

# Health Benefits of Physical Activity Related to An Urban Riverside Regeneration

Cristina Vert, Mark Nieuwenhuijsen, Mireia Gascon, James Grellier, Lora E. Fleming, Mathew P. White and David Rojas-Rueda

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**Table 1.** Questions included in the survey conducted by Barcelona local authorities in 2014-2015. These surveys were administered to Park users [1]. This is an adapted version of the original survey (in Catalan) and includes the key assumptions used for the model.

| Questions *  | Answers   |
|--|---|
| 1. Sex   | <input type="radio"/> Men<br><input type="radio"/> Women  |
| 2. Age   | <input type="radio"/> _____ years old   |
| 3. Where do you live?  | <input type="radio"/> Sant Adrià de Besòs<br><input type="radio"/> Santa Coloma de Gramenet<br><input type="radio"/> Badalona<br><input type="radio"/> Montcada i Reixac<br><input type="radio"/> Barcelona   |
| 4. Reason to come to the Besòs River:                          | <input type="radio"/> Walk (for pleasure)<br><input type="radio"/> Sport-bicycle<br><input type="radio"/> To walk to/from work<br><input type="radio"/> To be healthy <sup>a</sup><br><input type="radio"/> Sport-run<br><input type="radio"/> Others: _____ (specify) <sup>b</sup> |
| 5. Day when you usually come to the Park:<br>(Multiple answer) | <input type="radio"/> Weekday (Monday–Friday)<br><input type="radio"/> Saturday<br><input type="radio"/> Sunday/holiday   |
| 6. Frequency <sup>c</sup> :                                    | <input type="radio"/> More than 3 days/week<br><input type="radio"/> 1 day/week<br><input type="radio"/> 1 day/month<br><input type="radio"/> Occasionally  |
| 7. Duration of the visit to the Besòs River <sup>d</sup> :     | <input type="radio"/> Less than 1 hour<br><input type="radio"/> 1–2 hours<br><input type="radio"/> 2–4 hours<br><input type="radio"/> >4 hours  |

\* The original survey included more questions. However, in this table we only report questions that have been used for this study. <sup>a,b</sup> “To be healthy” and “Others” are not physical activity categories. Thus, users who answered any of these two options were excluded of the study sample. <sup>c</sup> In order to use these values in the analysis, we assumed that: “more than 3 days/week”=“5.5 days/week” [considering that the maximum expected days/week would be 7, and the minimum expected days/week would be 4. Thus, the mean of these values would be:  $5.5 = (7+4)/2$ ]; “1 day/week”=“1.0 day/week”; “1 day/month”=“0.25 days/week” ( $0.25 = 1 \text{ day} / 4 \text{ weeks}$ ); “occasionally”=“0.0 days/week”. We assumed these values being as conservative as possible. <sup>d</sup>In order to use these values in the analysis, we assumed: “less than 1 hour”=“0.5 hours/day”; “1–2 hours”=“1.0 hours/day”; “2–4 hours”=“2.0 hours/day”; “>4.0 hours”=“4 hours/day”. We assumed these values being as conservative as possible.

**Table 2.** Exposure-response function for each outcome [2–4].

| <b>Health outcome</b> | <b>Risk estimate<br/>[RR (95% IC)]</b> | <b>Exposure</b>   | <b>Age group</b> |
|-----------------------|--|-------------------|------------------|
| All-cause mortality   | 0.810 (0.760, 0.850)                   | 11 MET hours/week | ≥18 years        |
| IHD                   | 0.909 (0.857, 0.964)                   | 10 MET hours/week | ≥18 years        |
| Ischemic stroke       | 0.910 (0.831, 1.000)                   | 10 MET hours/week | ≥65 years *      |
| Type 2 diabetes       | 0.980 (0.967, 0.996)                   | 10 MET hours/week | ≥18 years        |
| Colon cancer          | 0.978 (0.940, 1.016)                   | 10 MET hours/week | ≥18 years        |
| Breast cancer         | 0.987 (0.971, 1.003)                   | 10 MET hours/week | ≥18 years        |
| Dementia              | 0.720 (0.600, 0.860)                   | 33 MET hours/week | ≥65 years *      |

- Exposure-response functions for ischemic stroke and dementia were available for subjects ≥65 years old. The study population was divided by age groups (18 to 64 years old, and ≥65 years old), with the aim of assigning appropriate age-specific incidence rates and exposure-response functions for each health outcome.

**Table 3.** List of assumptions considered for the assessment of health and health-related economic benefits of the urban riverside regeneration project.

| Assumption  | Justification   |
|---|---|
| <ul style="list-style-type: none"> <li>The sample of survey respondents is representative of the study population. The survey was conducted by Barcelona local authorities and used in this study to estimate health and health-related economic benefits of the urban riverside regeneration project.</li> </ul>   | <ul style="list-style-type: none"> <li>Data and description of the procedure employed by local authorities to conduct the surveys was not available. However, this is official data which is being used by local authorities to assess the usability of the Besòs Riverside Park. To our knowledge, this is the only official data available at this moment.</li> </ul>   |
| <ul style="list-style-type: none"> <li>Scenario 1: 100% of the physical activity practised in the Besòs Riverside Park is new and related to the study intervention. Scenario 2: 50% of the physical activity practised in the Besòs riverside park is new and related to the study intervention (considered in the analysis), the other 50% was previously conducted somewhere else (e.g. on the beach, in a park, in the gym, etc) (not considered in the analysis).</li> </ul> | <ul style="list-style-type: none"> <li>Data on the physical activity behaviour of the users of the Besòs Riverside Park before the intervention was not available. However, park infrastructure, including access to the riverbanks did not exist previously and the people could not use the area before the intervention completion.</li> </ul>   |
| <ul style="list-style-type: none"> <li>Base levels of physical activity of the study population are similar than those reported for the whole population of Barcelona [5,8]</li> </ul>  | <ul style="list-style-type: none"> <li>Data on the base levels of physical activity of the specific study population was not available. Nevertheless, this data was available at city level and it was expected to be similar among the Barcelona population and the study population.</li> </ul>   |
| <ul style="list-style-type: none"> <li>Survey data on frequency of the visits to the Park (Supplementary Material –Table S1), we assumed: <ul style="list-style-type: none"> <li>A) “more than 3 days/week”=“5.5 days/week”</li> <li>B) “1 day/month”=“0.25 days/week”</li> </ul> </li> </ul>   | <ul style="list-style-type: none"> <li>Based on a conservationist approach: <ul style="list-style-type: none"> <li>A) Maximum potential value = 7 days/week. Minimum potential value = 4 days/week. Thus, the mean of these values is: <math>5.5 = (7 + 4)/2</math>.</li> <li>B) <math>0.25 = 1 \text{ day} / 4 \text{ weeks}</math>.</li> </ul> </li> </ul>  |
| <ul style="list-style-type: none"> <li>Survey data on duration of the visits to the Park (Supplementary Material –Table S1), we assumed: <ul style="list-style-type: none"> <li>C) “less than 1 hour”=“0.5 hours/day”</li> <li>D) “1–2 hours”=“1.0 hours/day”</li> <li>E) “2–4 hours”=“2.0 hours/day”</li> <li>F) “&gt;4.0 hours”=“4 hours/day”</li> </ul> </li> </ul>  | <ul style="list-style-type: none"> <li>Based on a conservationist approach: <ul style="list-style-type: none"> <li>A) Maximum potential value=59 minutes. Minimum potential value=1 minute. Thus: <math>30 = (1 + 59)/2</math>. And 30 minutes=0.5 hours.</li> <li>B) Most conservative value.</li> <li>C) Most conservative value.</li> <li>D) Most conservative value.</li> </ul> </li> </ul>                               |
| <ul style="list-style-type: none"> <li>For Scenario 1, the estimated number of visits to the Park per day is 1 for all the Park users, except for the walking commuters, who need to go to and from work. Thus, for this group of users the number of visits per day is 2.</li> </ul>   | <ul style="list-style-type: none"> <li>Most conservative value.</li> </ul>  |
| <ul style="list-style-type: none"> <li>Non-linear exposure-response function between physical activity and health outcomes</li> </ul>   | <ul style="list-style-type: none"> <li>There is epidemiological evidence that suggest the exposure-response relationship between physical activity and health outcomes is non-linear [4].</li> </ul>  |
| <ul style="list-style-type: none"> <li>Data from 2014-2015 surveys (number of users, duration, frequency and type of physical activity) is assumed to be constant though the time</li> </ul>  | <ul style="list-style-type: none"> <li>Health benefits of physical activity do not emerge instantaneously and require regular practise. Data used for this study was collected 15 years after the completion of the riverside park, which means that the users who were using the infrastructure at this moment, may be users who have been using it for some time and that might continue using it in the future.</li> </ul> |

**Table 4.** Quartiles of basal levels of physical activity reported in the Barcelona Health Survey [5], a population-based randomized sample studying the health status of Barcelona residents. Levels of physical activity are reported in quartiles, Q1 being the lowest level of physical activity reported for the Barcelona population, and Q4 the highest level of physical activity.

| Quartile | MET hour/week |
|----------|---------------|
| Q1       | 0.4           |
| Q2       | 8.5           |
| Q3       | 22.5          |
| Q4       | 42.4          |

MET: Metabolic equivalent of task.

**Table 5.** Direct health-care cost in euros for morbidity outcomes in Spain [6,7].

|              | Cost per case (euros) |
|--------------|-----------------------|
| IHD          | 1,123                 |
| Stroke       | 2,214                 |
| DM2          | 2,782                 |
| Colon cancer | 3,031                 |
| Brest cancer | 1,095                 |
| Dementia     | 5,830                 |

**Table 6.** Descriptive analysis of the study population.

|  | Total population:<br>≥18 years old<br>(N = 5,753) | ≥18 and ≤ 64 years old<br>(N = 2,848) | ≥65 years old<br>(N = 2,932) |
|--|---|---------------------------------------|------------------------------|
| <b>Age</b> [median (min-max)]  | 48 (18–85)  | 42 (18–64)                            | 70 (65–85)                   |
| <b>Sex</b> (%)   |   |                                       |                              |
| Men  | 65  | 61                                    | 78                           |
| Women  | 35  | 39                                    | 22                           |
| <b>Main activity conducted<br/>in the Besòs Riverside<br/>Park</b> (%) |   |                                       |                              |
| Walking for leisure  | 38  | 55                                    | 21                           |
| Cycling  | 49  | 19                                    | 78                           |
| Running  | 12  | 24                                    | 1                            |
| Walking for commuting  | 1   | 2                                     | 0                            |

**Table 7.** Sensitivity analysis using the minimum visit duration to the Park (i.e. 30 min/day) reported by walking commuter users. Results for Scenario 1 and Scenario 2.

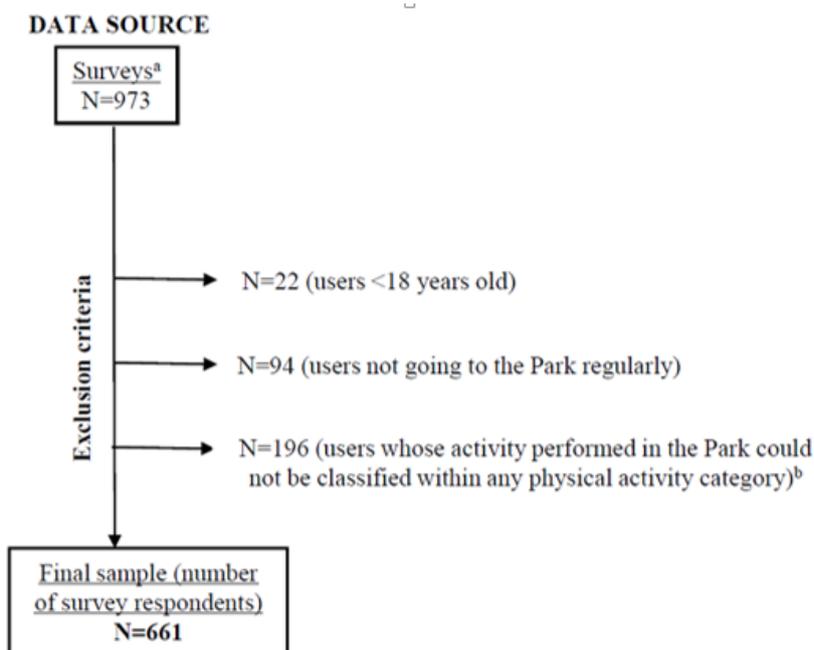
|                       | Scenario 1                 |                                       |  | Scenario 2                |                                       |  |
|-----------------------|----------------------------|---------------------------------------|--|---------------------------|---------------------------------------|--|
|                       | DALYs/year<br>(95% CI)     | Direct Costs (euros/year)<br>(95% CI) | VSL (euros/year)<br>(95% CI)                     | DALYs/year<br>(95% CI)    | Direct Costs (euros/year)<br>(95% CI) | VSL (euros/year)<br>(95% CI)                     |
| Cycling               | -7.9 (-14.6; -2.4)         | -25,284 (-46,826; -9,108)             | -15,629,701<br>(-21,916,593; -11,401,939)        | -5.3 (-9.7; -1.7)         | -16,818 (-30,648; -6,149)             | -10,426,408<br>(-14,505,355; -7,651,506)         |
| Walking for leisure   | -2.4 (-4.3; -0.7)          | -4,487 (-8,154; -1,608)               | -7,304,560<br>(-10,144,657; -5,367,509)          | -1.6 (-2.8; -0.5)         | -2,920 (-5,236; -1,059)               | -4,753,055<br>(-6,557,344; -3,510,218)           |
| Running               | -0.8 (-1.4; -0.2)          | -146 (-264; -28)                      | -460,256<br>(-643,971; -336,315)                 | -0.5 (-0.9; -0.1)         | -99 (-178; -19)                       | -305,284<br>(-423,907; -224,357)                 |
| Walking for commuting | 0.0 (-0.1; 0.0)            | -10 (-17; -2)                         | -29,541<br>(-41,092; -21,682)                    | 0.0 (-0.1; 0.0)           | -6 (-11; -1)                          | -19,300<br>(-26,663; -14,239)                    |
| <b>TOTAL</b>          | <b>-11.1 (-20.4; -3.4)</b> | <b>-29,926 (-55,262; -10,746)</b>     | <b>-23,453,984</b><br>(-32,746,312; -17,127,445) | <b>-7.4 (-13.5; -2.3)</b> | <b>-19,843 (-36,074; -7,229)</b>      | <b>-15,504,047</b><br>(-21,513,268; -11,400,319) |

DALYs: Disability Adjusted Life Years; VSL: value of statistical life.

**Table 8.** Sensitivity analysis considering the minimum visit duration to the Park (i.e. 30 min/day) reported by cyclists >65 years old. Results for Scenario 1 and Scenario 2.

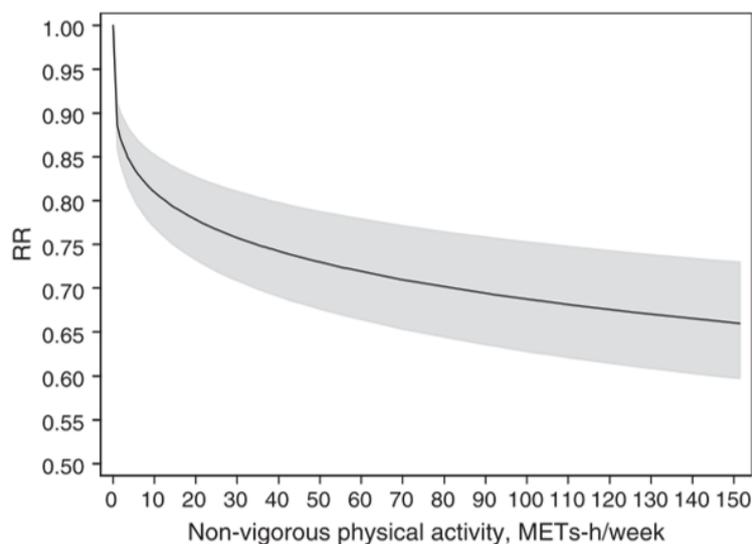
|                       | Scenario 1                |                                       |  | Scenario 2                |                                       |  |
|-----------------------|---------------------------|---------------------------------------|--|---------------------------|---------------------------------------|--|
|                       | DALYs/year<br>(95% CI)    | Direct Costs (euros/year)<br>(95% CI) | VSL (euros/year)<br>(95% CI)                     | DALYs/year<br>(95% CI)    | Direct Costs (euros/year)<br>(95% CI) | VSL (euros/year)<br>(95% CI)                     |
| Cycling               | -6.3 (-11.4; -1.9)        | -16,256 (-29,574; -5,912)             | -15,629,701<br>(-21,916,593; -11,401,939)        | -4.2 (-7.5; -1.3)         | -10,591 (-19,006; -3,898)             | -10,426,408<br>(-14,505,355; -7,651,506)         |
| Walking for leisure   | -2.4 (-4.3; -0.7)         | -4,487 (-8,154; -1,608)               | -7,304,560<br>(-10,144,657; -5,367,509)          | -1.6 (-2.8; -0.5)         | -2,920 (-5,236; -1,059)               | -4,753,055<br>(-6,557,344; -3,510,218)           |
| Running               | -0.8 (-1.4; -0.2)         | -146 (-264; -28)                      | -460,256<br>(-643,971; -336,315)                 | -0.5 (-0.9; -0.1)         | -99 (-178; -19)                       | -305,284<br>(-423,907; -224,357)                 |
| Walking for commuting | -0.1 (-0.2; 0.0)          | -18 (-33; -1)                         | -58,213<br>(-82,133; -16,786)                    | -0.1 (-0.1; 0.0)          | -13 (-23; -2)                         | -39,448<br>(-55,172; -28,834)                    |
| <b>TOTAL</b>          | <b>-9.5 (-17.3; -2.8)</b> | <b>-20,907 (-38,026; -7,550)</b>      | <b>-23,452,730</b><br>(-32,787,354; -17,122,548) | <b>-6.3 (-11.4; -1.9)</b> | <b>-13,622 (-24,443; -4,979)</b>      | <b>-15,524,195</b><br>(-21,541,777; -11,414,915) |

DALYs: Disability Adjusted Life Years; VSL: value of statistical life.



**Figure 1.** Exclusion criteria used to define the sample of survey respondents for analysis in this study.

<sup>a</sup> Survey administered to Park users in 2014–2015 by Barcelona local authorities [1]. <sup>b</sup> Users who responded “to be healthy” or “others” as the “reason to come to the Besòs River” in the survey (see Supplementary Material – Table S1), were excluded of the sample of this study. This was because these activities could not be classified in a physical activity category according to the physical activity classification described by Ainsworth et al. 2011 [9]. This classification provides the energy cost of a wide variety of physical activities (e.g. dancing, walking, cycling, doing home activities like mopping or cleaning windows, etc.), which can be compared with other epidemiological studies providing data on self-reported physical activity.



**Figure S2.** Non-linear exposure-response function between physical activity in METs hour/week and relative risks (RR) for all-cause mortality. Data obtained from a meta-analysis [4] including 22 studies. Shaded areas represent 95% confidence intervals.

$$RR \text{ for } 1 \text{ MET } \frac{\text{min}}{\dots} = A \left( \frac{1}{B^{(Y)}} \right)$$

$$RR \text{ basal} = \left( RR \text{ for } 1 \text{ MET } \frac{\text{min}}{\dots} \right)^{C^{(Y)}}$$

$$RR \text{ scenario} = \left( RR \text{ for } 1 \text{ MET } \frac{\text{min}}{\dots} \right)^{D^{(Y)}}$$

**A = RR reference value.** Risk estimate from exposure-response function obtained from meta-analysis [2–4]. See Supplementary Material – Table S2.

**B = METs minutes/week reference value.** Physical activity value from exposure-response function obtained from meta-analysis. See Supplementary Material – Table S2.

**C = METs minutes/week basal value.** Base levels of physical activity [5,8].

**D = METs minutes/week basal + Scenario value.** Base levels of physical activity [5,8] + estimated physical activity levels of the study population (Table 1).

**Y = power transformation of 0.25** [4].

**Figure 3.** Formulae for the calculation of the relative risk (RR) used to estimate the health benefits for our study population.

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