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Research Paper

# Impact of a riverside accessibility intervention on use, physical activity, and wellbeing: A mixed methods pre-post evaluation

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A B S T R A C T

*Introduction:* Access to natural outdoor environments can promote physical activity, social cohesion, and improved psychological well-being. In 2016, an urban riverside regeneration project to facilitate access to the riverbank for pedestrians and cyclists was conducted in Barcelona (Spain). We aim to evaluate its effect in terms of changes in use and physical activity of users, and changes in local's use and perception of the urban riverside, and their corresponding self-perceived health and well-being.

*Methods:* We conducted systematic observations, before and after the intervention, using the System for Observing Parks and Recreation in Communities (SOPARC) to quantify the use and physical activity levels of users and compared them over time. Qualitative assessment consisted of semi-structured face-to-face interviews with the locals.

*Results:* We observed a 25% increase in users of the renovated area of the river after the intervention. There was an increase in sedentary users and those engaged in moderate levels of physical activity [7.7% vs. 12.0% sedentary users, and 66.9% vs. 68.7% moderately active users before and after the intervention respectively, $p < 0.001$]. The growth of users in the renovated area was mainly driven by females, adults, children, and the non-Caucasian population. Resident interviewees, in general, reported to be happy to live near the river, where they usually go for a stroll, and thought living near the riverside area might benefit their health and well-being. Overall, residents seemed satisfied with the intervention.

*Conclusions:* Nature-based interventions in socioeconomically-deprived neighbourhoods might reduce inequalities in access to natural areas, creating attractive destinations for residents, promoting physical activity and/or creating opportunities for social interactions, and improving their health and well-being.

## 1. Introduction

Urban planning plays an important role in the promotion of human health and well-being (Sarkar & Webster, 2017). Urban design might influence human behaviour in terms of physical activity and social cohesion, which are both determinants of physical and mental health and well-being (Chuang, Chuang, & Yang, 2013; Nieuwenhuijsen, 2018; De Vries, Van Dillen, Groenewegen, & Spreeuwenberg, 2013). Regular physical activity is positively associated with the prevention and treatment of non-communicable diseases like obesity, diabetes, cancer, cardiovascular diseases (CVD), as well as improved mental health and well-being (National Institute for Health and Clinical Excellence, 2012; World Health Organization, 2018). Physical inactivity is a risk factor for mortality and is linked with many non-communicable diseases (Lee, Shiroma, Lobelo, & Puska, 2012). Despite the overwhelming evidence of the benefits of physical activity on health, in high-income countries 26% of men and 35% of women were insufficiently physically active in 2010 (World Health Organization, 2019) and this trend has remained stable over time (Guthold, Stevens, Riley, & Bull, 2018).

Green spaces are considered to be open surfaces with vegetation such as parks or gardens (WHO Regional Office for Europe, 2016), while blue spaces are considered "outdoor environments – either natural or manmade – that prominently feature water and are accessible to humans" (Grellier et al., 2017). There is evidence suggesting that access to these natural outdoor environments promotes physical activity, social cohesion, and improved psychological well-being (Gascon, Zijlema, Vert, White, & Nieuwenhuijsen, 2017; Nieuwenhuijsen, Khreis, Triguero-Mas, Gascon, & Dadvand, 2017). However, cities do not always have sufficient, accessible natural outdoor environments for the population (Nieuwenhuijsen et al., 2018). Given the health benefits

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associated with access to these environments, urban planners and policy makers should ensure that all the population have access to them to facilitate regular physical activity, promote social cohesion, and reduce stress (World Health Organization, 2018).

One way of achieving this is through the regeneration of natural urban areas. In this sense, a growing body of studies have been assessing the health benefits of a variety of urban regeneration projects (Hunter et al., 2015; Kramer, Lakerveld, Stronks, & Kunst, 2017; Macmillan et al., 2018; Moore et al., 2018; Stappers, Van Kann, Ettema, De Vries, & Kremers, 2018). A recent review of the impacts and effectiveness of urban green space interventions and health reveals that there is still inconclusive evidence on the effectiveness of some urban green space interventions (World Health Organization, 2017). However, the same review acknowledges the powerful opportunities for public health improvements that these interventions might bring, given their capacity of providing environmental, social, and health benefits (World Health Organization, 2017). Nature-based interventions might bring benefits for all the population, especially among lower socioeconomic status groups (World Health Organization, 2017). This is particularly important given that socioeconomically-deprived populations tend to have worse health than their wealthier counterparts (Ball, 2015; Beenackers et al., 2012).

Systematic evaluations of urban regeneration projects are key in providing professionals (e.g. urban planners, parks planners, housing development professionals, public health professionals, or medical practitioners) and policy makers with reliable information to properly design, implement, and maintain nature-based interventions, or to improve those that are already part of our cities, considering the health perspective and maximizing health benefits. The aims of the present study are (1) to quantitatively evaluate the impact of an urban riverside regeneration project in a socioeconomically-deprived neighbourhood in terms of changes in: i) use of the area and, ii) physical activity among users over time; and (2) to assess the local community's use and perception of the urban riverside and its surroundings before and after the intervention, as well as their self-perceived health and well-being, through a qualitative assessment.

## 2. Methods

### 2.1. The intervention: an urban riverside regeneration project in the Besòs river

In August 2016, the Barcelona Metropolitan Area, a public administration responsible of social and environmental policies in the metropolitan territory of Barcelona, started an intervention (Farrero et al., 2015) to regenerate a section of *Parc Fluvial del Besòs* (Besòs Riverside Park), located in the northeast of Barcelona (Catalonia, Spain) (Fig. 1A). The section of the riverbank affected by this intervention was between "La Ribera" neighbourhood and a water treatment plant (right and left side of the river downstream, respectively) (Fig. 1B). "La Ribera" neighbourhood is in Montcada i Reixac, a city in the Barcelona metropolitan area with 35,599 inhabitants (Idescat, 2018). As with other parts of the city, the creation of this neighbourhood was the result of a quick expansion of the city in the 60 s and 70 s to accommodate immigration from Southern Spain. Currently, it is characterized by a high proportion of migrants of different nationalities (38.2%), with Moroccan and Pakistani constituting the largest percentage (March & Batllet, 2015). The urban riverside regeneration project aimed to provide access to the riverbank to promote its use and enjoyment by the population. The intervention affected 735 m along the right side of the river downstream, and a total surface area of approximately 52.619 $m^2$. It included the construction of two paved walkways: one on the lower part of the river, and another one on the upper part (Fig. 2A). Moreover, four new access points to the riverbank were provided: two wheelchair-accessible ramps and two sets of stairs connecting the upper and the lower parts of the river (Fig. 2B) (Farrero et al., 2015). Before the intervention, the lower and the upper parts of the river were not connected as there was no access to the riverbank.

### 2.2. Pre/post-intervention evaluation

We conducted a mixed-methods pre/post-intervention evaluation to assess the number of users in the study area, their physical activity level, and the local community's use and perception of the new intervention over time. We followed the same procedure, described below, for both the pre- and post-evaluation.

#### 2.2.1. Systematic observations of riverside users

We employed the System for Observing Parks and Recreation in Communities (SOPARC) (Mckenzie & Cohen, 2006) to conduct systematic observations which quantified the number of users and their socio-demographic characteristics and current physical activity levels. The reliability and feasibility of the SOPARC tool has been shown previously (McKenzie, Cohen, Sehgal, Williamson, & Golinelli, 2006), and it is widely used in similar studies (Cohen et al., 2014, 2015, 2011; Evenson, Jones, Holliday, Cohen, & Mckenzie, 2017; King, Litt, Hale, Burniece, & Ross, 2015; Van Hecke et al., 2017). For this study, four researchers were trained using the SOPARC protocol and training videos, whose methodology has been adapted for this study (Mckenzie & Cohen, 2006).

We divided the study area into two target areas: i) the renovated area, on the right side of the river downstream, where "La Ribera" neighbourhood is located, and; ii) the non-renovated area, on the left side of the river, next to the water treatment plant. Target areas were sub-divided into two locations: i) the lower part, at the riverbank level; and ii) the upper part, above the riverbank level (Fig. 1B). The observations were conducted in November-December 2016 (pre-evaluation: during the implementation of the intervention, although this did not affect normal use of the area) and then again in November 2017 (post-evaluation: when the intervention was finished). Observations were conducted in 13 one-hour sessions for each period of evaluation (i.e. pre and post) in largely comparable timeframes (Fig. S1 – Supplementary Material). Sessions were spread across weekdays and weekend days, and between different time slots: 5 sessions in the morning (8:30–9:30 h), 5 sessions in the midday (11:30–12:30 h), and 3 sessions in the afternoon (16:30–17:30 h) (Fig. S1 – Supplementary Material). Each one-hour session included 6 observation periods of 7 min each, with breaks of 3 min in between. Observations were performed from a predefined position (on each side of the river), allowing the visibility of the whole study area (Fig. 1). Observers worked in pairs (two observers per position) visually scanning from left to right within the defined area to document the following characteristics of each observed user: location (upper or lower), perceived gender (female or male), perceived age group (child = 0–12 years old; teenager = 13–20 years old; adults = 21–59 years old; or seniors ≥ 60 years old), perceived ethnicity [Caucasian – i.e. white-skinned, of European origin –, Latin-American, Black, Asian, North African, or other (these are the predominant ethnic groups in the study area)], and activity level (sedentary = lying down, sitting or standing; moderate (walking) = walking at a casual pace; or vigorous = any activity that expended more energy than casual walking). The type of activity (e.g. running, cycling, skating, etc.) was only specified for vigorous physical activity (Fig. S2 – Supplementary Material). Temperature and weather conditions were also reported for each session. Observations were not conducted on rainy days but were rescheduled for another day.

#### 2.2.2. Physical activity assessment

To assess the energy expended by the observed users, for each target area, period of evaluation, and location (i.e. lower and upper part of the river) we summed the total number of sedentary, moderate, and vigorous users and we multiplied it by the respective Metabolic Equivalent

A) Location of the section of the Besòs Riverside Park affected by the urban riverside regeneration project (Farrero i Compte et al. 2015).


B) Renovated (pink) and non-renovated (yellow) area of the Besòs Riverside Park. Dark and light colours indicate the upper and lower location of the area, respectively. The intervention (i.e. paved walkway, ramps, and stairs) is marked in blue. Red dots indicate the position at which observers made their recordings (Adapted from the Map of Newnham Campus, Seneca College from: "Toronto, Ontario." Map, Google Maps. Accessed 23 Apr. 2014).

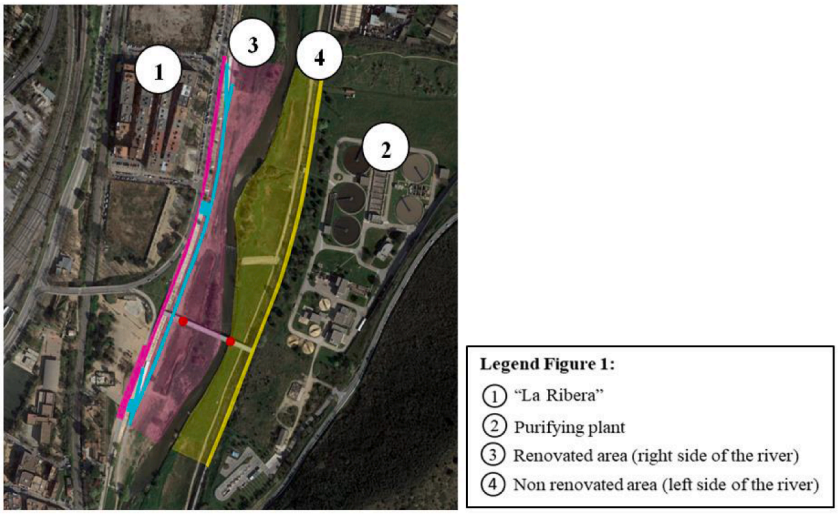


**Fig. 1.** Setting of the study area: A) Location of the section of the Besòs Riverside Park affected by the urban riverside regeneration project; B) Renovated and non-renovated area of the Besòs Riverside Park.

of Task (METs) for each category. For sedentary observations, corresponding to the specific activity "sitting quietly, general" of the compendium of physical activities developed by Ainsworth et al. (2011), we used a score of 1.3 METs; for moderate observations, corresponding to "walking for pleasure", we used a score of 3.5 METs; and for vigorous observations, corresponding to "bicycling, general", we used a score of 7.5 METs. We summed the respective values for each category and divided the total by the observed number of users in each assessment area; a convention used previously (Van Dyck et al., 2013; Van Hecke et al., 2017).

### 2.2.3. Interviews with the local community

We conducted semi-structured face-to-face interviews to assess the attitudes of the residents of "La Ribera" in relation to the natural environment around their neighbourhood, and particularly the Besòs Riverside Park and the urban riverside regeneration project. Interviews were also conducted to evaluate potential changes in self-perceived health and well-being of the local community over time. The interview content was based on in-depth semi-structured interview protocols developed by the PHENOTYPE project (http://www.phenotype.eu/en/) and was adapted to our study. It included questions on the use and perception of green and blue spaces and about the neighborhood, on how participants interact with these spaces, health and well-being status of the participants, physical activity behavior, and social interactions (Table S1 – Supplementary Material). For the pre-evaluation, study participants were recruited by contacting the municipality and

A) Right side of the Besòs Riverside Park (renovated area), before and after the urban riverside regeneration project [Photos taked by: Mireia Gascon in June 2016 (image A.1.) and Cristina Vert in November 2017 (image A.2.)].



B) Ramps and stands stairs, constructed on the right side of the Besòs Riverside Park (renovated area), to provide access to the riverbank (Photos taken by Cristina Vert, November 2017).

**Fig. 2.** Images of the renovated area of the Besòs Riverside Park: A) Renovated area of the Besòs Riverside Park, before and after the intervention; B) Provision of access to the riverbank.

organizing informative talks about the project. We also recruited participants in the neighbourhood streets, the local civic centre, and other relevant public spaces of "La Ribera" neighbourhood until theoretical saturation. This is a criterion for discontinuing data collection when more data do not provide more information related to the research question (Saunders et al., 2018). For the post-evaluation, the same participants were contacted by phone and researchers arranged a meeting with them to conduct the interview. All participants were 18 years old or older and resided in "La Ribera" neighbourhood. These interviews were mainly conducted on the street, but also in the civic centre, in a bar, or at the participant's residence. Interviews were conducted in Spanish or Catalan and were audio recorded. Information about the project was given to the participants, and before enrollment in the study all participants were asked to indicate their informed consent to participate. Participants did not receive any financial incentive for their participation in this study. All the methods were approved by the Clinical Research Ethics Committee of the Parc de Salut MAR.

Interviews were transcribed verbatim and coded using ATLAS.ti 7.5 computer-assisted qualitative data analysis software. We identified significant quotes in the transcriptions, and developed thematic codes (grouped in different categories and sub-categories). Codes were created inductively, based on the identification of relevant topics during the interview assessment. Interviews were separately coded and

compared by two different researchers to ensure consistency and reliability. If necessary, codes were merged, deleted, created, or renamed if both researchers agreed. Based on the grounded theory approach (Noble & Mitchell, 2016), we theorised about the main topics identified within the interviews and ended up with an explanatory statement summarizing the most relevant information extracted from the interviews. We used ATLAS.ti to count the frequency that codes were discussed before and after the intervention. We also assessed potential differences between genders, age groups, and ethnicities.

### 2.3. Data analysis

SOPARC observations were manually recorded on a paper form, entered into a Microsoft Excel database, and then imported into STATA version 14. We measured the degree of agreement between observers using the Intraclass Correlation Coefficient (ICC) (Hallgren, 2012). Then, for each day, time slot, and target area we randomly selected one of the two observations in order to avoid duplicates. If there were missing values for the selected observer, we replaced them with the values provided by the excluded partner observer. Otherwise, we coded missing observations as men, adults, Caucasian, and walking because these were the main characteristics of the study population. Observations were summarized by year and target area, and stratified by location, gender, age group, ethnicity, and activity level. We employed chi-square tests to compare categorical variables describing socio-demographic characteristics of the users before and after the intervention. We also assessed if the weather conditions and temperature significantly varied between assessment periods using chi-square tests and Student's *t*-test, respectively. Moreover, we have used multinomial logistic regression models to assess the effects of the urban riverside regeneration project (i.e. pre/post intervention) and the target area (i.e. renovated and non-renovated area) on the user's physical activity levels. We assessed effect modification using likelihood ratio test (LRT). We also assessed the influence of other covariates (i.e. gender, age, ethnicity, location, day of the week, and time slots). Our analysis was based on the methodological approach proposed by SOPARC (Mckenzie & Cohen, 2006).

## 3. Results

### 3.1. Agreement between observers and good reproducibility of the procedure

For each SOPARC evaluation session there were two observers assessing the same target area. Before assuming that missing values corresponded to adult Caucasian males walking, the overall ICC between observers was 0.996 (95% CI; 0.994, 0.998), showing the highest agreement for activity level [0.998 (95% CI; 0.997, 0.999)], and the lowest agreement for ethnicity [0.866 (95% CI; 0.806, 0.908)]. After replacing missing values, results were very similar (data not shown). For gender we replaced 0.7% missing values, 1.6% for age, 4.4% for ethnicity, and 0.3% missing values for activity level (data not shown). In any case, ICC values ranged from 0.866 to 0.999 indicating high agreement between observers and good reproducibility of the procedure.

### 3.2. Use of the urban riverside area

Following the completion of the urban riverside regeneration project, the total number of users in the whole Besòs riverside area slightly increased from 3478 to 3631 (Table 1). The number of users significantly increased in the renovated area (30.2% in 2016 vs. 36.1% in 2017, $p < 0.001$), while significantly decreased in the non-renovated area (69.8% in 2016 vs. 63.9% in 2017, $p < 0.001$]. More specifically, in the lower part (riverbank) of the renovated area, we observed a noticeable increase of users (1.7% in 2016 vs. 15.9% in 2017, $p < 0.001$), whereas in the upper part the number of users decreased (98.3% in 2016 vs. 84.1% in 2017, $p < 0.001$) (Table 1). However, the total number of users was higher in the non-renovated area both before and after the intervention compared to the renovated area (Table 1).

Overall, more males were observed in the riverside area than females, both before and after the intervention. However, after the intervention, we observed a 43% increase in females at the renovated area of the river while the number of females decreased 26% in the non-renovated area (Tables 1 & S2 – Supplementary Material). The pattern for males was the opposite (Tables 1 & S2 – Supplementary Material). When looking at both areas of the river, gender differences over time were not statistically significant ($p = 0.227$) (Table 1).

The most prevalent age group was adults (59.8% and 59.5% of the users in 2016 and 2017, respectively), followed by seniors (34.1% and 36.1% of the users in 2016 and 2017, respectively). Teenagers and children were underrepresented (i.e. from 6.1% in 2016 to 4.4% in 2017 of the total users), although the percentage of children in the renovated area significantly increased after the intervention (1.7% in 2016 vs. 4.0% in 2017, $p < 0.001$), whereas in the non-renovated area the percentage of children decreased (1.8% in 2016 vs. 1.2% in 2017, $p < 0.001$) (Tables 1 & S3 – Supplementary Material). To ensure that our results were not strongly influenced by the presence of a school group (N children = 23; N teenagers = 50) conducting an organized activity on the upper part of the non-renovated area during one session in the pre-evaluation, we conducted a sensitivity analysis excluding these users. Results were similar when compared to the full sample (Table S4 – Supplementary Material).

More than 90% of the users were coded as Caucasians. However, a significant increase of non-Caucasian users was observed in the renovated area after the intervention (2.6% of non-Caucasian users in 2016 vs. 7.8% in 2017, $p < 0.001$) (Table 1).

We observed 110 and 209 users with at least one dog in 2016 and 2017, respectively. These users were mainly Caucasians, adults or seniors, and predominantly males (data not shown). Although the intervention was designed to enable use by people of all physical abilities, we only observed 8 disabled users (6 in 2016 and 2 in 2017) during the whole study period (data not shown).

Finally, regarding the potential influence of temperature and weather conditions, the proportion of sunny days in 2016 was exactly the same as in 2017 (i.e. 61.5%) (data not shown). However, the mean temperature in 2016 was higher than in 2017 [12.8 °C (95% CI; 10.9, 14.6) in 2016 vs. 9.3 °C (95% CI; 6.0, 12.6) in 2017, $p = 0.056$]. And the minimum values reported in 2016 were also higher than in 2017 (6 °C and 2 °C, respectively). The maximum values were similar for both years (18 °C in 2016 and 19 °C in 2017) (data not shown).

### 3.3. Energy expenditure

On average, for the pre- and post-evaluation period and for both areas of the river, users were most often moderately (46.5%) or vigorously (47.0%) active, while a smaller proportion were sedentary (6.5%) (Table 1). The most predominant activity among vigorously active users in both study periods was cycling (84.5%) followed by running (11.7%). The rest of the vigorously active users practised other activities such as roller skating, skateboarding, or playing with a dog (data not shown). When pooling data from both sides of the river, the percentage of users engaging in sedentary, moderate, or vigorous levels of physical activity barely changed from 2016 to 2017 ($p = 0.447$) (Table 1). However, when we looked at each side of the river (i.e. renovated and non-renovated area), we observed a significant increase of users engaging in sedentary and moderate levels of physical activity in the renovated area (7.7% of sedentary users in 2016 vs. 12.0% in 2017; and 66.9% of moderately active users in 2016 vs. 68.7% in 2017, $p < 0.001$), and a significant increase of users engaging in vigorous levels of physical activity in the non-renovated area (56% in 2016 vs. 62.4% in 2017, $p < 0.001$) (Table 1). Thus, in the post-intervention evaluation period, the risk being sedentary and moderate compared

**Table 1**
Characteristics of the total number of users observed in Besòs Riverside Park by target area, for the pre and post-evaluation SOPARC assessment.

| | Renovated area | | | Non-renovated area | | | Both areas | | |
|---|---|---|---|---|---|---|---|---|---|
| | PRE (2016) N = 1049 | POST (2017) N = 1312 | p-value[b] | PRE (2016) N = 2429 | POST (2017) N = 2319 | p-value[b] | PRE (2016) N = 3478 | POST (2017) N = 3631 | p-value[b] |
| *Location [N, (%)]* | | | | | | | | | |
| Upper | 1031 (98.3) | 1103 (84.1) | 0.000 | 2072 (85.3) | 2047 (88.3) | 0.003 | 3103 (89.2) | 3150 (86.6) | 0.001 |
| Lower | 18 (1.7) | 209 (15.9) | | 357 (14.7) | 272 (11.7) | | 375 (10.8) | 481 (13.3) | |
| *Demographic characteristics of the users [N, (%)]* | | | | | | | | | |
| *Gender* | | | | | | | | | |
| Female | 282 (26.9) | 403 (30.7) | 0.041 | 484 (20.0) | 356 (15.4) | 0.000 | 768 (22.1) | 759 (20.9) | 0.227 |
| Male | 767 (73.1) | 909 (69.3) | | 1943 (80.0) | 1963 (84.7) | | 2710 (77.9) | 2872 (79.1) | |
| *Age group* | | | | | | | | | |
| Children [a] | 18 (1.7) | 52 (4.0) | 0.000 | 43 (1.8) | 27 (1.2) | 0.000 | 61 (1.8) | 79 (2.2) | 0.000 |
| Teens [a] | 71 (6.8) | 36 (2.7) | | 80 (3.3) | 42 (1.8) | | 151 (4.3) | 78 (2.2) | |
| Adults | 484 (46.1) | 734 (56.0) | | 1595 (65.7) | 1428 (61.6) | | 2079 (59.8) | 2162 (59.5) | |
| Seniors | 476 (45.4) | 490 (37.3) | | 711 (29.3) | 822 (35.4) | | 1187 (34.1) | 1312 (36.1) | |
| *Ethnicity* | | | | | | | | | |
| Caucasian | 1022 (97.4) | 1215 (92.6) | 0.000 | 2390 (98.4) | 2276 (98.1) | 0.147 | 3412 (98.1) | 3491 (96.1) | 0.000 |
| Latin-American | 9 (0.9) | 23 (1.8) | | 13 (0.5) | 4 (0.2) | | 22 (0.6) | 27 (0.7) | |
| Black | 2 (0.2) | 8 (0.6) | | 5 (0.2) | 5 (0.2) | | 7 (0.2) | 13 (0.4) | |
| Asian | 10 (0.9) | 26 (1.9) | | 8 (0.3) | 14 (0.6) | | 18 (0.5) | 40 (1.1) | |
| North-African | 6 (0.6) | 23 (1.8) | | 10 (0.4) | 16 (0.7) | | 16 (0.5) | 39 (1.1) | |
| Other | 0 (0.0) | 17 (1.3) | | 3 (0.1) | 4 (0.2) | | 3 (0.1) | 21 (0.6) | |
| *Physical activity level [N, (%)]* | | | | | | | | | |
| Sedentary | 81 (7.7) | 158 (12.0) | 0.000 | 130 (5.4) | 89 (3.8) | 0.000 | 211 (6.1) | 247 (6.8) | 0.447 |
| Moderate | 702 (66.9) | 901 (68.7) | | 928 (38.2) | 782 (33.7) | | 1630 (46.8) | 1683 (46.3) | |
| Vigorous | 266 (25.4) | 253 (19.3) | | 1371 (56.4) | 1448 (62.4) | | 1637 (47.1) | 1701 (46.9) | |

[a] During one sampling session in 2016, observers observed a group of scholars (N child = 23; N teen = 50) doing an organized academic activity along the study setting. We conducted a sensitivity analysis excluding these users (Table S4 – Supplementary Material).

[b] P-values based on Chi-squared tests to compare the distribution of sociodemographic characteristics of users between the pre (year 2016) and post (year 2017) intervention evaluation.

**Table 2**
Association [Relative Risk Ratio (RRR) 95% CI] between post intervention evaluation period (year 2017) – having the pre-intervention evaluation period (year 2016) as the reference – and covariates, with user's physical activity level [i.e. sedentary, moderate and vigorous (reference)], for the renovated and non-renovated area.

| | Renovated area Physical activity level (Reference = Vigorous) | | Non-renovated area Physical activity level (Reference = Vigorous) | |
|---|---|---|---|---|
| | Sedentary RRR (95% CI) | Moderate RRR (95% CI) | Sedentary RRR (95% CI) | Moderate RRR (95% CI) |
| POST (2017) [Reference = PRE (2016)] | 1.78 (1.26; 2.51)* | 1.25 (0.99; 1.57) * | 0.68 (0.49; 0.94) * | 0.67 (0.58; 0.78) * |
| *Covariates* | | | | |
| Females (Ref = males) | 2.73 (1.74; 4.29) * | 6.55 (4.68; 9.17) * | 8.23 (5.66; 11.96) * | 10.12 (8.19; 12.51) * |
| *Age group (Ref = adults)* | | | | |
| Children | 5.22 (2.23; 12.26) * | 1.57 (0.70; 3.55) | 41.84 (18.89; 92.65) * | 11.06 (5.70; 21.48) * |
| Teens | 0.78 (0.33; 1.83) | 1.18 (0.69; 2.01) | 19.95 (11.53; 34.51) * | 1.08 (0.61; 1.91) |
| Senior | 2.41 (1.66; 3.51) * | 4.80 (3.71; 6.22) * | 7.26 (5.03; 10.46) * | 8.30 (7.06; 9.75) * |
| Non-Caucasian (Ref = Caucasian) | 2.99 (1.44; 6.21) * | 2.19 (1.24; 3.88) * | 8.77 (3.55; 21.65) * | 6.17 (3.43; 11.08) * |
| Lower location (Ref = Upper location) | 4.14 (2.21; 7.77) * | 4.40 (2.62; 7.38) * | 0.33 (0.16; 0.67) * | 0.39 (0.30; 0.51) * |
| Weekend (Ref = weekday) | 0.48 (0.33; 0.70) * | 0.50 (0.39; 0.65) * | 0.27 (0.18; 0.40) * | 0.43 (0.37; 0.51) * |
| *Time of the day (Ref = midday)* | | | | |
| Morning | 0.18 (0.11; 0.30) * | 0.54 (0.42; 0.69) * | 0.11 (0.06; 0.21) * | 1.02 (0.86; 1.21) |
| Afternoon | 0.66 (0.40; 1.08) | 0.94 (0.65; 1.36) | 0.79 (0.54; 1.15) | 1.49 (1.20; 1.85) * |

RRR: Relative Risk Ratio.
Ref = Reference.
* Statistically significant ($p < 0.05$).

with vigorous was significantly higher for users in the renovated area (e.g. RRR for sedentary users = 1.78 (95% CI 1.26; 2.51)), and lower for those in the non-renovated (e.g. RRR for moderately active users = 0.67 (95% CI 0.58; 0.78)) (Table 2). Sedentary users in the renovated area mainly used the stairs to sit or lie on, although some users also sat on the benches, or leant against the fence, both in the upper and the lower part of the river (Fig. 2-A.2).

Even though in both areas of the river females and males were mainly moderately and vigorously active users respectively (Fig. S3 – Supplementary Material); in the post-intervention evaluation period sedentary use of the renovated area increased for both females and males (Fig. 3). Nevertheless, females had a significant higher risk being sedentary and moderately active both in the renovated and in the non-renovated area, compared with males (Table 2).

Of all the age groups identified in this study, children had the highest risk being sedentary (e.g. RRR for sedentary children in the renovated area = 5.22 (95% CI 2.23; 12.26)) in both areas of the river (Table 2). Despite this, the increase of moderately active users over time

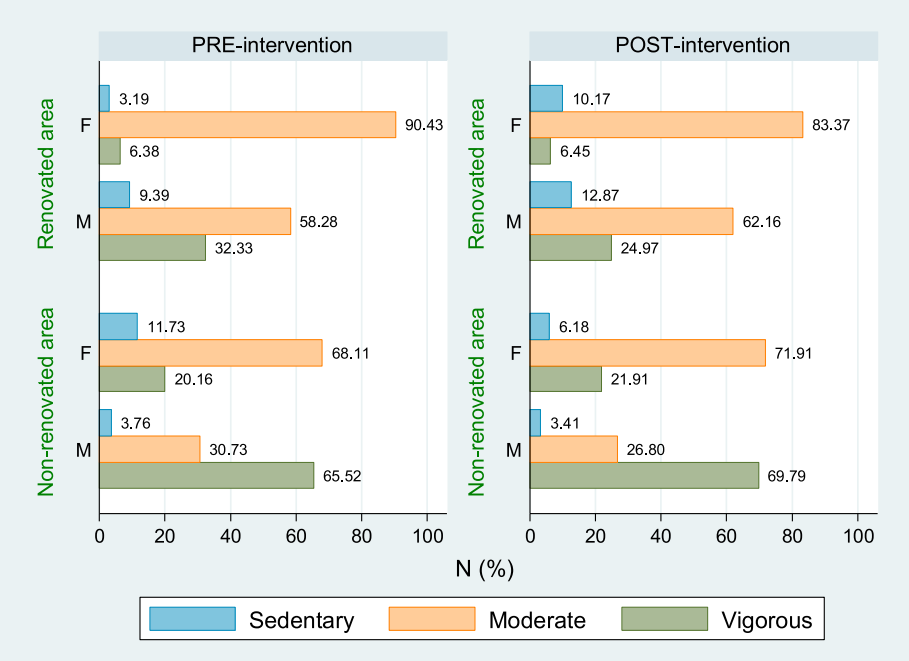


**Fig. 3.** Levels of physical activity by target area (i.e. renovated and non-renovated area) and period of evaluation (i.e. pre/post-evaluation), and stratified by gender (F = female; M = male).

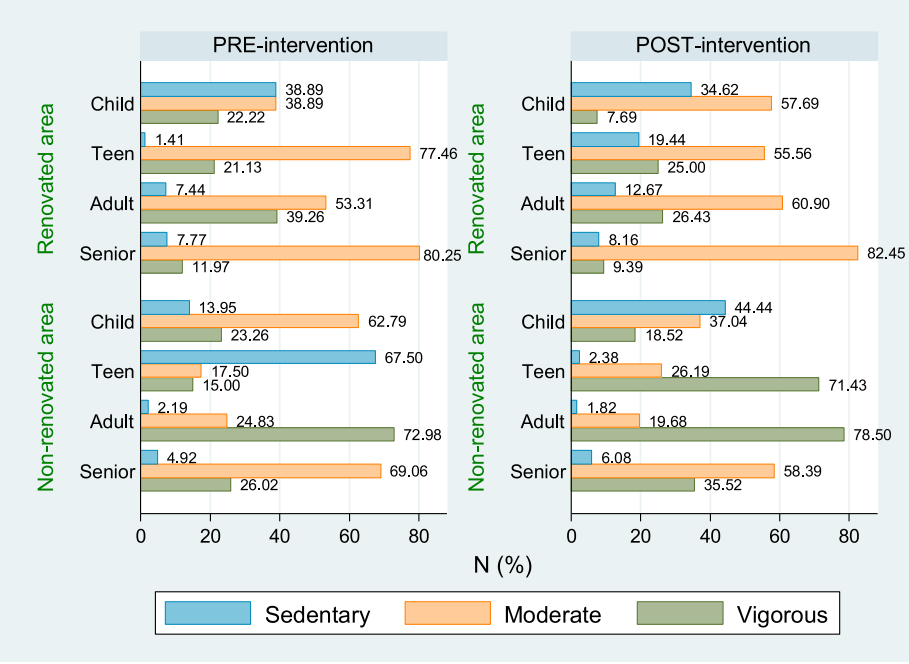


**Fig. 4.** Levels of physical activity by target area (i.e. renovated and non-renovated area) and period of evaluation (i.e. pre/post-evaluation), and stratified by age group.

in the renovated area was mainly driven by children (38.9% in 2016 vs. 57.7% in 2017) and adults (53.3% in 2016 vs. 60.9% in 2017), although the proportion of moderately active seniors also increased (Fig. 4). In the non-renovated area, teenagers experienced the highest increase of vigorous physical activity levels (from 15.0% in 2016 to 71.4% in 2017) (Fig. 4). We also observed an increase of vigorous levels of physical activity for adults and seniors, but not for children (Fig. 4).

Non-Caucasians had a significantly higher risk of being sedentary and moderately active users than Caucasians (Table 2). The risk was higher in the non-renovated area than in the renovated area (e.g. RRR for moderate non-Caucasian in the non-renovated area = 6.17 (95% CI 3.43; 11.08)) (Table 2). However, in the post-evaluation, the proportion of sedentary non-Caucasian users increased in both the renovated (from 0% in 2016 to 18.6% in 2017) and the non-renovated area (from 2.6% in 2016 to 16.3% in 2017) (Fig. 5). Likewise, the proportion of Caucasian vigorously active users increased in the non-renovated area (from 56.8% in 2016 to 63.4% in 2017), while the proportion of non-Caucasian vigorously active users decreased (from 35.9% in 2016 to 11.6% in 2017) (Fig. 5).

Users in the lower part of the renovated area had a significant higher risk being sedentary and moderately active than those in the upper part. In the non-renovated area the pattern was the opposite

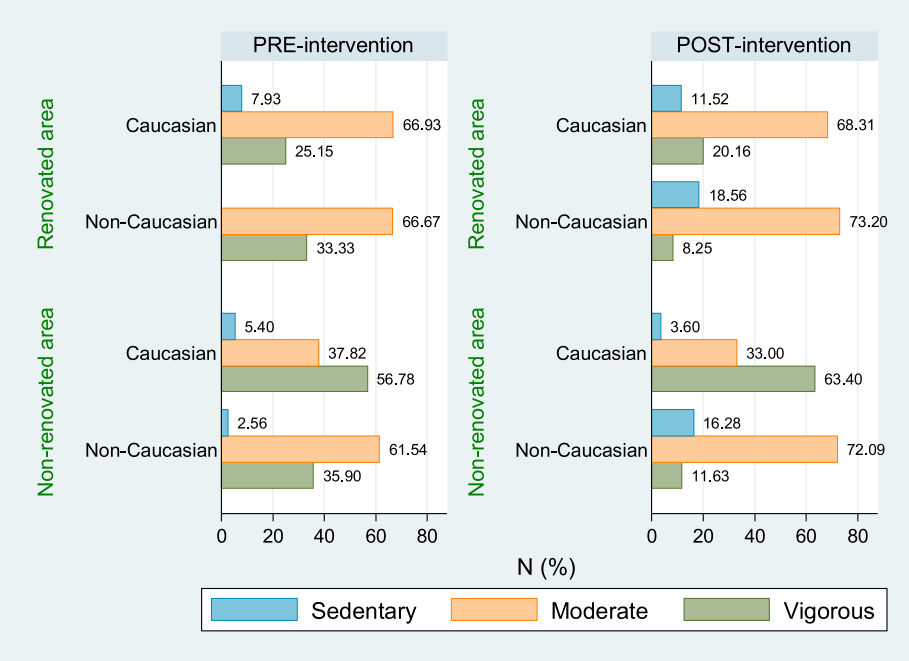


**Fig. 5.** Levels of physical activity by target area (i.e. renovated and non-renovated area) and period of evaluation (i.e. pre/post-evaluation), and stratified by ethnicity.

(Table 2). The users' risk being sedentary and moderately active, compared with being vigorously active, decreased in the weekend (e.g. RRR for moderately active users in the weekend in the renovated area = 0.50 (95% CI 0.39; 0.65)), compared with the rest of the week, in both areas of the river (Table 2).

Overall, we did not observe changes in energy expenditure (expressed in METs/observation) after the intervention (Table 3). However, we observed an 8% decrease of METs/observation in the renovated area and 5% increase in the non-renovated area (Table 3). This was mainly driven by the decrease of energy expended in the lower part of the river, and the increase of energy expended in the upper part of the river in the renovated and non-renovated area respectively (Table 3). Nevertheless, moderately active users were the most prevalent activity group in the renovated area, whereas in the non-renovated area it was vigorously active users (Table 1).

### 3.4. Local community's use and perception of the urban riverside

For the qualitative assessment of the intervention we interviewed a total of 17 participants in the pre-evaluation, and 6 of them were interviewed again in the post-evaluation period (Table S5 – Supplementary Material). The rest of the participants did not participate in the post-evaluation due to different reasons: they moved to another neighbourhood (N = 2), they experienced health problems or hospitalizations (N = 2), they did not answer phone calls (N = 4), or they were not willing to participate due to incompatibility with their workday schedule (N = 3). The length of the interviews ranged between 15 and 40 min.

#### 3.4.1. Socio-economic context

All the participants were residents of "La Ribera" neighbourhood, and most of them mentioned they were living there due to affordable housing. Some participants had been living in "La Ribera" for a long time, and others were newcomers (mainly from outside Spain). Most of the participants reported to be satisfied with the neighbourhood. They liked the area, they were familiar with it, and they had many social interactions, either in the street or the civic centre. In fact, participants highlighted social cohesion among residents, especially among those who had lived there for longer. However, many participants also complained about anti-social behaviour of the residents (e.g. offensive language, disrespectful behaviour, noise, dirtiness, etc.).

#### 3.4.2. Use and perception of the urban riverside

Most of the participants reported using the riverside area, especially for walking or walking the dog, but also for cycling, running, or playing with their children:

> *"I always follow the same route because, as I told you, hmm…we walk, then we stop, we look at…in the river, we look at some ducks…you know…we look at them for a while, then we keep walking a little bit more, and so on. And we like it…to walk and…looking around" (Adult, female, Caucasian)*

A few elderly people mentioned they used to go to the riverside area but no longer visited it due to health reasons. Some participants

**Table 3**
Energy expenditure (in mean METs/observation) by target area and for the pre and post-evaluation SOPARC assessment.

| | Renovated area | | | Non-renovated area | | | Both areas | | |
|---|---|---|---|---|---|---|---|---|---|
| | PRE (2016) | POST (2017) | Comparison between years [% of change] | PRE (2016) | POST (2017) | Comparison between years [% of change] | PRE (2016) | POST (2017) | Comparison between years [% of change] |
| *Mean METs/observation* | | | | | | | | | |
| Upper | 4,34 | 4,12 | −5 | 5,44 | 5,80 | 7 | 5,08 | 5,21 | 3 |
| Lower | 4,59 | 3,41 | −26 | 6,79 | 6,74 | −1 | 6,69 | 5,29 | −21 |
| **Total** | 4,34 | 4,01 | −8 | 5,64 | 5,91 | 5 | 5,25 | 5,22 | 0 |

expressed their discomfort of sharing the area with dogs mainly due to the presence of animal excrement, but also because they considered that dogs damaged the riverside area:

*"Another of the measures that they would have to do is not to let people walk the dogs by the river, because…because there are nests, because there are animals and they break them down. Also, they should stop bringing the dogs [to the riverside] because it seems to me that it does a lot of damage to the river" (Senior, male, Caucasian)*

Frequency of visits to the riverside varied among participants (from daily to sporadic visits). However, participants usually used the riverside more during the summer months than during the winter months. The majority of the participants went to the riverside with someone else (e.g. relative, friends, their children, etc.), and only a few of them went alone. Nevertheless, the reasons given for visiting the riverside with others varied amongst participants. Thus, we do not know whether this was due to safety reasons or other factors. However, most of the participants thought the riverside area was a safe place, at least during the day because there was light. Participants did not report going to the riverside area at night, indicating the lack of lighting as a reason:

*"Yes, it is safe [the riverside area] Well…yes, it's safe during the day. At night I do not know… It must …that must be as insecure as anywhere else…" (Adult, male, Caucasian)*

Although most of the participants mentioned the affordable cost of the apartments as the main reason to move to "La Ribera" neighbourhood, the majority acknowledged the proximity to the river as a plus for the neighbourhood. They liked either seeing the river from home (if possible), walking along it, or even observing and playing in the river being in contact with the water. In their opinion, having the river close to their home might benefit their health and well-being. In fact, many participants highlighted the importance of having natural environments around their residence:

*"Well…as I told you it's a troubled neighbourhood…When I feel comfortable, when I go up the mountain…When I go to the Serralada la Marina or when I'm walking along the river. Then I feel comfortable" (Senior, male, Caucasian)*

It gave them a sense of restoration, calmness and enjoyment. The self-perceived health and well-being benefits of practising physical activity along the river versus practising it in urban areas were also mentioned by several participants.

One of the participants' favourite aspects of the river was the presence of a variety of animals and vegetation. They highlighted the importance of preserving the nature of the area:

*"Well… [I like] the vegetation, the animals that have come, like the seagulls, the ducks…Since…in the eighties…there were not [animals], not at all! In the nineties either" (Senior, female, Caucasian)*

Other participants though, complained about wild boars because there are many of them and they perceived that their presence is encouraged by residents who continue to feed them. Also, some participants complained about the maintenance of the vegetation:

*"Well there are too many plants…too many herbs…that's what I do not like…I would like them [those responsible for park maintenance] to come more often to take care of what is the, the herbs of the river… And that they could cut them…they might take care of them to keep nature alive, right?" (Adult, female, Caucasian)*

In general, long-time residents of "La Ribera" neighbourhood perceived the quality of the river water as improved compared to its past condition, when it was more polluted. They thought the river and riverbank had improved over time, in terms of cleanliness, beauty, flora, and fauna of the area. However, other participants considered the river and its surroundings as dirty, and most of them reported this as a result of anti-social behaviour of some people who threw rubbish in the river or did not respect the area. In line with this, many participants reported annoyance at the bad odour that came from the river. Some of them suspected it originated from the water treatment plant located next to the river. The bad odour was worse in summer and sometimes residents of "La Ribera" reported that this caused throat irritation.

*"I don't like the odour…well, when you walk along the river…i don't know…the odour…it's horrible next to the river!" (Adult, female, non-Caucasian)*

Another concern of the participants using the riverside area was the presence of both walkers and cyclists, using the same lanes. They thought there should be a bicycle line separate from the walkway because they perceived it to be unpleasant or even dangerous to share the space with cyclists. For some participants this was a reason to not use the riverside.

Nevertheless, one of the main complaints reported by the participants before the intervention was that access to the riverbank was not properly provided, and they wanted it to be improved. Before the intervention, some people jumped the fences to reach the riverbank, which was a dangerous practice:

*"When it is not cold, we go on a picnic with my children down there [lower part of the riverside area]…it's fine (…). What happens, of course… is that we have to jump the fence, and it is uncomfortable. Otherwise you have to walk for…I don't know, about 1 km!" (Adult, female, Caucasian)*

#### 3.4.3. Assessment of the urban riverside regeneration project

As mentioned before, the main aim of the urban riverside regeneration project was to facilitate access to the riverbank. In general, participants knew that an intervention was being conducted, but they did not know about the details. Among participants, it was very common to both positively and negatively compare this urban riverside regeneration project with another one conducted some kilometers further away, next to Barcelona, which was larger and more ambitious than the one assessed in this study. For this one, some participants highlighted the necessity of keeping the river as natural as possible, respecting the original fauna and flora, and avoiding the incorporation of artificial elements such as paved walkways, or newly planted grass.

Overall, participants were satisfied with the renovation. They said that the access to the riverbank significantly improved. They liked the appearance of the riverside park, and some participants mentioned that more people were going to the riverbank after the intervention:

*"[The access provided by the renovation] It's good for the people… for… for the children…for everything…for doing sport. Also for the residents of the neighbourhood" (Adult, female, non-Caucasian)*

Participants highlighted the fact that riverside users were mainly physically active along the river. They mainly walked for pleasure, although some users also reported to run or cycle:

*"My reason [to go to the riverside area] is…because I like it, I've already told you that I like so much the river, the birds and so, but I also go [to the riverside area] because…I like walking. I go for a stroll with my husband" (Adult, female, Caucasian)*

Nevertheless, many participants had the feeling that the intervention was unfinished (e.g. unconnected walkway, some access points were closed, lack of equipment like benches, toilets, etc.). Also, some participants thought some users may not respect the renovated area. Finally, a participant mentioned that the walkway could be closer to the river to be able to see and listen to the water when walking.

## 4. Discussion

### 4.1. Main findings

According to our assessment, the urban riverside regeneration project undertaken in a section of the Besòs Riverside Park, in the municipality of Montcada i Reixac, showed increased use, mainly due to a greater presence of females, adults, children, and the non-Caucasian population. The highest increase of users was observed in the lower part of the renovated area, indicating that users employed the stairs and ramps dedicated to facilitate access to the riverbank. Our results also suggest an increase in vigorously active users in the non-renovated area, and an increase of users engaging in sedentary and moderate levels of physical activity in the renovated area. Thus, in this study, the renovation of the Besòs Riverside Park seemed to mostly facilitate relaxation rather than increased physical activity. However, previous studies have suggested that a number of strategies such as introducing signage, organised activities, and promotional incentives, may increase the physically active use of a park, at least in the short-term (Roberts, McEachan, Margary, Conner, & Kellar, 2018).

A study examining the effect of improved safe access to a park in a low-income and majority African-American neighborhood in the USA reported similar results (Schultz, Wilhelm Stanis, Sayers, Thombs, & Thomas, 2017). This is also in line with a realist review suggesting that urban regeneration projects might stimulate leisure-time walking (i.e. moderate physical activity) among adults in deprived areas (Kramer et al., 2017). A predominance of sedentary and moderate physical activity behavior in the renovated area (closer to “La Ribera” neighborhood) might indicate this area is being used as a destination for residents for activities such as leisure or strolling. Moreover, the segregation of types of physical activity practiced on each side of the river might ease concerns the local community has about cyclists and walkers sharing the same space. Our findings indicate that vigorously active users prefer to use the upper part of the non-renovated area, whereas moderate and sedentary users prefer to use the renovated area, thus reducing the potential conflicts of uses, particularly between cyclists and walkers. Sedentary activities in parks or other open spaces may promote social benefits and so improve human’s mental health and well-being (Van Hecke et al., 2017). Moreover, reaching the Besòs Riverside Park promotes physical activity among those users walking or cycling to the park, even if they are sedentary once they arrive to their destination (Cohen et al., 2007; Van Hecke et al., 2017). According to this, it may be equally important to provide appropriate infrastructure that supports active travel (e.g. walking or cycling) to the river, as it is providing activity-supportive infrastructure at the river.

The demographic profile of the users was slightly different from before to after the intervention. First, we observed a significant increase of female users – adults and children – in the renovated area. In line with other studies (Joseph & Maddock, 2016), they were mainly engaged in moderate physical activity, although we observed an increase of female users engaged in sedentary activities as well. A potential hypothesis to explain the increase of adult females could be that these were at the riverside park together with their children, whose age group significantly increased in the renovated area as well. Findings of the interviews conducted in this study did not suggest that the increase of females in the renovated area was due to improved perceptions of safety after the intervention. However, having an outdoor natural space available and accessible closer to their homes might be more convenient to use, especially if they go with their children. Moreover, a qualitative review reported that females viewed parks as safe places to meet and socialize with each other (McCormack, Rock, Toohey, & Hignell, 2010). In any case, our results suggest a reduction of gender inequalities in the park after the intervention even though the number of males was substantially higher than females on both sides of the river, and males were more engaged in vigorous physical activity than females, which are similar results to those reported by other similar studies (Evenson et al., 2017; Joseph & Maddock, 2016; King et al., 2015; McKenzie et al., 2006; Van Dyck et al., 2013; Van Hecke et al., 2017). Second, we observed that adults and seniors were more likely to visit the Besòs Riverside Park than children and teenagers. This is consistent with other studies, although not for seniors which are usually an underrepresented group of users in the parks (Evenson et al., 2017; Joseph & Maddock, 2016; Schultz et al., 2017). As children and teenagers were also not frequent users, strategies to engage them to actively use the riverside area (e.g. skate park, climbing wall, organization of dancing events, etc.) might be considered to ensure that the area appealing to different age groups. Finally, we observed a large difference in the amount of Caucasian and non-Caucasian users in the whole riverside park, non-Caucasians being less prevalent, which does not reflect the population characteristics of “La Ribera” neighborhood. However, our findings suggested an increase over time on the engagement of non-Caucasian users, both in the renovated and in the non-renovated area. Reducing inequalities of access to natural environments for different ethnic groups remains a public health priority.

Our results do not seem to be influenced by weather conditions because, as mentioned before, we did not conduct observations on rainy days, and the proportion of sunny days was the same in the pre and post-evaluation period. Moreover, temperatures were similar in both periods of evaluation. Thus, the increase of users reported in the post-evaluation period was not influenced by warmer temperatures in this period.

## 5. Limitations

Our study faced some limitations. First, we conducted the pre-evaluation during the construction period and thus were not able to obtain a true baseline. However, we do not think this affected our results because characteristics of the study area during the construction work were similar to those before the job started (e.g. access to the riverbank was not provided in either situation). Nevertheless, we acknowledge the construction could deter people from visiting due to presence of – for example – noise, dust, or debris. Second, in line with other studies (Evenson et al., 2017), we conducted systematic observations only in one season (autumn). Thus, it may not be representative of the use of the park during the whole year. However, this does not affect our results because the aim of this study was to compare the use of the park between two comparable periods of evaluation. Future research might investigate how improvements to natural environments might differentially affect its use according to seasonality. Third, SOPARC is a feasible and reliable tool, but sometimes it was difficult to identify the gender, age group, or ethnicity of the users due to the distance between them and the researchers, or because users were obscured by a scarf, hat, coat, etc. This was acknowledged, and two researchers did the same observations at the same time in order to avoid misclassification. Fourth, although researchers tried to obtain a representative sample of the local community, interviews were mainly conducted with females, adults, and Caucasians of the “La Ribera” neighborhood. This implies that different recruitment strategies are needed in order to recruit “harder-to-reach” demographic groups (i.e. non-Caucasians). Finally, we acknowledge the risk of gentrification as in any other urban regeneration project (Cole, Garcia Lamarca, Connolly, & Anguelovski, 2017; McCartney et al., 2017). Urban regeneration projects should be always accompanied with policies and regulations (e.g., to safeguard affordable housing, protect senior homeowners, to regulate land use, etc.) that impede or reduce potential gentrification effects.

### 5.1. Strengths

An important strength of the current study is that it combines quantitative and qualitative methodologies. It helps interpreting the results given that each method is complemented by the other one, exploiting the benefits, and reducing their own limitations (Shenton,

2004). Moreover, triangulation by using different methods may be a strategy to ensure credibility of the results (Gaber & Overacker, 2012; Shenton, 2004). On the one hand, we used the SOPARC tool, which has been typically used in the USA (Evenson et al., 2017; Joseph & Maddock, 2016). This is one of the first studies employing SOPARC in a European country (Pawlowski et al., 2017; Van Dyck et al., 2013; Van Hecke et al., 2017). SOPARC allowed us to easily quantify the number of people using the park before and after the intervention and to estimate their levels of physical activity in the park, using a non-invasive technique. It is a non-expensive method, although it is time-consuming. Further studies may consider other technological options to avoid this problem [e.g. apps that facilitate data collection and management (Evenson et al., 2017)]. On the other hand, interviews allowed us to better understand the behaviour, needs and concerns of the local community. This is an effective method widely used in other studies evaluating health effects of nature-based interventions (World Health Organization, 2017). Moreover, in this study we have mainly focused on the benefits related to the use of and practice of physical activity in the Besòs Riverside Park, but, thanks to the qualitative assessment, we have also considered some risks or concerns related to it (e.g. pollen allergies, vandalism, or incidents with cyclists). Another strength of the current study is that, given the study design, it is relatively easy and affordable to conduct a follow-up to assess the persistence or not of the effects of this intervention. Moreover, the design of this study allowed us to conduct a pre/post-evaluation and assess changes produced after the intervention. Finally, a key strength of this study is the ability to compare the renovated area with the non-renovated area, which has been used as a control.

Results of this study will be shared with stakeholders (including the local community, the municipality, healthcare professionals, and those responsible for the civic centre, etc.) because these findings might be helpful to identify the strengths and desired improvements for the Besòs Riverside Park, and thus underline its importance as a public health resource.

## 6. Conclusions

We found that the urban riverside regeneration project undertaken in the Besòs Riverside Park in “La Ribera” neighbourhood in Montcada i Reixac, promoted the use of this area by improving the accessibility to the riverbanks. Results suggest a reduction in inequalities, mainly in the renovated area, in terms of gender and ethnicity. Physical activity levels did not increase after the intervention because of the redistribution of uses in each side of the river: increase of vigorously active users in the non-renovated area, and increase of moderately active and sedentary users in the renovated area. Nature-based interventions in socio-economically-deprived neighborhoods might reduce inequalities in access to natural areas for deprived communities, thereby creating destinations for residents, promoting physical activity and/or creating opportunities for social interactions, and thus improving their health and well-being.

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## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.landurbplan.2019.103611.

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