Pollinosis in the conditions of climate changes

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Abstract. The aim of the study was to study the content of plant pollen and fungal spores in the air of Karakol of the Kyrgyz Republic and assessment of their contribution to the development of pollinosis in the conditions of climate changes. The article is devoted to the current problem of the impact of climate change on aerobiological particles – plant pollen and fungal spores. There is a worldwide trend for rising temperatures. The number of people suffering from allergies – pollinosis – is steadily increasing. Concentration of pollen of allergenic species may increase, the timing and duration of the dusting season may change. Moreover, in recent years, there is a sharp increase in pollen allergy morbidity observed in the country. Data from Karakol city for 2015-2017 showed that pollen of 34 plant taxa and 24 taxa of fungal spores were present in the air. The pollen of leading aeroallergens was contained in the air of Karakol in significant amounts and for a significant period. The novelty of the study was that for the first time in Kyrgyzstan, aerobiological studies were carried out with a volumetric method using volumetric certified Lanzoni apparatus. The idea that there is a need for programs, continuous aeropalynological studies that will predict the number, taxonomic composition and behavior of aeroallergens is substantiated. This has important public health implications, as it will allow an assessment of the allergenic environment, allowing people with allergies to avoid or reduce the severity of the course of the disease.

Keywords: plant pollen; fungal spores; aeroallergens; climate change; pollinosis; aerobic spectrum; air bio-particle monitoring

1. Introduction

The processes that characterize the nature of morbidity are complex and contradictory, and in general, they can be seen as a response of the human body to changes in the socio-economic and ecological environment. In the 1970s, according to the WHO, the condition of mixed populations in different countries depended on an average of 50-60% on economic security and lifestyle, 18-20% on environmental conditions, and 20-30% on the level of medical care. Modern hygienic science has established that environmental degradation increases the level of morbidity of the population by an average of 20%. The development of industry, urban agglomerations, increased flow of vehicles and noises have a significant impact on the environment, and as a consequence, on the health of the population as a whole. Thus, environmental determinants of health play just as important a role in health promotion, maintenance and restoration as biological, social and behavioral factors [1].

In recent years, certain studies of biomedical science have focused on the impact of climate change on aeroplankton (components of the air microflora), which have unique abilities to survive and

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reproduce, genetically and morphologically change, and carry negative consequences for humanity. Aerobiological research has become particularly important because of the ubiquitous increase in the rate of pollinosis (diseases caused by aeroallergens). The presence of specific proteins (allergens) in the composition of pollen grains can cause allergic diseases in humans.

The symptoms of pollinosis are typical for the Kyrgyz Republic. Increasing levels of biological contamination (including plant pollen and fungal spores), environmental pollution, and changes in the immune status of the population caused a large-scale spread of pollinosis. In the Kyrgyz Republic, there is no service for the prevention of allergic diseases, although the territory of the republic (198.5 thousand km^2) includes many climatic zones with the most diverse type of vegetation, quantitative, and taxonomic composition of air pollen causing diverse clinical symptomatology of pollinosis.

The article is aimed to study the content of plant pollen and fungal spores in the air of Karakol (Kyrgyz Republic) and assess their contribution to the development of pollinosis in the conditions of the climate change.

2. Materials and Methods

There were several overall objectives of the research paper. 1. The study of the impact of climate change on aeroallergens (in this regard, the development of the concept of "Aeroallergens as indicators of climate change and environmental pollution"). 2. The determination of pollen concentration of dominant species of allergenic plants and fungal spores in the air environment of Karakol. 3. The study of the influence of meteorological factors on the concentration of aeroallergens. 4. The analysis of the impact of changes in land use on the aerobiological spectrum (plant pollen and fungal spores). 5. The analysis of the state of greening of the city of Karakol. 6. The development of pollinosis prevention measures for the territory of the Kyrgyz Republic.

The city of Karakol is located in the eastern part of the basin, at the altitude of 1716 meters ASL (middle mountains), at the northern foot of the ridge Terskey Ala-Too. The climate of the city is continental. Until recently, it was characterized by softness and relatively small fluctuations in temperature. Average annual temperature is 5º C, January – up to 6º C, July – up to 18º C, the average annual rainfall was 350-450 mm.

The tests were carried out by volumetric method using volumetric certified apparatus "Lanzoni s.r.l.", model VPPS 2010. The pollen trap was placed on the roof of a building in Karakol city, far from park zones and industrial enterprises, at a height of 13 meters above the ground level. Pollen and spore concentrations were counted during the entire growing season from April to October 2015-2017. Counting of pollen grains and fungal spores from aerobiological samples and their identification was performed according to standardized methods, the data were presented as the number of pollen grains per 1 m^3 of air [2,3]

The microscopic study was performed using Carl Zeiss (Germany) and MEIJI (Japan) light microscopes. Pollen grains were identified mainly to genus or family using identifiers and atlases were used to identify them [4,5]. For identification of fungal spores, the authors used a phytoparasitic fungi identifier, an atlas of allergenic spores, and a specially developed identifier based on a dichotomous key, [6,7,8].

For all identified pollen and spore taxa, the beginning and end of the dusting periods, maximum daily values, and total values were determined. During the three observation seasons (2015-2017), 530 aeropalynological samples were collected and processed.

3. Results

The data for 2015-2017 showed that in the air of Karakol, from the third decade of April, pollen of 34 plant taxa was present, 9 of which were dominant: Artemisia (Artemisia), cereals (Poaceae), hemp (Cannabiaceae), pigweeds (Chenopodiaceae), Asteraceae, sedges (Cyperaceae), pine (Pinales), birch (Betula), poplar (Populus). Unidentified taxa, including damaged pollen, made up the rest of the spectrum. Aerobiological spectrum of Karakol included two spore-pollen waves: spring-summer spore-pollen wave (April-June) and summer-autumn spore-pollen wave (July-October), which was long due to the presence of pollen of weeds and cereals that are known to be strong bioallergens. This dusting wave was the most powerful and prolonged. It was primarily caused by the flowering of Artemisia, Chenopodiaceae, and Poaceae. Summer-autumn rise caused by a large group of plants, which flowering dates coincide and a significant amount of pollen falls in the foothills and mountains, increases the risk of pollinosis. The air in Karakol contained the pollen of 24 taxa of angiosperms (Angiospermae), 15 taxa of woody and shrub plants, 14 taxa of grasses, and 5 taxa of Gymnospermae belonging to coniferous (Pinopsida) class. It also contained 24 taxa of fungal spores: 15 taxa belonging to the type of imperfect fungi (Deuteromycetes, Fungi imperfecti) and 9 spore taxa from the type of perfect (Fungi perfecti) fungi (Ustilaginaceae, Coniophoraceae, Erysiphaceae, Tilletiaceae, Pucciniaceae, Pythiaceae) (Table 1).

Table 1. Amount of plant pollen and fungal spores in Karakol by years.

	Years of the study					
	2015		2016		2017	
Trees	14 taxa		19 taxa		15 taxa	
	2,186 pg/cm^2	2.5%	24,155 pg/cm^2	26.44%	33,596 pg/cm^2	30.3 %
Grasses	9 taxa		11 taxa		12 taxa	
	76,440 pg/cm^2	89.1%	47,474 pg/cm^2	52%	77,323 pg/cm^2	69%
Cereals	6,585 pg/cm^2	7.7%	19,325 pg/cm^2	21.1%	17,340 pg/cm^2	15.5 %
Fungal spores	10 taxa		18 taxa		24 taxa	
	102,153 s/cm^2	100%	98,541 s/cm^2	100%	204,565 s/cm^2	100 %

Note: pg – pollen grains, s – spores

Kupriyanov (1978) singles out 3 families, which representatives pollen sensitizes people to the greatest extent: cereals (Poaceae), asteraceae (Asteraceae) and pigweeds (Chenopodiaceae). In addition to cereals, the top ten global aeroallergens include pollen from birch, willow, sycamore, olive, wormwood, ragweed, and Chenopodiaceae. Around 90% of the above species fell on Lanzoni trap slides in Karakol. Taxonomic composition of pollen allergens in the air and pollen of individual taxa determines the frequency of pollinosis. In Karakol, the pollen of weeds (Artemisia, Chenopodiaceae) is most dangerous in summer-autumn period. Its maximum concentration is shown on Fig. 1.

Among the fungal spores, the allergens met worldwide are Alternaria, Cladosporium, Aspergillus, and Penicillium. The amount of spores in the air varies widely throughout the year and in different years, reaching high concentrations in summer due to nutrients in the soil and a complex of meteorological factors. Therefore, in the air of Karakol, the concentrations peaked in summer and early autumn, when rainy days were followed by sunny, dry and windy days. Despite a relative constancy of the presence of the main fungal spore taxa for this region, Cladosporium and Alternaria (spore formation in Alternaria and Cladosporium occurs from March, when there is still snow, to deep autumn), each season of the study time was different. The productivity of individual taxa varied primarily due to climatic and meteorological conditions. During the study period of 2015-2017, the trap tapes collected fungal spores of 24 taxa: 15 taxa of the class Deuteromycetes (imperfect fungi or Fungi imperfecti) and 9 taxa of the class Fungi perfecti (perfect fungi) (Fig. 2).

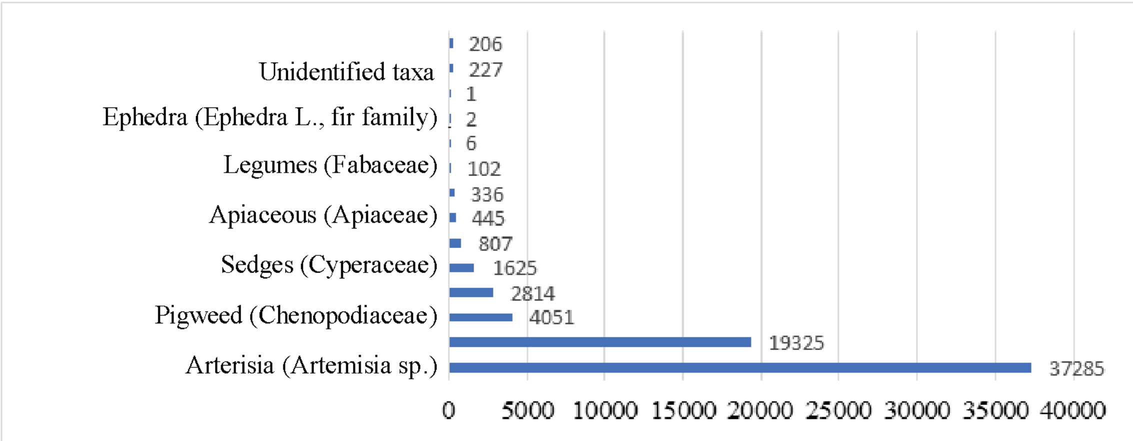

Fig. 1. Quantitative and qualitative composition of grass pollen (pg/cm^2).

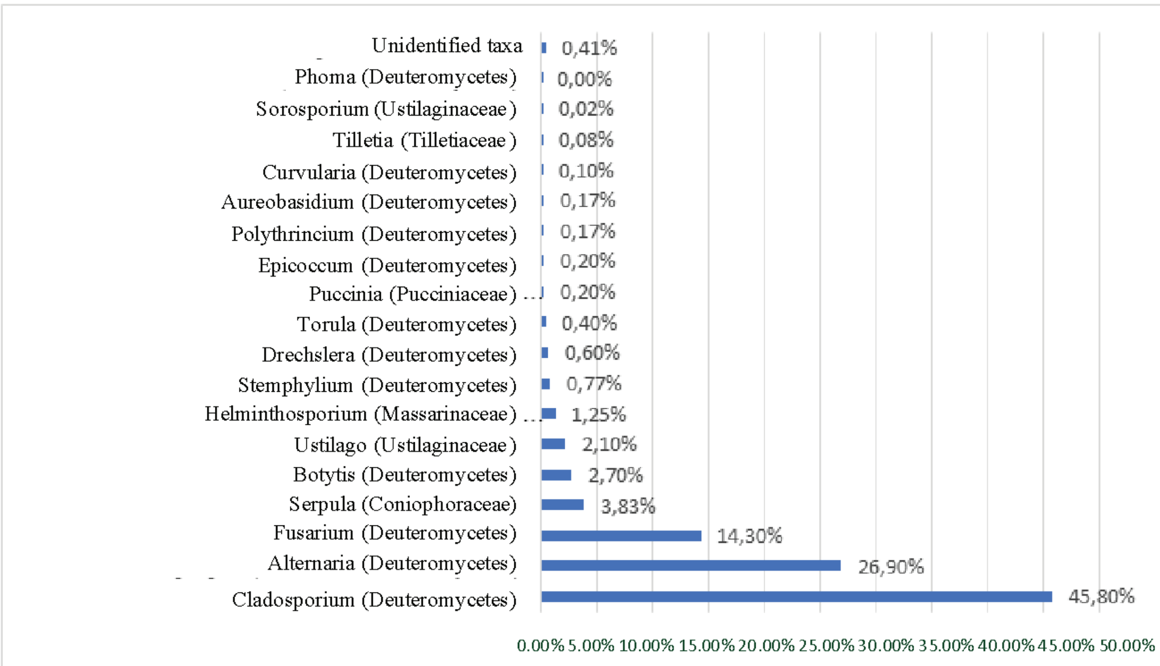

Fig. 2. Quantitative and qualitative composition of mushroom spores, %.

It should be noted that on certain days, a very large number of fungal spore taxa, including the tandem of Alternaria and Cladosporium spores, fell on the trap tapes at once. Alternaria and Cladosporium were registered during the whole season in the years of observation. Respiratory diseases caused by rust and black imperfect fungi were described more than 60 years ago and sensitization to various fungi is now clearly proven. Nevertheless, the significance of many fungi for allergy remains difficult to assess and requires special studies.

In 2019, the population of Karakol was 77,752 thousand people (34,630 thousand men and 43,122 thousand women). According to the Issyk-Kul Regional Medical Information Center, over the past four years (2016-2019), there has been an upward trend in the morbidity of the population of Karakol, both among adults and adolescents over 14 years old and children under 14 years old (Fig. 3). The main contribution to the morbidity of adult population in the city was made by diseases of respiratory organs (16%), digestion (16%) system, urogenital system (15%), and blood circulation system (12%). Respiratory diseases prevailed in children (42%) (Figs. 4, 5).

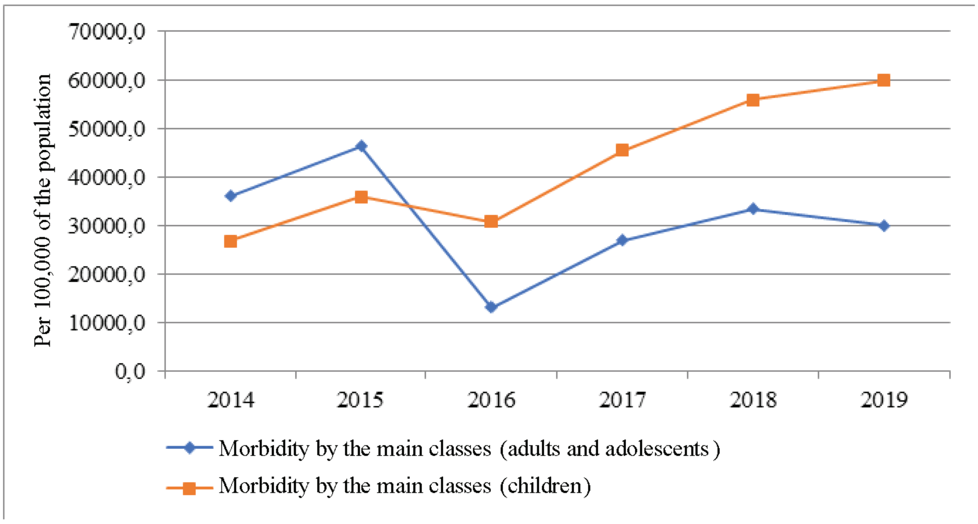

Fig. 3. Morbidity by the main classes in adults and children in 2014-2019.

Fig. 4 shows the prevalence of allergic rhinitis (pollinosis) in adults and children in Karakol for 2015-2019. The data shows that there was a sharp increase in this disease since 2016, when children were particularly sensitive (Fig. 5).

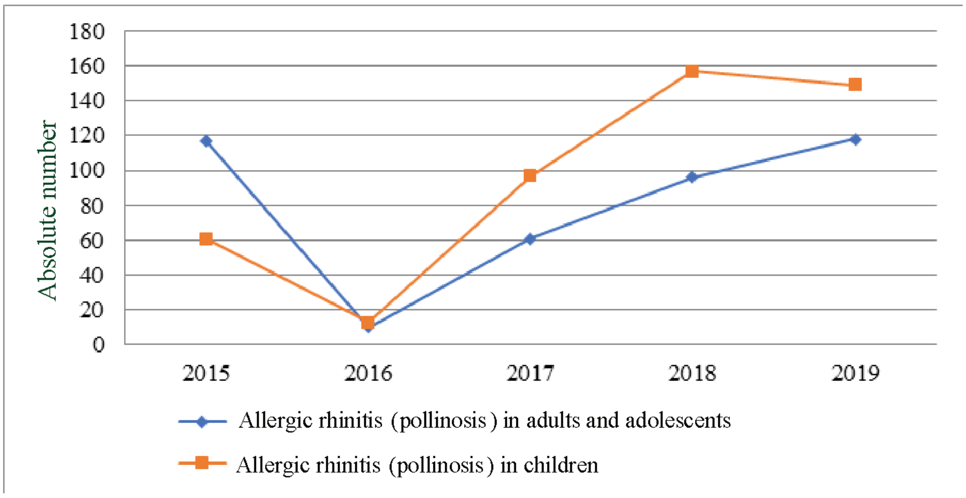

Fig. 4. Morbidity by the allergic rhinitis in adults and children in 2015-2019.

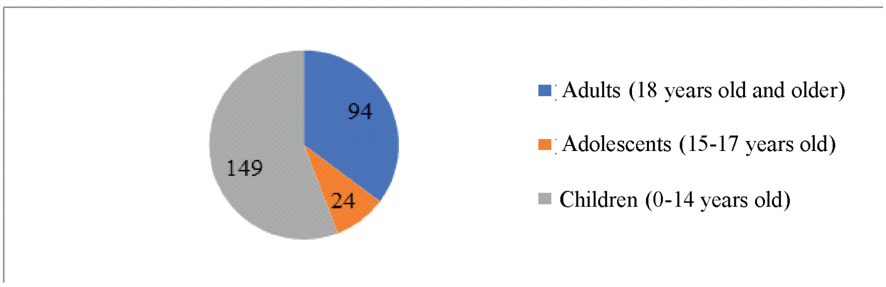

Fig. 5. The prevalence of allergic rhinitis by age group (absolute number) for 2019.

Pollinosis mainly affects the mucous membranes and the upper respiratory tract, causing seasonal allergic rhinitis, sinusitis, nasopharyngitis, laryngitis and mucous membrane lesion of adjacent areas, and eyes, causing conjunctivitis. In some cases, it may manifest as coughing, wheezing, shortness of breath and choking attacks, up to the development of bronchial asthma. Pollinosis is dangerous because it can provoke bronchial asthma (the presence of allergic rhinitis increases the risk of bronchial asthma by 3 times).

The awareness of the spore-pollen spectrum of a particular area is of great importance in the work of doctors on the prevention of pollen allergy. Unfortunately, during the season of plant pollen allergy exacerbation, not all patients can go to an allergist, since the latter is severely lacking in the Kyrgyz Republic (especially in the regions). In such cases, patients go to family doctors or general practitioners, or pediatricians, wherein they cannot receive qualified allergological care. Half of patients with allergic rhinitis do not go to a doctor at all, others do so when their symptoms become unbearable. Very often, pollen allergy, especially in children, is mistaken for an acute respiratory infection. The data in Table 2 shows that the incidence of respiratory diseases is increasing among children, adults and adolescents alike. The absolute number of respiratory disease cases in children under age 14 increased from 76,519 in 2013 to 125,883 in 2017. In 2013, about one third of children living in Bishkek had respiratory diseases. In 2017, this proportion increased to 46%.

Table 2. Data on the morbidity with certain diseases among adults, adolescents, and children in Bishkek.

Data on the morbidity with certain diseases among adults and adolescents in Bishkek (primarily registered in adults and adolescents)						
	2013		*2016*		*2017*	
Disease class	*Abs.*	*Per 100 thousand*	*Abs.*	*Per 100 thousand*	*Abs.*	*Per 100 thousand*
Allergic rhinitis (pollinosis)	998	147.3	1.712	242.0	2.139	297.8
Bronchial asthma	140	20.7	259	36.6	245	34.1
Data on the morbidity with certain diseases among children in Bishkek (primarily registered in children younger 14 years old)						
	2013		*2016*		*2017*	
Disease class	*Abs.*	*Per 100 thousand*	*Abs.*	*Per 100 thousand*	*Abs.*	*Per 100 thousand*
Allergic rhinitis (pollinosis)	468	205.5	813	310.5	1.256	460,0
Bronchial asthma	57	25.0	84	32.1	98	35.9

4. Discussion

Allergenic aerobiological particles will vary quantitatively and qualitatively depending on climate and environmental conditions. Observational data show that recent regional climate changes, especially temperature increases, have already affected a variety of physical and biological systems in many parts of the world. The structure of allergens also changes in response to climate change [9].

Meteorological factors such as temperature can also influence the interaction between allergens and air pollution, causing adverse respiratory effects because the damage to the respiratory epithelium associated with air pollution increases airway permeability, stimulating allergen-induced responses, and the absorption of pollutants on pollen grain surfaces can alter their allergenic potential. Climate change will lead to the worsening of almost all climate hazards as well as the associated burden of disease [10].

The pollen concentration of allergenic species may increase, and the timing and duration of the pollen season may change. Anthropogenic influences may change pollen concentrations over time. Some plant taxa may decrease or disappear altogether, some may migrate, their ranges may change (appearance of botanical taxa in new geographic areas different from their natural range), pollen production, distribution, allergenicity, and ruderal (weed) vegetation will increase [11, 12, 13, 14]. In other words, climate change can increase the duration of aeroallergens seasons as well as pollen counts, geographic coverage, and allergenicity, [15].

Currently, many studies confirm this position. The question of the behavior of aeroallergens under conditions of climate change has been the focus of research attention in many countries in recent years. It has been noted that the geographical ranges of many plant and animal species have shifted in recent decades in response to the observed climate change, their abundance and seasonal activity have changed (examples being the migration of birds or pollen production) [16]. This displacement may lead to an increased incidence of pollinosis and vector-borne diseases in the European region [17].

Regarding temperature, there is an upward trend in almost all regions of the Central Asia. It is obvious that climate change can affect the quantity and quality of water resources and their seasonal dynamics, agriculture, and human health. In addition to warming, there is also an imbalance of all geosystems on the planet, which is manifested in the growth of the number and strength of all dangerous hydrometeorological phenomena: floods and droughts, heat waves and sharp frosts, squally winds, heavy snowfalls, etc. It should be noted that the rate of temperature change in Kyrgyzstan has a non-linear nature and has significantly increased in recent decades. For the entire period of observations, the average annual temperature increase was 0.0104 ºC/year. Within 1960-2010 period, the rate more than doubled to 0.0248 ºC/year, and within 1990-2010 period, it was 0.0701 ºC/year. An increase in the average annual temperature was observed in all climatic zones and regions of the republic [18].

At the same time, the number of people suffering from allergies is steadily increasing. The cause is considered to be the quality of the environment, the quality of food, and increased consumption of medications. Global warming was called the leading cause of the increase in the number of people with allergies. According to statistics, from 20% to 40% of the world's population suffer from one form of allergy [19]. It is predicted that by 2020, two-thirds of the world's population will live in urban areas, and an increased risk of respiratory allergies caused by aeroallergens is expected [20]. Aeroallergens were shown to be responsible for 63% and pollen for more than 92% of cases of allergic rhinitis, [21, 22]. Taxonomic composition of pollen allergens in the air and pollen of individual taxa determines the incidence rate of pollinosis. The authors believe that the taxonomic diversity of plant pollen (pollen of weed, trees) and fungal spores (with global allergens – Alternaria and Cladosporium) of Karakol city, with the maximum concentration in summer-autumn period, is one of the reasons of pollinosis prevalence rise.

Because of an increasing number of plant pollen allergies, it is necessary to monitor aeroallergens in all regions of the republic, as it is an additional complex in pollen allergy prevention. Monitoring allows the specialists to estimate peculiarities of seasonal and daily dynamics of pollen of separate taxa, to control qualitative and quantitative composition of pollen rain, and to forecast its further changes. Restriction of contact with the allergen (allergen avoidance) is an important task in preventing exacerbations in the daily life of a patient with an allergic disease. Awareness of causative allergens can increase the effectiveness of preventive and therapeutic measures. This requires reliable and scientifically grounded information about the allergen [23].

5. **Conclusion**

The study results analysis of the pollinosis in the conditions of the changing climate allowed the authors to make the *following conclusions*:

1. The pollen of the leading aeroallergens (wormwood, cereals, pigweed) is contained in the air of Karakol in significant quantities and for a considerable period (up to 150 days) in Karakol in significant quantities and for a considerable period (up to 150 days). Qualitative and quantitative

composition of pollen in air of different years was almost identical, but there were differences in the prevalence and presence of certain taxa. Species composition of tree pollen caught on trap tapes showed that pollen of conifers (gymnosperms) prevailed by quantity. In the air of Karakol, out of 24 taxa of fungi, the main allergens (tandem of spores Alternaria and Cladosporium) fell in significant quantities.

2. There has been a sharp increase in allergic rhinitis prevalence in Karakol since 2016, when children were particularly sensitive. The incidence rate of respiratory diseases is increasing among children, adults, and adolescents (data for Bishkek).

3. The results of experimental studies of plant pollen and fungal spores have important implications for public health. Ongoing aeropalynological studies are needed to develop a system for alerting the public and medical facilities about pollen and spore concentrations in 1 m^3 of air ("pollen rain") to assess the allergenic environment, which will allow people with allergies to avoid or reduce the severity of the disease.

4. Scientific research on aeroallergens and allergic diseases is needed to adapt to the effects of climate change. These are primarily monitoring of aeroallergens (plant pollen and fungal spores); predicting aeroallergen patterns; management of allergenic plants (up to elimination of some species); state policies on landscaping settlements; access to medical care and medicines [16]. Such programs would predict the number, taxonomic composition, and behavior of aeroallergens.

5. Air monitoring for the detection of bio-particles is becoming a necessary line of research in many countries, as a cost of planned adaptation in the context of human health protection. It is an additional complex in carrying out the prevention of pollinosis. Unfortunately, there is no national pollen monitoring program in the Kyrgyz Republic. Despite the relatively well-developed monitoring system in some parts of the world (Europe, USA and Russia), in most regions, there is no such system at all.

6. Climate change is associated with longer pollen seasons, increased pollen production, changes in the types of pollen observed in a particular location, and increased pollen allergenicity. Since pollen can negatively affect such health indicators as allergies and asthma, any increase in pollen associated with climate change can lead to an increased burden of asthma and allergies.

7. Climate change and its many consequences are very difficult to understand. It is more than an increase in temperature and humidity. But considering some already visible climate changes in the Kyrgyz Republic (extreme weather events – abnormal heat, heavy rains, squally winds) and expected changes in the future, it is necessary to create a program of air bio-particles monitoring not only within Kyrgyzstan, but also in Central Asia as a whole [24]. Therefore, studying the content of plant pollen and fungal spores in the air of a particular locality in the Kyrgyz Republic and assessing their contribution to the development of pollinosis in the light of climate change is a theoretically and practically significant work.

References

1. WHO: Regional Office for Europe, 2013, 14. Health 2020: a European policy framework supporting action across government and society for health and well-being. Copenhagen. https://apps.who.int/iris/handle/10665/131300
2. Meyer-Melikyan N.R. Severova E.E., Gapochka G.P., Polevova S.V., Tokarev P.I., Bovina I.Y., 1999. Principles and Methods of aeropalynological studies. MSU, Moscow, p. 48.
3. Methods of Aerobiological studies of the plant pollen and fungi spores for the comparison of pollen release calendars. Ministry of Health of the Republic of Belarus, Republican scientific-practical center of hygiene, Minsk, 2005. 27 p.
4. Kobzar, V.N., 2010. Microscopic expertise. KRSU, Bishkek, p. 152.
5. Kupriyanova L.A., Aleshina L.A., 1972. Pollen and spores of the flora in the European part of the USSR. V. 1. Science, Leningrad, p. 219.
6. Pidoplichko N.M., 1977. Fungi – parasites of modern cultivated plants. Naukova Dumka, Kiev.

7. Wilken-Jensen K., Gravesen S., 1984. Atlas of Moulds in Europe causing respiratory allergy. ASK Publishing, Copenhagen, 110 p.
8. Kobzar N.V., Osmonbaeva K.B., 2018. The influence of the changes in land-use management on the spectrum of fungi spores. Newsletter of Science and Practice. Nizhnevartovsk: Science and Practice 4(11).36, 51–60.
9. D'Amato G., Bergmann K., Cecchi L., Annesi-Maesano I., Sanduzzi A., Liccardi, G., Carolina Vitale C., Stanziola A., D'Amato M., 2014. Climate change and air pollution: Effects on pollen allergy and other allergic respiratory diseases. Allergo Journal International 23.1, 17–23. https://doi.org/10.1007/s40629-014-0003-7
10. D'Amato G., Holgate S.T., Pawankar R., Ledford D. K., Cecchi L., Al-Ahmad M., Al-Enezi F., Al-Muhsen S., Ansotegui I., Baena-Cagnani C. E. et al. 2015. Meteorological conditions, climate change, new emerging factors, and asthma and related allergic disorders. A statement of the World Allergy Organization 8.25. https://doi.org/10.1186/s40413-015-0073-0
11. Ariano R., Canonica G.W., Passalacqua G., 2010. Possible role of climate changes in variations in pollen seasons and allergic sensitizations during 27 years. Ann. Allergy Asthma Immunol 104, 215–222.
12. Beggs P.J., 2004. Impacts of climate change on aeroallergens: Past and future. Clin. Exp. Allergy 34, 1507–1513.
13. Bonofiglio T., Orlandi F., Ruga L., Romano B., Fornaciari M., 2013. Climate change impact on the olive pollen season in Mediterranean areas of Italy: Air quality in late spring from an allergenic point of view. Environ. Monit. Assess 185, 877–890. https://doi.org/10.1007/s10661-012-2598-9
14. Ziska L.H., Beggs, P.J., 2012. Anthropogenic climate change and allergen exposure: The role of plant biology. J. Allergy Clin. Immunol. 129, 27–32. https://doi.org/ 10.1016/j.jaci.2011.10.032
15. De Sario M., Katsouyanni K., Michelozzi P., 2013. Climate change, extreme weather events, air pollution and respiratory health in Europe. European Respiratory Journal 42, 826–843. https://doi.org/ 10.1183/09031936.00074712
16. Thuiller W, 2007. Climate change and the ecologist. Nature 448, 550-552.
17. WHO: Regional Office for Europe, 2013. Protecting health from climate change: a seven-country initiative. Copenhagen. https://www.euro.who.int
18. Orlovskiy N.S., Zonn I.S., Kostyanoy A.G., Zhiltsov S., 2019.The changes of climate and water resources in the Central Asia. Issues of Diplomatic Academy of Russia. Russia and the World 1.19, 56–78.
19. D'Amato G., Cecchi L., Bonini S., Nunes C., Annesi-Maesano I., Behrendt H., Liccardi G., Popov T., Cauwenberge P., 2007. Allergenic pollen and pollen allergy in Europe. Allergy 62.9, 976–990. https://doi.org/10.1111/j.1398-9995.2007.01393.x
20. D'Amato G., Vitale C., De Martino A., Viegi G., Lanza M., Molino A., Sanduzzi A., Vatrella A., Annesi-Maesano I., D'Amato M., 2015. Effects on asthma and respiratory allergy of Climate change and air pollution. Multidiscip. Respir. Med. 10, 39. https://doi.org/10.1186/s40248-015-0036-x
21. Kashef S., Kashef M. A., Eghtedari F., 2003. Prevalence of aeroallergens in allergic rhinitis in Shiraz. Iranian journal of allergy, asthma, and immunology 2.4, 185–188.
22. Pazouki N., Sankian M., Nejadsattari T., Khavari-Nejad R.A., Varasteh A.R., 2008.Oriental plane pollen allergy: Identification of allergens and cross-reactivity between relevant species. Allergy & Asthma Proceedings 29.6.
23. Minaeva N.V., Shiryaeva D.M., 2021.Pollinosis and additional information resources. RMJ. Medical Review 5.1, 38–42.
24. Osmonbaeva K.B., Kobzar V.N., 2017. The comparative analysis of the methods of plant pollen and fungi spores capture. European scientific conference "Science and Education", Penza, 70–76.