NATIONAL SPORTS ACADEMY

"VASSIL LEVSKI"

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PHYSICAL EXERCISES AND INCIDENCE OF INFLUENZA AND ACUTE RESPIRATORY DISEASES

Abstract
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ABBREVIATIONS

CL – Confidence level
MEM – Moving epidemic method
NRL – National Reference Laboratory
NSA – National Sports Academy
GP – General Practitioner
ARD – Acute respiratory diseases
WHO – World Health Organisation
RT-PCR – Reverse transcription polymerase chain reaction

Introduction

The constantly growing sports activities, the expanding range of sports and the increasing number of participants in national and international tournaments, lead to the inevitable increase in viral diseases related to sports.

Respiratory viral infections are the most common diseases that athletes encounter sooner or later. They are practically inevitable when many people gather in one place, as happens at sports competitions or when camps and tournaments are held with organized meals, transport, etc. These diseases have different severity - from very mild forms to severe, life-threatening infections, such as influenza and its complications.

Physical activity improves overall health and can be effective in preventing and reducing the severity and duration of acute respiratory infections. Exercise affects the immune system and can both improve its function and cause an immunosuppressive effect and increase susceptibility to the causes of respiratory diseases. An increased incidence of acute respiratory infections is observed mainly during periods of intense training and competition, probably due to a combination of physiological and mental stress. Studying and knowing the relationships between physical activity and influenza and acute respiratory diseases (ARD) is important not only for sport but also for public health. Training activities of appropriate intensity can be used in addition to other prophylactic measures against acute respiratory tract infections.

It is assumed that moderate, regular physical activity improves health and reduces the risk of developing influenza and ARD. Severe, hard exercises leads to an increased risk of disease as a result of induced immunosuppression, but usually this is for a short period after exercise and does not significantly affect the overall incidence in these athletes.

Objective and tasks

The objective of this dissertation is to determine the importance of physical activity for the incidence of influenza and ARD in athletes with different intensity of physical activity.

In order to achieve this objective, the following tasks are assigned:

1. To conduct a study on the level of incidence of influenza and ARD among practitioners of different sports, depending on the intensity of exercises.
2. To analyze the data from the Influenza and Acute Respiratory Infections Information System during the respective influenza season, the etiology of the causative agents and the age distribution of the infected persons.
3. To monitor the main epidemiological characteristics of influenza and ARD in athletes.
4. To determine the main risk and protective factors that affect the diseases of influenza and ARD in athletes.
5. To evaluate the applied measures for prevention and control of influenza and ARD in sports practitioners.
6. To determine the groups of athletes at the highest risk of disease and to propose modern preventive and anti-epidemic measures.

Methodology

1. Object, subject and contingent to examination

The object of the study is the incidence of influenza and ARD in athletes.

The subject of the study is the relationship between physical activity and the incidence of influenza and ARD in athletes.

189 students (65 women and 124 men) from the second year at the National Sports Academy (NSA) "Vassil Levski" were studied, full-time and part-time training in various specialties, practicing a certain sport or engaged in fitness or other physical activities for maintaining good health and optimal physical form. The persons surveyed are aged 19 to 49 and are grouped into two age groups – up to 29 years and over 30 years, so as to match the age groups in the Influenza and Acute Respiratory Infections Information System.

2. Methods of examination

An epidemiological analysis of the incidence of influenza and ARD in Bulgaria in the seasons 2018/2019 and 2019/2020 was made, and the data were compared with a study of the incidence of influenza and ARD in athletes during the respective seasons. At the end of the 2018/2019 season, 106 students were interviewed using the method of direct standardized interview. During the 2019/2020 season, due to the state of emergency in the country in connection with the COVID-19 pandemic, the questionnaire was adapted for work in an online environment and was completed by 83 students through the NSA platform.

2.1. Epidemiological analyses of the incidence of influenza and ARD

For the analysis of the incidence during the observed two influenza seasons the data from the Influenza and Acute Respiratory Infections Information System were used. The information system is an Internet-based tool for collecting and analyzing the data from the conducted sentinel surveillance of influenza and ARD, and contains a database on the number of cases and the incidence of influenza and ARI by age groups, regions and weeks. The system allows data processing using the following statistical methods:

2.1.1. Percentile method

Percentiles are statistical quantities that answer the question of where a value is located in the frequency distribution and what is the number of values that are less than or greater than a predetermined value. Percentile or percentile point (value) is such a point of the frequency distribution, to the left of which lie (have smaller values) a certain percentage of points. For example, the 50th percentile, which is marked P_{50}, is the point below which they will lie, i.e. will be smaller, 50% of all measured values. Quantitative assessment of the incidence of influenza and ARD is made on the basis of the following classification of percentiles:

Table 1. Influenza and ARD epidemic intensity levels

Incidence level	Quantitative assessment
Very low	Values < 50th percentile
Low	50th ≤ Values < 70th percentile
Average (basic)	70th ≤ Values < 85th percentile
Medium high	85th ≤ Values < 95th percentile
High	95th ≤ Values < 99th percentile
Very high	Values ≥ the 99th percentile

2.1.2. Moving epidemic method

The Moving epidemic method (MEM) is used as a second method to assess the onset and end, as well as to determine the level of intensity of influenza epidemics. An epidemic threshold for the incidence of influenza and ARD is calculated, which is defined as a 95% upper Confidence Level (CL) of the geometric or arithmetic mean obtained from the highest incidence values in the pre-epidemic period of 10 previous influenza seasons. In a similar way, a post-epidemic threshold is calculated, which marks the end of the influenza epidemic, and the corresponding levels of intensity of the epidemic incidence are determined:

Medium intensity - 40% upper CL
High intensity - 90% upper CL
Very high intensity - 97.5% upper CL

2.2. Standardised interview

To collect the necessary information about the incidence of influenza and ARI in athletes, the method of direct standardized interview was used - this is a type of survey method in which all questions are prepared in advance, and the order of their questioning is determined. As a form it is closest to a survey, but the questions are asked personally, face to face and the answers are recorded by the interviewer and not by the respondent.

Advantages and limitations of the method.

A standardized interview with a computer or other portable device is one of the latest technologies for conducting highly structured interviews. It significantly increases the quality of the prepared questionnaires and increases the opportunities for direct control over the process of gathering information. The advantages of this method are related to the possibility of obtaining specialized information even on poorly studied scientific problems, as well as higher quality of results compared to written surveys without personal verbal contact between the researcher and the researched person. Direct contact between the interviewer and the subject significantly increases the likelihood of achieving the objectives of the survey – increases the percentage of correctly answered questions and reduces the risk of complete or partial ignorance of some questions. Interviewing of this type is closer to everyday communication, which in turn increases the likelihood of giving reliable answers. The main advantage of a direct (face-to-face) interview is that the researcher can adapt the questions (if and as much as necessary), clarify any ambiguities and ensure that the answers are correctly understood by repeating or reformulating the questions. This helps to understand and research more complex questions and topics, but it also involves serious additional work on the part of the interviewers.

The standardized computer interview also has its limitations. This type of interview requires a number of laptops or other portable devices to work with in the field and that support wireless internet connection. Another limitation is related to the training and qualities of the interviewers - they must be extremely well acquainted with the problem of the survey, have a very good knowledge of working with portable devices and related programs, be trained to work with electronic questionnaires and last but not least are very well instructed to work with the specific questionnaire. The results of the interview depend a lot on the personal qualities of the researchers - good communication skills are needed such as clear diction, lack of speech problems and dialect layers on speech, conscious and good control over facial expressions and gestures (nonverbal communication), ability to listen without interference the response of the subject. In addition, this type of interview is time consuming and more difficult to apply to a large number of respondents.

2.3. Electronic questionnaire

The high quality questionnaire is a key element of a successful survey. For the purposes of the research, a questionnaire was developed, which is programmed in electronic form and is filled in directly on a web-based platform on a computer or other portable device. This makes it possible to formulate different types of questions, to make more complex answer scales, to introduce tabular questions and to make different transitions, which largely guarantees the maximum accuracy and reliability of the information and the better quality of the collected data. In addition, the electronic form of the questionnaire greatly facilitates the process of entering the collected data and their further processing.

3. Organization of the study

The survey was conducted in two stages: in May 2019, after the end of the influenza season 2018/2019 and in May 2020, after the end of the influenza season 2019/2020. The interviews in 2019 are organized and conducted on the territory of the NSA, by trained specialists from the Department of Physiology and Biochemistry. The questionnaire in 2020 was completed online through the NSA platform.

4. Statistical methods

The following statistical methods were used to solve the set tasks:

- Tabular and graphical analyses;
- Estimation of the indicators for relative share - for statistical testing of the hypotheses about the significance of the difference between relative shares from different samples with a small number of observed cases, the ϕ-Fisher transformation was used. In accordance with the nature of the studies, a

critical level of significance p_T=0.05 was adopted. The statistical significance of the observed differences was determined on the basis of the ratio between the critical level of significance p_T and the probability of the occurrence of the empirical characteristic ($t_{ем}$); $p_{ем}$ =p:

- At p≤0.05 – the observed difference between the calculated indicators is statistically significant, due to legitimate reasons;
- At p>0.05 – the observed difference is statistically insignificant, due either to the action of random factors, or in the given study in connection with the limited scope of the study cannot prove the effect of naturally occurring causes;

- Assessment of the intensity of the epidemic process of influenza and ARD was performed on the basis of Percentile and the Moving epidemic method;
- Binary logistic regression analyses was applied to assess the factors influencing influenza and ARD diseases, p-values below 0.05 were considered statistically significant;
- The choice of variables for the multiple regression model was made at p<0,1. The multiple model is carried out using the sequential inclusion method in order to remain only significant variables;
- To assess the relationship between a categorist factor and a quantitative result, a dispersion analysis has been applied;
- Comparisons in pairs were made using the Bonferoni method.

Results and analyses

1. Analyses of the incidence of influenza and ARD in Bulgaria

The influenza epidemic in the 2018/2019 season begins in early January, lasts 5 weeks and is characterized by very high intensity. In the 4th week (21.01 – 27.01.2019), the epidemic reached its peak with 247.92 per 10,000 average weekly incidence. Young children from 0 to 4 age are most affected, with the highest registered incidence in the 4th week of 2019 – 894.80 per 10,000, followed by the age groups 5-14 and 15-29 years with values of 644.29 and 325.52 per 10,000 people, respectively. During the season in the National Reference Laboratory (NRL) "Influenza and ARD" with Real Time RT-PCR were detected 381 (66%) positive results for pandemic virus A (H1N1)pdm09, 198 (34%) for influenza A virus (H3N2) and lack of circulation of type B viruses, which definitely determines the etiology of the epidemic.

In the 2019/2020 season, the influenza epidemic also began in early January, but lasted longer – 9 weeks and was again characterized by very high intensity. In the 5th week (27.01 – 02.02.2020) the epidemic reached its peak with 242.69 per 10,000 average weekly incidence. Again, young children from 0 to 4 years are most affected, with the highest registered incidence in the 5th week of 2020 - 958.56 per 10,000, followed by the age groups 5-14 and 15-29 years with values of 769.87 and 287.70 per 10,000 people, respectively. During the first peak of the epidemic (3-7 week) in the NRL "Influenza and ARD" the leading etiological role of influenza A(H3N2) was proved, while in the second (8-11 week) – of B/Victoria.

2. Analyses of influenza and ARD in the respondents

2.1. Characteristics of influenza and ARD

A statistically significant reduction in influenza and ARD was found with an increase in the age of the subjects studied (p=0.004). In the younger age group - up to 29 years, more than two thirds of the respondents (70.9%) suffered from influenza and ARD, while in the age group over 30 years less than half of the participants were ill (46.3%). The higher incidence of young people and children is a characteristic feature of influenza, which is confirmed by the analyses of the incidence of influenza and ARD for the two observed seasons in Bulgaria.

Depending on the type of sport practiced, the highest percentage of patients is among footballers (78.1%), followed by those engaged in fitness (75.0%), as well as among athletes practicing basketball, volleyball and handball (68.2%). Collective sports, such as football (which has the largest number of players in each team), basketball, volleyball, handball and fitness, which is practiced indoors, often in crowded halls, without the ability to provide the necessary physical distance, predetermine the higher risk of infection and the higher incidence of influenza and ARD (table 2). In these sports, athletes are for a long time in close contact, indoors, due to which there is a high risk of exposure to various infectious agents.

Table 2. Distribution of sick people according to the type of sport practiced

			Without disease	With disease	Total
Type sports	Combat sports	Number	13	25	38
		%	34,2%	65,8%	100,0%
	Football	Number	7	25	32
		%	21,9%	78,1%	100,0%
	Basketball/ Volley-ball/ Handball	Number	7	15	22
		%	31,8%	68,2%	100,0%
	Winter sports	Number	7	7	14
		%	50,0%	50,0%	100,0%
	Fitness	Number	6	18	24
		%	25,0%	75,0%	100,0%
	Other sports	Number	25	34	59
		%	42,4%	57,6%	100,0%
Total		Number	65	124	189
		%	34,4%	65,6%	100,0%

A statistically significant association was found between influenza and ARD and the presence of some chronic diseases in athletes (p=0.037). All persons with bronchial asthma were ill (5/100%), as well as most of those with various other allergies (9/81.8%).

There is a statistically significant association between influenza and ARD and the use of anabolic steroids and hormones by athletes (p=0.049). All persons who stated that they were taking such substances were ill during the observed period (7/100%).

Smoking-related habits largely determine the incidence of disease in subjects. During the winter season, there was a statistically significant increase in influenza and ARI among smokers compared to non-smokers (p=0.003) (table 3).

Table 3. Distribution of sick people according to smoking habits

			Without disease	With disease	Total
Smoking	Non-smokers	Number	52	94	146
		%	35,6%	64,4%	100,0%
	Smokers	Number	7	29	36
		%	19,4%	80,6%	100,0%
	Quit smoking	Number	6	1	7
		%	85,7%	14,3%	100,0%
Total		Number	65	124	189
		%	34,4%	65,6%	100,0%

The severity of influenza and ARD is also higher among users of tobacco and tobacco products. The disease lasts on average 1 day more in smoking athletes, they miss about 1 day more school and training days during the winter, in addition, there is a statistically significant increase in the average number of visits to the doctor by smokers compared to non-smokers (p=0.018).

The training of athletes participating in national as well as national and international competitions is much more serious, at a much higher level, so they can be defined as "elite" athletes. A smaller proportion of elite athletes were ill during the winter season (58%) than other athletes (70%), which is probably related to the greater attention to their health, but nevertheless this percentage is significant and shows the need for strengthening preventive measures against ARD and influenza among elite athletes.

Of all athletes who participated in competitions, almost one third (28.8%) of the performance deteriorated and did not achieve the expected results due to a history of acute respiratory infection (table 4). Elite athletes who had competitions during the winter missed an average of 0.6 tournaments due to influenza and ARD, compared to 0.06 missed races by other competitors. The deterioration of the results due to illness in the participants in national, as well as in national and international competitions is statistically significant, compared to the participants only in local and regional tournaments (p=0.0053).

Table 4. Importance of the disease for the performance and results achieved in competitions*

			Regional competitions	National and international competitions	Total
Impact of the disease on the results achieved	Affect	Number	5	12	17
		%	14,7%	48,0%	28,8%
	No effect	Number	29	13	42
		%	85,3%	52,0%	71,2%
	Total	Number	34	25	59
		%	57,6%	42,4%	100,0%

**χ2 group difference significance test: p-value = 0.0053*

2.2. Preventive measures for influenza and ARD

Non-specific prevention of influenza and ARI is associated primarily with hygienic measures to limit the spread of respiratory infections. The majority of athletes (55.6%, 105 people) take additional vitamins, supplements and immunostimulants, but this is part of their preparation, not targeted prevention during the autumn-winter season to prevent disease. Slightly more than half of the respondents (51.9%, 98 people) state that they observe good hygiene, with frequent hand washing and ventilation of the premises during the winter season. One in four (25.4%, 48 people) tries to avoid contact with sick people, closed premises and mass gatherings. Only a quarter of the respondents provide enough sleep and rest - 25.9% (49 people), not enough attention is paid to proper balanced nutrition, and a healthy diet is last among the applied preventive measures - 22.2% (42 people).

Although most of the respondents stated that they follow the hygienic measures for prevention of the disease and are accordingly familiar with them, 19.1% (36 people) attend fitness and other indoor activities when they are sick, and 29.6% (56 people) continue training, if possible, regardless of the presence of respiratory disease.

Specific measures for the prevention of influenza are related to the administration of influenza vaccines. In order to track the attitudes of the interviewees towards influenza vaccination, data were collected on the influenza immunizations performed until the beginning of the study. Only 12.2% (23 people) are familiar with influenza vaccines and have ever been immunized against influenza. Of all respondents, only 2.6% (5 people) were vaccinated against influenza at the beginning of the observed epidemic seasons and have real protection against the disease. In addition, the direct standardized interview found that students were unfamiliar with influenza vaccines and did not distinguish between them and mandatory childhood vaccines. It also turned out that almost all students who have been vaccinated against influenza are foreign nationals who have received information about influenza immunizations in the countries they come from, and where active campaigns for the prevention of influenza among athletes are vaccinated and conducted annually.

2.3. Incidence of influenza and ARD by season and by age groups

Based on the registered diseases during the two observed seasons, the total incidence in the examined persons was calculated. For each period of the influenza season it is respectively: pre-epidemic - 3703.70 per 10,000, epidemic - 4391.53 per 10,000 and post-epidemic - 1798.94 per 10,000. The incidence curve in the respondents correlates with that of the observed sentinel population in the same age range (fig. 1). In athletes, as in the general population, the highest incidence is recorded during the epidemic period of the influenza season, while the lowest incidence is in the post-epidemic period, when viral respiratory infections are rapidly declining.

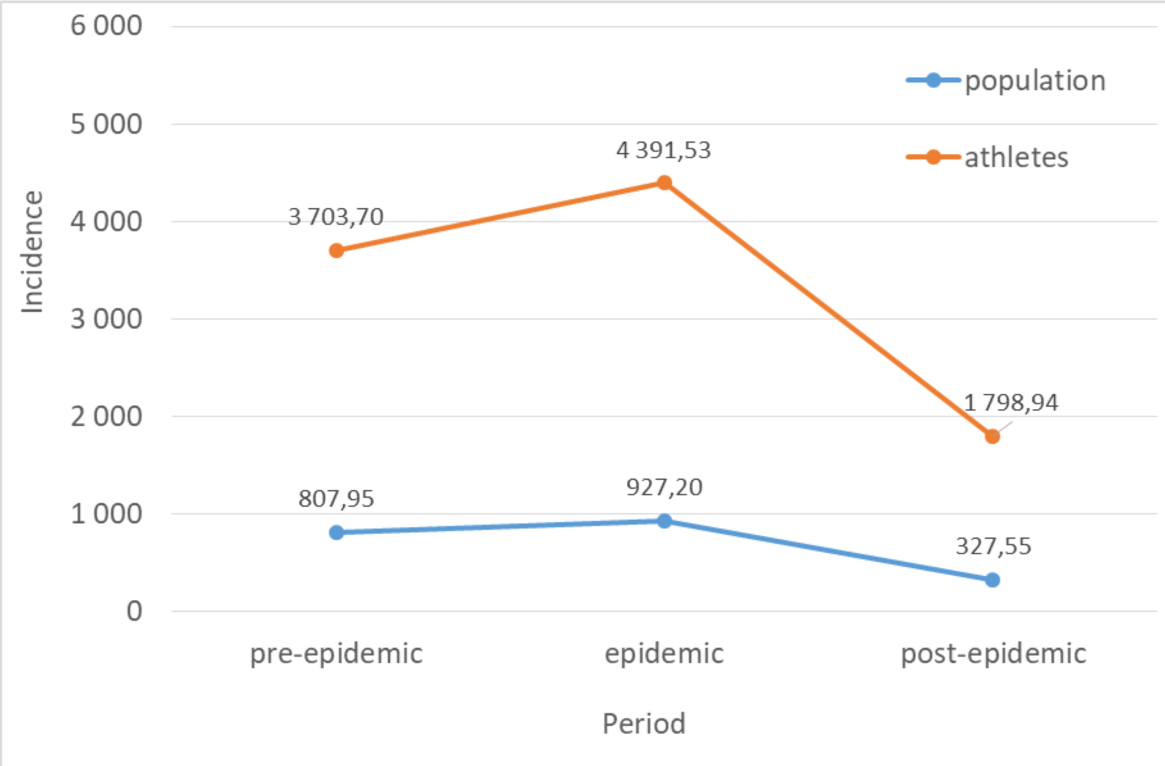

Figure 1. Incidence during the three periods of influenza season in the respondents and sentinel population

The registered incidence in the respondents is higher, as it is calculated on the basis of reported diseases of ARD and influenza, while in the sentinel population it is calculated only on the basis of visits to the physician in connection with these diseases. If the incidence of the respondents is recalculated by reducing the average rate of primary visits to a general practitioner (GP) - 3.3 (i.e. for every 3.3 reported cases, 1 has sought medical help), see the full correlation of the data (fig. 2). However, the incidence among respondents remains slightly higher than in the sentinel population, probably due to more frequent and prolonged contact between students and the longer time spent with many people indoors, dormitories, sports and classrooms.

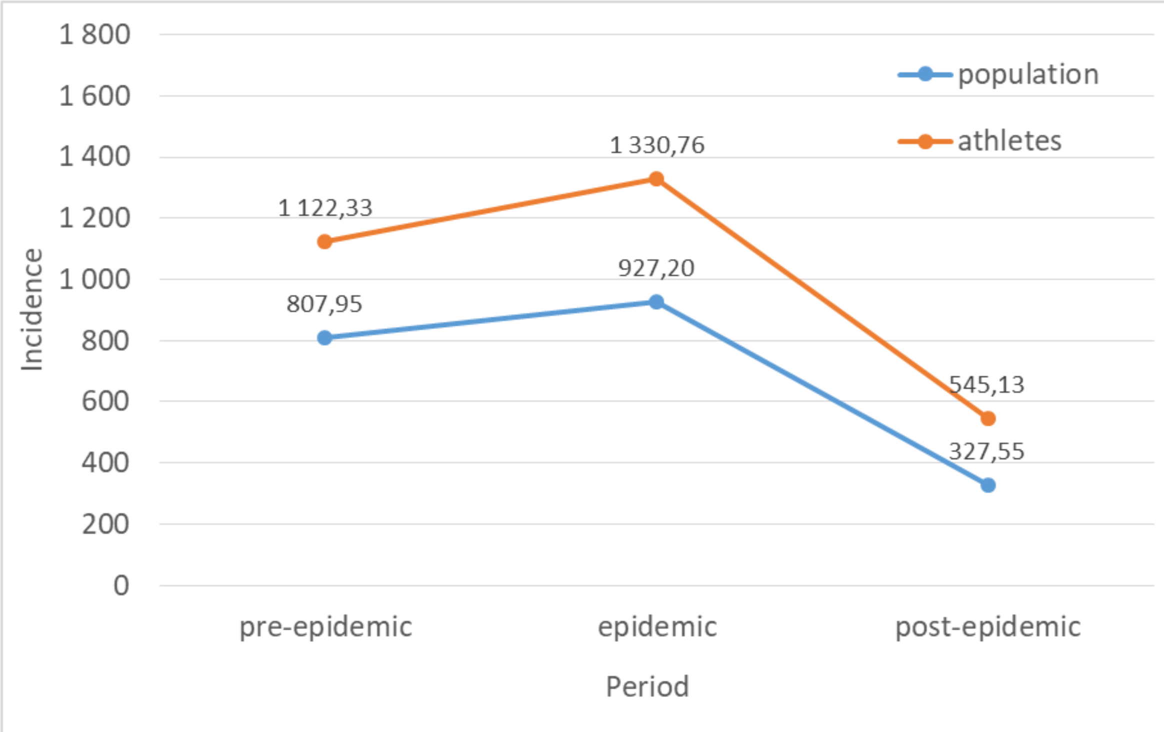

Figure 2. Correlation of incidence in the respondents and sentinel population

If the incidence is compared separately for the two influenca seasons, there is also a correlation of the data, with the highest influenza and ARD incidence recorded during the epidemic period of the season for 2018/2019, both in the surveyed persons and in the sentinel population (5,283.02 and 1,233.51 per 10,000, respectively, fig. 3). It is noticeed that the incidence of the surveyed athletes is significantly higher during the epidemic period, when the prevalence of influenza viruses in the country prevails.

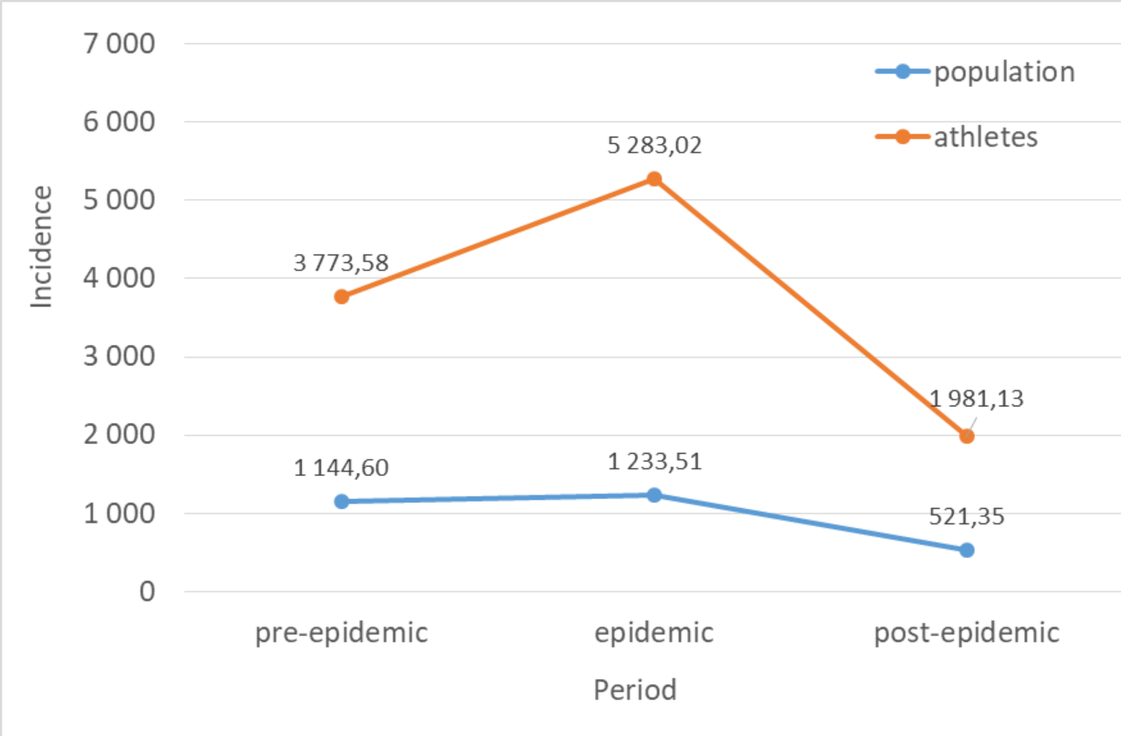

Figure 3. Incidence of influenza and ARD in the 2018/2019 season in the respondents and sentinel population

In the 2019/2020 season, the registered incidence among the respondents was the highest in the pre-epidemic period - 3,614.46 per 10,000, after which it began to decrease (3,253.01 and 1,566.27 per 10,000), in contrast from the sentinel population, where the highest values are preserved with a small difference during the epidemic period of the season (fig. 4). This decline in incidence among students surveyed coincides with the announcement of a influenza holiday in the winter of 2020, the cancellation of many sporting events and the ensuing state of emergency.

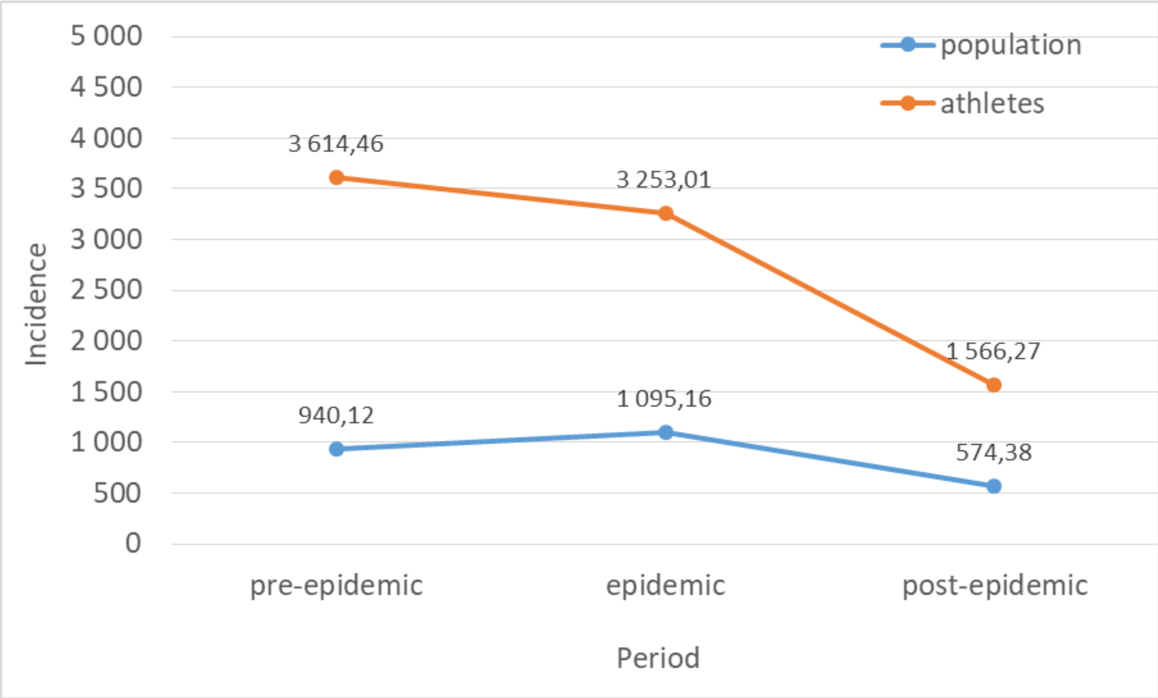

Figure 4. Incidence of influenza and ARD in the season 2019/2020 in the respondents and sentinel population

If the incidence is compared by age groups, again a higher incidence of influenza and ARD is registered in persons up to 29 years of age, as well as in the sentinel population (figs. 5 and 6). However, respondents in the age group over 30 years had significantly more illness during the epidemic period of the season, compared to the sentinel population (3,414.63 and 678.87 per 10,000, respectively). This is probably due to the fact that in most of these students the form of education is part-time and they attended classes during the seasonal influenca epidemics in both observed seasons. This proves the need for prophylaxis through immunization with influenza vaccines in these students.

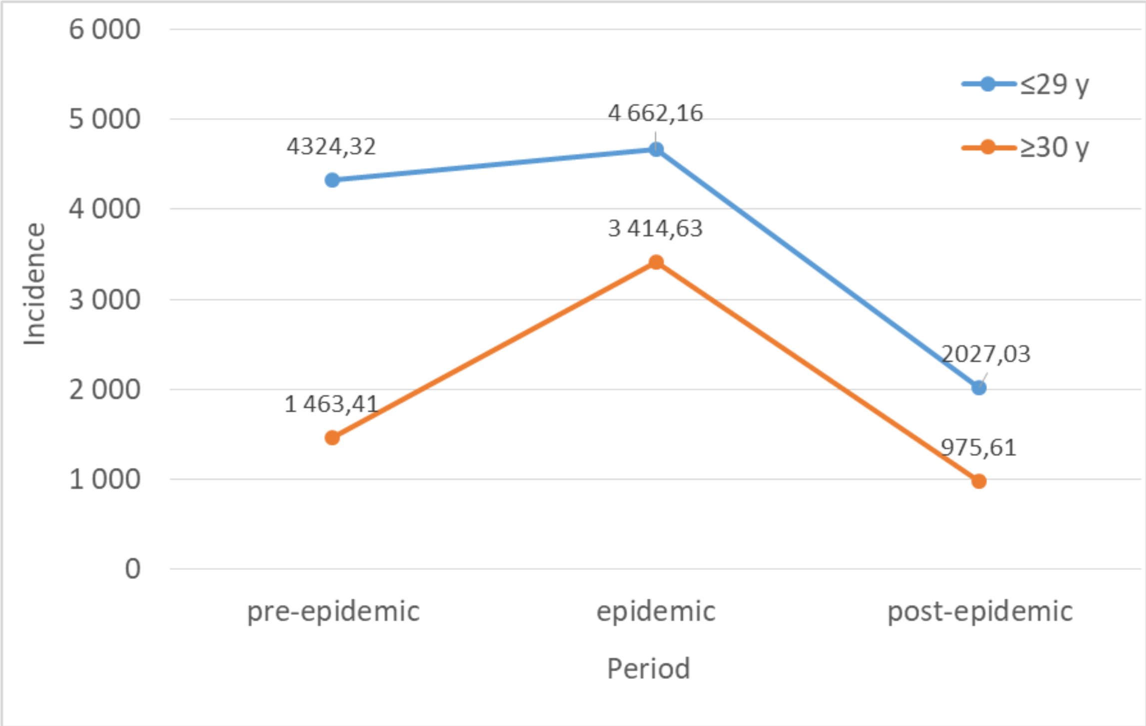

Figure 5. Incidence of influenza and ARD in the respondents by age groups

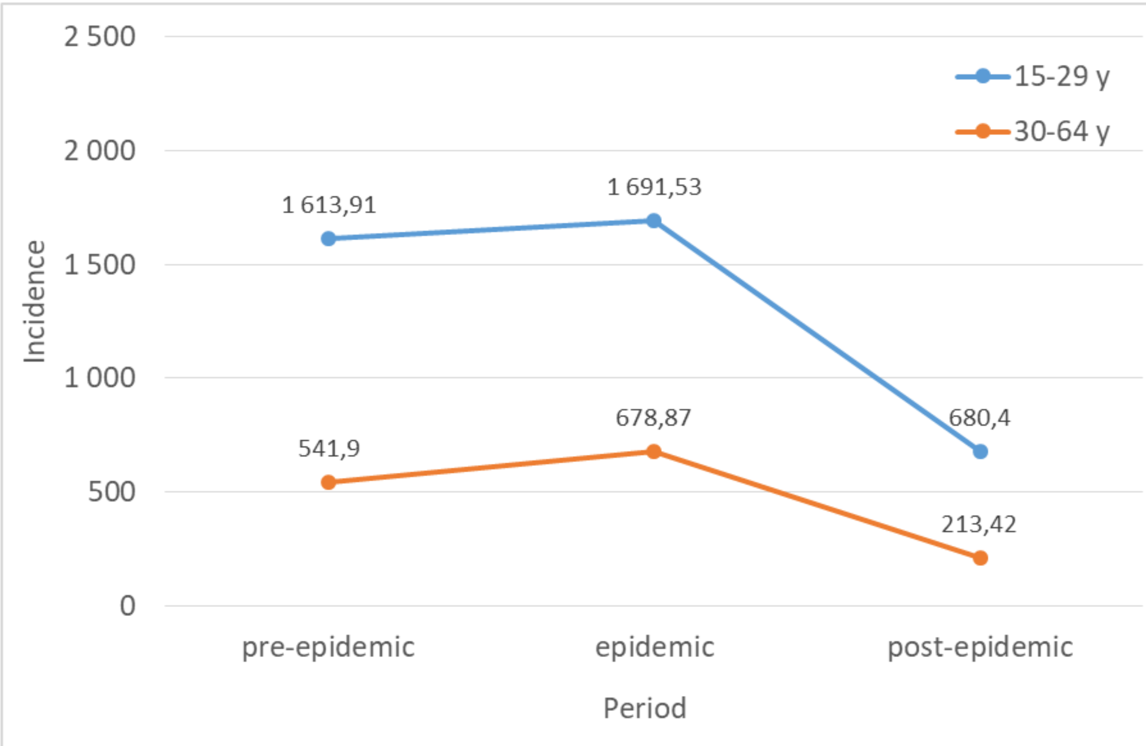

Figure 6. Incidence of influenza and ARD in the sentinel population by age groups

2.4. Relationship between incidence of influenza and ARD and physical exercises

Depending on the physical activity, the respondents are divided into the following three groups: low, moderate and high exercises (table 5). The criteria used by the World Health Organization (WHO) were used for categorization, and the data were grouped according to the minutes for training per day, the number of days of training per week and the self-assessment of the respondents.

According to the self-assessment scale, the physical exertion of the respondents was defined as "mild" (score 1-4), "moderate" (score 5-7) and "severe" (score 8-10). Based on this distribution, the respective exercises are defined:

- **Low:**
  - All who train only 1 day

  Or

  - ≥2 days, less than 150 min, with "moderate" efforts

  Or

  - ≥2 days, under 75 min, with "severe" effort

  Or

  - All with "mild" efforts
- **Moderate:**
  - ≥2 days, 150-300 min, with "moderate" effort

  Or

  - ≥2 days, 75-150 min, with "severe" effort
- **High:**
  - ≥2 days, over 300 min, with "moderate" efforts

  Or

  - ≥2 days, over 150 minutes, with "severe" efforts

The method of self-assessment, combined with the data on the duration of the training sessions allows for a very easy and effective way to make a quantitative assessment of the intensity of the exercises. The technique of self-assessment is convenient to use, quite reliable and consistent with objective physiological indicators to determine the intensity of training. It is often used as a stand-alone method for determining and tracking training loads, but it is recommended to be combined with other methods and indicators for greater accuracy.

Table 5. Distribution of respondents according to physical exercises

		Frequency	Percent	Valid percent	Cumulative percent
Physical exercises	Low	79	41,8	41,8	41,8
	Moderate	26	13,8	13,8	55,6
	High	84	44,4	44,4	100,0
	Total	189	100,0	100,0	

Of the three groups of respondents, those with low physical exercises (73.4%) were the most affected, followed by those with high physical exercises (60.7%) and moderate exercises (57.7%, fig. 7). The resulting curve corresponds to the J-curve for people with low and moderate exercises, but differs for people with high physical activity. They have been found to suffer less from influenza and ARD than those with low exercises, and the resulting curve is actually closer in shape to the S-curve.

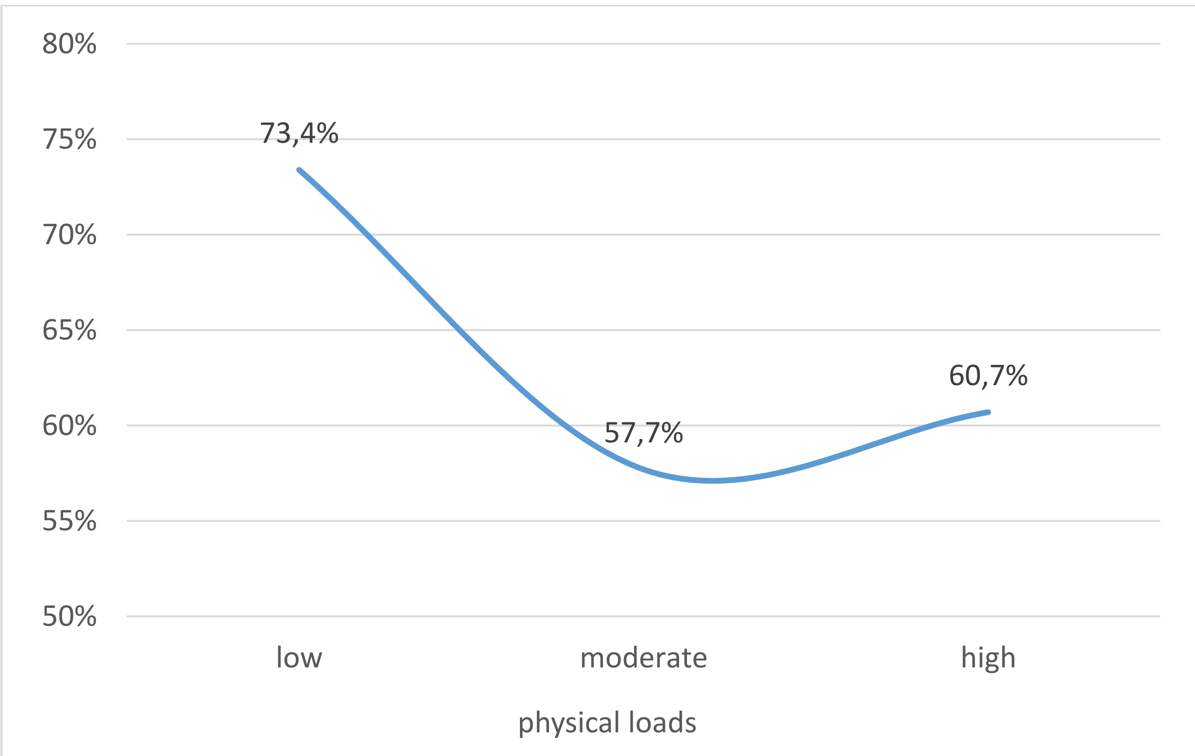

Figure 7. Influenza and ARD according to physical exercises

The highest incidence in all three types of exercises was registered during the epidemic period of the season, when diseases caused by influenza viruses dominated (respectively 4683.54 per 10,000 for low exercises, 3461.54 per 10,000 for moderate and 4,404, 76 per 10,000 for high exercises, fig. 8). During all three periods of the influenza season, the incidence is highest in people with low physical activity. In people with high physical activity in the non-epidemic periods a lower incidence is registered, but in the epidemic period, it is high and even close to the incidence at low physical activity. This is a serious problem, as most of these athletes are elite athletes participating in national and international tournaments. All this shows the need for enhanced preventive measures and the introduction of immunization programs with influenza vaccines among athletes and especially among elite athletes.

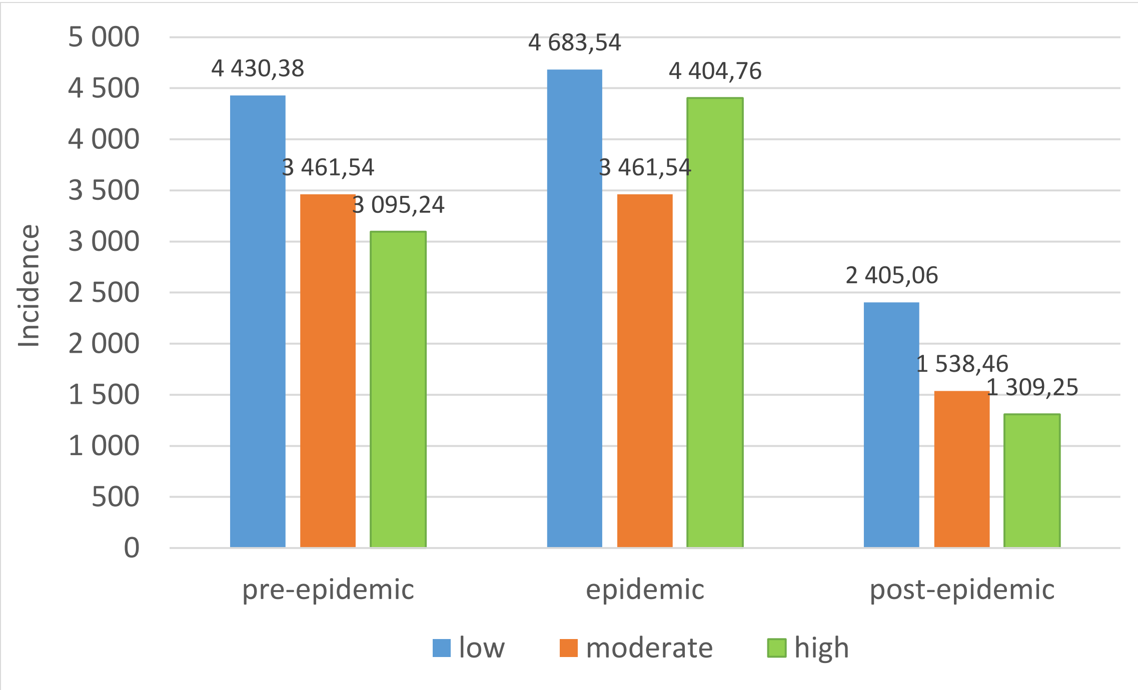

Figure 8. Incidence during the three periods of the influenza season depending on physical exercises

In order to determine the severity of influenza and ARD, for patients with different intensity of physical exercises, the average duration of the disease in days was calculated, as well as the average number of missed school days as a result of disease (table 6). For the purposes of the analyses, the indicator "missed school days" was used, as all respondents attend classes, while a much smaller part of them work or train daily to include missed working and training days in the assessment. People with moderate physical activity are ill for the shortest time - on average 5 days and have missed at least school days due to the disease - on average 0.5 days. The longest duration of influenza and ARD was registered in people with low exercises - almost 6 days (5.7), while the most school days were missed by respondents with high intensity of physical exercises - 1.5 days.

Table 6. Severity of the disease depending on physical exercises

Physical exercise	Duration of the disease in days		Missed school days	
	Total	Mean	Total	Mean
Low	35	5,7	35	1,2
Moderate	17	5,0	17	0,5
High	49	5,1	49	1,5

2.5. Factors influencing influenza and ARD

Binary logistic regression analyses was applied to assess the factors influencing influenza and ARD. P-values below 0.05 were considered statistically significant. Significant factor variables were selected with single models (at significance level 90% or $p<0.1$). They are used to compile a multiple model by the method of sequential inclusion, in order to leave only significant variables. To assess the relationship between the categorical factor and the quantitative result, a dispersion analyses was applied. The pairwise comparisons were made using the Bonferoni method.

Table 7 presents the variables that have been shown to have an impact on influenza and ARD.

Table 7. Variables affecting influenza and ARD

	p-value	HR*	1/HR	95% CL	
Age	0,004	0,944	1,059	0,908	0,982
Intake of vitamins, supplements and immunostimulants	0,087	1,702	0,588	0,926	3,129
Enough sleep and rest	0,009	0,410	2,439	0,209	0,803
Number of training days per week	0,050	0,811	1,233	0,658	1,000
Self-assessment of physical effort during exercise on a scale of 1 to 10	0,011	0,618	1,617	0,426	0,897

**Hazard ratio*

With increasing age, the likelihood of influenza and ARD decreases. Every year the chance of disease decreases by 5.9%. Actually the intake of vitamins, supplements and immunostimulants is a risk factor for influenza and ARI, but the results are significant at a confidence level of 90%, i.e. should be interpreted with caution as not all possible reasons for taking these substances have been taken into account. Ensuring enough sleep and rest is a protective factor for influenza and ARD. The probability of diseases is twice as high in the absence of adequate sleep and adequate rest. The higher number of training per week and the higher intensity of physical effort according to the self-assessment of the subjects also play the role of protective factors.

With these significant variables, a multiple model was compiled to assess their statistical significance when considered simultaneously as factors influencing influenza and ARD (table 8).

Table 8. Combined effects of variables on influenza and ARD

	p-value	HR	1/HR	95% CL	
Age	0,009	0,948	1,055	0,910	0,987
Enough sleep and rest	0,048	0,495	2,021	0,247	0,993
Self-assessment of physical effort during exercise on a scale of 1 to 10	0,027	0,644	1,552	0,437	0,950

The combined effects of the variables - increasing age, more sleep and rest and higher levels of physical effort during exercise play the role of protective factors for influenza and ARD.

Summary

Physical activity has an impact on influenza and ARD, as moderate physical activity has a positive effect and leads to a reduction in diseases and their severity. High-intensity physical activity does not cause more incidence and does not significantly affect the course of the disease. A number of additional factors, such as habits, lifestyle and age, also influence the incidence of influenza and ARD. Knowing and using them in the training of athletes will help reduce diseases and improve athletic performance.

Conclusions

1. People with moderate physical exercises suffer less from the influenza and ARD and the disease is milder, but further studies are needed to prove their role as a protective factor.
2. High-intensity physical exercises does not lead to a statistically significant increase in the incidence of influenza and ARD, nor to a more severe disease.
3. The analyses of the incidence of influenza and ARD during the two observed seasons show that the influenza epidemics in the country are of different duration

and intensity, but mainly affect children and young people. Young people and children are major spreaders of respiratory diseases and should be covered by preventive measures.

4. The results of the study on the epidemiology of influenza and ARD in athletes confirm the great importance of these infections, both for public health and for sports at the elite and mass level.

5. Diseases of influenza and ARD are the cause of serious losses in sports - there is a statistically significant deterioration of the results achieved by sick elite athletes, the training regime is violated, training days are missed, as well as participation in responsible competitions.

6. Athletes confirm one of the main characteristics of influenza and ARD - young people suffer more but lighter compared to older people.

7. Smoking is a risk factor leading to a statistically significant increase in the number of athletes with influenza and ARD, as well as to a more severe diseases, with loss of more school and training days, longer illness and a statistically significant increase in outpatient visits.

8. The presence of bronchial asthma and other chronic allergies in athletes is a risk factor with statistical significance for influenza and ARD, so it is necessary to provide immunizations with influenza vaccine and implement enhanced preventive measures for people with allergies.

9. Incorrect use of vitamins, supplements and immunostimulants by healthy people is a statistically significant risk factor for the development of influenza and ARD, which proves the need for medical supervision and monitoring in their use in sports.

10. Ensuring sufficient sleep and rest is a statistically significant protective factor reducing the incidence of influenza and ARD in athletes, which is underestimated and often neglected in the training of athletes.

11. In team sports and indoor sports, there is a higher risk of infection and spread of influenza and ARD, therefore control and prevention measures should depend on the type of sport practiced and the competition program, with particular attention to periods of increased incidence.

12. There is a low awareness among athletes about the correct behavior during influenza and ARD, preventive measures, as well as the possibilities for prevention and the benefits of influenza vaccinations.

13. The promotion of influenza vaccine immunizations among part-time students is likely to reduce incidence during the epidemic period of the influenza seasons (January and February).

14. High incidence is registered during the periods of epidemic increase among athletes and especially among elite athletes, so it is necessary to introduce immunization programs with influenza vaccines in accordance with the individual training regime and competition schedule.

Contributions

1. Contributions of original scientific character

1.1. The first comprehensive study in Bulgaria was conducted, which takes into account the physical activity of athletes, the incidence of influenza and ARD and the applied preventive measures in athletes.

1.2. A review of the WHO's official recommendations for physical activity and current definitions for influenza and ARD has been reviewed and then applied to assess respiratory incidence in athletes.

1.3. A comparative analysis of the official data on the incidence of influenza and ARD among the sentinel population in Bulgaria and the data from the survey among athletes was performed and the main characteristics of respiratory diseases in sports were formulated.

2. Contributions enriching existing knowledge

2.1. An analyses of the data on the incidence of influenza and ARD in Bulgaria in the seasons 2018/2019 and 2019/2020 has been made and three periods of spread of respiratory infections have been defined: pre-epidemic, epidemic and post-epidemic.

2.2. The relationship between the level of physical exercises and the incidence of influenza and ARD in the country has been studied, which will help to develop strategies to reduce respiratory diseases and improve health through properly dosed sports activities.

2.3. The theory of the S-curve and the absence of a statistically significant difference in the incidence of influenza and ARD in elite athletes and those with moderate physical activity has been confirmed.

3. Contributions of a scientifically applied nature

3.1. An electronic questionnaire has been developed to determine the level of physical activity, the incidence of influenza and ARD and the applied preventive measures in athletes.

3.2. A reliable and easily applicable method for assessing the severity of physical exercises based on the duration of training and self-assessment of physical effort has been developed.

3.3. An analysis of the incidence of influenza and ARD in athletes has been made and the specific groups at increasing risk of disease have been identified, to which prevention measures should be directed as a priority - practicing team sports, indoor sports and elite athletes.

3.4. The risk and protective factors influencing the incidence of influenza and ARD in athletes have been identified, which can be successfully applied for the development of modern preventive programs in sports.

3.5. Recommendations for influenza vaccine prophylaxis in athletes are given.

Recommendations

Based on the analysis and conclusions from the dissertation, several suggestions can be made for the continuation of work and for the development of new research projects:

1. Conducting studies to prove the importance of moderate physical exercises as a protective factor for the development of influenza and ARD.
2. Additional studies on the relationship between changes in training loads (increased volume and intensity) and the risk of disease.
3. The analyses is the basis for future studies to determine risk factors, routes of transmission and specific diseases in different sports, differentiate between aerobic and anaerobic exercises and their role in the development of influenza and ARD.
4. Additional studies on the relationship between the risk of influenza and ARD and long travel, incl. jet lag and insufficient sleep.
5. It is important to establish the role of vitamins, supplements and immunostimulants used in sports for the development of influenza and ARI, depending on the type of preparations, dose, duration of use.
6. The tendency of athletes (especially at the elite level) to continue to training and compete, despite the symptoms of illness and physical complaints, shows the need to control and monitor their condition in the presence of respiratory infections.
7. In order to improve the health of athletes and the results achieved, especially during the winter season, it is necessary to prepare a program to promote immunizations with influenza vaccines among athletes and their teams.

8. The high incidence of influenza and ARD, the significant losses and the low awareness of prevention options, indicate the need to develop a strategy for the control and prevention of infectious diseases in sport, including immunization recommendations, guidelines for preventive measures and personal hygiene.

Publications related to the dissertation:

1. **Georgieva T.** Seasonal influenza vaccination in athletes. Sport and science, Issue 1,2/2020, 279–288, ISSN 1310-3393

2. **Georgieva T.,** M. Kojouharova. Prevention and treatment of influenza in pandemic situation, Nosocomial infections, vol. 5, issue 1-2, 2008, 49-54, ISSN 1312-4765

3. Kurchatova A., M. Kojouharova, **T. Georgieva**, A. Georgiev. Modern system for influenza and acute respiratory infections epidemiological surveillance in Bulgaria, Infectology, 2008, XLV, 4, 14-19, ISSN 0861-8259