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## **"I'm sick? I don't train!" – Relation between training during upper respiratory infection and myocarditis**

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## **Abstract**

### **Introcutdion**

Myocarditis is one of the leading causes of sudden cardiac deaths among athletes. One of the factors increasing the risk of this disease is engaging in sports training during an infection. Many athletes, regardless of their level of advancement, are not aware of the risks associated with training during an infection, and those who are aware often ignore them and continue training.

### **Purpose**

Assessment of behaviors and awareness among runners in Poland regarding the risk of developing myocarditis as a result of training during respiratory tract infections.

### **Material and method**

In December 2023, a voluntary and anonymous online survey was conducted among a group of 399 adult runners from Poland. The survey included 13 questions, consisting of 11 single-choice questions and 2 multiple-choice questions.

### **Results**

The percentage of individuals who do not associate training during an infection with an increased risk of myocarditis amounts to as much as 44.4% (n=177), while a staggering 86.7% (n=346) of respondents declare that they undertake training during respiratory infections.

### **Conslusion**

After analyzing the survey, it's evident that while the Polish running community recognizes the risks of training during infections, many still exercise despite symptoms. Although most understand that intense training and early return to sports can harm health, awareness of myocarditis risks from exertion during infection is lacking. Despite protocols for post-illness return to sports, there's a need for campaigns to educate the running community on infection-related training risks.

**Key words:** myocarditis, physical activity, respiratory system infections, athletes, cardiology, runners

## Introduction

"It is said that 'sport is health,' but is it always? The positive impact of regular physical activity on the immune system's improvement is a widely recognized fact. [1] The question arises, where is the limit beyond which we no longer derive benefits from practicing sports? Among both professional athletes and those who engage in sports recreationally, many risky behaviors are often observed, which can have serious health consequences. One such behavior is continuing physical exercises despite clear symptoms of infection such as runny nose, cough, or even fever. The immunosuppressive effect of training, [2,3,4] fatigue, and exposure to environmental factors (e.g., training under unfavorable weather conditions) can increase the risk of developing infections, which in turn may lead to myocarditis. [5,6,7] Myocarditis can be caused by many factors, typically viruses that attack the upper respiratory tract. [8,9] Myocarditis is one of the most common causes of sudden cardiac death among athletes. [10,11,12] In a German study conducted on a group of 349 individuals registered due to sudden cardiac arrest associated with sports over a period of 6 years, it was found that myocarditis occurred in 13 young individuals (3.7%). In most of these patients, myocarditis was preceded by upper respiratory tract infections. [13] Although the general prognosis is good, myocarditis can lead to heart failure, arrhythmias, conduction disorders, or dilated cardiomyopathy as a consequence. [14] Given its insidious, hard-to-observe course and potentially dangerous consequences, [9] it is particularly important for athletes and physically active individuals to be aware of the risks associated with exercising during infections, as well as possible ways to prevent complications.

## Purpose

Assessment of behaviors and awareness among runners in Poland regarding the risk of developing myocarditis as a result of training during respiratory tract infections.

## Method

In December 2023, a voluntary and anonymous online survey was conducted among a group of 399 adult runners from Poland. The survey included 13 questions, consisting of 11 single-choice questions and 2 multiple-choice questions. The obtained results were processed using Excel and discussed based on current literature. The informed consent was obtained from all individuals participating in the study.

## Results

The survey was participated by 399 individuals who practice running at various levels of expertise. Men constituted 56.1% (n=224) of this group, while women made up 43.9% (n=175). The respondents were divided into three age groups: less than 23 years, 24-34 years, and 35 years or older, among which the largest group was those aged 35 or older, accounting for 42.9% (n=171). The majority of participants, 43.6% (n=174), described their level of expertise as "amateur-competitive," indicating the combination of intense sports training with family and professional life. It should be noted that this is only a conventional division, as determining the level of expertise and professionalism poses a significant challenge, with the line between amateur and professional being ambiguous and subject to various interpretations. The largest group, 35.3% (n=141), declared their running tenure to be between 5-10 years.

Variable		N	%
Gender	Male	224	56,1
	Female	175	43,9
Age	<23	79	19,8
	23-34	149	37,3
	≥35	171	42,9
Level of advancement	Recreational	77	19,3
	Amateur	124	31,1
	Pro-amateur (semi-pro)	174	43,6
	Professional	24	6
Running experience	<1	22	5,5
	1-3	84	21,1
	3-5	83	20,8
	5-10	141	35,3
	≥10	69	17,3

Table 1: Characteristics of the study group

Out of the surveyed, 380 individuals declared that they do not suffer from diabetes, hypertension, or lipid metabolism disorders, meaning that the 19 respondents who disclosed having these conditions represent 4.8% of the participants, with 84.5% of them being aged 35 and older.

The majority, 69.4%, of the respondents declare getting sick up to 2 times a year, 27.3% fall ill 3 to 5 times a year, while only 3.3% report more than 5 infections in a year.

In the event of fever, 80.7% of the participants abstain from training, resuming physical activity in the presence of other symptoms. A total of 13.3% completely refrain from training when noticing any symptoms of infection, whereas 6% continue their training regardless of symptoms.

Among those who engage in physical activity (n=345) during an infection, 82% (n=283) of the respondents reduce the intensity of their training, while the remaining 18% (n=62) stick to their original training plans.

The survey also inquired about diagnostic tests performed. According to the results, 61.7% (n=246) of the participants had undergone at least one test in the last two years that could help detect signs of myocarditis. The following tests were conducted: chest X-ray by 28.6% (n=114), heart echocardiogram by 23.8% (n=95), EKG by 53.9% (n=215), chest CT by 4.5% (n=18), chest MRI by 3.3% (n=13), and Holter EKG by 6.8% (n=27) of the respondents. 38.3% (n=153) had not undergone any of these tests in the two-year period.

The survey also asked about symptoms observed by the participants that could indicate, among other things, signs of myocarditis. The following numbers of individuals reported experiencing specific symptoms: decreased exercise tolerance by 11.3% (n=45), chest pain by 12.5% (n=50), heart arrhythmia by 11.5% (n=50), shortness of breath at rest or during moderate exercise by 4.5% (n=18), chronic fatigue by 25.1% (n=100), and lower limbs edema by 5.5% (n=22). 59.1% (n=236) did not observe any of the aforementioned symptoms in themselves.

Variable		N	%
Suffering from diabetes, dyslipidemia or hypertension	Yes	19	4,8
	No	380	95,2
Frequency of infections in a year	≤2	277	69,4
	3-5	109	27,3
	>5	13	3,3
Training despite having an upper respiratory tract infection	Yes, but only if there is no fever.	322	80,7
	Yes, regardless of the number and severity of symptoms.	24	6,0
	No	53	13,3
Modifications in training plan if training during infection	Reducing intensity and/or volume	283	82,0
	No modifications	62	18,0
Examinations performed in the last two years	chest radiograph	114	28,6
	echocardiography	95	23,8
	electrocardiography	215	53,9
	chest CT	18	4,5
	chest MRI	13	3,3
	Holter monitor	27	6,8
	none	153	38,3
Symptoms noticed in the last two years	decreased exercise tolerance	45	11,3
	chest pain	50	12,5
	heart arrhythmia	46	11,5
	shortness of breath at rest or during moderate exercise	18	4,5
	chronic fatigue	100	25,1
	lower limbs edema	22	5,5
	none	236	59,1

Table 2: Behavior of the study group

The study also explored the knowledge of Polish runners regarding the risks associated with physical exertion during respiratory tract infections. Over half, specifically 55.6% (n=222), believe that endurance training during an infection may be related to the development of myocarditis. Respondents making up 63.7% (n=254) of all participants think that intense endurance training can impair the body's immune response. Nearly ¾ of the surveyed, precisely 73.4% (n=293), agree with the statement that an early return to intense training can have adverse health effects.

These findings highlight a significant awareness among the running community about the potential risks of training during illness, especially concerning endurance activities. The recognition of the need for caution in resuming intense physical activities post-infection is crucial for preventing potential health complications, including those as serious as myocarditis. This awareness can lead to more informed decisions about training during and after illness, emphasizing the importance of listening to one's body and allowing adequate recovery time.

Variable		N	%
Question 1: Do you think that endurance training during infection may be related to myocarditis?	Yes	222	55,6
	No	177	44,4
Question 2: Do you think that intense endurance training can weaken the body's immunity?	Yes	254	63,7
	No	145	36,3
Question 3: Do you think that an early return to intensive training after an infection may adversely affect your health?	Yes	293	73,4
	No	106	26,6

Table 3: Questions and answers

## Discussion

The analysis of the obtained data allows us to outline the awareness of the Polish running community regarding the risks associated with exercising during infections. Due to the lack of clear guidelines based on strong evidence regarding training during infections, for the purposes of this study, it was assumed that fever is a sign of a more severe infection. This symptom is easily recognizable to everyone, even those without medical knowledge. A significant majority, 80.7% (n=322), declare abstaining from training in the event of fever, while 13.3% (n=52) refrain from training upon noticing any symptoms. Consequently, only 6% (n=24) continue training despite being infected. Among this group, 33.3% (n=8) do not

reduce the intensity and/or volume of exercises previously planned. Such behavior poses the highest risk of adverse health consequences. It is worth noting that these individuals represent only 2% of all respondents.

A large portion of respondents declared undergoing diagnostic tests in the past two years that could reveal signs indicative of past or ongoing myocarditis. Unfortunately, as many as 38.3% (n=153) did not undergo any of these tests in the last two years. Among this group, 42.1% (n=64) were aged 35 and older, 42.8% (n=65) were aged 23-34, and 15.1% (n=23) were under 23 years old. Examining the declared level of expertise of these individuals reveals that professionals account for only 2.0% (n=3) of this group, amateur-competitive runners constitute 38.8% (n=59), while amateurs account for 34.2% (n=52), and recreational runners make up 25% (n=38). It can be concluded that professionals are relatively well cared for in this regard. Sports regulations require them to undergo tests at least once a year to renew their sports federation license. They are often also under the care of physicians employed by the sports federation or club.

It is worth examining the group of amateur-competitive runners (n=174), which is the largest in this study. These individuals often train almost as intensively as professionals, combining it with their professional work and family obligations. This leaves them with less time for recovery than professionals, which may have health implications. The majority, 71.8% (n=125), of them experience infections up to 2 times a year, 25.9% (n=45) experience infections 3-5 times a year, and 2.3% (n=4) experience infections more than 5 times a year. There were no significant deviations observed among amateur-competitive runners from the overall respondents regarding training despite illness or modifying training assumptions. This group constitutes 38.8% of individuals who did not undergo any tests in the last two years. They also do not report more frequent occurrence of concerning symptoms than the rest of the respondents. However, they represent the largest group (44.1%, n=78) answering "no" to the question "Do you think endurance training during an infection may be related to myocarditis?"

The second largest group were amateurs (n=124). They differ from the previous group, especially in the intensity and volume of training, treating sports as a hobby. There are no significant differences in the frequency of infections in this group compared to amateur-



competitive runners. They also do not stand out in terms of training during infections, both in terms of undertaking training itself and modifying the training plan. As many as 41.9% (n=53) of them did not undergo any diagnostic tests in the last two years. This constitutes 34.2% of all individuals who did not undergo any tests, making amateurs the second largest group in this regard. The frequency of experiencing concerning symptoms is at a similar level to the other groups.

Professionals tend to get sick slightly more often than the other groups, reporting infections as follows: 45.8% (n=11) up to 2 times a year, 50.0% (n=17) 3-5 times a year, and 4.2% (n=1) more than 5 times a year.

The level of knowledge among Polish runners regarding training during infections and the associated risks is not at its highest level. It also varies at different levels of expertise, as presented below.

In response to question 1: "Do you think endurance training during an infection may be related to myocarditis?" 222 people (55.6%) answered "yes" and 177 people (44.4%) answered "no." Among those who answered "yes," men and women were exactly 50% each, with 49.6% of men and 63.4% of women answering affirmatively. Individuals aged 23-34 and 35 years and older accounted for 40.1% (n=89), with the youngest group being the least numerous (19.8%, n=44), and individuals aged 23-34 being the most likely to answer affirmatively (59.7%), while those aged 35 and older were the least likely (52.0%). Professionals were most likely to answer "yes" (58.3%), while recreational runners were least likely (54.5%).

Do you think that endurance training during infection may be related to myocarditis?

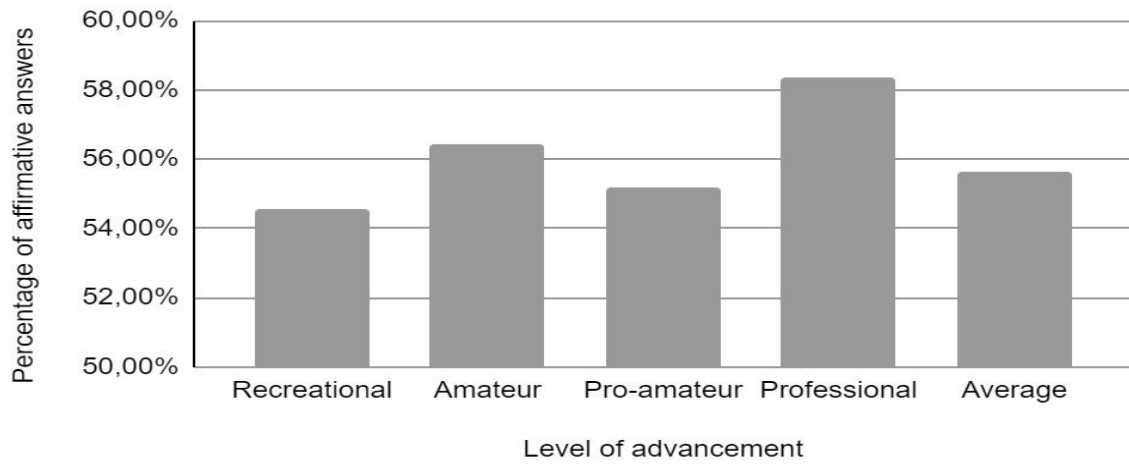


Figure 1. Knowledge about relation between training during infection and myocarditis

In response to question 2: "Do you believe that intense endurance training can weaken the body's immune system?" 254 individuals (63.7%) answered "yes" and 145 individuals (36.3%) answered "no." Affirmatively, 63.8% (n=143) were men and 63.4% (n=111) were women. The most common affirmative responses came from individuals aged 23-34 (67.8%), while those under 23 years old were the least likely to answer affirmatively (59.4%). When examining responses across different levels of expertise, it is clear that individuals identifying as amateur-competitive and professional athletes answered affirmatively significantly more often. As many as 71.8% of amateur-competitive athletes responded "yes," while affirmatively responding amateurs accounted for only 54.8% of this group.

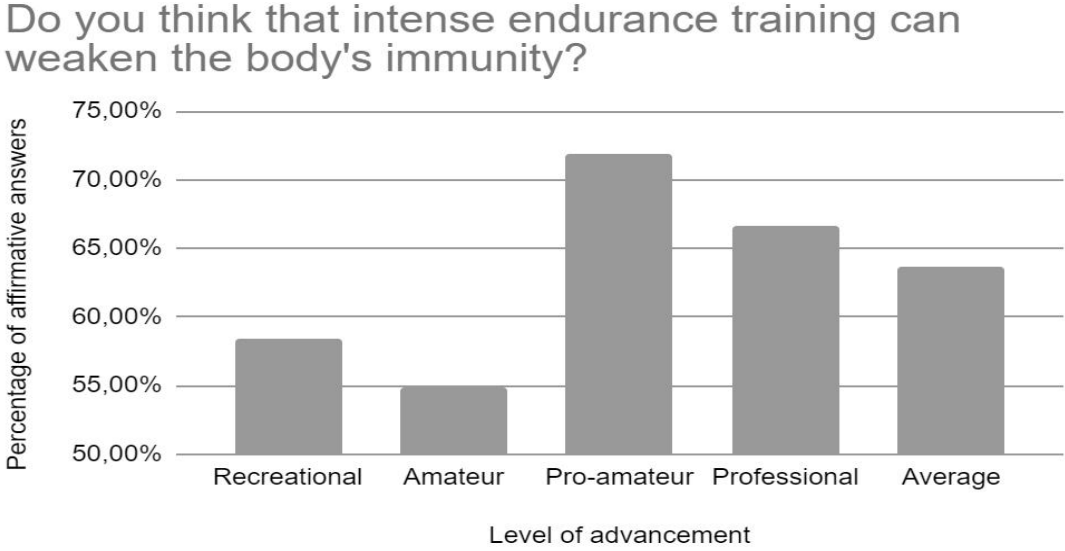


Figure 2: Knowledge about relation between intense endurance training and body's immunity

In response to question 3: "Do you believe that returning to intense training early after recovering from an infection can have adverse effects on health?" 73.4% (n=293) of respondents answered "yes," while 26.6% (n=106) answered "no." Affirmatively, 70.5% (n=158) were men and 77.1% (n=135) were women. Respondents under the age of 23 had the highest affirmative responses, with 78.5%, followed closely by those aged 23-34, with 76.5%, while the group aged 35 and older had the lowest affirmative responses, with 68.4%.

Similarly to previous questions, there is a clear difference between the group of professionals and the other groups. As many as 83.3% of professionals answered "yes." Amateurs were the least likely to respond affirmatively, although 71% of them still did so.

Do you think that an early return to intensive training after an infection may adversely affect your health?

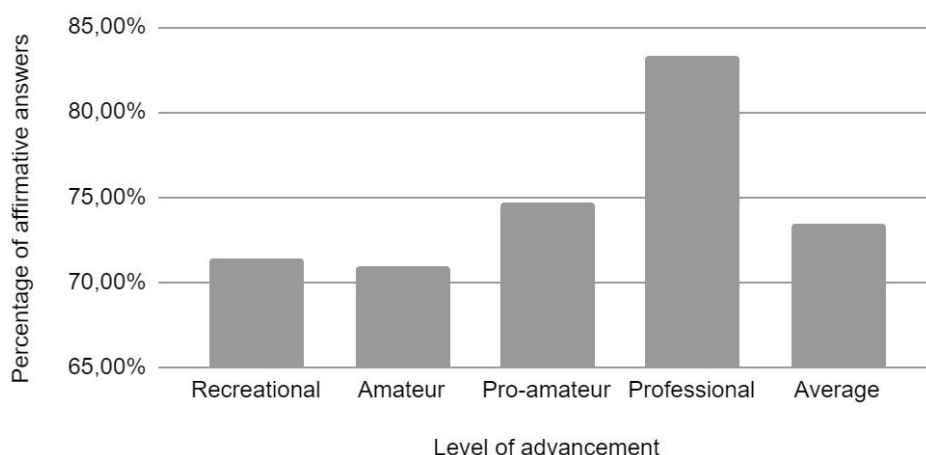


Figure 3: Knowledge about relation between early returning to sport and health

Does experience matter? Examining the responses to the questions, one can observe a tendency that individuals with a running experience of 10 years or more are more likely to respond affirmatively, while those with a running experience of 1-3 years are least likely to do so. Beginner runners (with less than 1 year of experience) also frequently responded affirmatively.

Running Experience	Question 1	Question 2	Question 3
<1	59,1%	63,6%	86,4%
<1,3)	48,8%	46,4%	72,6%
<3,5)	61,4%	59,0%	68,7%
<5,10)	53,9%	71,6%	73,8%
≥10	59,4%	73,9%	75,4%

Table 4: Percentage of affirmative answers depending on running experience

What about the symptoms? Unfortunately, myocarditis cannot be identified by a single, specific symptom, and those that may occur are very nonspecific. [15] Taking chronic fatigue as the most common symptom, in the case of runners, it will most likely manifest as a result of inadequate recovery [16], inadequate calorie intake [17,18,19], or excessively strenuous training beyond one's capabilities [16]. The same applies to swelling of the lower limbs,

which may result from, for example, a sedentary lifestyle, particularly for individuals working at a desk job. [20] Only a combination of several co-occurring symptoms along with other deviations identified in diagnostic tests allows for a diagnosis. Nevertheless, it is important to remain vigilant and pay attention to any deviations from the norm. The table below shows the percentage of individuals at different levels of advancement who have observed a particular symptom in themselves over the past 2 years. Of particular note is the frequency of chest pain among professionals, which is almost twice the average. Shortness of breath at rest and during moderate exercise also affects professionals more frequently than other groups. On the other hand, they less frequently experience chronic fatigue, which may be the result of better regeneration and more well-designed training plans. None of the professionals reported a weakening of exercise capacity or swelling of the lower limbs. Recreational runners also stand out significantly, as they more frequently than others reported reduced exercise tolerance or chronic fatigue.

	Decreased exercise tolerance	Chest pain	Heart arrhythmia	Shortness of breath at rest or during moderate exercise	Chronic fatigue	Lower limbs edema
Recreational	22,1%	7,8%	13,0%	5,2%	35,1%	7,8%
Amateur	11,3%	8,1%	9,7%	3,2%	26,6%	7,3%
Pro-amateur	8,0%	10,9%	12,1%	4,6%	21,2%	4,0%
Professional	0%	20,8%	12,5%	8,3%	12,5%	0%
Average	11,3%	12,5%	11,5%	4,5%	25,1%	5,5%

Table 5: Frequency of symptoms in particular groups

## Conclusions

Upon analysis of the survey results, it can be concluded that the Polish running community generally understands the dangers associated with endurance training during illness, yet often continues to exercise despite experiencing symptoms of illness. Most individuals are aware that intense training lowers immunity and that returning to sports too early can be detrimental to health. However, knowledge about the possibility of developing myocarditis due to exertion during illness is much lower. Despite the emergence of subsequent return-to-sport

protocols after illness [21,22], there is a lack of campaigns reaching the broader running community that could raise awareness about the risks of training during illness.

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