sustainability

MDPI

Article

Particular Dimensions of the Social Impact of Leisure Running: Study of Poland

Jakub Ryszard Stempień [1,*], Magdalena Dąbkowska-Dworniak [2], Małgorzata Stańczyk [3,4], Marcin Tkaczyk [3,4] and Bartłomiej Przybylski [5]

1 Department of Rural and Urban Sociology, University of Lodz, 90-136 Lodz, Poland
2 Department of Economics and Finance, Jan Kochanowski University in Kielce, 25-369 Kielce, Poland
3 Department of Pediatrics, Immunology and Nephrology, Polish Mother's Memorial Hospital Research Institute of Lodz, 93-338 Lodz, Poland
4 Department of Pediatrics, Nephrology and Immunology, Medical University of Lodz, 90-419 Lodz, Poland
5 Department of Social Structures and Social Change, University of Lodz, 90-136 Lodz, Poland
* Correspondence: jakub.stempien@uni.lodz.pl

Abstract: This study addresses the social impact of the popularity of recreational running (called: running boom). Four dimensions are classified: (1) economic, (2) health and psychological well-being, (3) environmental and (4) social (in narrow sense). The first three of these were included in the analysis performed. The analysis relates to Polish society in 2018 and is based on a thought experiment assuming that 3.4 million recreational runners engage in leisure activities as passive and indifferent to their surroundings as possible instead of running. What economic, health, and environmental consequences would this have? The interdisciplinary analysis uses and combines existing scientific findings. The economic effects of the running boom include at least PLN 1.7 billion spent annually on the purchase of running equipment (not including effects related to employee health, development of running tourism, etc.). The health effects include at least a 30% reduction in the risk of death in the next 15 years for the population of runners. Finally, the carbon footprint of Polish amateur runners can be estimated at 2.9 million tons of CO_2.

Keywords: leisure running; leisure-time sport; running events; running boom

check for updates

Citation: Stempień, J.R.; Dąbkowska-Dworniak, M.; Stańczyk, M.; Tkaczyk, M.; Przybylski, B. Particular Dimensions of the Social Impact of Leisure Running: Study of Poland. *Sustainability* **2022**, *14*, 11185. https://doi.org/10.3390/su141811185

Academic Editors: Ewa Malchrowicz-Mośko and Grzegorz Kwiatkowski

Received: 30 June 2022
Accepted: 2 September 2022
Published: 7 September 2022

1. Introduction

Recreational running seems to be a phenomenon that has permanently entered the contemporary social life. Over the last decades, it has involved millions of people around the world, and it is worth asking about the multidimensional consequences of this social phenomenon. The beginnings of running's popularity can be traced back to the second half of the 20th century in the United States. Already, the 1970s were proclaimed in 1980 by the *Chicago Daily Herald* as the decade of running. At the end of this decade, the number of people completing the New York City Marathon exceeded 10,000 [1]. As statistics show, both the number of marathon events and the number of participants increased during this period [1]. The fact that the beginnings of the popularity of recreational running were in the 1970s is no coincidence. It was then that the so-called fitness revolution took place [2], conditioned, among other things, by the popularity of Marc Lalonde's report "A New Perspective on the Health of Canadians", which was published in 1974. Lalonde emphasized the great importance of the influence of lifestyle on an individual's health, confronted with the significance of such elements as genetic factors, environmental conditions, and especially the functioning of healthcare [3].

In the 1970s and 1980s the so-called first wave of the running boom took place. Then, in the 1990s, in a global perspective, the number of participants in running events and the number of events themselves remained relatively stable [1]. However, since the beginning of the 21st century, we have been observing the so-called second wave, which is distinctive in its specific features. First, it covers not only North America and Europe (like the first wave), but also other continents, especially Asia. As Scheerder, Breedveld and Borgers [1] reported, in 2013, marathon participants in Asia accounted for as much as 18.7% of the global marathoner population, while in 1980 this percentage was only 0.4%. At the same time, the share of marathons held in Asia in the global volume of such events increased from 4.6% to 10.5%.

The running boom has thus become a global phenomenon. At the same time, the second wave is marked by an egalitarianization of running, which is now also attractive to women and people of all ages [1], although it still remains dominated by people of higher social status [4,5]. It is also a much "higher" wave than the one observed in the 1970s and 1980s. This means that leisure running is now much more popular than it was during the first wave. The report "The State of Running 2019" [6] mentions 70,000 running events that were to be held worldwide in 2019, in which 107.9 million people were expected to participate (the authors write about individual results). The European population of amateur runners was estimated at 45–55 million people at the beginning of the second decade of the 21st century [7]. International studies show that the COVID-19 pandemic had not limited the amateur running activity [8].

2. Aim and Theoretical Perspective of the Study

The running boom is the subject of studies and research conducted by representatives of numerous scientific disciplines. Authors of humanist- and social-science-orientation papers generally analyze changes in the intensity of the phenomenon over time, extract profiles of amateur runners from studies, and consider issues of runners' motivation [1,9,10]. In contrast, representatives of physical culture and health sciences are keen to focus on the effectiveness of running training, running injuries, the role of physical activity in disease prevention, etc. [11–16]. Economists consider the issue of the size and structure of the so-called running market [7,17–20].

It can be stated, however, that current academic investigations of the running boom are inadequate for at least two reasons. Firstly, there is a lack of interdisciplinary analyses of the phenomenon in question, in which the perspectives of individual scientific disciplines are integrated. Second, there is no concrete question about the output of the running boom. Usually the running boom is "justified" on the basis of large-scale health, as well as psychological and possibly economic benefits associated with mass physical activity. However, we strongly emphasize that these justifications lack precision and concrete data. The question of possible negative effects of the popularity of recreational running (if we do not consider running injuries) is not addressed at all. Thus, the purpose of our work is to develop an answer to the following questions: How are the lives of contemporary people, contemporary societies, co-shaped by the running boom? Would it be different from today if the phenomenon of the running boom did not exist? In other words, the aim of this paper is to examine the social impact of the running boom.

In our view, in the broadest terms, the social impact of the running boom can be noted and analyzed along four dimensions: (1) economic; (2) health and psychological well-being; (3) ecological/environmental; (4) social, in narrow sense.

In order to estimate the social impact of the popularity of recreational running, it would be reasonable to narrow the analysis to a specific area and indicate a time frame. Therefore, we would like to propose an analysis on a national scale (national population), with reference to one calendar year. We focus our considerations on the Polish population two years before the outbreak of the COVID-19 pandemic, so we refer to 2018.

Three of four distinguished dimensions (health, economic and environmental) have some common features, thus making it possible to include them in one study. These include a certain specific relevance in this case, first, of quantitative analyses and, second, of short-term analyses. In other words, it would be possible and reasonable to perform for these three dimensions a separate, methodologically unified national study estimating the effects of the running boom in the perspective of one year (or in other case, for example, five years or a decade). It seems that these effects would be perfectly measurable (quantitative), with reference, for example, to indicators such as the incidence of certain diseases (health dimension), demand for products, number of workplaces, contribution to GDP (economic dimension) or carbon footprint and, more broadly, ecological footprint (environmental dimension). The social impact, in the narrow sense of the running boom, should be analyzed in a separate study, conducted over a long period of time, taking into account the vector of social change and petrification, and conducted on three levels of sociological considerations (macro-social, mezzo-social and micro-social) [21].

Thus, in the presented work, we focus on the economic, ecological and health effects of the running boom that can be registered annually on a population scale. We will refer to the Polish population in 2018.

3. Materials and Methods

In order to operate answer to the question formulated above, regarding the social impact of the running boom in economic, health and environmental dimensions as precisely as possible, we relied on a thought experiment. It consisted in comparing the actual situation, in which a certain percentage of the population is engaged in recreational running, with a situation in which, instead of running, these people would devote themselves to leisure activities as passive and indifferent to their surroundings as possible, i.e., they would spend their time reading books borrowed from the nearby library (or from friends). What would be the public health, economic, and environmental consequences of this? An analysis designed in this way will make it possible to estimate a social impact of the running boom.

The analysis presented here will therefore be interdisciplinary. The primary method of the study will be the use of existing data (reports from national physical activity surveys, etc.), using concepts, measures and data appropriate for particular disciplines. A separate sub-analysis was conducted on each of the selected areas (economic, health and psychological well-being and environmental), with a common starting point (methodological assumptions and preliminary statistical data), and a final synthesis of findings. In the three sub-analyses, we relied on found data documenting the importance of recreational running (or more broadly: physical activity in general). Each sub-analysis was thus based on its own search of the literature. Its results—as a kind of element of the traditional "discussion" found in scientific texts—are covered in this paper. Based on the collected data, our own calculations were made, dedicated to the population of amateur runners in Poland in 2018, allowing us to estimate the significance of the running boom in each of the three dimensions.

Future forecasts in the field of health impact were based on calculations according to the naive method—a forecasting method for analyzing time series without trends. This method was used with a low coefficient of variation V < 5% and assuming that there will be no significant changes in the most important factors in the time frame of observation. Mathematical calculations based on a proportional prediction of variables were performed with MS Excel software and Statistica PL 10.0 package.

We shall start by pointing out that in representative surveys of the Public Opinion Research Center (CBOS), recreational running was declared by 11% of adult Poles in 2018 (see Table 1) [22]. Referring to the size of the Polish population that is 18+ as recorded by the Central Statistical Office (CSO), we can calculate that this percentage should refer to 3.4 million people. Of these, more than half (55%), i.e., 1.9 million people, report regular running, while the rest (45%; 1.5 million) run occasionally (see Table 2).

The population of Polish adult recreational runners consists of equal proportions of women (1.6 million) and men (1.6 million). The largest share is held by people between 25 and 44 years of age (1.3 million in total). In older age groups, jogging is somewhat less popular. The details are summarized in Table 1.

Table 1. Share of the population engaged in running/jogging in 2018 in the total population aged 18 and over—by sex and age.

Specification		**In %**	**Absolute Numbers (In Thousands)**
Total		11	3462
Sex	Males	11	1652
	Females	10	1645
Age	18–24 years old	28	316
	25–34	22	619
	35–44	11	680
	45–54	8	527
	55–64	3	581
	65 years old and older	2	741

Own calculations based on data Public Opinion Research Center (CBOS) and Central Statistical Office (GUS).

Table 2. Individuals engaged in recreational running in Poland in 2018—by regularity of training.

Specification	**In %**	**Absolute Numbers (In Thousands)**
Regularly	55	1904
Occasionally	45	1558
Total	100	3462

Own calculations based on data Public Opinion Research Center (CBOS) and Central Statistical Office (GUS).

Recreational runners in Poland willingly participate in so-called running events, i.e., sports competitions open to amateurs, where at least one of the disciplines is running a certain distance. The National Census of Runners 2014 showed that 58% of Polish recreational runners have participated in running competitions at least once in their lives. Men (63%) are more likely to do so than women (49%). It is meaningful that the willingness to participate in such events increases over the course of a running career. When asked about participation in competitions, 32% of those training for less than a year, 59% of those training for 1–2 years and 77% of those training running for at least three years answered in the affirmative [23].

As www.maratonypolskie.pl (accessed on 2 June 2022) shows, 4120 running events were organized in Poland in 2018. A representative study [24] documented that running events in Poland (measured for 2017) on average gather 339 participants at the starting line (arithmetic mean) and are most often held at a distance not exceeding 10 km (67%). The average run length in 2017 was 15.3 km. A majority (74%) of the competitions are held in cities, but they are generally small cities with a population of less than 100,000 (42% of all running competitions).

4. Results

4.1. Economic Impact of the Running Boom

In the scientific literature, it is not difficult to come across the view of the positive economic effects of both amateur and professional sport. According to the report "Polish Sport Market" of the Polish Economic Institute, "Polish sport generates more added value for the Polish economy than it seems, and it also provides an opportunity to reduce costs, among others, in the area of health care, hence every zloty spent on sport has a multiplier effect not only for the economy, but for the health of society" [25] (p. 4). One can guess that the value added to the economy is mainly brought by popular sports (e.g., soccer) that are played professionally, but recreational running also contributes to this.

We may learn also that if one were to consider different forms of activity in terms of the human cost incurred, running is a relatively inexpensive sport, especially if we are talking about recreational/amateur running, compared to other sports [26–29]. The longer a runner's running experience and commitment, the more money he or she spends on products related to the sport. We can consider the purchase not only of basic products but also of high-end ones or of additional equipment and apps [30]. With the growing interest in running, there are more and more specialty stores, but also, for example, discount stores are expanding their offer with products specifically aimed at runners. Pedometers, sports watches that monitor activity and various types of apps that, for example, monitor activity, motivate the user to run a certain distance, etc., are becoming more and more popular.

Scholars argue that running can improve the quality of health (disregarding injuries), then it improves productivity and efficiency at work [31], thus resulting in a promotion/raise and also benefiting the employer and business; however, at the same time, it can be assumed that, for medical entities, the runner brings financial losses because, for example, he or she does not have to buy medicines [32,33]. On the other hand, deteriorating health reduces a worker's productivity, which consequently lowers his or her salary and may limit participation in the labor market. Then the employer incurs costs (e.g., someone to replace the sick employee), while the treatment entities earn money from the sick person, e.g., from his/her treatment, etc.

One can encounter the statement that recreational running is a product of local and regional tourism [34], and as a product that sells well, it should bring economic benefits. The concept of cross-country tourism appears here, which "can be understood as a type of recreation that includes trips related to the pursuit of a running hobby" [35] (p. 63). Within the framework of cross-country tourism, we distinguish different types of trips: from independent ones through those with organizers (guided cross-country tours, cross-country camps or the most popular running events) [35] (p. 63). Growing interest in participation in running events causes there to be more and more such events. A running event can add prestige to the place where it takes place, making it well-known and frequented. It can also have a positive impact on the inhabitants, as the interest can result in local investments and thus improve the comfort of the inhabitants (e.g., by replacing/repairing sidewalks and streets). However, the organization of a mass run requires high costs, which are financed to a small extent by the runners themselves and to a larger extent by sponsors and public or local government funds, the help of volunteers is also useful [36]. Entry fees are often not enough to cover the basic costs of organizing the event. However, the better prepared the event is, the more it promotes the place (city, region, etc.) and helps to create its image. In addition, people accompanying runners also come to the run, among others, thus creating additional financial benefits for sponsors and regional entrepreneurs who organize additional services for fans [30]. Participation in a running event involves costs such as the entry fee, travel, accommodation and food (if one is a visitor), and if a runner comes with friends or family, more money is earned by local entrepreneurs for the group than for a single person. The magnitude of costs depends on individual components that are difficult to estimate.

The participation of volunteers in the organization of runs allows the organizers to significantly reduce costs, but it is difficult to quantify, because the volunteers not only give their time but often also lend their private equipment (phone, car, camera, etc.) or skills (e.g., taking pictures) [37]. Volunteering has a positive impact on those involved, as it allows us to broaden our interests, learn about an area from the inside or increase our self-esteem, as we feel important and needed in a place and in a group.

One may argue that interest in running or participation in mass races leads to the creation of companies, whether they deal with learning to run or organizing races, which thus creating additional jobs.

In conclusion, there is a mutual impact of recreational running (as an amateur sport) and the economy. Interest in running affects the economy. According to Stepan, "economic success is almost automatically linked to good health and a fit body" [38] (p. 9). Consequently, it can be assumed that sports, i.e., recreational running, among others, exclusively or mainly positively affect the economy. On the other hand, all of the above observations lack precision. Arguments are presented in favor of the thesis of the beneficial economic impact of sport (amateur and professional), but a direct question can be asked: how significant is this impact? So, let us take all the above statements as a basis for formulating a hypothesis about the significant economic impact of free-time sport—in our case, the running boom. We next try to verify this thesis.

According to a study conducted in 2014 by Stempień [39], it appears that runners spent on average PLN 1074.34 on running, of which PLN 642.52 was spent on equipment and PLN 431.82 on participation in competitions (with amounts higher for men by about PLN 80–100) (PLN means the Polish currency called "zloty"). If we assumed that these data are valid in 2018 (constant prices) and that runners who train regularly spend exactly the above amount on running equipment annually, while occasional runners spend half of it, we could calculate that the community of Polish recreational runners (constituted by 3.4 million people) spends PLN 1.7 billion on running equipment every year. Let us point out that an essentially similar value of the Polish running market was obtained by Breedveld and colleagues [7]. It turns out that they estimated the amount of consumer expenditure at 313 million EUR in 2013, which can be roughly translated into 1.4 billion PLN (assuming an exchange rate of 1 EUR = 4.5 PLN).

Summing up the above information, we can say that recreational running, which is a cheap leisure-time sport and does not bring such financial benefits to the economy as, for example, skiing or soccer, positively influences the economy, because, at least for the purchase of equipment alone, runners spend, according to the presented data, about 1.7 billion PLN per year. However, if we look at it from a broader perspective, i.e., globally and from the Polish economy according to its own calculations based on data Central Statistical Office (GUS), the above amount in 2018 accounted for 0.08% of the domestic demand and 0.09% of the gross value added (while it accounted for 12% of the gross value added concerning activities related to culture, entertainment and recreation), so it can be said that it is practically unnoticeable and does not contribute to the economic development of the country to a greater extent. Referring to our thought experiment, we can conclude that if 3.4 million Polish amateur runners stopped training, it would have consequences (probably negative) in terms of the national economy that would be difficult to notice. It would simply be an extremely insignificant event.

4.2. Impact of the Running Boom on Health and Psychological Well-Being

Running is considered a healthy form of physical activity, although the literacy on the topic of the runners themselves is not always based on current medical knowledge [40]. Although it would seem obvious from a doctor's point of view, a healthy lifestyle is not the primary motivation for people who decide to engage in such physical activity. Gerasimuk et al. analyzed the motivation of amateur runners to start this physical activity and found that that pro-health motivation concerns mainly people aged 41–50 who decide to participate in the marathon, while younger and older decide to run mainly for non-health reasons; the runners aim to achieve their goals and be able to test themselves and compete [10]. It could be said that, in these groups, the health consequences of running are merely a by-product, not an end in themselves. However, despite this, these ambitious runners are "exposed" to the good side effects of their passion, whether they like it or not.

The health benefits of running are wide. In the literature, the positive effect of running is raised, especially in relation to the condition of the circulatory system and cardiovascular risk, which can be translated into prolonged life as a result of lower risk of cardiovascular diseases (CVD), i.e., strokes and heart attacks. A meta-analysis conducted in 2020 by Pedisic et al. showed that, regardless of the time spent on running, it probably significantly improves the health of the population and extends the life span [11]. The authors conclude that any time you spend on running, even $1\times$/week, is better than no running, but there is no simple correlation between the intensity-amount of running and the degree of health-promoting effects. However, the reviews of the literature presented in 2015 and 2018 by Lavie et al. and McMullen et al., respectively, highlighted gaps in scientific knowledge in relation to the long-term effects of long-term intensive and regular running [41,42]. In recent years, evidence of myocardial fibrosis, arrhythmia and calcification of the coronary vessels has been shown in people undergoing high-intensity exercise. It is difficult to say about the prognostic value of these data, but it does not seem appropriate to recommend the pursuit of vigorous, long-term physical exertion. Therefore, if we assume that amateur runners are mostly in the moderate-intensity group, then running has significant health benefits for them. In order to determine the extent of the positive effects of running on the risk of CVD, one can cite the American study by Lee et al., which analyzed the relationship between running and the risk of death due to cardiovascular events in a group of 55,137 adults (mean age 44 years) over 15 years. About 24% (i.e., approx. 13,233) of them were runners [13]. Compared to non-runners, they had a 30% and 45% lower risk of dying from all causes and cardiovascular causes, respectively, gaining a 3-year greater life expectancy. What is more is that even short intervals of time spent on running and low intensity of running significantly reduced the risk of death. Long runners (mean 5.9 years) were found to have the lowest risk of death. A total of 3.4 million people run regularly in Poland, which is 11% of the adult population (see Table 1). Of course, the pro-health effect of running becomes apparent after several years. So, if all 3.4 million people would stop running, in this group, their risk of death within 15 years would increase by at least 30% (from 30 to 46 deaths/10,000 patient years of follow-up) and the estimated life expectancy would be shortened by about 3 years. Consequently, approximately 69,000 more people from this group would die within 15 years. It can also be postulated that, in the next fifteen years, this group of adult Poles (31.5 million) would die less by 90,000 people and the estimated life expectancy could be extended by about 4–5 months.

Taking into account the data from the cited works, one must not forget about the critical analysis of the participant qualification system for research, which assumes that the running fashion concerns people with initially similar health condition, on whom regular physical activity has a beneficial effect.

A very interesting issue in light of the running boom in association with intense career activity seems to be the assessment of the health consequences of running in only free time, such as a weekend. O'Donovan et al. conducted a study in which they showed the relationship of such cumulative physical effort (group of so-called "weekend warriors"—reporting moderate activity lasting at least 150 min/week or vigorous activity lasting at least 75 min/week during one or two sessions) with the risk of death in general and related to CVD and cancer. Compared to inactive participants, the weekend warriors had a 34% lower risk of death overall, a 40% lower risk of dying from CVD, and an 18% lower risk of dying from cancer. Weekend warrior also enjoys health benefits, as do those who adhere to regular physical activity [43]. It can be postulated that increasing the percentage of people who only run on weekends could also contribute to the reduction of cardiovascular risk in the Polish population. There are not enough precise data from Poland, according to which a more in-depth calculation can be made, because the available works do not distinguish this specific group of runners in Poland.

Among the positive health consequences measurable for the Polish population, there is also a reduction in the risk of developing type 2 diabetes [12]. Data from 19,347 adults were analyzed at two time points. The mean follow-up was 6 years. Approx. 29.5% were running as amateurs from the beginning of the observation. It was calculated that runners had a 28% lower risk of developing type 2 diabetes compared with non-runners. It was also found that the longer you spend running, the lower your risk of developing diabetes is. If the running population in Poland decreased to 0% from 11%, 2% more people from this population (68,000) would develop diabetes within 6 years.

The literature also provides other evidence of the health benefits of amateur running: Improving body composition and aerobic fitness and enhancing muscle performance [44]. Amateur running is associated with a lower risk of depression [45]. A link between moderate exercise and the induction of good mood and enhancement of executive functions has been noticed, as demonstrated by neuroimaging techniques showing cortical activation of the relevant brain regions responsible for inhibitory control and mood regulation [46]. It has been noticed that running can be a form of therapy for many psychological conditions, i.e., depression, anxiety, tension, mood changes, low self-esteem, etc. [47].

The health consequences of the running boom, although as mentioned to be largely a real health good, may also have some undesirable effects. Knowledge or supposed knowledge (widespread, but not supported by scientific evidence) about health risks may result in reduced willingness to engage in such activity. Life-threatening running situations occur under exceptional circumstances and are described as casuistry rather than the typical adverse effects of running. The literature describes, inter alia, exercise-induced anaphylaxis or massive rhabdomyolysis after running an ultra-marathon [14–16]. Extensive analyses were also carried out on the frequency and causes of sudden cardiac deaths (SDC) during intense physical effort such as marathon or ultra-marathon. The frequency of these events varies between 1:11,000 and 1:80,000 depending on gender and age [48,49]. However, at the root of these events are genetically determined or acquired cardiovascular abnormalities that have not been detected previously. Therefore, it should be emphasized that in a truly healthy population (previously tested for cardiovascular abnormalities), these events are unheard of. As long as people starting recreational jogging are healthy, SCD will not be a burden for the general population—in other words, the risk of this type will be the same for runners and non-runners. Moreover the health consequence of not running, as mentioned earlier, will be an increased risk of cardiovascular disease.

In fact, the most vital risk is the negative health consequences of running, which are injuries of the musculoskeletal system, such as damage to the knee and ankle joints, tendons and aponeuroses, along with inflammation and pain, as well as stress fractures. In a study by Fokkema et al., it was shown that injuries are the most common cause of the discontinuation of running in people who have started such physical activity. Among less than 30% of those who stopped running within 6 weeks of starting, 48% mentioned injuries related to running as the cause [50]. It has been investigated that an increased risk of injuries occurs particularly in people who had previously suffered an injury (before starting sports activity), are overweight, run in competitions and run intensively (>2 h/week and >20 km/week) [51]. Interval training, on the other hand, can reduce the risk of injury [52]. Although the risk of injury in runners seems to be increased, there is evidence that recreational running is not so heavily burdened with it. In the literature review, Alentorn-Geli et al. indicate that recreational runners have the lowest risk of hip and knee injuries compared to professional runners and the control group (incidence of these injuries respectively: 3.5% vs. 13.3% vs. 10.2%) [53]. These results indicate that not only long-term vigorous running poses a risk of damage to the musculoskeletal system but the lack of any activity also contributes to it. Therefore, it can be speculated with high probability that in the group of adults from 2018 practicing amateur jogging, optimization of the risk of injuries can be achieved. If this group (3.4 million people) stopped running permanently, paradoxically, it would almost triple the risk of osteoarticular complications in the next few years. Based on the estimated calculations, the number of people requiring medical interventions would increase numerically from 119,000 to 347,000. On the other hand, increasing the percentage in the Polish population from 11% to 24% (recorded in other highly developed countries) could bring about a 6.5% reduction in the need for these interventions in the group of people that would start recreational running—i.e., 270,000 fewer patients with chronic joint problems.

Based on the belief in the health-promoting effect of running, numerous studies are constantly conducted, which in effect are performed to minimize the risk of injuries and increase the efficiency and satisfaction with running, and thus contribute to maintaining the observed global trend—the running boom. So far, it is unclear how to reduce the risk of injury while running—the effectiveness of any currently used intervention for this purpose has not been absolutely proven [54]. In addition to attempts to identify factors that increase the risk of injuries, newer and newer technological solutions are being developed. For example, special shoes (smart shoes) are being designed, thanks to which it is possible to achieve optimal energy expenditure and optimal heart function during physical activity and monitor daily physical activity [55]. The hardness and weight of the shoes are analyzed in terms of injuries risk [56,57]. Exoskeletons are constructed to improve running performance [58–60]. All of these solutions may have the potential to reduce the risk of injuries and improve the quality of running, which could ultimately lead to an increase in the number of regular runners and, as a result, increase the health and life expectancy of the population.

There are data in the literature that running in a polluted environment might potentially negatively impact the runners' health. Both populations, the professional and leisure runners, could be affected. Zoladz et al. proved that a marathon run increases the rate of deposition of the airborne particulate matter in the respiratory tract of the runners as a consequence of the minute ventilation generated during the race. They also reported that a decrease of the particulate matter content in the air attenuated this process [61]. The air pollution showed a negative impact on the athletic performance with regard to maximal exercise performance or maximal oxygen utilization [62,63]. Furthermore, after running in an unfriendly environment, the authors reported increased perceived exertion level and reduced lung function and irritation. Increased pollution levels were responsible for slower marathon times, especially in less professional runners [64,65]. There is therefore an agreement between experts that there should be special consideration given to the pollution level in the environment of planned marathon runs upon analysis because of the proven influence on performance and potential effect on health. It can be also postulated that the choice of events located in the rural areas (potentially less polluted) is more justified for health-related reasons. In conclusion, recreational running has clearly beneficial health aspects for a runner, which extend to the entire population and may affect the general adult population in Poland. Based on the data from the available professional literature, one can speculate that the promotion of this leisure activity significantly reduces the risk of death, diabetes incidence and the number of hip and knee joint injuries for the population. The postulated numbers are so important that they may be of importance for the organization of health care and the costs of providing it throughout the country.

4.3. Environmental Impact of the Running Boom

This subsection focuses on the ecological consequences of the running boom. Ecological analyses in the field of sports and recreational activities still have a rather novel value, although some tools and concepts proven in other areas of analysis can be used here. Thus, the framework of this analysis is the concept of the ecological footprint.

"Ecological footprint" is an umbrella term—a collective concept including several more specific concepts, such as carbon footprint, water footprint, energy footprint, or environmental footprint [66]. In general, the term "ecological footprint" refers to the amount of land necessary to sustain any kind of human activity and capable of absorbing the consequences and side effects of such activity, i.e., the waste or greenhouse-gas emission produced. A concept invented by Wackernagel and Rees [67] was later developed into a tool used in many particular areas, for example: to assess systems' sustainability [68], biotechnology and bioengineering [69], urban areas' regeneration processes [70,71], goods production and supply chains [66] or fuel production [72].

"Carbon footprint" is more specific term, but as well as ecological footprint, it lacks a clear definition in science. It refers to a broad spectrum of tools used to assess the amount of greenhouse-gas emissions produced in connection with various human activities. Despite the name, the carbon footprint concept is used to analyze not only carbon dioxide but the overall GHG emissions [73]; however, some authors distinguish more specific tools, such as the nitrogen footprint, which is used to assess the amount of nitrous oxide produced, especially in agriculture [74]. Nevertheless, the carbon footprint is a tool used to assess the sustainability of different industries, individual consumption, and communication [75], as well as green policies' development and implementation processes [76]. Moreover, this tool has also been used lately in the analyses of sports and recreational activities, including active sports participants in general [77], sports tourism [78], skiing and snowboarding [79], university team sports events [80], football fandom [81], and—what is most interesting from the point of view of the topic of this paper—marathon runners [82]. There is also relatively a significant number of analyses of sports mega-events' carbon footprints, especially FIFA World Cup events [83–87].

"Water footprint" is a term that refers to the amount of freshwater that is consumed during the execution of any human activity. This concept is used mainly as a theoretical concept and analytical tool in the analyses in the field of agriculture [88], food production [89], food consumption [90], and food-waste production [91].

"Energy footprint" and "environmental footprint" are the terms used in engineering sciences and refer to the amount of resources consumed by a product or performance during its lifecycle, with the latter concept taking into account multidimensional criteria, not only the amount of energy needed. Those are applicable in the analyses of the footprint of different materials, including textiles used in sportswear [92,93].

In the area of the methodology for calculating the ecological footprint, we can observe a large variety, which is probably partly a derivative of the terminological diversity described above and partly a result of methodological problems with calculating the precise and reliable values. In addition to the analyses mentioned above, there are also many online open-access ecological footprint calculators, with Global Footprint Network's Ecological Footprint Calculator being one of the most popular and most extensive of them. These online footprint calculators are a combination of an extensive survey questionnaire with a self-diagnostic tool. As Kok and Barendregt [94] point out, there is ample evidence that this kind of tool has several impacts on individual behavior, with the most important impact being enhancing knowledge about ecology. On the other hand, online footprint calculators may also have negative effects, such as provoking the emotions of doubt and hopelessness in more environmentally aware users, or undermining users' confidence in the tool, related to the expectation to provide very detailed and complex information in the survey.

The last issue is also related to the fundamental methodological problem of the ecological footprint analyses of human activities, including sports and recreational activities such as leisure running. Based just on the existing data, it is impossible to fully assess the level of ecological or carbon footprint in this field. Only an extensive survey focusing on the exact lifestyle of leisure runners could provide relevant data enabling the measurement of the environmental impact of such forms of activity. The studies that resulted in the specific estimation of carbon footprint of sports participants, such as Wicker's study [77], were based on the data collected in a survey. An average yearly footprint of 844 kg of carbon dioxide emissions has been estimated, and this study was restricted to active sports participants in Germany in 2015. Wicker's finding included also that nature sports and individual sports participants were responsible for higher numbers of emissions, suggesting that if we would like to assess the carbon footprint of the leisure runners, we should take into account values higher than average. On the other hand, technological progress and the trend to include more environmentally sustainable materials, processes and technologies in the production of different items (including sportswear, for example), as well as raising awareness of the need for sustainable solutions during sport events (including substituting single-use plastic cups or bottles with seaweed ecologic cups, as was practiced at the London Marathon, or resigning from sending paper information to the participants, as was practiced at the Boston Marathon), suggest that the values of carbon footprint identified in Wicker's study, may be significantly reducing from year to year. Assuming that Wicker's average carbon footprint value could be the value approximately describing the environmental impact of an average leisure runner in Poland, the environmental impact of Polish "running boom" can be estimated as shown in Table 3.

Table 3. Share of the carbon footprint of the population engaged in running/jogging in 2018 in Poland.

Specification		In %	Carbon Footprint (In Tons of CO_2)
Total		11	2,921,928
Gender	Men	11	1,394,288
	Women	10	1,388,380
Age	18–24 years old	28	266,704
	25–34	22	522,436
	35–44	11	573,920
	45–54	8	444,788
	55–64	3	490,364
	65 years old and older	2	625,404

Own calculations based on data Public Opinion Research Center (CBOS) and Central Statistical Office (GUS) and Wicker (2019).

If we want more precise estimation, the following minimal set of data would be required to assess the carbon footprint of a leisure runner:

- What additional sportswear do the leisure runners purchase in connection with their activity?
- What additional equipment do the leisure runners purchase in connection with their activity?
- Where do they run—near or far from their everyday-life activity spaces—-and what kind of transportation they use to get there?
- Do they participate in running events, and if yes, how often, how far from their place of living, and what kind of transportation do they use to get there?
- How does running affect their hygiene and dietary patterns?

Despite the inability to calculate a precise and complete carbon footprint, estimations of the ecological impact of specific aspects of running can be shown in Table 4.

Table 4. Carbon footprint of running shoes of leisure runners.

Specification		In %	Absolute Numbers (In Thousands)	Carbon Footprint (In Tons of CO_2)
Total		100	3462	77,042
Number pair of running shoes	1	47	1627	22,778
	2	31	1073	30,044
	3	10	346	14,532
	4 or more	5	173	9688
	No special shoes	5	173	0

Own calculations based on data from Narodowy Spis Biegaczy (2014) [23] and the estimated average value of carbon footprint of running sneakers [95].

Data—though non-representative and collected in various research studies by using various methodologies [19,23,39,96]—clearly show that the majority of Polish leisure runners run in everyday-life activity spaces, using existing pavements or walking alleys. The eventual participation in running events is most likely restricted to local and/or regional events, hence, it does not require long-distance travels. Even if Polish runners participate in running events abroad, most of them choose events in the neighboring countries of Germany and Czechia [96], so it may be assumed that they do not require air travel, which—in all estimations mentioned above [82]—turns out to be the main environmental cost connected to sports activities. Given that the average Polish leisure runners run in their everyday-life activity spaces, and they participate in seven running events annually, to which they travel on average 100 km from their hometown by a medium petrol car, they produce an estimated 280 kg of CO_2; this would give a total amount of over 969 kilotons of CO_2 per year for the whole Polish leisure runners' community.

When it comes to the environmental impact of runners' equipment, the carbon footprint of purchasing special footwear dedicated to this kind of activity can be estimated. For example, given that an average pair of sneakers has a carbon footprint of 14 kg of carbon dioxide, we performed calculations for Polish leisure runners and present them in the Table 4.

On the other hand, dietary patterns may be the only lifestyle element related to running that can contribute to reducing the carbon footprint. A total of 25% of Polish runners declare following a special diet that is dedicated to their activity, but without any further detailed specifications [39]. On the other hand, 13% of the running population in Poland declare a vegetarian or vegan diet. Within the estimation that the vegetarian diet (in comparison to regular diet) spares 0,8 ton of emissions, the Polish leisure-running community would contribute to the reduction of its carbon footprint even by up to 360 kilotons of carbon dioxide per year.

These estimations suggest that a likely higher negative impact on environment, connected to using sports equipment, footwear and sportswear, additional travels, litter produced during sports events, etc., may be compensated with other sports-related aspects that are more environmentally friendly, for example, a more planned diet, less fossil-fuel-dependent travel patterns, healthier everyday routine, etc. Eventually this calculation might even prove the insignificance of sports activity in regard to the overall carbon footprint of the population.

More detailed research and data on carbon footprint of leisure running (and carbon footprint of other everyday life activities) would be required to enable more precise estimations or calculations.

5. Conclusions and Limitations

The analysis that we presented in this paper was based on a thought experiment. What changes could be observed if—in the case of Polish society—all recreational runners (and there were 3.4 million of them in 2018) gave up their passion in favor of passive and indifferent leisure activities (such as reading books borrowed from the library)? We considered the social impact of the running boom on three dimensions: economic, health (along with the issue of psychological well-being) and environmental. The analyses performed allow us to formulate the following conclusions.

In economic terms, one would expect the following consequences of the disappearance of the running boom in favor of physically indifferent and passive entertainment:

- PLN 1.7 billion would be lost from the national economy—that is how much domestic demand would decrease. This would mean a reduction in demand (and therefore sales) by 0.08%.

In health and psychological-well-being terms, one would expect the following consequences of the disappearance of the running boom in favor of physically indifferent and passive entertainment:

- In the in-scope population the risk of death within 15 years would increase by at least 30% and the estimated life expectancy would be limited by more or less 3 years. This means that about 69,000 more people from this group would die within 15 years (considering size of Polish society as 38 million of people, this gives a number of 0.2%).
- 2% more people from the in-scope population (68,000) would develop type 2 diabetes within 6 years.

- The risk of osteoarticular complications would nearly triple in the next few years. The number of people requiring medical interventions would rise to 347,000.

In environmental/ecological terms, one would expect the following consequences of the disappearance of the running boom in favor of physically indifferent and passive entertainment:

- The national carbon footprint would decrease by about 2.9 million tons of CO_2.

One may ask how to judge the economic, health and environmental impact of the running boom presented here. Is it substantially significant on a population-wide scale?

We believe that our analysis proves that the economic impact of the running boom that was raised in some works and studies is overestimated. The impact of this phenomenon on the national economy (sales and labor market) is actually negligible and the positive economic results developed (however unquestionable) are more than modest.

On the other hand, the effects of the running boom on public health seem more significant. It can be assumed that about 0.2% of the population is protected from premature death and the same percentage from developing type 2 diabetes, i.e., from a serious chronic disease. Admittedly, this is not a high percentage, but we are referring here to the supreme values of health and life.

If we claim that, in our thought experiment, the national carbon footprint would decrease by about 2.9 million tons of CO_2 (due to the disappearance of the running boom), this would mean a "saving" of about 75 kg of CO_2 for each of Poland's 38 million citizens. This is a modest result, given that it is estimated that the annual carbon footprint of a Polish resident is about 8–9 tons of CO_2. Therefore, a cautious opinion can be formed that the carbon footprint of the running boom (as well as its economic significance) is not significant on a population-wide scale.

It is difficult to compare the social costs and benefits of the running boom. However, the question of this balance should be asked. We hope that our work will contribute, at least in a modest way, to the enrichment of social imagination and awareness, which are the keys to actor-driven action.

Our study has certain limitations. First of all, regarding the economic dimension, we must admit that the basic problem was the lack of sources discussing the economic importance of recreational running in relation to Polish society. Much more readily available were studies on the economic impact of sports in general or physical recreation as a whole. Regarding the health issue, we assumed that reports concerning the population of runners in high-income nations might be directly translated into the environment of average- and low-income countries. The chosen methods of prognosis are of quite low quality and gave no possibility of "ex ante" assessment. In case of an environmental issue—what we have already mentioned—the major problem was the terminological chaos (should we instead be talking about carbon footprint, or maybe ecological footprint, and how to calculate it). We also have to face the problem of the lack of data that could enable more precise calculations.

Author Contributions: Conceptualization, J.R.S.; methodology, J.R.S.; software, not applicable; validation, J.R.S.; formal analysis, M.D.-D., M.S., M.T., and B.P.; investigation, not applicable; resources, J.R.S., M.D.-D., M.S., M.T., and B.P.; data curation, J.R.S., M.D.-D., M.S., M.T., and B.P.; writing—original draft preparation, J.R.S., M.D.-D., M.S., M.T., and B.P.; writing—review and editing, J.R.S.; visualization, J.R.S. and B.P.; supervision, J.R.S.; project administration, J.R.S.; funding acquisition, not applicable. All authors have read and agreed to the published version of the manuscript.

Funding: This study received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Publicly available datasets were analyzed in this study. This data can be found here: www.maratonypolskie.pl; https://stat.gov.pl/.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Scheerder, J.; Breedveld, K.; Borgers, J. Who Is Doing a Run with the Running Boom? The Growth and Governance of One of Europe's Most Popular Sport Activities. In *Running across Europe. The Rise and Size of one of the Largest Sport Markets*; Scheerder, J., Breedveld, K., Eds.; Hampshire: Palgrave Macmillan, UK, 2015; pp. 1–27.
2. Scheerder, J.; Van Bottenburg, M. Global running. Evolutie van de loopsport vanuit een internationaal perspectief. In *Vlaanderen loopt! Sociaal-Wetenschappelijk Onderzoek Naar de Loopsportmarkt*; Scheerder, J., Boen, F., Eds.; Academia Press: Ghent, Belgium, 2009; pp. 43–78.
3. Hancock, T. Lalonde and beyond: Looking back at "A New Perspective on the Health of Canadians". *Health Promot.* **1986**, *1*, 93–100. [CrossRef]
4. Curtis, J.; McTeer, W. Toward a Sociology of Marathoning. *J. Sport Behav.* **1981**, *4*, 67–81.
5. Bridel, W.; Markula, P.; Denison, J. Critical consideration of runners and running. In *Endurance Running—A Socio-Cultural Examination, Bridel, W., Markula, P., Denison, J., Eds.*; Routledge: London, UK, 2016; pp. 1–15.
6. Andersen, J.J. The State of Running 2019. 2020. Available online: https://runrepeat.com/state-of-running (accessed on 31 December 2021).
7. Breedveld, K.; Scheerder, J.; Borgers, J. *Running across Europe: The Way Forward In Running across Europe. The Rise and Size of one of the Largest Sport Markets*; Scheerder, J., Breedveld, K., Eds.; Hampshire: Palgrave Macmillan, UK, 2015; pp. 241–264.
8. DeJong, A.F.; Fish, P.N.; Hertel, J. Running behaviors, motivations, and injury risk during the COVID-19 pandemic: A survey of 1147 runners. *PLoS ONE* **2021**, *16*, e0246300. [CrossRef] [PubMed]
9. Waśkiewicz, Z.; Nikolaidis, P.T.; Chalabaev, A.; Rosemann, T.; Knechtle, B. Motivation in ultra-marathon runners. *Psychol. Res. Behav. Manag.* **2018**, *12*, 31–37. [CrossRef]
10. Gerasimuk, D.; Malchrowicz-Mośko, E.; Stanula, A.; Bezuglov, E.; Achkasov, E.; Swinarew, A.; Waśkiewicz, Z. Age-Related Differences in Motivation of Recreational Runners, Marathoners, and Ultra-Marathoners. *Front. Psychol.* **2021**, *12*, 738807. [CrossRef]
11. Pedisic, Z.; Shrestha, N.; Kovalchik, S.; Stamatakis, E.; Liangruenrom, N.; Grgic, J.; Titze, S.; Biddle, S.J.; Bauman, A.E.; Oja, P. Is running associated with a lower risk of all-cause, cardiovascular and cancer mortality, and is the more the better? A systematic review and meta-analysis. *Br. J. Sports Med.* **2020**, *15*, 898–905. [CrossRef]
12. Wang, Y.; Lee, D.; Brellenthin, A.G.; Eijsvogels, T.M.H.; Sui, X.; Church, T.S.; Lavie, C.J.; Blair, S.N. Leisure-Time Running Reduces the Risk of Incident Type 2 Diabetes. *Am. J. Med.* **2019**, *10*, 1225–1232. [CrossRef]
13. Lee, D.; Pate, R.R.; Lavie, C.J.; Sui, X.; Church, T.S.; Blair, S.N. Leisure-time running reduces all-cause and cardiovascular mortality risk. *J. Am. Coll. Cardiol.* **2014**, *64*, 472–481. [CrossRef]
14. John, M. Exercise induced anaphylaxis: One more cause for syncope. *West Va. Med. J.* **1994**, *12*, 518.
15. Lecina, M.; López, I.; Castellar, C.; Pradas, F. Extreme Ultra-Trail Race Induces Muscular Damage, Risk for Acute Kidney Injury and Hyponatremia: A Case Report. *Int. J. Environ. Res. Public Health* **2021**, *21*, 11323. [CrossRef]
16. Chlíbková, D.; Knechtle, B.; Rosemann, T.; Tomášková, I.; Novotný, J.; Žákovská, A.; Uher, T. Rhabdomyolysis and exercise-associated hyponatremia in ultra-bikers and ultra-runners. *J. Int. Soc. Sports Nutr.* **2015**, *12*, 29. [CrossRef] [PubMed]
17. Hertrich, S.; Mayrhofer, U. Adidas, le Marché des Chaussures de Running. 2015. Available online: https://EconPapers.repec.org/RePEc:hal:journl:hal-01205745 (accessed on 29 June 2022).
18. Reis, T.S.M.; de Lima, A.M.R.; Cister, A.M. NIKE CORRE: Generation Y moves the running market. *J. Sports Sci.* **2016**, *4*, 300–310.
19. Waśkowski, Z.; Jasiulewicz, A. Aktywność sportowa polskich biegaczy i wynikający z niej potencjał marketingowy. *Qual. Sport* **2017**, *3*, 20–30. [CrossRef]
20. Kasperska, E. Service Market for Organisers and Participants of Running Events. *Ekon. Probl. Usług.* **2018**, *130*, 55–66. [CrossRef]
21. Stempień, J.R. Social footprint of the leisure running boom in Poland. *Pol. Sociol. Rev. in print*.
22. Omyła-Rudzka, M. *Poles' Physical Activity*; CBOS report No. 5776/2018; CBOS: Warsaw, Poland, 2018.
23. Raport Polska Biega-Narodowy Spis Biegaczy 2014 [The National Census of Runners 2014]. Available online: http://polskabiega.sport.pl/pdf/nsb_raport.pdf (accessed on 31 December 2021).
24. Stempień, J.R.; Mielczarek, R.; Tokarski, J. New perspectives in social studies on recreational running: The case of Poland. *Phys. Cult. Sport. Stud. Res.* **2021**, *93*, 24–37. [CrossRef]
25. Kutwa, K.; Rafał, M. *Polish Sport Market*; Polish Economic Institute: Warsaw, Poland, 2019.
26. Janeczko, E.; Tomusiak, R.; Woźnicka, M.; Janeczko, K. Preferencje społeczne dotyczące biegania jako formy aktywnego spędzania czasu wolnego w lasach. *Sylwan* **2018**, *162*, 305−313.
27. Waśkowski, Z. Bieganie jako forma aktywnego spędzania wolnego czasu przez kobiety—motywy, preferencje i oczekiwania. *Mark. I Rynek* **2014**, *11*, 483–491.
28. Borgers, J.; Vos, S.; Scheerder, J. Belgium (Flanders) Trends and Governance in Running. In *Running across Europe. The Rise and Size of one of the Largest Sport Markets*; Scheerder, J., Breedveld, K., Eds.; Hampshire: Palgrave Macmillan, UK, 2015; pp. 28–58.
29. Baran, J.; Lis, M.; Magda, I. *Ocena korzyści Społecznych Inwestycji w Sport w Odniesieniu do Ponoszonych Kosztów. Raport Analityczny*; Instytut Badań Strukturalnych: Warsaw, Poland, 2016.
30. Grabus, M.; Szymański, M. Społeczno-ekonomiczny wymiar biegania amatorskiego w Polsce. *Przestrz. Ekon. Społeczeństwo* **2017**, *11*, 133–152.

31. Hermanowski, T.; Drozdowska, A. Ocena wartości życia i zdrowia, pomiar korzyści związanych z technologiami medycznymi, rodzaje kosztów w opiece zdrowotnej. In *Szacowanie Kosztów Społecznych Choroby i Wpływu Stanu Zdrowia na Aktywność Zawodową i Wydajność Pracy*; Hermanowski, T., Ed.; Wolters Kluwer: Warsaw, Poland, 2013; pp. 13–30.
32. Borcuch, A. *Bieganie a Efektywność Pracy Zawodowej*; Self-publisher: Warsaw, Poland, 2018.
33. Malińska, M. Skuteczność programów interwencyjnych promujących aktywność fizyczną w miejscu pracy. *Med. Pr.* **2017**, *68*, 277–301.
34. Dzięgiel, A.; Lubowiecki-Vikuk, A.P. Imprezy biegowe jako specyficzny rodzaj wydarzeń sportowych. *Zesz. Naukowe. Tur. I Rekreac.* **2013**, *12*, 119–135. [CrossRef]
35. Parzonko, A.J.; Szuba, M. Uczestnictwo w imprezach biegowych jako forma rekreacji ruchowej. *Tur. I Rozw. Reg.* **2017**, *7*, 61–71. [CrossRef]
36. Kasperska, E.; Kasperski, M. Ekonomiczne aspekty turystyki biegowej. *Zesz. Nauk. Uniw. Szczecińskiego. Ekon. Probl. Tur.* **2015**, *30*, 9–24. [CrossRef]
37. Delaney, L.; Fahey, T. *Social and Economic Value of Sport in Ireland*; Economic and Social Research Institute: Dublin, Ireland, 2005.
38. Stepan, L. *Sport to Pieniądz, Współczesny Sport w Świecie Biznesu*; Wydawnictwo Naukowe Katedra: Gdańsk, Poland, 2020.
39. Stempień, J.R. Ladies and gentlemen on your marks, get set, go! *About leisure time sport and the popularity of running among men and women, AUL Folia Sociol.* **2015**, *55*, 183–209.
40. Stempień, J.R.; Stanczyk, M.; Tokarski, J.; Tkaczyk, M. Running for Health? Polish Long-Distance Leisure Runners and the Problem of Health Literacy. *Pol. Sociol. Rev.* **2020**, *211*, 379–391.
41. Lavie, C.J.; Lee, D.; Sui, X.; Arena, R.; O'Keefe, J.H.; Church, T.S.; Milani, R.V.; Blair, S.N. Effects of Running on Chronic Diseases and Cardiovascular and All-Cause Mortality. *Mayo Clin. Proc.* **2015**, *11*, 1541–1552. [CrossRef]
42. McMullen, C.W.; Harrast, M.A.; Baggish, A.L. Optimal Running Dose and Cardiovascular Risk. *Curr. Sports Med. Rep.* **2018**, *6*, 192–198. [CrossRef]
43. O'Donovan, G.; Lee, I.; Hamer, M. Stamatakis EAssociation of "Weekend Warrior" and Other Leisure Time Physical Activity Patterns With Risks for All-Cause, Cardiovascular Disease, and Cancer Mortality. *JAMA Intern. Med.* **2017**, *177*, 335–342. [CrossRef]
44. Lu, Y.; Wiltshire, H.D.; Baker, J.S.; Wang, O. The Effects of Running Compared with Functional High-Intensity Interval Training on Body Composition and Aerobic Fitness in Female University Students. *Int. J. Environ. Res. Public Health* **2021**, *21*, 11312. [CrossRef]
45. Matias, T.S.; Lopes, M.V.V.; da Costa, B.G.G.; Samara Silva, K.S.; Schuch, F.B. Relationship between types of physical activity and depression among 88,522 adults. *J. Affect. Disord.* **2022**, *15*, 415–420. [CrossRef]
46. Damrongthai, C.; Kuwamizu, R.; Suwabe, K.; Ochi, G.; Yamazaki, Y.; Fukuie, T.; Adachi, K.; Yassa, M.A.; Churdchomjan, W.; Soya, H. Benefit of human moderate running boosting mood and executive function coinciding with bilateral prefrontal activation. *Sci. Rep.* **2021**, *11*, 22657. [CrossRef] [PubMed]
47. Markotić, V.; Pokrajčić, V.; Babić, M.; Radančević, D.; Grle, M.; Miljko, M.; Kosović, V.; Jurić, I.; Karlović Vidaković, M. The Positive Effects of Running on Mental Health. *Psychiatr Danub* **2020**, *32*, 233–235. [PubMed]
48. Harmon, K.G.; Asif, I.M.; Klossner, D.; Drezner, J.A. Incidence of sudden cardiac death in National Collegiate Athletic Association athletes. *Circulation* **2011**, *123*, 1594–1600. [CrossRef]
49. Albert, C.M.; Mittleman, M.A.; Chae, C.U.; Lee, I.M.; Hennekens, C.H.; Manson, J.E. Triggering of sudden death from cardiac causes by vigorous exertion. *N. Engl. J. Med.* **2000**, *343*, 1355–1361. [CrossRef] [PubMed]
50. Fokkema, T.; Hartgens, F.; Kluitenberg, B.; Verhagen, E.; Backx, F.J.G.; van der Worp, H.; Bierma-Zeinstra, S.M.A.; Koes, B.W.; van Middelkoop, M. Reasons and predictors of discontinuation of running after a running program for novice runners. *J. Sci Med. Sport* **2019**, *22*, 106–111. [CrossRef]
51. Sanfilippo, D.; Beaudart, C.; Gaillard, A.; Bornheim, S.; Bruyere, O.; Kaux, J.F. What Are the Main Risk Factors for Lower Extremity Running-Related Injuries? *A Retrospective Survey Based on 3669 Respondents. Orthop. J. Sports Med.* **2021**, *11*, 23259671211043444.
52. Hespanhol Junior, C.L.; Oliveira Pena Costa, L.; Dias Lopes, A. Previous injuries and some training characteristics predict running-related injuries in recreational runners: A prospective cohort study. *J. Physiother.* **2013**, *59*, 263–269. [CrossRef]
53. Alentorn-Geli, E.; Samuelsson, K.; Musahl, V.; Green, C.L.; Bhandari, M.; Karlsson, J. The Association of Recreational and Competitive Running With Hip and Knee Osteoarthritis: A Systematic Review and Meta-analysis. *J. Orthop. Sports Phys. Ther.* **2017**, *47*, 373–390. [CrossRef]
54. Yeung, S.S.; Yeung, E.W. Gillespie LD Interventions for preventing lower limb soft-tissue running injuries. *Cochrane Database Syst. Rev.* **2011**, *7*, CD001256.
55. Eom, H.; Roh, J.; Hariyani, Y.S.; Baek, S.; Lee, S.; Kim, S.; Park, C. Deep Learning-Based Optimal Smart Shoes Sensor Selection for Energy Expenditure and Heart Rate Estimation. *Sensors* **2021**, *21*, 7058. [CrossRef]
56. Ren, D.; Aubert-Kato, N.; Anzai, E.; Ohta, Y. Random forest algorithms for recognizing daily life activities using plantar pressure information: A smart-shoe study. *PeerJ* **2020**, *28*, e10170. [CrossRef] [PubMed]
57. Fuller, J.T.; Bellenge, C.R.; Thewlis, D.; Tsiros, M.D.; Jonathan DBuckley, J.D. The effect of footwear on running performance and running economy in distance runners. *Sports Med.* **2015**, *45*, 411–422. [CrossRef] [PubMed]

58. Malisoux, L.; Gette, P.; Backes, A.; Delattre, N.; Cabri, J.; Theisen, D. Relevance of Frequency-Domain Analyses to Relate Shoe Cushioning, Ground Impact Forces and Running Injury Risk: A Secondary Analysis of a Randomized Trial With 800+ Recreational Runners. *Front. Sports Act. Living* **2021**, *11*, 744658. [CrossRef]
59. Witte, K.A.; Fiers, P.; Sheets-Singer, A.L.; Collins, S.H. Improving the energy economy of human running with powered and unpowered ankle exoskeleton assistance. *Sci. Robot.* **2020**, *25*, eaay9108.
60. Sawicki, G.S.; Beck, O.N.; Kang, I.; Young, A.J. The exoskeleton expansion: Improving walking and running economy. *J. Neuroeng. Rehabil.* **2020**, *17*, 25. [CrossRef]
61. Zoladz, J.A.; Nieckarz, Z. Marathon race performance increases the amount of particulate matter deposited in the respiratory system of runners: An incentive for "*clean air marathon runs*". *PeerJ* **2021**, *17*, 9. [CrossRef] [PubMed]
62. Morici, G.; Cibella, F.; Cogo, A.; Palange, P.; Bonsignore, M. Respiratory effects of exposure to traffic related air pollutants during exercise. *Front. Public Health* **2020**, *11*, 8.
63. Giles, L.; Carlsten, C.; Koehle, M. The pulmonary and autonomic effects of high-intensity and low-intensity exercise in diesel exhaust. *Environ. Health* **2018**, *17*, 1–12. [CrossRef] [PubMed]
64. Guo, M.; Fu, S. Running with a mask? The effect of air pollution on marathon runners' performance. *J. Sports Econ.* **2019**, *20*, 7. [CrossRef]
65. Hodgson, J.R.; Chapman, L.; Pope, F.D. Amateur runners more influenced than elite runners by temperature and air pollution during the UK's Great North Run half marathon. *Sci Total Environ.* **2022**, *842*, 156825. [CrossRef] [PubMed]
66. Muthu, S.S. Textile processing and resource depletion: Calculating the ecological footprint of textile products. In *The Textile Institute Book Series. Assessing the Environmental Impact of Textiles and the Clothing Supply Chain*, 2nd ed.; Woodhead Publishing: Cambridge, UK, 2020; pp. 95–103.
67. Wackernagel, M.; Rees, W. *Our Ecological Footprint: Reducing Human Impact on the Earth*; New Society Publishers: Philadelphia, PA, USA, 1996.
68. Nautiyal, H.; Goel, V. Chapter 3—Sustainability assessment: Metrics and methods. In *Methods in Sustainability Science: Assessment, Prioritization, Improvement, Design and Optimization*; Ren, J., Ed.; Elsevier: Amsterdam, The Netherlands, 2021; pp. 27–46.
69. Gavrilescu, M. Sustainability. In *Comprehensive Biotechnology, 3rd ed*; Moo-Young, M., Ed.; Pergamon Press: Oxford, UK, 2011; pp. 974–993.
70. Balaban, O. Smart cities as drivers of a green economy. In *Handbook of Green Economics*; Acar, S., Yeldan, E., Eds.; Academic Press: Cambridge, MA, USA, 2019; pp. 69–92.
71. Verma, P.; Singh, R.; Singh, P.; Raghubanshi, A.S. (Eds.) Urban ecology—Current state of research and concepts. In *Urban Ecology*; Elsevier: Amsterdam, The Netherlands, 2020; pp. 3–16.
72. Silalertruksa, T.; Gheewala, S.H. Chapter Eight-Land–Water–Energy Nexus of Biofuels Development in Emerging Economies: A Case Study of Bioethanol Policy in Thailand. In *The Role of Bioenergy in the Bioeconomy: Resources, Technologies, Sustainability and Policy*; Lago, C., Caldés, N., Lechón, Y., Eds.; Academic Press: Cambridge, MA, USA, 2018; pp. 379–402.
73. Caro, D. Carbon Footprint. In *Encyclopedia of Ecology*, 2nd ed.; Fath, B., Ed.; Elsevier: Amsterdam, The Netherlands, 2019; pp. 252–257.
74. Leip, A.; Uwizeye, A. Nitrogen Footprints. In *Encyclopedia of Ecology*, 2nd ed.; Fath, B., Ed.; Elsevier: Amsterdam, The Netherlands, 2019; pp. 370–382.
75. Cushman-Roisin, B.; Cremonini, B.T. *Data, Statistics, and Useful Numbers for Environmental Sustainability*; Elsevier: Amsterdam, The Netherlands, 2021; pp. 179–237.
76. Jacob-Lopes, E.; Queiroz Zepka, L.; Costa Deprá, M. Carbon footprint and carbon market. In *Sustainability Metrics and Indicators of Environmental Impact*; Jacob-Lopes, E., Queiroz Zepka, L., Costa Deprá, M., Eds.; Elsevier: Amsterdam, The Netherlands, 2021; pp. 91–116.
77. Wicker, P. The carbon footprint of active sport participants. *Sport Manag. Rev.* **2019**, *22*, 513–526. [CrossRef]
78. Grofelnik, H.; Perić, M.; Wise, N. Applying carbon footprint methods possibilities to the sustainable development of sports tourism. *WIT Trans. Ecol. Environ.* **2020**, *248*, 153–163.
79. Wicker, P. The carbon Footprint of Active Sport Tourists: An Empirical Analysis of Skiers and Boarders. *J. Sport Tour.* **2018**, *22*, 151–171. [CrossRef]
80. Dolf, M.; Teehan, P. Reducing the carbon footprint of spectator and team travel at the University of British Columbia's varsity sports events. *Sport Manag. Rev.* **2015**, *18*, 244–255. [CrossRef]
81. Loewen, C.; Wicker, P. Travelling to Bundesliga matches: The carbon footprint of football fans. *J. Sport Tour.* **2021**, *25*, 253–272. [CrossRef]
82. Castaignède, L.; Veny, F.; Edwards, J.; Billat, V. The Carbon Footprint of Marathon Runners: Training and Racing. *Int. J. Environ. Res. Public Health* **2021**, *18*, 2769. [CrossRef]
83. Ahmed, F.; Pretorius, L. Mega-events and Environmental Impacts: The 2010 FIFA World Cup in South Africa. *Alternation* **2010**, *17*, 274–296.
84. Cartwright, A. Can Mega Events Deliver Sustainability? The Case of the 2010 FIFA World Cup in South Africa. In *International Handbook on the Economics of Mega Sporting Events*; Maennig, W., Zimbalist, A., Eds.; Edward Elgar Publishing: Cheltenham, UK, 2012; pp. 127–139.

85. Diederichs, N.; Roberts, D. Climate protection in mega-event greening: The 2010 FIFA™ World Cup and COP17/CMP7 experiences in Durban, South Africa. *Clim. Dev.* **2016**, *8*, 376–384. [CrossRef]
86. Crabb, L. Debating the success of carbon-offsetting projects at sports mega-events. *A case from the 2014 FIFA World Cup. J. Sustain. For.* **2018**, *37*, 178–196.
87. Meza Talavera, A.; Al-Ghamdi, S.G.; Koç, M. Sustainability in Mega-Events: Beyond Qatar 2022. *Sustainability* **2019**, *22*, 6407. [CrossRef]
88. Chen, K.-H.; Wang, H.-C.; Han, J.-L.; Liu, W.-Z.; Cheng, H.-Y.; Liang, B.; Wang, A.-J. The application of footprints for assessing the sustainability of wastewater treatment plants: A review. *J. Clean. Prod.* **2020**, *277*, 124053. [CrossRef]
89. Sandefur, H.N.; McCarty, J.A.; Boles, E.C.; Matlock, M.D. Peanut Products as a Protein Source: Production, Nutrition, and Environmental Impact. In *Sustainable Protein Sources*; Nadathur, S.R., Wanasundara, J.P.D., Scanlin, L., Eds.; Academic Press: Cambridge, MA, USA, 2017; pp. 209–221.
90. Gerbens-Leenes, P.W. Dietary Transition: Longterm Trends, Animal Versus Plant Energy Intake, and Sustainability Issues. In *Vegetarian and Plant-Based Diets in Health and Disease Prevention*; Mariotti, F., Ed.; Academic Press: Cambridge, MA, USA, 2017; pp. 117–134.
91. Chapagain, A.K.; James, K. Accounting for the Impact of Food Waste on Water Resources and Climate Change. In *Food Industry Wastes*; Kosseva, M.R., Webb, C., Eds.; Academic Press: Cambridge, MA, USA, 2013; pp. 217–236.
92. McCann, J. Environmentally conscious fabric selection in sportswear design. In *Textiles for Sportswear*; Shishoo, R., Ed.; Woodhead Publishing: Cambridge, UK, 2015; pp. 17–52.
93. Wang, L.; Shen, B. A Product Line Analysis for Eco-Designed Fashion Products: Evidence from an Outdoor Sportswear Brand. *Sustainability* **2017**, *9*, 1136. [CrossRef]
94. Kok, A.L.; Barendregt, W. Understanding the adoption, use, and effects of ecological footprint calculators among Dutch citizens. *J. Clean. Prod.* **2021**, *326*, 129341. [CrossRef]
95. McLoughlin, D. All Eco Sneakers Do Is Kill The Planet a Little Bit Slower [Study]. Available online: https://runrepeat.com/eco-sneakers-research (accessed on 11 December 2021).
96. Stempień, J.R. Bieganie, zwiedzanie i klasa średnia-przygarść socjologicznych uwag i obserwacji o turystyce biegowej. In *Inspiracje Sportem w Turystyce Kulturowej, Kazimierczak, M., Ed.*; Wydawnictwo Akademii Wychowania Fizycznego w Poznaniu: Poznań, Poland, 2016; pp. 48–58.