Multifactorial model of willingness to get vaccinated in medical students during 3rd wave of COVID-19 pandemic

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Vaccination of the population is the most essential and decisive measure in overcoming the COVID-19 pandemic that has involved the whole world. The vaccination of healthcare workers and medical students who can spread the infection among patients is crucial.

Objective: *to study the attitude towards vaccination among medical students.*

Patients and methods. *From 18 to 22 June 2021, an anonymous Internet survey of 364 students of medical and technical universities was conducted. The sample included 135 medical students with no immunity to COVID-19 – who had not been ill or vaccinated. Three variants of behavioral strategies related to vaccination were compared: refusal to vaccinate, observation of the situation, consent to vaccination.*

Results and discussion. *The key factors influencing the choice of a behavioral strategy for avoiding vaccination are the belief that COVID-19 infection is not dangerous for young people and that the vaccine is not studied enough. The willingness to get vaccinated is associated with denial of insufficient knowledge about the vaccine, belief in its safety and effectiveness, fear of infecting loved ones. The observer student group is characterized by an intermediate position on vaccination beliefs.*

Conclusion. *To increase the willingness for vaccination, it is necessary, first of all, to spread the information about the vaccine, its safety (inability to cause severe complications, death) and effectiveness in preventing infection, reducing the level of anxiety concerning vaccination. It is also important to spread awareness about the danger of infecting loved ones and increase personal responsibility for the health of their loved ones.*

Keywords: *COVID-19; SARS-CoV-2; vaccination; multifactorial model of willingness to get vaccinated; medical students.*

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Vaccination of the population is currently the most important and decisive measure to overcome the COVID-19 pandemic that has engulfed the whole world. According to various researchers, in order to achieve collective immunity, the proportion of vaccinated population should be from 64% to 75%. Of particular importance is vaccination of medical workers and medical students who are at the forefront of the fight against the epidemic and play an important role in providing vaccination recommendations to various population groups. The analysis of foreign databases and domestic literature has shown that the attitude to vaccination among the population and medical workers is contradictory. Thus, a survey of 2.678 medical professionals in France, French-speaking Belgium and Quebec [1] (Verger P, Scronias D, Dauby N, et al, 2020) showed high acceptance in 48.6% of cases, moderate acceptance in 23.0% and doubts about the necessity of vaccination in 28.4%. The key factors in decision-making process were evidence of the effectiveness and safety of the vaccines, as well as awareness of vaccination success in other countries.

A meta-analysis based on 35 studies [2] (Nirbachita Biswas 1, Toheeb Mustapha 1, Jagdish Khubchandani et al, 2021) found that the prevalence of fluctuations in relation to COVID-19 vaccination among medical professionals worldwide ranged from 4.3% to 72% in all studies including 76471 participants. Concerns about the safety, efficacy and potential side effects of available vaccines are noted as the main reasons for hesitancy of medical professionals regarding vaccination against COVID-19. According to the American Dental Association, only 56% of dentists were ready to take the COVID-19 vaccine, of those who did not want to take the vaccine, 63% reported that they would take it if it was prescribed by the health system, but 16.3% of the total number of respondents would not take a COVID-19 vaccine even if it was prescribed [3]. Similar data are provided by Italian researchers [4].

According to the research data of the Astrakhan Medical University, out of 78 students surveyed, only 13 (16.6 %) were ready to be vaccinated [5]. A survey of 2177 Russian doctors conducted by the analytical bureau GxP News (09.07.2021) revealed that 37% of doctors were not ready to be vaccinated, and 39% would not advise their loved ones to do it [6].

A meta-analysis of twenty-eight nationally representative samples revealed that as the pandemic progressed, the percentage

Table. 1 Impact of factors on the relative probability of choosing a behavioral strategy regarding vaccination

Factor	Refusal	Observing the situation (hesitancy)	Consent	Indicator varies within the limits
Male sex	2.5 p=0.21	**0.2** p=0.046	1.1 p=0.90	1/0
Age	1.1 p=0.70	1 p=0.88	0.8 p=0.21	17-25
Education year	0.9 p=0.44	1 p=0.94	1.4 p=0.20	1-6
Belief that the vaccine causes a heart attack	1.9 p=0.24	1.6 p=0.39	**0.2** p=**0.02**	1/0
The vaccine causes infertility	2.1 p=0.21	0.4 p=0.15	0.8 p=0.81	1/0
The vaccine is more dangerous than COVID	1.1 p=0.83	**0.3** p=0.048	1.5 p=0.46	1/0
The vaccine causes a genome change	2.0 p=0.26	1.2 p=0.83	0.4 p=0.27	1/0
COVID it is not very dangerous for my health	0.8 p=0.74	1.4 p=0.58	0.9 p=0.94	1/0
The vaccine causes an exacerbation of the course of chronic diseases	0.8 p=0.70	1.1 p=0.91	1.5 p=0.50	1/0
COVID is not dangerous for people of my age	**4.1** p=0.001	**0.4** p=0.047	**0.4** p=0.049	1/0
COVID gives a more stable immunity than vaccination	2.2 p=0.047	1.1 p=0.88	**0.3** p=**0.047**	1/0
You cannot get sick	0.6 p=0.37	**1.5** p=0.44	1 p=0.95	1/0
After vaccination the COVID infection is more severe	0.8 p=	**1.9** p=0.35	**0.5** p=0.45	1/0
Vaccination gives little protection against infection	2.6 p=0.71	1.1 p=0.87	**0.5** p=0.23	1/0
The vaccine is insufficiently studied	**4.8** p=0.045	**1.6** p=0.55	**0.1** p=**0.01**	1/0
You can get infected from the vaccine	0.8 p=0.63	1.1 p=0.84	0.8 p=0.66	1/0
Friends were ill	0.5 p=0.37	**33.4** p=**0.01**	**0.3** p=0.13	1/0
Fear of getting infected with the COVID	**0.5** p=0.03	**3.1** p=0.001	0.9 p=0.80	1-5
Factor	**Refusal**	**Observing the situation (hesitancy)**	**Consent**	**Indicator varies within the limits**
Fear of infecting loved ones	0.9 p=0.65	**0.4** p=**0.0**	**2.3** p=**0.03**	1-5
Fear of an unfavorable outcome	1.3 p=0.35	1.3 p=0.46	0.6 p=0.15	1-5

Values in the table show the relative probability (OR), reflecting how many times the presence of a factor increases the probability of a behavioral strategy choice. The cells with key factors are filled with gray color.

of people intending to be vaccinated decreased, and the percentage of people intending to refuse vaccination increased [7]. The analysis of sociological studies in the Russian Federation also reflects a decrease in the willingness of the population to get vaccinated against coronavirus from 63% to 38% over the past year, which may be due to dulling of fear of the coronavirus infection itself [8]. As Israeli researchers rightly note [9], uncertainty about the vaccine remains an obstacle to full vaccination of the population against highly infectious diseases. In turn, students are the group with the largest number of contacts, and some of them can be regarded as "super-spreaders" capable of infecting the largest number of people.

Thus, the problem of motivating medical workers and medical students to get vaccinated against COVID-19 is extremely relevant in the current period of the third wave of the pandemic.

The aim of the research is to study the attitude to vaccination of medical university students.

Patients and methods. In the period from 18.06 to 22.06, we conducted an anonymous Internet survey of 364 medical (n=331) and technical (n=33) university students in Moscow and Ivanovo about their attitude to vaccination against COVID-19. The sample included 135 medical students with no immunity to COVID-19 who did not get sick and were not vaccinated. Of these, 119 were women and 16 were men. The age group was from 17 to 25 years (mean age 21.3±2.4 years). Research methods: a questionnaire of 13 questions regarding the perception of COVID-19 infection and attitude to vaccination against it, developed by Ya.V. Malygin for this study. The questionnaire is presented in the appendix. Beliefs about the vaccine and COVID-19, as well as fears of students were evaluated using a 5-point Likert scale. The degree of conviction corresponding to the top-2 (rather agree or absolutely agree) was evaluated as agreement with the statement. The modified questionnaire of subjective stress factors (V.L. Malygin, 2000) includes 5 scales: significance of general social problems; significance of everyday problems; significance of personal problems; significance of production problems; significance of COVID-19 problems. For the analysis, only the 5-th scale «The significance of COVID-19 problems» was used, consisting of 4 questions: health problems; threat of infection with COVID-19; threat of infection of relatives with COVID-19; adverse outcomes in case of infection with COVID-19. The students were asked about their plans for vaccination in the coming month. Based on the answers, the respondents were divided into 3 groups: 1) refusal («I am not planning to be vaccinated» 2) monitoring the situation («I will be observing the development of the situation in order to make a decision later» 3) consent («I will agree to be vaccinated if I need it for my work/study» and «I am planning to be vaccinated voluntarily next month»). Statistical data processing was carried out

using descriptive statistics and the logit regression equation of the nonlinear estimation block.

Results: Out of all 364 students surveyed, 164 people (45.1%) had COVID-19. Two hundred students (54.9%) did not get sick. Fifty-four (14.8%) did not get sick because they were vaccinated. A total of 76 people (20.1%) were vaccinated at the time of the survey.

The study of the attitude of students to vaccination was conducted on 135 students of medical universities with no immunity to COVID-19 who were not ill and were not vaccinated. Students of technical universities (n=11) who participated in the survey were excluded from further research due to their small number. This sample (135 students) was divided into 3 subgroups based on different behavioral strategies regarding vaccination: those who refused to be vaccinated, Group 1 (n=63, 46.67%); those who took a waiting attitude to the situation (hesitant) - Group 2 (n=41, 30.37%); and those who were willing to be vaccinated or encouraged by the administration of their university to do so, Group 3 (n=31 – 22,96%).

Multivariate analysis with equation logit regression allowed to identify the main factors influencing the formation of behavioral strategies in relation to vaccination (Table. 1). Statistical analysis of the data was performed using the software complex STATISTICA 6.0.

As can be seen from Table 1, in Group 1 (refusal of vaccination), the most significant factors influencing the choice of a behavioral strategy for refusing vaccination are the belief that COVID-19 infection is not dangerous for people of the respondent's age (increases the relative probability of refusing vaccination by 4.1 times) and the associated low fear of contracting COVID (an increase in the severity of fears of contracting by 1 point on a 5-point scale reduces the probability of falling into the «refusal» group by 5 times), as well as the lack of knowledge about the vaccine (*OR*=4.8) and conviction that the vaccine gives little protection against the infection (*OR*=2.6).

Inclusion in the group of observers (doubters) was determined by the following factors: female gender (*OR*=5) and different experiences related to COVID-19 among friends and relatives (*OR*=33.4), fear of getting infected with COVID-19 (with an increase in fear of getting infected by 1 point on a 5-point scale, *OR* increases by 3.1 times), as well as beliefs that COVID is more dangerous than the vaccine itself (*OR*=3) and that COVID is dangerous for people of the respondent's age (*OR*=2.5). At the same time, the absence of fear of infecting loved ones allows not to take immediate vaccination actions: with an increase in fear of infecting loved ones by 1 point on a 5-point scale the probability of falling into the group of doubters increases by 2.5 times. Thus, inclusion of the respondents in Group 2 was influenced by awareness of the danger of COVID-19 for themselves and underestimation of the risk of infecting other people.

Readiness for vaccination was associated with the denial of insufficient knowledge about the vaccine (*OR*=10), assurance in its safety (denial that vaccination can cause a heart attack increases the probability of falling into this group by 5 times). The fear of infecting loved ones is also significant – an increase in the severity of these fears by 1 point (on a 5-point scale) increases the probability of readiness for vaccination by 2.3 times. In addition, as with Group 2, inclusion in Group 3 was influenced by the awareness of the danger of COVID-19 despite the young age of the respondents (*OR*=2.5).

As can be seen from Table 2, in the refusal group, the key beliefs that contribute to maintaining the mood for refusal of

Table 2 The prevalence of beliefs regarding vaccination and COVID-19 among medical students

Beliefs	**Group 1 Refusal N= 63** **Abs (%)**	**Group 2 Observing the situation (hesitancy) N=41** **Abs (%)**	**Group 3 Consent N=31** **Abs (%)**
The vaccine is quite likely to cause a heart attack, stroke or death	32 (50,8)	19 (46,3)	*7 (22,6)*
The vaccine can lead to infertility	31 (49,2)	12 (29,3)	7 (22,6)
The vaccine is more dangerous than the disease caused by COVID-19	19 (30,2)	*4 (9,8)*	5 (16,1)
The vaccine causes changes in the genome	16 (25,4)	6 (14,6)	4 (12,9)
COVID-19 infection is not as dangerous as it is said	17 (27,0)	8 (19,5)	4 (12,9)
The vaccine exacerbates the course of chronic diseases	44 (69,8)	31 (75,6)	16 (51,6)
COVID-19 infection is not very dangerous for people of my age and gender	**41 (65,1)**	*13 (31,7)*	*12 (38,7)*
If you have been exposed to COVID-19 in the past, it will give a more stable immunity than the vaccine itself	33 (52,4)	15 (36,6)	*6 (19,4)*
If you are careful and have a strong immune system, you cannot get sick for a long time	47 (74,6)	32 (78,0)	21 (67,7)
After vaccination	15 (23,8)	6 (14,6)	2 (6,5)

Beliefs	Group 1 Refusal N= 63 Abs (%)	Group 2 Observing the situation (hesitancy) N=41 Abs (%)	Group 3 Consent N=31 Abs (%)
COVID-19 infection is more difficult to tolerate			
Vaccination against COVID-19 is ineffective (protection against infection is insufficient)	46 (73,0)	22 (53,7)	11 (35,5)
The COVID-19 vaccine is not sufficiently studied	**61 (96,8)**	41 (100)	*22 (71,0)*
As a result of vaccination, there is a high risk of contracting COVID-19	39 (61,9)	23 (56,1)	11 (35,5)

Key beliefs that contribute to the refusal are marked bold, key beliefs that reduce the probability of refusal are marked cursive.

vaccination are underestimation of the danger of infection for young people (65%), and the belief that the vaccine is insufficiently studied (96.8%). Students of Group 2 occupy an intermediate position in terms of beliefs regarding vaccination and COVID-19 between the group of refusers and the group of those who agree to be vaccinated. Among those who agree to get vaccinated, unlike the other groups, there is a widespread belief in the safety of the vaccine (the ability to cause a heart attack – 22.6%), denial of the safety of COVID for young people (38.7%), a low degree of agreement with the thesis that having had COVID gives a more stable immunity than the vaccine, and a relative low conviction that the vaccine is insufficiently studied (71.0%).

Discussion. The most significant factor influencing the choice of a behavioral strategy for refusing vaccination is the belief that COVID is not dangerous for young people, and the vaccine is insufficiently studied. More often, this group included young people whose friends were not infected by COVID-19. In order to reduce the commitment of students to refuse vaccination, it is necessary to neutralize these beliefs.

The group of observers (doubters) is characterized primarily by the presence of unmodified factors: female gender and different experiences related to COVID-19 among their relatives. The probability of falling into this group was also associated with the fear of contracting COVID-19 and low fears of infecting loved ones. The respondents from this group, in contrast to those who refused vaccination, were aware of the danger of COVID for young people. The group of hesitant students occupies an intermediate position in terms of beliefs regarding vaccination and COVID-19 between the group of refusers and the group of those who agreed to get vaccination. At the same time, the combination of fear of COVID-19 infection with underestimation of the risk of infecting loved ones obviously determined the behavioral tactics of waiting. A pronounced fear of infection can contribute to «paralysis of actions» – refusal to make any decisions. In order to move from a behavioral strategy of observation to a strategy of consent to vaccination, it is necessary to reformulate negative beliefs about the ability of the vaccine to cause severe side effects («the vaccine can cause a heart attack, stroke or death»), to reduce the belief that the disease itself gives a more stable immunity than vaccination, to convince students of the safety of the vaccine, as well as increase their responsibility for possibility of infecting their loved ones.

Readiness for vaccination is associated with the denial of insufficient knowledge about the vaccine, belief in its safety, and fear of infecting loved ones. Among those who agree to vaccination, 77.4% of students reject the ability of the vaccine to cause a heart attack or stroke, more than 1/3 are confident that the vaccine is sufficiently studied. In this group there is a widespread belief in other characteristics of the vaccine that are important: its effectiveness, ability to facilitate the course of COVID-19, inability to change the genome, as well as the risk of infection, inability of COVID-19 infection to produce a stronger immune response than the vaccine.

According to a number of studies [11; 12; 13], the key factors in making a decision about vaccination are data on the effectiveness and safety of vaccines, recommendations from medical professionals and knowledge that vaccination was successful in other countries. In addition, the importance of personal benefit is noted, especially among the group of those who are hesitant about vaccination.

Conclusion. The obtained data allowed us to develop a multifactorial model of the formation of students' behavioral strategies in relation to vaccination. The key factors influencing the choice of a behavioral strategy for refusing vaccination are the belief that the vaccine is insufficiently researched and that COVID is not dangerous for young people. Readiness for vaccination is associated with denial of insufficient knowledge of the vaccine, conviction of its safety, awareness of the danger of COVID for young people, fear of infecting loved ones. The group of students who prefer to monitor the situation and wait is characterized by an intermediate position in terms of beliefs regarding vaccination between the group of those who refuse and the group of those who agree to vaccination. There is a combination of fear of COVID-19 infection with underestimation of the danger of infecting loved ones. A pronounced fear of infection, combined with the belief that the vaccine is underexplored and conflicting beliefs about its properties, can contribute to «paralysis of actions» – refusal to make any decision. Thus, based on the importance of beliefs and their prevalence in different groups of students, in order to increase readiness for vaccination, it is necessary to spread information about the safety of the vaccine (its inability to cause severe complications, exacerbate the course of chronic diseases), its coverage in sufficient studies and effectiveness in preventing infection. It is also important to disseminate information about the danger of infection for young people and the danger of infecting other people.

Appendix.
Questionnaire on the perception of COVID-19 infection and attitudes to vaccination against it

	Completely disagree	Rather disagree	Rather agree	Completely agree	Not sure
The vaccine is quite likely to cause a heart attack, stroke or death					
The vaccine can lead to infertility					
The vaccine is more dangerous than the disease caused by COVID-19					
The vaccine causes changes in the genome					
COVID-19 infection is not as dangerous as it is said					
The vaccine exacerbates the course of chronic diseases					
COVID-19 infection is not very dangerous for people of my age and gender					
If you get over CAVID-19, it will give a more stable immunity than the vaccine					
If you are careful and have a strong immune system, you cannot get sick for a long time					
After vaccination, COVID-19 infection is more difficult to tolerate					
Vaccination against COVID-19 is ineffective (weakly protects against infection)					
The COVID-19 vaccine is not sufficiently studied					
As a result of vaccination there is a significant risk of contracting COVID-19					

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