











## Participants in popular mountain biking events in peri-urban protected areas: how many are too many?

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### Cite this article

Nogueira Mendes, R. M., Pereira da Silva, C., Farías-Torbido, E. I. & Santos, T. (2025). Participants in popular mountain biking events in peri-urban protected areas: how many are too many? *Apunts Educación Física y Deportes*, 159, 53-63. [https://doi.org/10.5672/apunts.2014-0983.es.\(2025/1\).159.06](https://doi.org/10.5672/apunts.2014-0983.es.(2025/1).159.06)

### Abstract

In peri-urban settings, popular outdoor sporting events such as mountain biking and trail running frequently occur in natural and protected areas. While managers and researchers may perceive the number of participants as increasing pressure on these territories, visitors, users and other stakeholders often view these activities favourably and as environmentally friendly. Leveraging data from a popular mountain biking event held in Arrábida Natural Park, encompassing 4,464 participants across six editions, this research investigated the spatial dynamics between the participants and the event region to evaluate what additional pressure these events might exert on these territories. Findings showed that up to 70 % of participants originated from the park's vicinity, with only 15% travelling beyond 50 km to attend the event. Moreover, the majority self-identified as regular park users, having ridden within the area nearly weekly, contrasting with non-regular users who resided farther away and rode in the area approximately once every nine months on average. Comparative analysis with 148 other popular mountain biking events nationwide, totalling 35,147 participants, revealed consistent distance patterns, albeit greater for events with larger participant numbers or held in less populated locales. When deciding whether or not to authorise these events, managers should always prioritise conservation and consider other factors such as seasonality and race routes. Nonetheless, these events could be harnessed to directly benefit the park's mission and activities, facilitating enhanced communication between managers and participants, most of whom are regular park users.

**Keywords:** management, MTB, outdoor activities, peri-urban parks, race events.

#### Edited by:

© Generalitat de Catalunya  
 Departament d'Esports  
 Institut Nacional d'Educació  
 Física de Catalunya (INEFC)

ISSN: 2014-0983

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#### Section:

Sport management, active  
 leisure and tourism

#### Original language:

English

#### Received:

April 8, 2024

#### Accepted:

August 14, 2024

#### Published:

January 1, 2025

#### Front cover:

Laura Kluge fighting for the puck  
 in the match between Germany  
 and Hungary during the Eishockey  
 Deutschland Cup, in Landshut,  
 Germany, on November 9, 2024  
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## Introduction

Races and other sports events are common manifestations of popular outdoor activities such as cycling or running. The number of practitioners of a particular sport usually correlates with the number and magnitude of events (e.g., races or tournaments) (Farías Torbidoni, 2015; Seguí Urbaneja & Farías Torbidoni, 2018) and is a good proxy of an event's popularity and success. Unlike elite national and international sports competitions, popular sports events or small-scale races (Mueller et al., 2018) are less demanding and open to anyone who regularly does physical activity.

Despite the competitive nature of these events, most participants frequently race within the open category. For these people, sports activity is a way of life (Sekot, 2012) shared with friends and relatives, usually without any ties to any club in particular (Dorado et al., 2022) and with a low level of federation membership (Quirante-Mañás et al., 2023). Unlike elite races or sports mega-events (Müller, 2015), these popular sports events attract more participants than spectators, similar to small-scale sports events (Gibson et al., 2012).

Outdoor recreational activities such as mountain biking and trail running, as well as the large sports events associated with them, take place close to nature, crossing into Protected Areas (PA) or Natura 2000 sites (Farias-Torbidoni et al., 2018; Nogueira Mendes et al., 2021a). In many cases, these territories welcome and encourage events and activities. For example, walking and cycling are frequently advertised by PA (Brown, 2016), and visitors and users perceive these activities as being environmentally friendly. These activities are generally considered good examples of eco- or nature and sustainable tourism, promoting respectful uses of the environment and increasing visitation. However, it is also common for PA mandates or management plans to include limits on visitor numbers and public use (Leung et al., 2018): it should not be forgotten that the primary missions of PA are to promote nature conservation and biodiversity, and to allow ecological cycles to take place undisturbed (European Commission, 2020; Maxwell et al., 2020).

Depending on how, when, where and by whom recreational activities are being carried out, strict conservation objectives can conflict with outdoor recreational uses due to environmental and social impacts. Negative impacts on soil, flora, and fauna are well acknowledged by many studies (Chiu & Kriwoken, 2003; Evju et al., 2021; Pickering et al., 2011; Salesa & Cerdà, 2020) as well as social impacts (Kleiner et al., 2022; Needham et al., 2004). Among these, massification is one of the most undesirable since it can push all impacts over acceptable limits (Gómez-Limón García & Martínez Alandí, 2016) and decrease visitor and user satisfaction.

For all these reasons, sports events are frequently seen by managers and researchers as resulting in massification and are

often unwanted in PA (Newsome et al., 2011). Management plans generally include restrictions or zoning areas for such outdoor recreational uses, but due to the constant development of new activities or new trends, it is not uncommon for PA policies to become outdated (Theede et al., 2014) –as well as, at times, challenging to oversee. At the same time, stakeholders such as local municipalities and practitioners see these activities and events as crucial for showcasing and marketing their region and, thus, as an excellent opportunity to attract new visitors and users (Nogueira Mendes et al., 2021a). As mentioned by many authors, outdoor sports and recreation are also a meaningful way to ensure people's greater mental and physical well-being, connect them with nature, and raise awareness of environmental issues and sustainable development, currently a real concern also for popular and smaller sport events (Ulloa-Hernández et al., 2023).

Nogueira Mendes et al. (2023) found that regular practitioners of mountain biking in protected and recreational parks of Lisbon Metropolitan Area (LMA) are from the surroundings of the PA and parks in question. According to the same study, most riders generally target the same area but will also use other areas nearby, i.e., ones within cycling distance or no more than one hour away by car from their residence. Using their local parks and PA leads to a sense of ownership (Brown, 2016), resulting in users frequently reacting against implementing new regulations or restrictions (Ferse et al., 2010). Similar feelings of ownership are also common regarding popular sports events, which can further pressure natural areas already threatened by many other issues.

While crowding and massification are often discussed in the context of PA visitation management, for popular sporting events that has yet to be explored in the scientific literature. Knowing *how many* users there are is crucial for managers, but *who* these participants are should also play a significant role in deciding whether to allow a popular sports event to occur in peri-urban protected or natural areas or not. Additionally, the organising and hosting capacity of the event itself should also be considered.

Using a popular mountain biking event as a case study, this research aimed to evaluate the extent to which such events in a peri-urban context represent extra pressure compared to the regular use of the area, considering that many participants should be from the surroundings and already regular park users. We used a local-scale analysis to understand: (i) where participants came from and (ii) how often they rode in the area, and whether they considered themselves regular users or not of the area where the race was taking place. Finally, as proof of concept, (iii) we evaluated whether the spatial patterns were similar in other contexts by analysing where participants came from for similar popular sports events at a national scale.

## Methodology

### Philosophical underpinning

Based on a positivist paradigm, in which the search for universal patterns is emphasised and a convergent design based on quantitative and qualitative data, this research assessed how popular sporting events within protected areas in peri-urban contexts represent extra pressure relative to outdoor recreational uses. This is a question that has been difficult to answer comprehensively due to the growing demand for sports events within PA over the last decades and the quick change in outdoor practices. To advance in the analysis and resolution of this topic, following the epistemological continuum (Landi, 2023), this research followed the objectivism approach where the knowledge exists independently from the researcher.

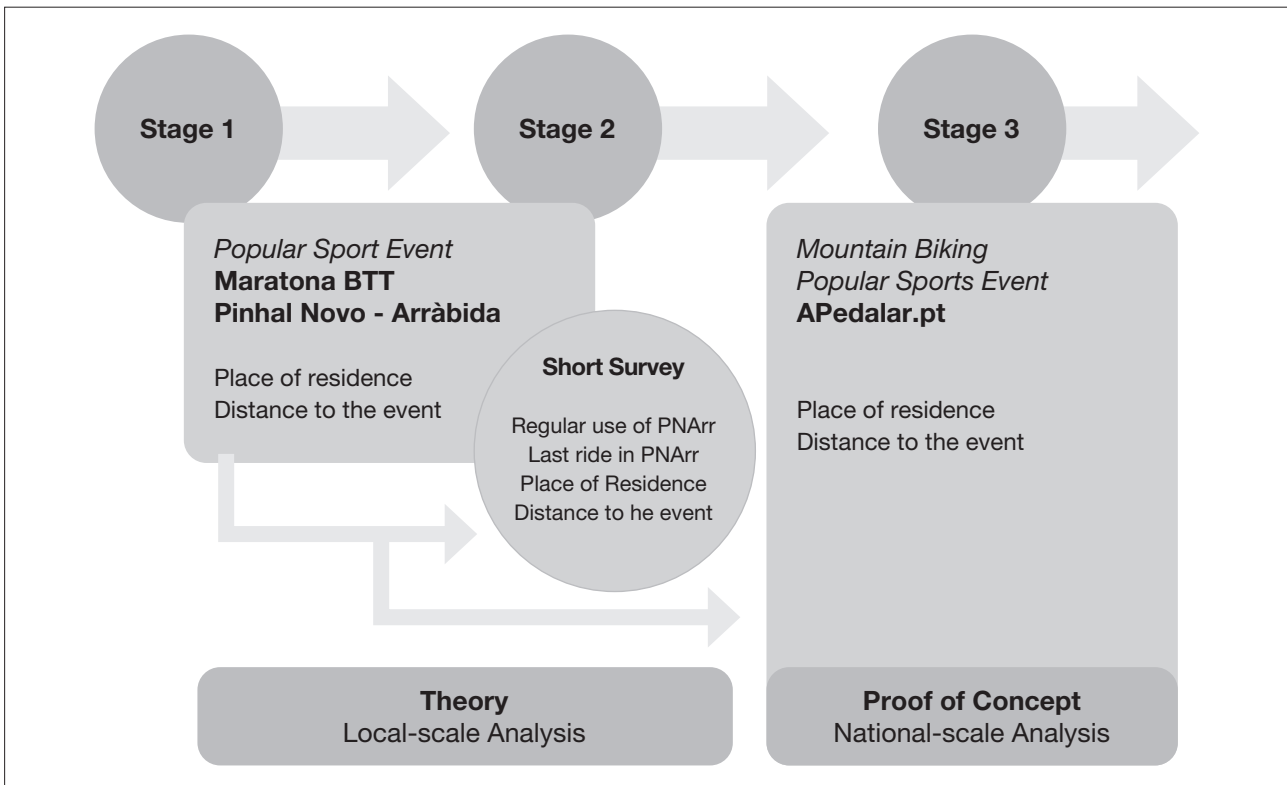
### Conceptual framework

A two-scale analysis, divided into three stages, was designed to evaluate the relationship between popular mountain biking events and participants' habits and places of residence (see the conceptual framework in Figure 1). The local-level analysis was conducted on Maratona BTT Pinhal Novo–Arrábida, the largest and most popular race event for Mountain Biking in Arrábida Natural Park (PNArr), within the LMA, Portugal.

This annual event has taken place 12 times and is organised by a local association (BTTascaDuXico) with the support of Palmela Municipality and Pinhal Novo Parish. The race has two distances (a marathon and a half marathon) that cross into the natural park and a third minor, guided ride (typical in many popular race events) that does not reach the park's boundary. For proof of concept, popular mountain biking events co-organised at the national level by APedalar.pt (<https://apedalar.pt/eventos/concluidos/2015>), one of the leading timing companies in Portugal, were considered. According to Nogueira Mendes et al. (2021a), this company holds around a quarter of all popular mountain biking events in the country.

The dataset for Stage 1 was provided by the event organisers and exclusively included the place of residence (not their personal address) of the 4,464 participants from six consecutive editions of Maratona BTT Pinhal Novo–Arrábida held between 2010 and 2016 (from the 5th to the 10th editions; there was no event in 2014). Using Google Earth PRO, the place of residence of each participant (unavailable for 393 bikers) was geocoded, and the Euclidean distance from the place of residence of each participant to the event's start point and the park boundaries was measured using point distance within ArcGIS Desktop 10.7 from ESRI. Average and maximum distances were recorded, and distances were grouped in percentiles (25th, 50th, 60th, 70th, 75th, 80th, 90th, and 95th) for each race edition.

**Figure 1**  
Conceptual framework and scale analysis dataset and study area.



The dataset for Stage 2 was collected via a short survey carried out at the 2016 and 2017 events. The organisers sent the request to participate in the survey to a random selection of 50 % of the event's participants. Data were anonymously collected using Kobotoolbox.org forms, where the study objectives were presented, reinforcing the voluntary nature of participation. The survey produced 219 valid answers, with a response rate of 31%, and it aimed to evaluate: (i) the participants' place of residence (for sample validation and comparison to the data used in stage 1); (ii) the last time they had ridden within the natural park and whether the participants considered themselves regular users of PNAr or not.

Stage 3, carried out at a national scale, included 148 of the 157 mountain biking events managed by Apedalar.pt in 2015, drawing 35,147 participants (the remaining nine events did not occur due to a lack of contestants). The start point of each event was gathered from Apedalar.pt or the event's social media or webpage. Distances from the place of residence (retrieved from the public lists of participants) to the event were measured using the same methods as for the local dataset. As with the previous stages, this dataset includes virtually all participants' places of residence, but no personal data were used or kept throughout this research.

Throughout the three stages, all data were analysed using description statistics, including average distances, percentiles, maximum and minimum values at all scale-analysis.

The location of Maratona BTT Pinhal Novo/Arrábida and the location of all events used for the national-level analysis are presented in Figure 2.

## Results

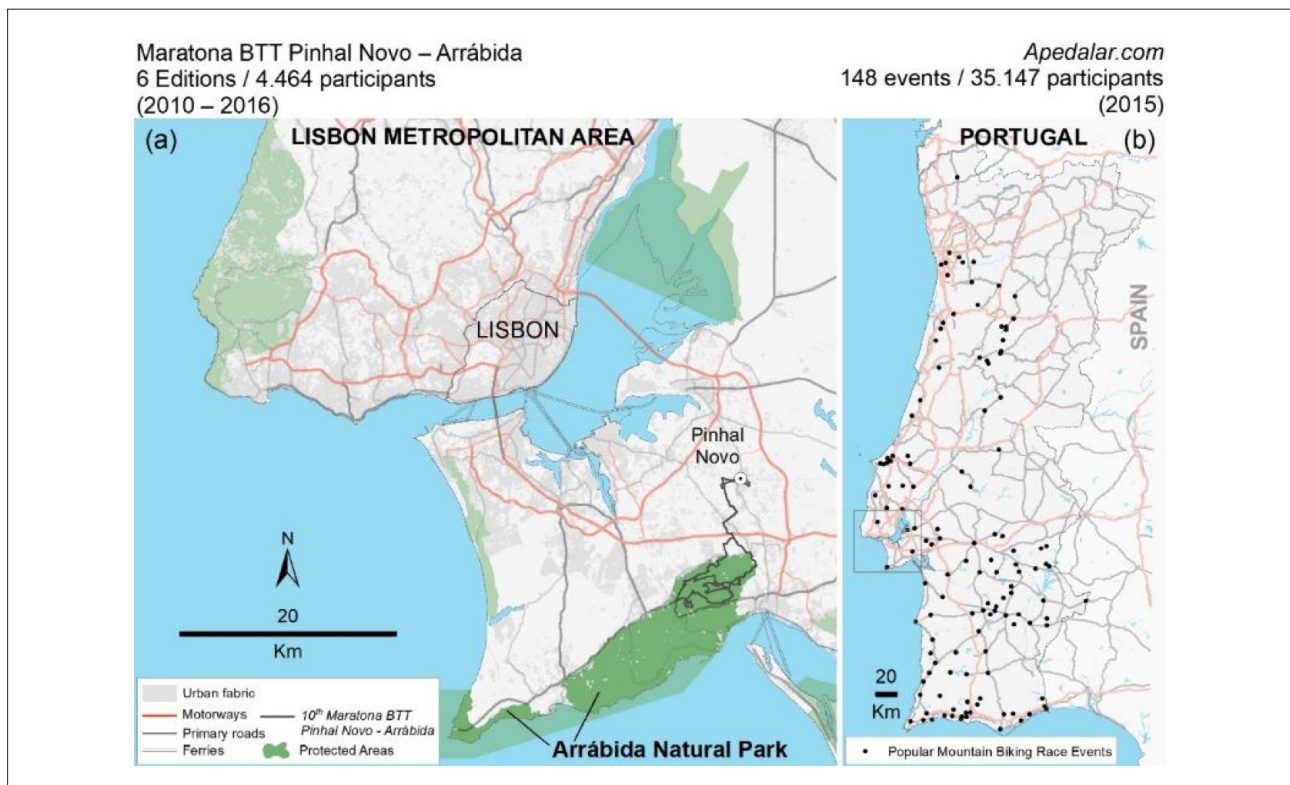
### Local-scale analysis

#### Stage 1 – Maratona BTT Pinhal Novo/Arrábida

Results from the local-scale analysis of the Stage 1 dataset are presented in Table 1. On average, for all race editions except for the 5th, the distance to the natural park is shorter than the distance to the event's starting point, although within the same value of magnitude—a pattern repeated up to the 60th percentile. Distances of more than 50 km to the event or PNAr are reached above the 85th percentile, except for the 8th and 10th editions (2013 and 2016, respectively). Both tendencies occur throughout the sub-dataset when all participants are analysed together.

**Figure 2**

Study area: (a) Arrábida Natural Park and race routes of the 10th Maratona BTT Pinhal Novo–Arrábida used for the local-level analysis; (b) Mainland Portugal and locations of the 148 mountain biking race events from [Apedalar.pt](http://Apedalar.pt) used for the national-level analysis. (Map produced by the authors based on open data from [dgterritorio.gov.pt](http://dgterritorio.gov.pt), [igeoe.pt](http://igeoe.pt) and [icnf.pt](http://icnf.pt))



**Table 1**

*Euclidian distances (km) from the residence place to the Maratona BTT Pinhal Novo/Arrábida start point and to the Arrábida Natural Park boundaries.*

Edition (Year)	Riders	AVG	P25th	P50th	P60th	P70th	P75th	P80th	P85th	P90th	P95th	MAX
5 <sup>th</sup> (2010)	703	28.92	12.04	21.62	28.69	31.67	35.90	41.10	45.53	51.84	87.45	276.47
PNArr		27.30	6.82	19.82	28.92	33.42	35.74	37.97	40.83	52.63	85.60	283.18
6 <sup>th</sup> (2011)	644	26.27	9.75	16.30	21.79	28.71	31.45	35.12	43.92	50.50	87.45	323.33
PNArr		24.74	6.82	15.69	19.57	29.08	32.28	35.52	39.65	46.29	85.68	330.06
7 <sup>th</sup> (2012)	811	28.46	12.04	18.82	21.77	28.84	31.18	36.70	44.57	69.52	87.45	301.82
PNArr		26.40	6.82	17.12	19.82	29.24	32.28	35.64	40.83	56.09	89.67	308.25
8 <sup>th</sup> (2013)	845	32.75	12.04	21.20	26.36	30.60	34.75	41.17	59.40	87.45	114.19	323.33
PNArr		30.53	6.82	18.16	22.79	31.72	33.46	39.29	52.33	89.42	106.37	330.06
9 <sup>th</sup> (2015)	760	32.32	12.04	21.20	26.66	31.45	35.05	39.78	46.74	70.18	104.49	985.41
PNArr		30.44	6.82	19.82	22.79	32.28	35.14	40.11	47.00	74.63	107.83	949.28
10 <sup>th</sup> (2016)	701	35.57	12.04	21.20	26.36	31.50	36.34	41.54	59.87	85.86	117.75	985.41
PNArr		33.02	6.82	19.13	22.79	32.28	35.64	40.83	65.53	81.32	124.24	949.28
TOTAL	4,464	30.75	12.04	21.20	24.65	30.85	34.32	39.78	45.56	70.18	99.94	985.41
PNArr		28.76	6.82	18.27	22.79	31.72	34.01	37.97	43.39	76.29	101.15	949.28

*Stage 2 – Short survey*

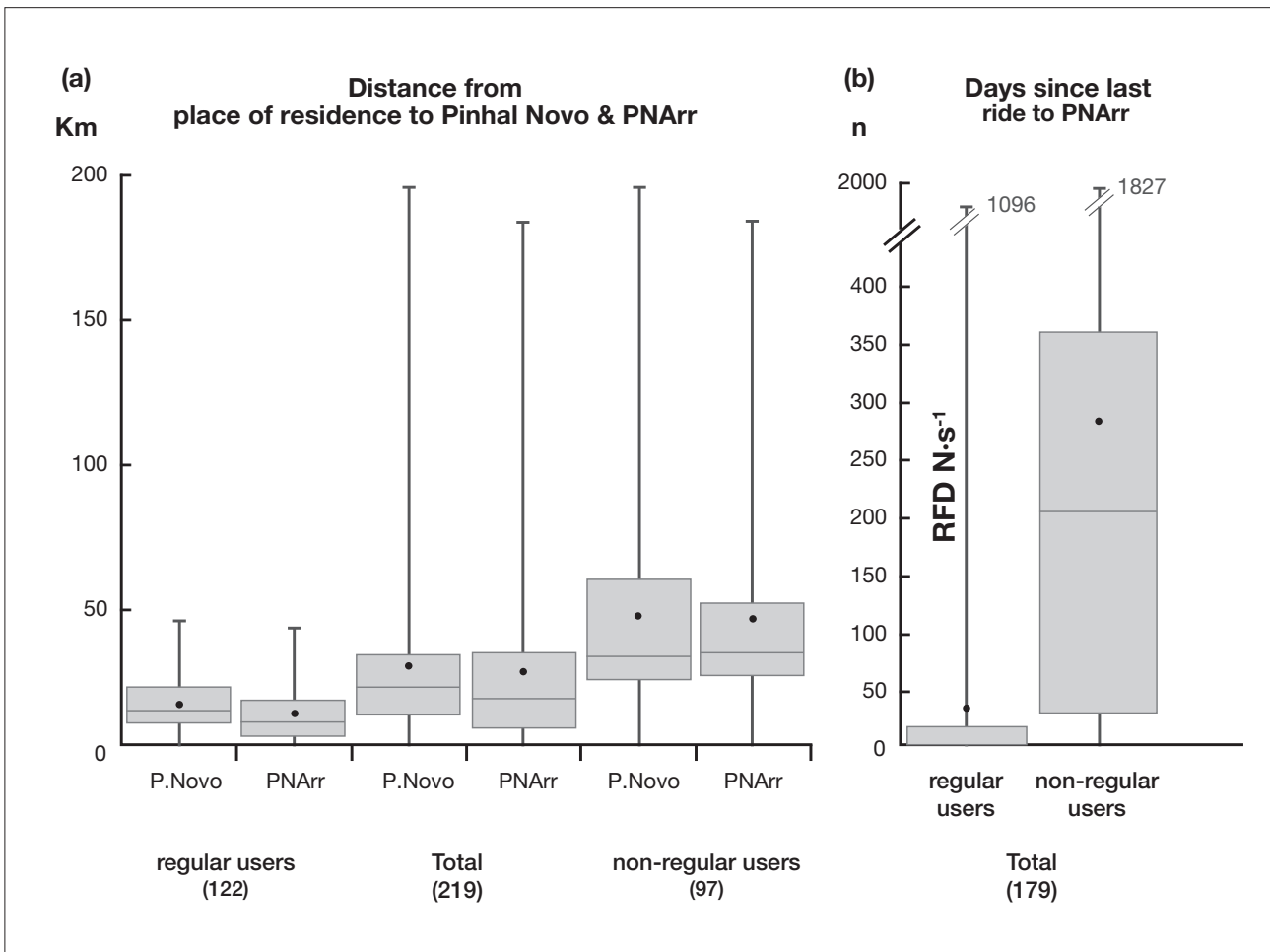
Figure 3 presents the boxplot results of the short survey carried out with participants of the 10th and 11th editions of the Maratona. 56% of the participants considered themselves regular riders of PNAr. On average, they lived less than 12 km from the park limits, and the maximum distance to their residence was 42 km, which is less than the average distance to the park limits for those who did not consider themselves regular users. For both categories combined, results are in line with, and within the same range of values as, those found for Stage 1, except for the 75th percentile for non-regular users, which surpasses 50 km. It should also be noted that there were bikers living close to the PNAr who did not consider themselves regular users of the park.

Regarding the last time that participants in the Maratona had cycled in the PNAr (answered by nearly 82 % of the respondents), those who considered themselves regular riders had done so, on average, within the preceding five weeks, although the median fell within the last seven days before the questionnaire was completed. For the non-regular users, the average values rose to nine months and the median to the last seven months.

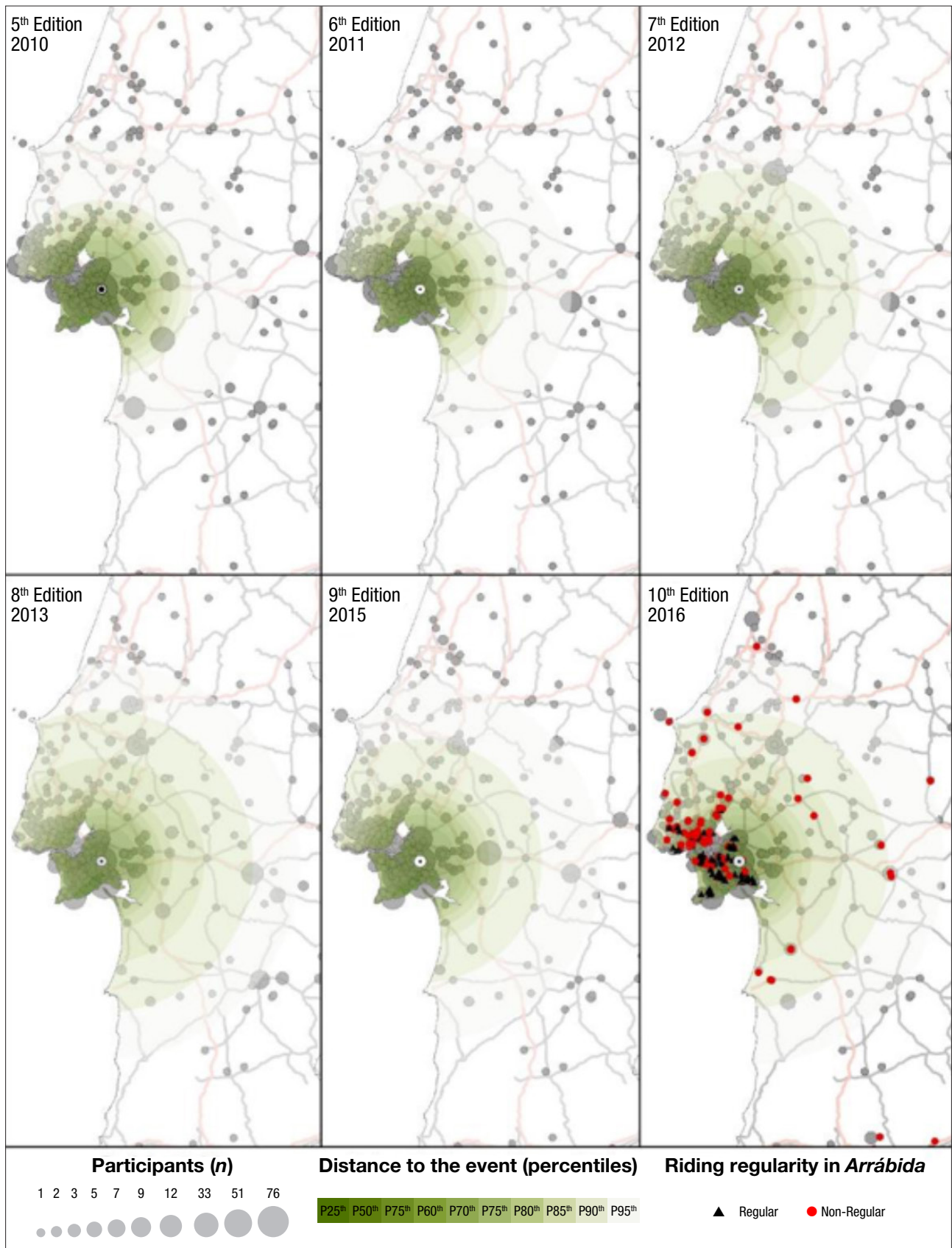
Figure 4 presents a geographical output of this case study's results, showing the place of residence of the Maratona participants. The map for the 10th edition also distinguishes between the places of residence for regular and non-regular users (results from the short survey).

**Figure 3**

Short survey dataset: (a) Boxplot distances from the place of residence to Pinhal Novo and PNAr; (b) Days since the last ride to PNAr. Boxes stand for the 2nd and 3rd quartiles, and black diamonds give average values. (Note: maximum values for (b) are outside the y-axis range.)



**Figure 4**  
Place of residence and distance percentiles from the Maratona BTT Pinhal Novo/Arrábida for the six editions analysed.



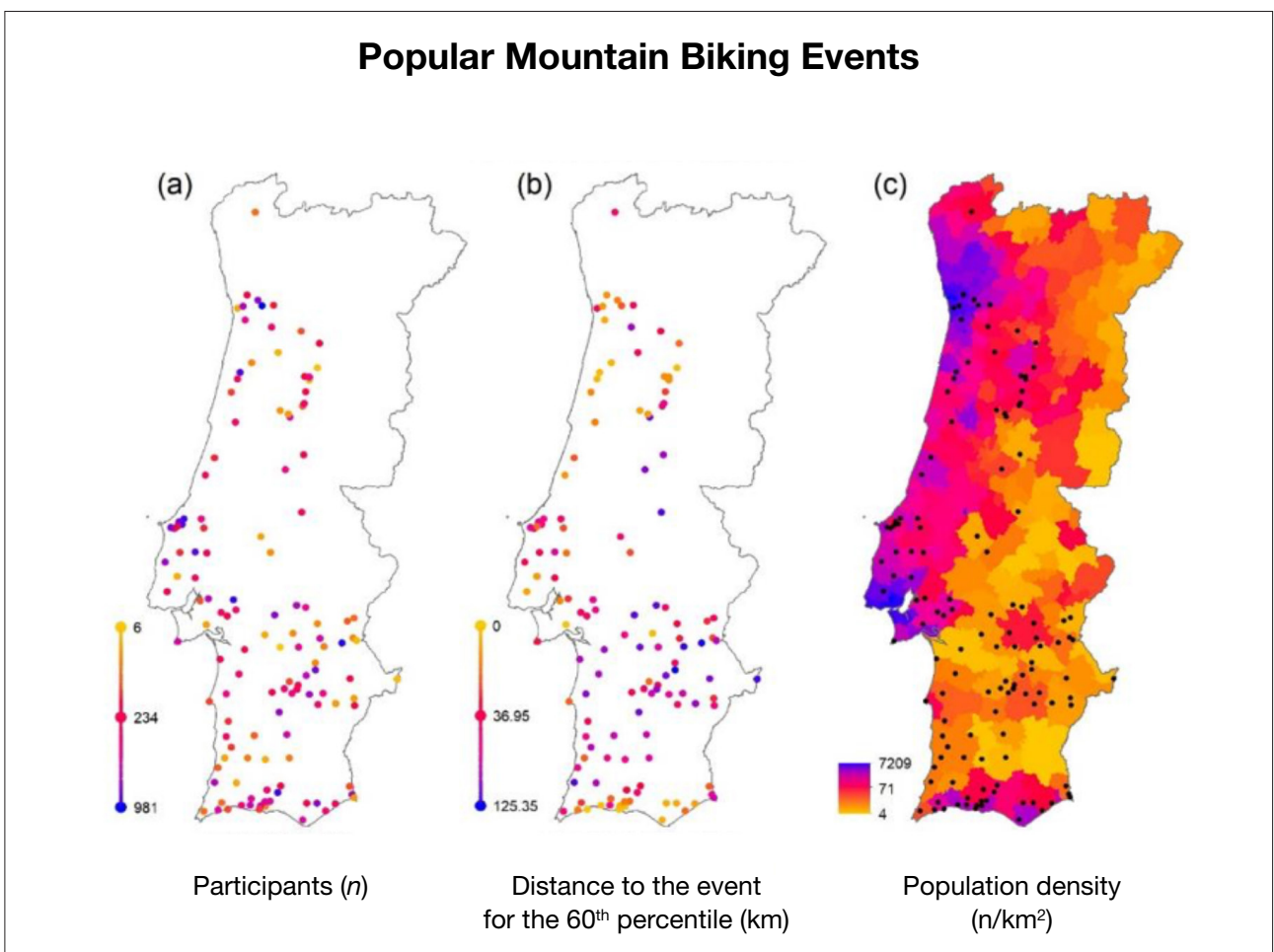
**Table 2**

Overall percentiles of distances from the place of residence to the mountain biking popular race events for the national level analysis, and the number of events where x % of the participants come from no more than 50 km away (data from Apedalar.pt).

	Avg	Percentiles									Max
		P25 <sup>th</sup>	P50 <sup>th</sup>	P60 <sup>th</sup>	P70 <sup>th</sup>	P75 <sup>th</sup>	P80 <sup>th</sup>	P85 <sup>th</sup>	P90 <sup>th</sup>	P95 <sup>th</sup>	
Distance to the event (km)	44.44	15.75	36.91	36.95	46.36	52.64	60.09	71.22	88.60	123.43	590.16
Events where x % of the participants come from < 50 km (n)	106	145	116	116	97	80	64	44	19	7	2

**Figure 5**

National-level analysis: (a) Number of participants per event; (b) Distance from the place of residence to the event for the 60th percentile; (c) Population densities of Portugal’s mainland plotted against locations of popular mountain biking events. (Sources: Apedalar.pt)



**National-scale Analysis**

*Stage 3 – Proof of concept*

In the national-scale analysis (see Table 2 and Figure 5), overall average distances are higher than those found within the local-scale analysis. Nevertheless, over 70 % of

the participants live within a 50 km radius of the event’s location. Moreover, even for the 75th percentile, for which overall distances to the event average 52.64 km, 80 out of the 148 events analysed (over 54 %) have three-quarters of participants from no more than 50 km away.



## Discussion

Mountain biking is popular in natural and protected areas in peri-urban contexts. Compared to other popular outdoor activities such as walking, hiking, or even trail running that target off-road trails, paths, or single tracks, mountain biking raises different and more complex challenges for managers: (i) It can contribute to more significant soil erosion due to speed and tire width, especially on wet surfaces (Evju et al., 2021) or downhill trails, many of which are illegal (Campelo & Nogueira Mendes, 2016; Farías-Torbidoni & Morera, 2020); (ii) Compared to other regular users, bikers are more frequent visitors than hikers and walkers (Farías-Torbidoni & Morera, 2020); (iii) Compared to other users, bikers are often less aware of their impacts and conflicts (Cessford, 1995; Dorado et al., 2022); and (iv) Increased accessibility due to e-Bikes, allowing more people to go for longer rides, attracting new and less sportive bikers to the activity (Mitterwallner et al., 2021), thus contributing to massification.

Acknowledging and monitoring the habits, expectations, motivations, preferences, and behaviors of mountain bikers, as well as those of other users, can influence the management of recreational activities directly. A network of recognised trails and paths that match the parks' conservation goals and users' preferences, re-routing users if necessary (Evju et al., 2021), would positively impact nature conservation. As is already the case in some PA, race routes could be limited to the main network of tracks and paths with preservation and conservation in mind (Gómez-Limón García & Martínez Alandi, 2016).

The results of this study show that secondary data—in this case, the place of residence of events' participants—could contribute to understanding and monitoring recreational sports activities. Our results demonstrate that most participants of popular mountain biking events (up to 70–75 %) are from the surrounding regions and consider themselves regular users of the race territory. Even without the event, most would probably ride in the area. Regarding the rest of the participants, some also use the park as one of their regular riding areas—which is common within LMA (Nogueira Mendes et al., 2023). While popular sporting events such as the Maratona BTT Pinhal Novo/Arrábida concentrate users along the race route, they also avoid dispersion, which could easily lead to social conflicts and environmental impacts, such as trespassing and habitat fragmentation—to name just two of the severe impacts of recreational uses within PNAr and other parks in the region (Nogueira Mendes et al., 2023).

Although these results may be specific to the event analysed and its context, the observed spatial patterns repeat themselves at the national level within other popular race events of mountain biking. Nevertheless, recreational outdoor sports in different development stages may demonstrate

different spatial patterns. In Portugal, for example, trail running is a relatively new activity compared to mountain biking and still attracts participants from far away (Julião et al., 2018; Nogueira Mendes et al., 2021b), but this is a pattern that might change with the sport's growing popularity and with the promotion of more events. Different patterns are also seen in more specialised sports, which usually involve fewer participants. For example, all triathlon events held in Portugal in 2015 combined involved only 15,673 participants, including affiliated and unaffiliated athletes (Federação de Triatlo Portugal, 2016), compared to the 35,147 participants for a quarter of all mountain biking events in Portugal studied here for the same year. Distances traveled to participate in popular sporting events may also depend on economic contexts, though this has yet to be studied in more detail. The larger average distances travelled by participants in events in southern Portugal are due not only to the lower population densities of the region, but also to the higher participation of bikers from Spain, for whom a drive of 80–100 km could represent the same cost (in terms of time and money) as for an AML resident participating locally.

An important reason to look at popular events such as the Maratona is that such races are the second largest manifestations of these popular outdoor activities themselves, regular practice being the first. Although only part of practitioners regularly participate in events, considering those who do have a high desire to participate again (Quirante-Mañas et al., 2023), surveying such events can help to monitor regular practice that also targets natural and protected areas (Julião et al., 2020) but is more challenging to study. For example, field surveys focusing solely on mountain bikers' places of residence would require substantially more resources to achieve the same amount of data.

Popular sports events could also be used to the direct advantage of the park's mission and conservation aims, for instance, to announce or advertise properly regulated trails and paths. Based on the number of participants and different race routes, events could also be used to test and verify the results of recreational ecology studies.

Trails and paths could be kept open, in good condition, and free from pioneer or exotic vegetation, and their sporadic use for events could simulate the now-abandoned practice of transhumance of sheep and goat herds (common in many mountain protected areas). This change has had significant environmental impacts, such as decreased native flora species.

Since few recreational ecology studies are conducted in real situations, demonstrations, and controlled field tests to study trampling or soil erosion (done before an event, immediately after it, and later) could be promoted, preferably outside the park's limits or in less sensitive areas. These events would also be an excellent opportunity to test new gear, such as drones or laser scans, to help improve

monitoring techniques. Finally, popular race events can be an excellent opportunity to increase communication, raise awareness about regulations, environmental impacts, and conflicts, and promote best practices and behaviors.

## Conclusions and recommendations

Popular sports events in peri-urban areas are mostly just another “Sunday ride” for their participants, who tend to take part in events held in areas that they already use regularly and are relatively close to their places of residence (up to 1 hour away). Distances from the place of residence to the event are consistent at peri-urban and national scales, although they tend to be greater for events with more participants or the ones in less-populated areas.

As suggested by previous research, e.g. Norman and Pickering (2017), this study demonstrates the value of using secondary data to monitor outdoor recreational uses of PA. Although some limitations could be pointed out to this type of research, namely the fact that not all practitioners of outdoor recreational activities are participants in this type of events, gathering secondary data from events is a relatively easy way to profile regular users, which could be important for park managers. Furthermore, popular mountain biking and trail running races, given the concentration in space and time of a significant number of participants, are also good opportunities to survey regular users of PA regarding other important issues related to the park’s mission, such as preferences or expectations, which could be used to develop recreational offers under the PA’s management plans and mandates. Future work could verify how these results are comparable for other sports or socioeconomic contexts or dig into the riding and sports attitude, which could lead to the mitigation of environmental impacts and promotion of better sustainable uses of PA.

To allow events or not in PA where strict conservation aims prevail, one should always consider the season and the projected race route, seeking alternatives if necessary. Creating new trails or paths for specific events should never be allowed, as well as night races. Races should start at least half an hour from the park limits to avoid large groups of riders arriving simultaneously on narrow roads or trails, and if this is not possible, small groups departing at short intervals should be arranged.

In the interest of limiting conflicts and impacts of popular outdoor recreational activities, it is preferable to sacrifice one day in the year, welcoming between 15 to 25 % of new visitors to participate in an organised event, than to have similar numbers of practitioners disorderly spread around every weekend during peak season. Finally, both environmental and social, direct and indirect knock-on effects of races should be evaluated in collaboration with practitioners and promoters

(Campbell et al., 2021). This would allow participant numbers in future iterations of a race to be increased or decreased, with the agreement and understanding of all those involved, promoting compatibility between recreational uses, events, and nature conservation in these peri-urban contexts.

## Acknowledgments

This work was financed by national funds through FCT-Foundation for Science and Technology, I.P., within the scope of the project “UIDB/04647/2020” of CICS.NOVA-Centro Interdisciplinar de Ciências Sociais da Universidade NOVA de Lisboa. The fourth author was also financed by national funds through the FCT, under the Norma Transitória-DL 57/2016/CP1453/CT0004. The work was also supported by the National Institute of Physical Education of Catalonia (INEFC), Spain.

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**Conflict of interest:** no conflict of interest was reported by the authors.



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