121(14.27)	333(39.98)	81(10.96)	309(43.28)
Seldom N (%)	442(14.10)	109(12.85)	143(17.17)	105(14.21)	85(11.90)
Sometimes N (%)	760(24.25)	217(25.59)	132(15.85)	254(34.37)	157(21.99)
Often N (%)	740(23.61)	246(29.01)	134(16.09)	226(30.58)	134(18.77)
Very often N (%)	348(11.10)	155(18.28)	91(10.92)	73(9.88)	29(4.06)
<i>Missing N</i>	0	0	0	0	0

P-value refers to the chi-squared test.

Table 3. Restoration outcome score (5 lowest score, 45 highest score), calculated using the nine items included in the scale proposed by Korpela & Ylén, 2009, and the mental health score, calculate with the Medical Outcome Study Short Form (SF-36) mental health subscale (0 lowest score, 100 highest score), in a cross-sectional sample of 3134 adults in four European cities and, divided by the four cities .

	Combined sample	Barcelona	Doetinchem	Kaunas	Stoke-on-Trent	P value
N	3134	848	833	739	714	
Restoration score (median, IQR)	17 [13]	18 [14]	11 [9]	18 [10]	21 [13]	<0.001
<i>Missing N (%)</i>	74	9	0	0	64	
Mental health (median, IQR)	76 [20]	72 [24]	84 [12]	72 [24]	76 [24]	<0.001
<i>Missing N (%)</i>	0	0	0	0	0	

P-value refers to the Kruskal-Wallis test

Table 4. Association between activities in green spaces and restoration outcome score in a cross-sectional sample of 3134 adults in four European cities. Negative values of the coefficient mean a negative association between the variables, the value of the coefficients is linked to

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	Combined sample		Barcelona		Doetinchem		Kaunas		Stoke-on-Trent	
Type of activity	$\beta$ (95%CI)	p	$\beta$ (95%CI)	p	$\beta$ (95%CI)	p	$\beta$ (95%CI)	p	$\beta$ (95%CI)	p
<i>Sport</i>										
Never										
Seldom	-0.29 (-2.00, 1.42)	0.737	-1.93 (-4.89, 1.03)	0.202	3.03 (-1.17, 7.22)	0.157	1.50 (-1.76, 4.74)	0.367	0.51 (-3.22, 4.25)	0.788
Sometimes	0.60 (-0.74, 1.93)	0.380	0.93 (-1.22, 3.09)	0.395	1.25 (-1.97, 4.47)	0.445	<b>2.99 (0.45, 5.53)</b>	<b>0.021</b>	-1.29 (-3.55, 0.98)	0.265
Often	1.19 (-0.10, 2.48)	0.071	1.66 (-0.19, 3.51)	0.079	<b>3.78 (1.03, 6.54)</b>	<b>0.007</b>	<b>3.48 (0.41, 6.56)</b>	<b>0.026</b>	-0.51 (-3.09, 2.07)	0.697
Very often	<b>2.29 (0.84, 3.74)</b>	<b>0.002</b>	2.27 (-0.23, 4.76)	0.079	<b>5.09 (2.30, 7.87)</b>	<b>&lt;0.001</b>	<b>5.77 (0.41, 6.56)</b>	<b>0.002</b>	0.35 (-2.25, 2.95)	0.792
<i>Picnic</i>										
Never										
Seldom	<b>1.74 (1.06, 2.41)</b>	<b>&lt;0.001</b>	<b>1.92 (0.52, 3.01)</b>	<b>0.007</b>	<b>1.80 (0.62, 2.97)</b>	<b>0.003</b>	<b>2.06 (0.71, 3.40)</b>	<b>0.003</b>	0.77 (-0.77, 2.30)	0.328
Sometimes	<b>3.02 (2.26, 3.77)</b>	<b>&lt;0.001</b>	1.90 (-0.07, 3.87)	0.058	1.70 (-0.41, 3.81)	0.115	<b>4.27 (3.18, 5.36)</b>	<b>&lt;0.001</b>	<b>1.69 (0.10, 3.27)</b>	<b>0.037</b>
Often	<b>2.96 (1.96, 3.97)</b>	<b>&lt;0.001</b>	<b>4.40 (2.24, 6.56)</b>	<b>&lt;0.001</b>	1.79 (-0.43, 3.81)	0.114	<b>3.73 (2.05, 5.41)</b>	<b>&lt;0.001</b>	1.49 (-1.22, 4.19)	0.281
Very often	<b>7.25 (5.16, 9.33)</b>	<b>&lt;0.001</b>	2.23 (-1.99, 6.45)	0.300	<b>3.78 (1.42, 6.13)</b>	<b>0.002</b>	<b>11.02 (8.65, 13.39)</b>	<b>&lt;0.001</b>	<b>5.51 (0.61, 10.41)</b>	<b>0.028</b>
<i>Meet family or friends</i>										
Never										
Seldom	<b>1.61 (0.78, 2.44)</b>	<b>&lt;0.001</b>	1.98 (0.04, 3.92)	0.046	<b>1.81 (0.69, 2.93)</b>	<b>0.002</b>	1.39 (-0.50, 3.28)	0.049	<b>2.45 (0.53, 4.37)</b>	<b>0.012</b>
Sometimes	<b>1.85 (1.11, 2.59)</b>	<b>&lt;0.001</b>	1.00 (-0.63, 2.64)	0.229	1.02 (-0.10, 2.05)	0.052	<b>3.44 (1.52, 5.37)</b>	<b>&lt;0.001</b>	<b>1.92 (0.17, 3.68)</b>	<b>0.032</b>
Often	<b>2.61 (1.52, 3.70)</b>	<b>&lt;0.001</b>	0.91 (-1.39, 3.22)	0.438	0.87 (-0.67, 2.42)	0.268	<b>5.44 (3.14, 7.75)</b>	<b>&lt;0.001</b>	<b>3.50 (1.38, 5.63)</b>	<b>0.001</b>
Very often	<b>4.40 (2.77, 6.04)</b>	<b>&lt;0.001</b>	1.87 (-0.56, 4.30)	0.112	1.37 (-1.36, 4.09)	0.326	<b>9.00 (5.57, 12.43)</b>	<b>&lt;0.001</b>	<b>5.27 (1.09, 9.44)</b>	<b>0.013</b>
<i>Walk and play with children</i>										
Never										
Seldom	0.47 (-0.51, 1.44)	0.348	1.56 (-0.13, 3.26)	0.081	1.02 (-0.33, 2.38)	0.140	-0.07 (-2.33, 2.19)	0.950	-1.04 (-4.20, 2.13)	0.521
Sometimes	0.75 (0.05, 1.45)	0.050	0.95 (-0.22, 2.12)	0.112	<b>1.44 (0.46, 2.43)</b>	<b>0.004</b>	<b>1.77 (0.13, 3.42)</b>	<b>0.034</b>	<b>-2.38 (-4.29, -0.47)</b>	<b>0.015</b>

Often	0.70 (-0.13, 1.54)	0.100	1.31 (-0.52, 3.28)	0.160	0.42 (-0.67, 1.52)	0.450	1.64 (-0.27, 3.54)	0.092	-1.35 (-3.10, 0.40)	0.130
Very often	0.92 (-0.30, 2.13)	0.140	0.20 (-2.42, 2.81)	0.883	0.93 (-0.52, 2.38)	0.207	<b>4.02 (1.25, 6.79)</b>	<b>0.004</b>	-0.40 (-2.77, 1.98)	0.742
<i>Tranquility</i>										
Never										
Seldom	-0.28 (-1.53, 0.97)	0.660	0.78 (-1.26, 2.81)	0.434	0.87 (-1.46, 3.20)	0.464	-0.96 (-4.08, 2.17)	0.550	-1.49 (-4.45, 1.47)	0.324
Sometimes	<b>2.02 (0.94, 3.09)</b>	<b>&lt;0.001</b>	<b>2.37 (0.51, 4.23)</b>	<b>0.013</b>	<b>1.81 (0.05, 3.56)</b>	<b>0.044</b>	0.79 (-2.09, 3.67)	0.591	<b>2.39 (0.30, 4.49)</b>	<b>0.025</b>
Often	<b>3.60 (2.35, 4.85)</b>	<b>&lt;0.001</b>	<b>5.10 (3.04, 7.15)</b>	<b>&lt;0.001</b>	<b>4.27 (2.56, 5.98)</b>	<b>&lt;0.001</b>	1.52 (-2.15, 5.20)	0.417	<b>3.25 (0.82, 5.68)</b>	<b>0.009</b>
Very often	<b>5.12 (3.66, 6.57)</b>	<b>&lt;0.001</b>	<b>7.73 (4.96, 10.49)</b>	<b>&lt;0.001</b>	<b>4.52 (2.41, 6.63)</b>	<b>&lt;0.001</b>	<b>4.64 (1.36, 7.93)</b>	<b>0.006</b>	<b>4.54 (1.25, 7.83)</b>	<b>0.007</b>
<i>Personal relaxing</i>										
Never										
Seldom	0.71 (-0.14, 1.55)	0.100	<b>2.19 (0.35, 4.02)</b>	<b>0.019</b>	0.19 (-1.07, 1.50)	0.764	1.56 (-0.75, 3.87)	0.185	-0.22 (-2.01, 1.58)	0.814
Sometimes	<b>1.84 (1.13, 2.55)</b>	<b>&lt;0.001</b>	<b>2.45 (0.90, 4.00)</b>	<b>0.002</b>	0.41 (-0.52, 1.34)	0.387	<b>3.07 (1.11, 5.03)</b>	<b>0.002</b>	<b>2.22 (0.82, 3.62)</b>	<b>0.002</b>
Often	<b>3.38 (2.58, 4.18)</b>	<b>&lt;0.001</b>	<b>4.42 (2.52, 6.31)</b>	<b>&lt;0.001</b>	<b>1.94 (0.91, 2.97)</b>	<b>&lt;0.001</b>	<b>5.05 (3.01, 7.09)</b>	<b>&lt;0.001</b>	<b>2.95 (1.30, 4.60)</b>	<b>&lt;0.001</b>
Very often	<b>5.70 (4.49, 6.90)</b>	<b>&lt;0.001</b>	<b>5.95 (3.68, 8.21)</b>	<b>&lt;0.001</b>	<b>3.60 (1.97, 5.22)</b>	<b>&lt;0.001</b>	<b>9.74 (7.10, 12.38)</b>	<b>&lt;0.001</b>	<b>6.14 (3.24, 9.04)</b>	<b>&lt;0.001</b>

Model was adjusted by age, education, neighborhood SES, perceived income, household composition, marital status, with random intercept at neighborhood level.  
 $\beta$  =regression coefficient; CI=confidence interval.



Table 5. Association between activities in green spaces and restoration outcome score, stratified for the mental health score, in a cross-sectional sample of 3134 adults in four European cities

N	Poorer mental health $\leq 76$		Better mental health $> 76$	
	1452		1316	
Type of activity	$\beta$ (95%CI)	p	$\beta$ (95%CI)	p
<i>Sport</i>				
Never				
Seldom	0.76 (-0.83, 2.35)	0.347	-1.13 (-4.29, 2.04)	0.485
Sometimes	1.32 (-0.06, 2.70)	0.060	-0.41 (-3.05, 2.24)	0.764
Often	2.25 (0.92, 3.59)	<b>&lt;0.001</b>	0.46 (-2.17, 3.09)	0.733
Very often	3.90 (2.23, 5.56)	<b>&lt;0.001</b>	1.15 (-1.53, 3.84)	0.400
<i>Pic nic</i>				
Never				
Seldom	1.54 (0.61, 2.47)	<b>0.001</b>	1.78 (0.75, 2.80)	<b>&lt;0.001</b>
Sometimes	3.04 (2.01, 4.07)	<b>&lt;0.001</b>	2.54 (1.30, 3.79)	<b>&lt;0.001</b>
Often	3.31 (1.82, 4.79)	<b>&lt;0.001</b>	2.47 (0.64, 4.30)	<b>0.008</b>
Very often	8.36 (5.22, 11.51)	<b>&lt;0.001</b>	5.76 (3.53, 7.99)	<b>&lt;0.001</b>
<i>Meet family or friends</i>				
Never				
Seldom	1.50 (0.38, 2.62)	0.009	1.29 (-0.04, 2.61)	0.057
Sometimes	1.88 (0.88, 2.88)	<b>&lt;0.001</b>	1.37 (0.33, 2.41)	<b>0.010</b>
Often	2.87 (1.36, 4.37)	<b>&lt;0.001</b>	1.84 (0.45, 3.23)	<b>0.009</b>
Very often	5.42 (3.22, 7.62)	<b>&lt;0.001</b>	2.92 (0.88, 4.97)	<b>0.005</b>
<i>Walk and play with children</i>				
Never				
Seldom	1.74 (0.52, 2.97)	<b>0.005</b>	-1.11 (-2.53, 0.31)	0.126
Sometimes	1.75 (0.90, 2.61)	<b>&lt;0.001</b>	-0.61 (-1.72, 0.50)	0.284
Often	1.47 (0.28, 2.67)	<b>0.015</b>	-0.17 (-1.27, 0.93)	0.764
Very often	2.03 (0.20, 3.85)	<b>0.030</b>	-0.22 (-1.64, 1.21)	0.765
<i>Tranquility</i>				
Never				
Seldom	1.08 (-0.57, 2.72)	0.199	-1.45 (-3.46, 0.57)	0.159
Sometimes	3.03 (1.65, 4.42)	<b>&lt;0.001</b>	0.65 (-1.13, 2.44)	0.474
Often	4.57 (3.02, 6.12)	<b>&lt;0.001</b>	2.94 (1.27, 4.62)	<b>0.001</b>
Very often	6.84 (4.91, 8.78)	<b>&lt;0.001</b>	4.21 (2.31, 6.11)	<b>&lt;0.001</b>
<i>Personal relaxing</i>				
Never				
Seldom	0.74 (-0.39, 1.88)	0.199	0.81 (-0.50, 2.11)	0.225
Sometimes	2.19 (1.08, 3.29)	<b>&lt;0.001</b>	1.10 (0.09, 0.73)	<b>0.033</b>
Often	3.60 (2.29, 4.91)	<b>&lt;0.001</b>	3.09 (2.00, 4.18)	<b>&lt;0.001</b>
Very often	6.72 (4.88, 8.56)	<b>&lt;0.001</b>	5.00 (3.55, 6.46)	<b>&lt;0.001</b>

Model was adjusted by city, age, sex, education, neighborhood SES, perceived income, household composition, marital status, with random intercept at neighborhood level.  $\beta$ =regression coefficient; CI= confidence interval.

## Highlights

- Restoration theory is based on the idea that is possible to improve mental health and decrease by stress visiting a natural environment
- The study aimed to understand the relationship between the type of activities, and restoration, according to the mental health status, in four European cities
- if there is a type of activity most related to restoration and if these activities were the same according to mental health, in four European cities
- The association between restoration and the type of activity done in green space had a similar trend in the four cities
- Visiting green spaces influenced more people with poorer mental health than people with better mental health
- Green prescription is important for the entire population to improve and protect their mental health, and well-being

**Declaration of interests**

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.

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

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