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Prevalence of ARVI, influenza, and COVID-19 pathogens in individuals without symptoms of respiratory infection

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Abstract

Introduction. SARS-CoV-2 can be transmitted by infected people without or with mild symptoms of acute respiratory infection (ARI). Monitoring based on nucleic acid amplification techniques is used to measure the prevalence of ARI pathogens and to assess the effectiveness of preventive measures.

The aim is to measure the prevalence of pathogens causing ARIs of viral etiology, influenza, and COVID-19 among individuals without ARI symptoms throughout age groups, to trace changes in the epidemic situation by weekly monitoring pathogens during the inter-epidemic period and at the beginning of a typical ARI epidemic season, to assess the effectiveness of medical masks for prevention of the above infections.

Materials and methods. A total of 14,119 people (including 4,582 children) without ARI symptoms went through examination, including questionnaire surveys, in 26 regions of Russia from August to October 2020. Nasopharyngeal and oropharyngeal swabs were tested by using AmpliSens ARVI-screen-FL, AmpliSens Influenza virus A/B-FL, and AmpliSens Cov-Bat-FL reagent kits (The Central Research Institute of Epidemiology of Rospotrebnadzor, Moscow).

Results. 11.1% of the tested samples showed positive results; the rhinovirus prevailed (7.32%), while SARS-CoV-2 was detected in 1.66%. In autumn, the proportion of SARS-CoV-2 infected cases increased from 0.49% to 4.02% (p < 0.001). The SARS-CoV-2 RNA concentration was up to 10^{10} copies/mL.

Conclusions. Differences in the prevalence of SARS-CoV-2 and rhinovirus among the age groups and over time were found and analyzed. Using of medical masks reduced the risk of infection with respiratory viruses and with SARS-CoV-2 by 51% and 34%, respectively. In case of prolonged exposure to a COVID-19 patient, healthy people must use a respirator for more effective protection. The individuals whose work was associated with a high level of social contacts were infected more rarely than other individuals in the same age group (p = 0.001); this fact supports the importance of anti-epidemic measures and commitment to their adherence by people whose profession entails frequent social contacts.

Keywords: *ARVI, COVID-19, asymptomatic course, PCR, medical masks*

Ethics approval. The study was conducted with the informed consent of the patients. The research protocol was approved by the Ethics Committee of the Central Research Institute of Epidemiology (protocol No. 106, June 16, 2020).

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Научная статья
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Распространённость возбудителей ОРВИ, гриппа и COVID-19 у лиц без симптомов респираторной инфекции

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Аннотация

Введение. В распространении SARS-CoV-2 могут участвовать инфицированные, у которых отсутствуют или слабо выражены симптомы острой респираторной инфекции (ОРИ). Мониторинг с использованием методов амплификации нуклеиновых кислот позволяет определить распространённость возбудителей ОРИ и оценить эффективность профилактических мер.

Цели — определить распространённость возбудителей ОРИ вирусной этиологии, гриппа и COVID-19 среди лиц без симптомов ОРИ в возрастных группах, проследить изменение эпидемической ситуации путём мониторинга в еженедельном режиме возбудителей в межэпидемический и в начале традиционного эпидемического сезона ОРИ, оценить эффективность медицинских масок для профилактики этих инфекций.

Материалы и методы. С августа по октябрь 2020 г. в 26 регионах РФ обследовано с анкетированием 14 119 лиц (из них 4582 детей), не имевших симптомов ОРИ. Мазки из носо-ротоглотки тестировали наборами реагентов «АмплиСенс ОРВИ-скрин-FL», «АмплиСенс Influenza virus A/B-FL» и «АмплиСенс Cov-Bat-FL» (ЦНИИ Эпидемиологии Роспотребнадзора, Москва).

Результаты. Положительные результаты были получены в 11,1% исследованных образцов, превалировал риновирус (7,32%), SARS-CoV-2 обнаружен у 1,66%. Осенью доля случаев инфицирования SARS-CoV-2 выросла с 0,49 до 4,02% (p < 0,001). Концентрация РНК SARS-CoV-2 составляла до 10^{10} копий в 1 мл образца.

Выводы. Установлены различия распространённости SARS-CoV-2 и риновируса в возрастных группах и в динамике. Применение медицинских масок снижало риск инфицирования респираторными вирусами на 51%, риск заражения SARS-CoV-2 — на 34%. Для обеспечения более эффективной защиты при продолжительном контакте с больным COVID-19 здоровым лицам необходимо использовать респиратор. Лица, чья профессия связана с высоким уровнем социальных контактов, инфицировались реже, чем лица этой же возрастной группы (p = 0,001), что подтверждает действенность противоэпидемических мер и приверженность к их соблюдению людьми, чья профессия связана с частыми социальными контактами.

Ключевые слова: *ОРВИ, COVID-19, бессимптомное течение, ПЦР, медицинские маски*

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Introduction

The data collected over the year, starting from the COVID-19 outbreak that took place in China at the end of December 2019 and throughout its transition into the pandemic demonstrate that the pathogen can be transmitted by SARS-CoV-2 infected individuals without or with mild symptoms of acute respiratory infection (ARI). The results of meta-analyses [1, 2] show that asymptomatic COVID-19 cases can account for 40–45%. In the meantime, these data were generally obtained from workers of healthcare facilities and restricted-access groups; therefore, they do not reflect the prevalence of asymptomatic infection in a population.

The rapid global spread of SARS-CoV-2 made it clear that extensive testing of population was of crucial significance for projection, effective implementation and correction of anti-epidemic measures. Nucleic acid amplification techniques take center stage in laboratory diagnostics of COVID-19 and in detection of its pathogen.

Based on the aforesaid, the area of special interest is analysis of prevalence of the COVID-19 pathogen among the healthy population and comparison with other pathogens of acute respiratory virus infection (ARVI), and influenza.

SARS-CoV-2 is primarily transmitted through respiratory droplets and contact routes, as the aerosols and droplets resulting from cough and sneezing settle down on objects and surfaces surrounding the infected person [3]. SARS-CoV-2 can replicate in cells of the gastrointestinal tract [4], therefore, the virus can be transmitted through a fecal-oral route.

Using of personal protective equipment (PPE), including medical masks, by both infected patients and healthy people is among the measures of nonspecific prevention of ARVI[1].

Until recently, no broad-scale studies have been conducted in Russia to assess the effectiveness of using medical masks and other PPE in a population to prevent ARVI, influenza, and COVID-19.

This study was intended to:

- measure and characterize the prevalence of ARVI, influenza and COVID-19 pathogens among people without ARI symptoms in different age groups during the inter-epidemic period and at the beginning of a typical ARVI epidemic season by using nucleic acid amplification techniques;

[1] Methodological Recommendation MR 3.1.0140-18, Nonspecific Prevention of Influenza and Other Acute Respiratory Infections.

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- trace changes in the epidemic situation through weekly monitoring of the prevalence of ARVI, influenza, and COVID-19 pathogens among people without ARI symptoms;
- assess the effectiveness of PPE for the purpose of prevention of COVID-19, ARVI, and influenza.

Materials and methods

The study was conducted as part of the pilot project of the *Federal Service for Surveillance on Consumer Rights Protection and Human Wellbeing and was* focused on weekly analysis of the prevalence dynamics for ARVI, influenza, and COVID-19 pathogens during the inter-epidemic period and at the beginning of the typical ARVI epidemic season from 1/8/2020 to 16/10/2020 in 26 regions of Russia.

The study participants were individuals who did not have any ARI symptoms within the last 2 weeks and at the time of the testing, and who signed their informed consent to participation in the study. The exclusion criteria were applicable to those who had visited other countries during the last 2 weeks as well as to restricted-access groups (military personnel, workers of long-term care facilities).

The laboratory tests were conducted by using the PCR method with real-time detection. To detect nucleic acids of 17 types of respiratory viruses: rhinovirus RNA, adenovirus DNA, RNA of human coronaviruses (229E, OC43, HKUI, NL63), bocavirus DNA, respiratory syncytial virus RNA, *metapneumovirus RNA*, parainfluenza virus RNA, influenza virus RNA, SARS-CoV-2 RNA, we used AmpliSens ARVI-screen-FL, AmpliSens Influenza virus A/B-FL, and AmpliSens Cov-Bat-FL reagent kits (The Central Research Institute of Epidemiology of Rospotrebnadzor). Nasopharyngeal and oropharyngeal swabs served as the biological material for the study; the swabs were collected in accordance with the methodological recommendations MR 3.1.0117-17 "Laboratory Diagnostics of Influenza and Other ARVI by Using the Polymerase Chain Reaction Method", MR 3.1.0169-20 "Laboratory Diagnostics of COVID-19"; the informed consent was signed by all the participants.

For statistical processing and visual presentation of data, we used PASW Statistics 18 (SPSS) and Microsoft Excel 2010.

Results

The study included 14,119 individuals (including 4,582 children, 9,532 adult individuals; no age information was available in 5 cases). For calculations and their analysis, the participants were divided into groups by age, social (schoolchildren and students) and professional criteria.

The age groups included:

- children under 6 years old (n = 2,116);
- children aged 6–17 years (n = 2,466);
- individuals aged 18–25 years (n = 2,786);
- individuals aged 26–64 years (n = 4,609);
- people aged 64 years and over (n = 2,137).

During the monitoring period, the target pathogens (combined) were detected in 1,572 (11.1%) participants. The absolute number and proportion of the positive results are shown in **Table 1**. The prevalence of SARS-CoV-2 as well as ARVI and influenza pathogens in age groups is presented in **Table 2**.

At the beginning of the epidemic season, the target pathogens (combined) were detected in 14.7% (689 out of 4,674) of the people and during the inter-epidemic

Table 1. The number and proportion of the SARS-CoV-2, ARVI, and influenza infected among people without ARI symptoms

Pathogen	Entire observation period 31–42 week (n = 14,119)		Interepidemic period (n = 9,445)		Beginning of the epidemic season (n = 4,674)		p
	n	%	n	%	n	%	
SARS-CoV-2 RNA	234	1,66	46	0,49	188	4,02	<0,001
Rhinovirus RNA	1033	7,32	624	6,61	409	8,75	<0,001
Adenovirus DNA	36	0,25	25	0,26	11	0,24	0,8
Human coronaviruses RNA (229E, OC43, HKUI, NL63)	19	0,13	10	0,11	9	0,19	0,2
Bocavirus DNA	18	0,13	15	0,16	3	0,06	0,2
Human respiratory syncytial virus RNA	21	0,15	17	0,18	4	0,09	0,2
Metapneumovirus RNA	27	0,19	16	0,17	11	0,24	0,4
Parainfluenza virus RNA	152	1,08	103	1,09	49	1,05	0,9
Influenza A RNA	24	0,17	20	0,21	4	0,09	0,1
Influenza B RNA	8	0,06	7	0,07	1	0,02	0,3
Total	1572	11,1	883	9,35	689	14,74	<0,001

Table 2. Prevalence of SARS-CoV-2, ARVI, and influenza pathogens in age groups

Pathogen	Age groups, years												p
	0–2 (n = 532)		3–5 (n = 1584)		6–17 (n = 2466)		18–25 (n = 2786)		26–64 (n = 4609)		>64 (n = 2137)		
	n	%	n	%	n	%	n	%	n	%	n	%	
All pathogens	80	15,04	299	18,88	341	13,83	262	9,40	389	8,44	154	7,21	<0,001
SARS-CoV-2 RNA	5	0,94	15	0,95	41	1,66	35	1,26	94	2,04	44	2,06	<0,01
Rhinovirus RNA	61	11,47	248	15,66	258	10,46	170	6,10	222	4,82	74	3,46	<0,001
Adenovirus DNA	9	1,69	9	0,57	2	0,08	4	0,14	9	0,20	3	0,14	<0,001
Human coronaviruses RNA (229E, OC43, HKUI, NL63)	2	0,38	2	0,13	3	0,12	7	0,25	4	0,09	1	0,05	0,2
Bocavirus DNA	1	0,19	2	0,13	5	0,20	4	0,14	4	0,09	2	0,09	0,8
Human respiratory syncytial virus RNA	1	0,19	4	0,25	3	0,12	2	0,07	6	0,13	5	0,23	0,6
Metapneumovirus RNA	2	0,38	7	0,44	2	0,08	5	0,18	8	0,17	3	0,14	0,2
Parainfluenza virus RNA	5	0,94	18	1,14	32	1,30	30	1,08	43	0,93	24	1,12	0,8
Influenza A RNA	1	0,19	2	0,13	4	0,16	6	0,22	7	0,15	4	0,19	1
Influenza B RNA	1	0,19	1	0,06	0	0,00	4	0,14	1	0,02	1	0,05	0,2

period they were detected in 9.35% (883 out of 9,445) of the people ($p < 0.001$).

Most of the detected cases of infection (7.32%) were caused by the rhinovirus. The proportion of individuals with rhinovirus infection was quite high both during the inter-epidemic period and at the beginning of the epidemic season – 6.61 and 8.75% of the participants, respectively.

SARS-CoV-2 was detected much less frequently: During the observation period, the virus was detected in 1.66% of examined persons. Yet, in autumn 2020, a statistically significant increase (8.3 times) in the proportion of the detected cases of SARS-CoV-2 infection (from 0.49 to 4.02%; $p < 0.001$) was recorded among the participants (Table 1) as compared to the proportion in August 2020.

The proportion of the detected cases with rhinovirus infection at the beginning of the epidemic season increased only 1.3 times as compared to the proportion in the inter-epidemic period (Table 1).

Parainfluenza viruses were detected equally frequently both during the inter-epidemic period and at the beginning of the epidemic season (1.09 and 1.05%). The prevalence of the other ARVI pathogens and influenza A and B viruses did not exceed 1% (Table 1).

Differences were found in the SARS-CoV-2 and rhinovirus detection dynamics. The chart of weekly dynamics (**Fig. 1**) shows an increase in the number of cases of rhinovirus infection starting from the 35th week and its decrease from the 40th week. During that time, the number of positive SARS-CoV-2 cases increased uniformly from the 35th week to the 42nd week (the increase over the 41st and 42nd weeks was 39 and 21%, respectively). The prevalence of other target pathogens did not exceed 1%; any spread was within the margin of error.

Our data on the dynamics of rhinovirus infection and SARS-CoV-2 prevalence among individuals without ARVI symptoms are in agreement with the data published in the National Weekly Bulletin issued by the Smorodintsev Research Institute of Influenza of the Ministry of Health of Russia regarding the frequency of diagnosis of rhinovirus infection and COVID-19 in people with ARVI symptoms[2]. Based on the data from the Smorodintsev Research Institute of Influenza, the proportion of positive cases of rhinovirus infection starts decreasing, while the SARS-CoV-2 detection rate starts increasing from the 39th week.

When making prognoses for the dynamics of an epidemic process, the priority attention should be given to the proper sample of participants, first of all, to the size of the sample to be able to identify statistically significant differences in detection rates of a pathogen.

To calculate the size of a sample group of participants, we used the following equation [5]:

$$n = \frac{Z^2pq}{\Delta^2},$$

where:

n — the size of the sample required for the study;

[2] Smorodintsev Research Institute of Influenza of the Ministry of Health of Russia. The National Weekly Bulletin for Influenza and ARVI for the 22nd Week of 2021. (31/5/21–6/6/21). Available at: https://www.influenza.spb.ru/system/epidemic_situation/laboratory_diagnostics

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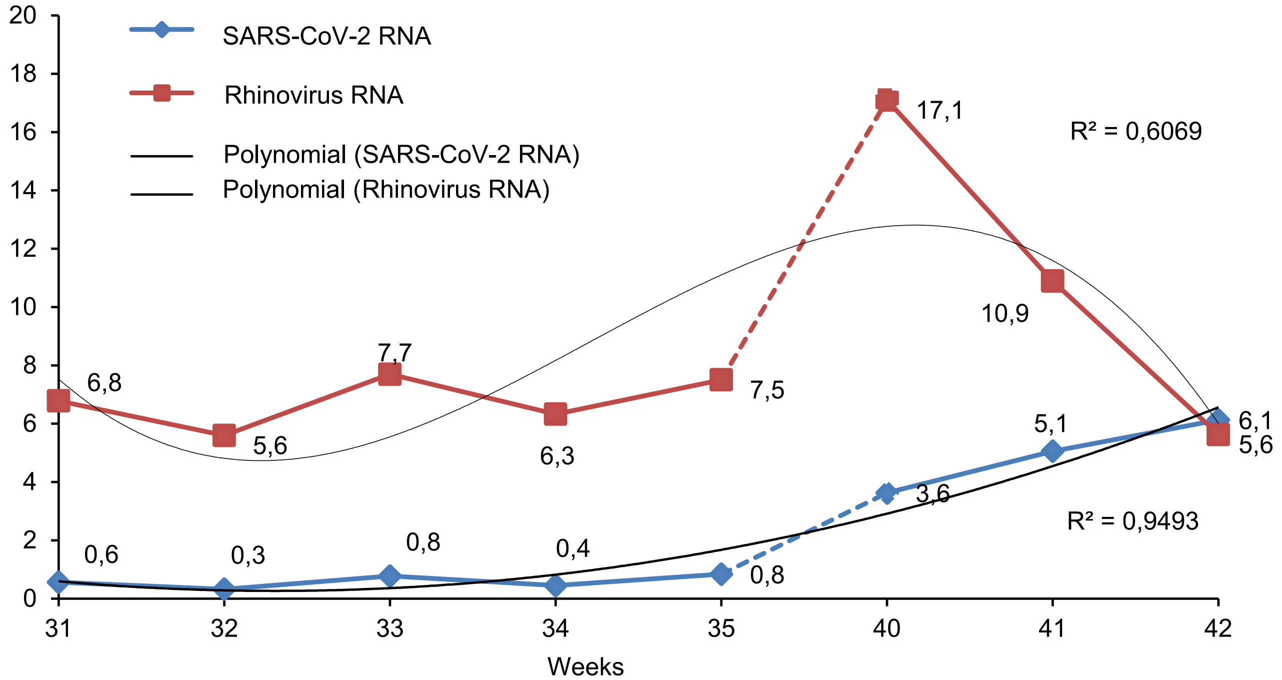

Fig. 1. Weekly dynamics of the number of the infected.
The vertical axis shows the proportion of positive cases in the total number of participants, %.

Z — the critical value for Student's t-test at the respective level of significance (when $\alpha = 0.05$ $Z = 1.96$);
p — the proportion of cases with the target sign in a population;
q — the proportion of cases without the target sign ($100 - p$) in a population;
Δ — the maximum permissible error.

During the first weeks of monitoring, we identified prevalence rates for ARVI, influenza, and COVID-19 pathogens, which were used in calculations of the sample size. The minimum size of the sample for pathogens with the prevalence exceeding 1% was at least 1,961 people. This size of the sample is sufficient for identification of statistically significant differences in variables when conducting monitoring focused on weekly dynamics. These sample sizes stayed almost unchanged till the end of the study.

The questions regarding what age groups were involved in the ARVI epidemic process and if there were any special features attributable to COVID-19 were of special interest. In other words, it was important to analyze changes in the detection of different pathogens of ARVI, influenza, and COVID-19 in people of different age.

During the monitoring period, the maximum proportion of detection of the target pathogens (combined) was recorded in the age group of 3-5 years (18.9%). The rhinovirus was detected in most of the cases; it was detected in 15.66% of participants in the age group of 3–5 years; then, in the decreasing order, there were the group of children under 2 years (11.5%) and the group of children aged 6–17 years (10.5%); in adult groups, rhinovirus was detected significantly less frequently ($p < 0.001$; Table 2).

On the contrary, SARS-CoV-2 was detected more frequently in adult participants over 26 years of age and more rarely in younger children (2.0% vs 0.95%) ($p < 0.01$). In the groups of participants aged 6–17 years and 18–25 years, SARS-CoV-2 was detected in 1.66 and 1.26% of participants, respectively.

The proportion of adenovirus-infected children under 2 years old was significantly higher than that of the older children (6–17 years): 1.69 and 0.08% ($p < 0.05$; Table 2).

There were also differences in the dynamics of detection of SARS-CoV-2 and rhinovirus in different age groups (**Fig. 2, 3**).

The 40th week demonstrated an increase in SARS-CoV-2 infection among the school-aged children (6–17 years), adult individuals aged 18–25 years and individuals aged over 64 years. A week later, we observed an increase in the proportion of infected adults aged 26–64; by the 42nd week, this proportion reached maximum values exceeding 2 and 3 times the proportion of SARS-CoV-2 infected children aged 6–17 and individuals aged 18–25, respectively. In the group of preschool children (0–5 years), no significant increase in the SARS-CoV-2 infection frequency was found in autumn (Fig. 2).

As for rhinovirus, on the contrary, individuals aged 26–64 years and over, as compared to other age groups, demonstrated the minimum infection level

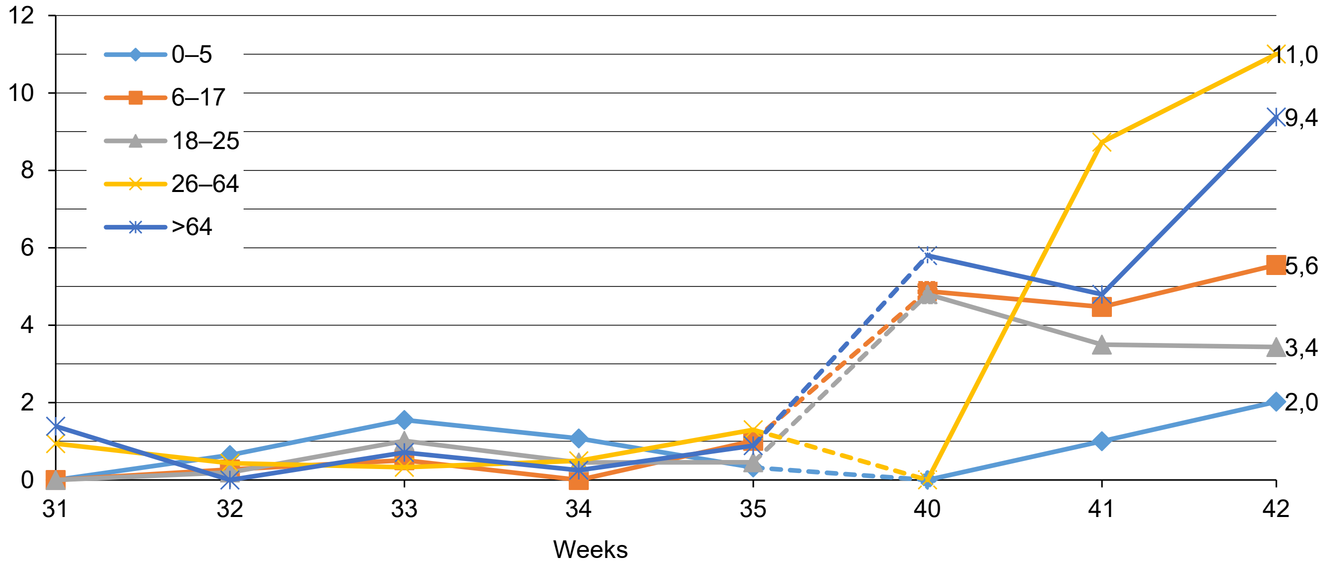

Fig. 2. Dynamics of the SARS-CoV-2 detection rates in age groups.
The vertical axis shows the proportion of positive cases in the total number of participants, %

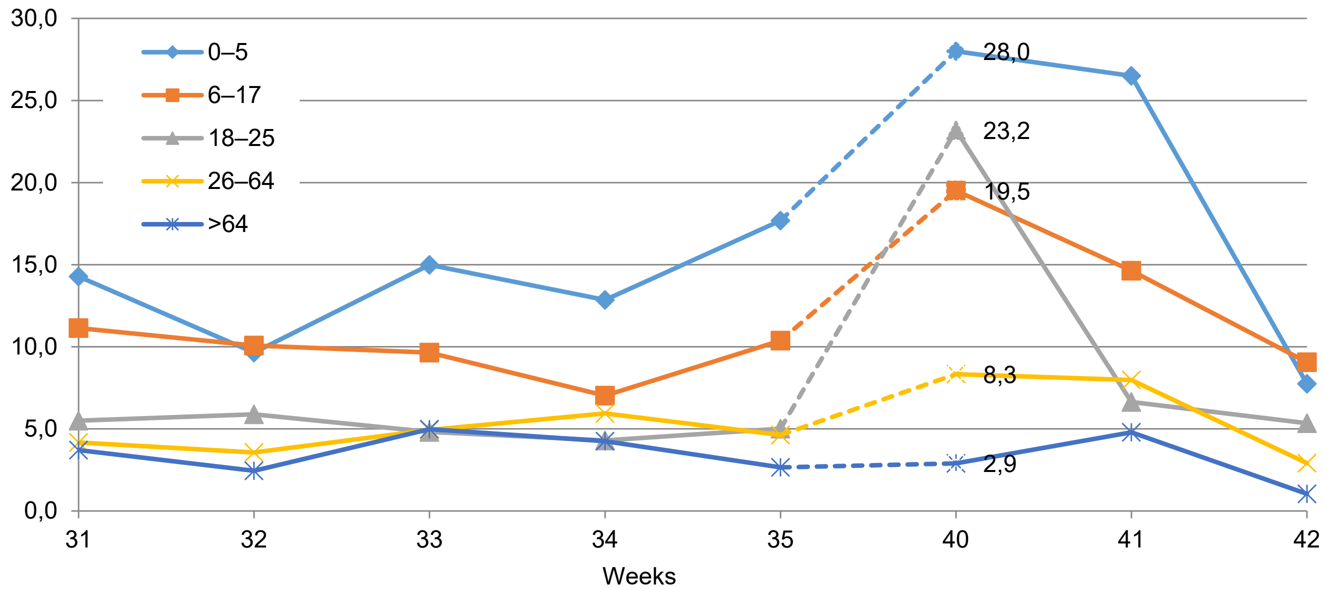

Fig. 3. Dynamics of rhinovirus detection rates in age groups.
The vertical axis shows the proportion of positive cases in the total number of participants, %.

throughout the monitoring period. At the same time, children and individuals aged 18–25 demonstrated a significant increase in the rhinovirus detection rate by the 40th week and a decrease to the initial level by the 42nd week (Fig. 3).

Discussion

Thus, the study found that in autumn 2020, the epidemic process of SARS-CoV-2 spread initially affected schoolchildren (6–17 years), young adults (18–25 years), and elderly people (>64 years) followed by adult people (26–64 years). Preschool children were involved in the epidemic process of SARS-CoV-2 spread to a lesser extent.

The prevalence of pathogens among students was estimated separately. At the beginning of the epidemic season, the students were infected with the above pathogens more rarely than children in total (11.5 and 19.7%; $p < 0.001$) and schoolchildren (11.5 and 18.9%; $p < 0.001$). Rhinovirus infection was detected in the students more rarely than in the children and schoolchildren (7.3, 15.5 and 13.2%; $p < 0.001$). At the same time, SARS-CoV-2 was detected in all 3 groups almost with the same frequency: 2.3, 2.4, and 3.7%. Thus, the

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obtained data cannot characterize students as a group of particular risk for ARI, including COVID-19.

It was found that preschool children contributed most heavily to spread of ARVI, while they are involved in spread of SARS-CoV-2 to a lesser extent as compared to other groups of the population.

To assess the PPE effectiveness, we conducted a survey among the participants who were asked to answer the following questions:

- "Do you use PPE?";
- "What PPE do you use (choose from the list)?";
- "Did you have close contact with an ARI patient within the last 2 weeks?".

The close contact with an ARI patient within the last 2 weeks was confirmed by 443 people. The list of PPE and the number of people who used the above PPE are shown in **Table 3**.

The analysis of the effectiveness of PPE (medical masks, gloves, antiseptic handwashing, respirator, protective shield, and their combinations) found that among the individuals who used PPE, the number of the infected with the target pathogens (ARVI, influenza, and COVID-19) generally was significantly smaller than among those who did not use PPE (9.6% vs 18.0%; $p < 0.001$) (**Table 4**). Using of PPE decreased the risk of infection with the target pathogens by 52%: the odds ratio (OR) = 0.48; 95% confidence interval (CI) 0.43–0.55.

It was found that using of PPE reduced the risk of infection with SARS-CoV-2 by 53% ($p < 0.001$; OR = 0.47; 95% CI, 0.35–0.63) and with rhinovirus — by 50% (OR = 0.5; 95% CI, 0.43–0.58) (Table 4).

Using of medical masks reduced the likelihood of being infected with any of the target pathogens 1.9 times; the risk of being infected when using medical masks decreased by 51% (18.0% vs 9.6%; $p < 0.001$; OR = 0.49; 95%, CI 0.41–0.57). When only medical masks were used, the likelihood of being infected with SARS-CoV-2 decreased by 34% (OR = 0.66; 95% CI, 0.47–0.93); the risk of rhinovirus infection decreased by 51% (OR = 0.49; 95% CI, 0.41–0.59). Using medical masks together with other PPE reduced the risk

Table 3. PPE combinations used by the study participants

Combinations of PPE	Full sample (n = 12,059)	
	n	%
Medical mask	3650	30,27
Gloves	8	0,07
Respirator	7	0,06
Hand sanitizers	295	2,45
Medical mask, hand sanitizers	3302	27,38
Medical mask, gloves, hand sanitizers	2854	23,67
Medical mask, gloves	1485	12,31
Medical mask, face shield, gloves, hand sanitizers	145	1,20
Medical mask, respirator, gloves, hand sanitizers	38	0,32
Medical mask, face shield, hand sanitizer	22	0,18
Респиратор, средства дезинфекции рук / Respirator, hand sanitizers	8	0,07
Medical mask, respirator, face shield, gloves, hand sanitizers	102	0,85
Respirator, gloves	12	0,10
Face shield, gloves, hand sanitizers	1	0,01
Respirator, face shield, gloves	1	0,01
Medical mask, face shield, gloves	37	0,31
Medical mask, respirator, gloves	8	0,07
Medical mask, respirator, face shield, gloves	2	0,02
Medical mask, respirator, hand sanitizers	13	0,11
Medical mask, respirator	15	0,12
Respirator, gloves, hand sanitizers	41	0,34
Face shield, hand sanitizers	1	0,01
Respirator, face shield, gloves, hand sanitizers	5	0,04
Gloves, hand sanitizers	7	0,06

of infection with the target pathogens by 54% (18.0% vs 9.2%; $p < 0.001$; OR = 0.46; 95% CI, 0.41–0.53). Among different combinations of using PPE, the most frequent one was the combination of medical masks and gloves. Using of gloves together with medical masks demonstrates an advantage as compared to medical masks alone (7.1 vs 9.6% of infected; $p = 0.007$). For the other PPE or their combinations, no statistically significant difference in the groups was found, though it can be explained by small numbers of the compared samples.

The obtained data are in agreement with the results of the meta-analysis [6]. Liang et al. found that medical masks had a significant protective effect against ARVI pathogens: the risk of infection reduced by 65% (OR = 0.35; 95% CI, 0.24–0.51).

The protective properties of medical masks used for prevention of COVID-19 were demonstrated by experiment. Ueki et al. simulated the process of airborne transmission of SARS-CoV-2: They placed two mannequin heads facing each other in a tightly sealed test chamber. The distance between the heads was 50 cm. One of the mannequin heads mimicked a SARS-CoV-2 source (it exhaled a mist of virus suspension containing SARS-CoV-2); the other mannequin head mimicked a recipient. The presence and viral loads in the recipient mannequin was detected and measured by using the PCR method and virus isolation in the cell culture [7]. When a medical mask was attached to the recipient mannequin, the number of viral particles reduced by 50% as compared to the situation when the recipient had no medical mask. When a medical mask was attached to the mannequin head exhaling a mist of virus suspension, the number of viral particles in the recipient reduced by 60%. During the experiment, the medical mask was attached most tightly to the "face" of the mannequin head.

In our study, among the participants who confirmed their close contact with ARI patients within the last 2 weeks, 24% of the participants had one of the target pathogens, though no statistically significant differences in the level of infection between the PPE users and non-users were found ($p = 0.06$). These results demonstrate that in addition to PPE, all the anti-epidemic measures must be instituted in the focus of infection, the most crucial of them being isolation of the infected[3]. If the sick person cannot be isolated, healthy people should use a respirator to have more effective protection during the prolonged exposure[4].

In our study, we kept a strong focus on prevention of ARVI and COVID-19, in particular, among people whose professional activities are associated with a high

[3] MR 3.1.0140-18 Nonspecific Prevention of Influenza and Other Acute Respiratory Infections

[4] MR 3.1.0140-18 Nonspecific Prevention of Influenza and Other Acute Respiratory Infections

Table 4. Effectiveness of using PPE

Combinations of PPE		Infected with any of the pathogens					Infected with SARS-CoV-2					Infected with Rhinovirus				
		infected		not infected		p, OR	infected		not infected		p, OR	infected		not infected		p, OR
		n	%	n	%		n	%	n	%		n	%	n	%	
All PPEs	used	1155	9,6	10904	90,4	$p < 0,001$ OR = 0,48 95% CI 0,43–0,55	172	1,4	11887	98,6	$p < 0,001$ OR = 0,47 95% CI 0,35–0,63	781	6,5	11278	93,5	$p < 0,001$ OR = 0,5 95% CI 0,43–0,58
	not used	370	18,0	1690	82,0		62	3,0	1998	97,0		252	12,2	1808	87,8	
Medical mask	used	351	9,6	3299	90,4	$p < 0,001$ OR = 0,49 95% CI 0,42–0,57	73	2,0	3577	98,0	$p = 0,02$ OR = 0,66 95% CI 0,47–0,93	234	6,4	3416	93,6	$p < 0,001$ OR = 0,49 95% CI 0,41–0,59
	not used	370	18,0	1690	82,0		62	3,0	1998	97,0		252	12,2	1808	87,8	
Medical mask combined with other PPEs	used	1077	9,2	10596	90,8	$p < 0,001$ OR = 0,46 95% CI 0,41–0,53	166	1,4	11507	98,6	$p < 0,001$ OR = 0,47 95% CI 0,35–0,63	724	6,2	1808	87,8	$p < 0,001$ OR = 0,47 95% CI 0,41–0,55
	not used	370	18,0	1690	82,0		62	3,0	1998	97,0		252	12,2	10949	92,8	

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level of social contacts. This group included 2,552 participants: checkout cashiers/sales staff from chain grocery stores, public transport employees (cab-drivers, ticket checkers, and conductors), security and passport control personnel at airports. It was found that during the onset of the epidemic season, the individuals whose work is associated with a high level of social contacts became infected more rarely than representatives of the same age group: SARS-CoV-2 was detected in 3.4% and 6.8% (p = 0.001), rhinovirus was detected in 4.0% and 5.7% (p = 0,09), all the pathogens collectively – in 9.0% and 13.8%, respectively (p = 0.001). Most likely, the lower level of infection is connected with stricter adherence to the anti-epidemic measures by employees whose work is associated with a higher risk of infection.

The data on the viral RNA load in individuals with COVID-19, but without ARI symptoms were of special interest.

Based on our data and with reference to amplification threshold cycle values and their dispersion (**Fig. 4**), the RNA loads in the tested participants ranged widely from the limit of detection to ~10^{10} RNA copies per mL of a sample.

Thus, individuals with asymptomatic COVID-19 infection and having high concentrations of SARS-CoV-2 can become a dangerous source of infection, especially when they do not wear medical masks, as even a short-term contact with them can trigger airborne transmission of the pathogen.

Conclusion

This study made it possible to measure the prevalence of ARVI, influenza and COVID-19 pathogens among individuals without ARI symptoms; its findings were instrumental in assessment of the effectiveness of medical masks in a population for prevention of the above infections.

Throughout the monitoring period, the above pathogens dominated by rhinovirus were detected in 11.1% of the participants; the SARS-CoV-2 RNA was detected in 1.66% of the participants; the other viruses accounted for maximum 1%. It should be remembered that among the detected individuals with infection, there could be "presymptomatic" individuals, i.e. those who could have ARI symptoms displayed later, since the design of the study did not imply any subsequent monitoring of the infected.

The study found differences in SARS-CoV-2 and ARVI frequencies in different age groups: At the beginning of the epidemic season, the spread of the COVID-19 pathogen involved school-aged children, young adults, and individuals over 64 years of age; adults aged 26–64 were the last to join. Preschool children participated in the epidemic process of SARS-CoV-2 spread to a lesser extent. Preschool children contribute most heavily to ARVI spread; among individuals over 26 years old, the level of rhinovirus infection throughout the monitoring period was the lowest. SARS-CoV-2, on the contrary, was detected more frequently in adults over 26 years old.

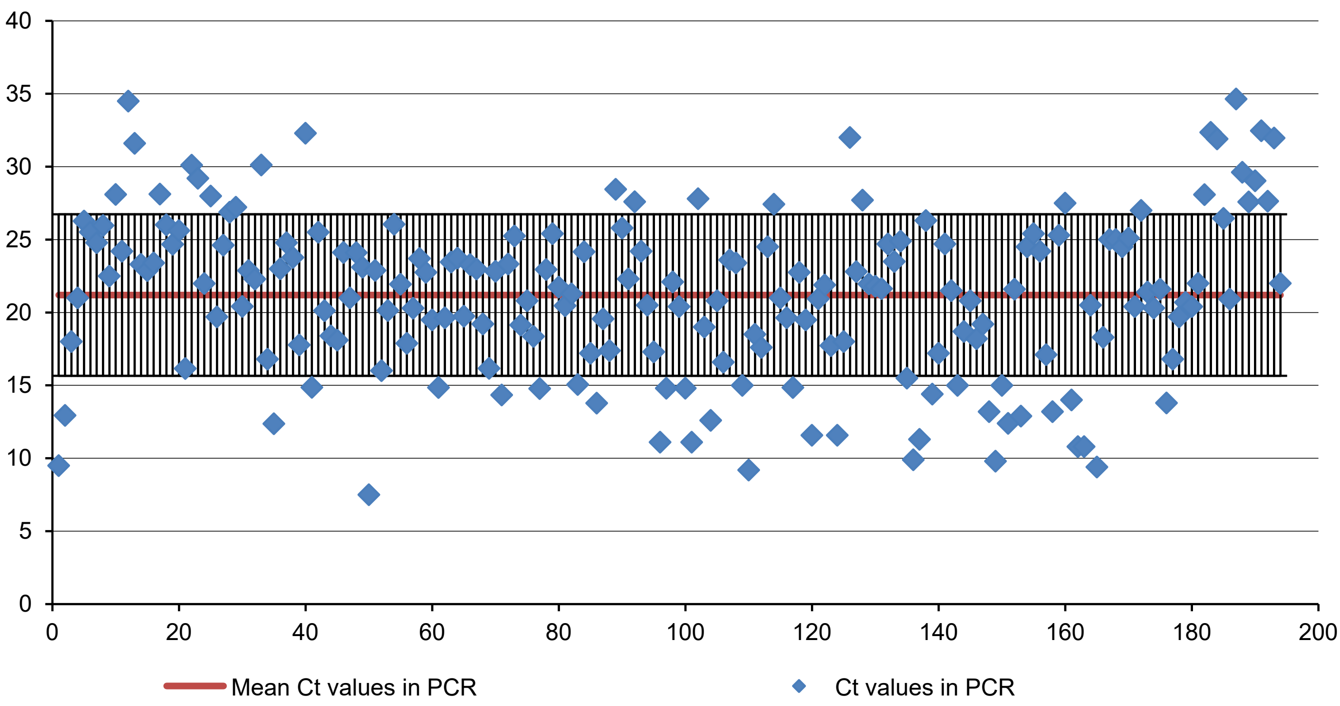

Fig. 4. Threshold cycle values in real-time PCR with fluorescent detection in SARS-CoV-2 infected individuals without ARI symptoms.

The horizontal axis shows the number of the sample positive for COVID-19; the vertical axis shows PCR threshold cycle values.

Our study has demonstrated that individuals without ARVI symptoms can have a high concentration of SARS-CoV-2 RNA (up to 10^{10} RNA copies per mL of a nasopharyngeal swab sample); therefore, they can be a dangerous source of infection, especially when they do not wear medical masks, as airborne transmission of the pathogen can occur even during a short-term contact with the above individuals.

It was found that among the people using PPE, the number of those who were infected with the above pathogens was significantly smaller than among those who did not use PPE (9.6% vs 18.0%; $p < 0.001$); using of medical masks reduced the risk of infection by 51% (OR = 0.49; 95% CI, 0.41–0.57). Medical masks combined with other PPE reduced the risk of infection with the above viruses by 54% (OR = 0.46; 95% CI, 0.41–0.53).

As for SARS-CoV-2, using of PPE reduced the risk of infection by 53% (OR = 0.47; 95% CI, 0.35–0.63); among individuals who used medical masks, the likelihood of being infected with SARS-CoV-2 decreased by 34% (OR = 0.66; 95% CI, 0.47–0.93).

Thus, wearing of medical masks in public places is a mandatory and effective anti-epidemic measure, as masks when worn by the infected, including individuals without ARI symptoms, reduce the virus spread, while masks worn by healthy people reduce the likelihood of their infection.

Healthy people should use a respirator for more effective protection during the long contact with a patient, for example, at a COVID-19 focal site.

It was found that individuals whose work is associated with a high level of social contacts became infected more rarely than other representatives of the same age group: At the beginning of the epidemic season, SARS-CoV-2 was detected in 3.4% and 6.8% of the tested people, respectively ($p = 0.001$), thus proving the effectiveness of anti-epidemic measures and demonstrating the commitment to their adherence by people whose work is associated with a higher risk of infection.

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REFERENCES

1. Oran D.P., Topol E.J. Prevalence of asymptomatic SARS-CoV-2 infection: A narrative review. *Ann. Intern. Med.* 2020; 173(5): 362–7. https://doi.org/10.1093/alcalc/agu083
2. He W., Yi G.Y., Zhu Y. Estimation of the basic reproduction number, average incubation time, asymptomatic infection rate, and case fatality rate for COVID-19: Meta-analysis and sensitivity analysis. *J. Med. Virol.* 2020; 92(11): 2543–50. https://doi.org/10.1002/jmv.26041
3. Kumar M., Taki K., Gahlot R., Sharma A., Dhangar K. A chronicle of SARS-CoV-2: Part-I — Epidemiology, diagnosis, prognosis, transmission and treatment. *Sci. Total Environ.* 2020; 734: 139278. https://doi.org/10.1016/j.scitotenv.2020.139278
4. Xiao F., Tang M., Zheng X., Liu Y., Li X., Shan H. Evidence for gastrointestinal infection of SARS-CoV-2. *Gastroenterology*. 2020; 158(6): 1831–3.e3. https://doi.org/10.1053/j.gastro.2020.02.055
5. Koychubekov B.K., Sorokina M.A., Mkhitaryan K.E. Sample size determination in planning of scientific research. *Mezhdunarodnyy zhurnal prikladnykh i fundamental'nykh issledovaniy.* 2014; (4): 71–4. (in Russian)
6. Liang M., Gao L., Cheng C., Zhou Q., Uy J.P., Heiner K., et al. Efficacy of face mask in preventing respiratory virus transmission: A systematic review and meta-analysis. *Travel Med. Infect. Dis.* 2020; 36: 101751. https://doi.org/10.1016/j.tmaid.2020.101751
7. Ueki H., Furusawa Y., Iwatsuki-Horimoto K., Imai M., Kabata H., Nishimura H., et al. Effectiveness of face masks in preventing airborne transmission of SARS-CoV-2. *mSphere*. 2020; 5(5): e00637-20. https://doi.org/10.1128/mSphere.00637-20

СПИСОК ИСТОЧНИКОВ

1. Oran D.P., Topol E.J. Prevalence of asymptomatic SARS-CoV-2 infection: A narrative review. *Ann. Intern. Med.* 2020; 173(5): 362–7. https://doi.org/10.1093/alcalc/agu083
2. He W., Yi G.Y., Zhu Y. Estimation of the basic reproduction number, average incubation time, asymptomatic infection rate, and case fatality rate for COVID-19: Meta-analysis and sensitivity analysis. *J. Med. Virol.* 2020; 92(11): 2543–50. https://doi.org/10.1002/jmv.26041
3. Kumar M., Taki K., Gahlot R., Sharma A., Dhangar K. A chronicle of SARS-CoV-2: Part-I — Epidemiology, diagnosis, prognosis, transmission and treatment. *Sci. Total Environ.* 2020; 734: 139278. https://doi.org/10.1016/j.scitotenv.2020.139278
4. Xiao F., Tang M., Zheng X., Liu Y., Li X., Shan H. Evidence for gastrointestinal infection of SARS-CoV-2. *Gastroenterology*. 2020; 158(6): 1831–3.e3. https://doi.org/10.1053/j.gastro.2020.02.055
5. Койчубеков Б.К., Сорокина М.А., Мхитарян К.Э. Определение размера выборки при планировании научного исследования. *Международный журнал прикладных и фундаментальных исследований.* 2014; (4): 71–4.
6. Liang M., Gao L., Cheng C., Zhou Q., Uy J.P., Heiner K., et al. Efficacy of face mask in preventing respiratory virus transmission: A systematic review and meta-analysis. *Travel Med. Infect. Dis.* 2020; 36: 101751. https://doi.org/10.1016/j.tmaid.2020.101751
7. Ueki H., Furusawa Y., Iwatsuki-Horimoto K., Imai M., Kabata H., Nishimura H., et al. Effectiveness of face masks in preventing airborne transmission of SARS-CoV-2. *mSphere*. 2020; 5(5): e00637-20. https://doi.org/10.1128/mSphere.00637-20

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