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WORK IN SCHOOLS IN THE PANDEMIC – A PROPOSAL OF A METHOD FOR CHILDREN TESTING ON COVID-19 VIRUS

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Abstract In the conditions of the pandemic caused by the Covid-19 virus, the work of schools became directly conditioned by the possibility of students and teachers to attend classes, both due to their poor health condition and due to the possibility of transmitting the infection. The main focus of this work is the determination of the ability of children to transmit the infection, as well as to point out the omissions in testing school-age children, having in mind the need to create a more realistic picture of the number of children infected with the Coronavirus. The absence of symptoms or relatively mild symptoms caused by the Covid-19 virus in infected children under the age of 18 have led most health workers to conclude that the virus is much less prevalent in this population, and that children are not the primary carriers of the infection. However, although it may be true, it is premature to make such a conclusion, because it has not been supported by appropriate tests. Most of the research done so far has been based on a study of children in whom the Covid-19 virus has already been confirmed or suspected. However, the complete enigma remains the population of children in schools who has not shown the classic symptoms that are recognizable for this virus, or do not show any symptoms. Respiratory infection is just one of the symptoms that can be most easily noticed, which is characterized by the Covid-19 virus. However, this virus can attack practically any organ in the body, and it does not have to show any visible manifestation at the moment that would indicate the existence of this virus in a child. Having all this in mind, as well as the fact that the number of asymptomatic cases in schools is unknown, the conclusion of this paper is that targeted testing of children in schools should be performed, regardless of the presence of symptoms or their absence. This can be done in the quickest and easiest way by the method of a random selection of a school in a city and by testing all children in the observed school for the presence of the Covid-19 virus. If it turns out that the percentage of infected students is higher than expected, the same testing procedure should be repeated in other schools in a particular city. Initially, all larger urban areas should conduct such initial testing, and the test results will indicate whether there is a need to continue with this type of testing in smaller urban areas also, ie to expand the scope of testing on the basis of application of this methodology. This approach, basically based on the principle of random sampling, can in a relatively fast and efficient way provide a more realistic picture of the presence of the Covid-19 virus in schools and the potential for students to further spread the virus to households and other environments.

Keywords: Covid-19; SARS-CoV-2 virus; pandemic; schools; students; Covid-19 testing; ergonomics.

1. INTRODUCTION

The Covid-19 virus pandemic was accompanied by a number of misconceptions. One of those misconceptions at the beginning of the epidemic was a general belief that children could not get the virus. At the time, the virus was thought to exclusively attack the elderly population, mostly over the age of 60. However, the effects of this virus and the knowledge about it have changed over time. It turned out that this virus can also endanger the population of people under 60. Nevertheless, it has been believed for a relatively long time that children can get Coronavirus only in exceptional cases (such as in the case of the parallel existence of a certain chronic disease).

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Over time, awareness has developed to some extent that school-age children can be ill due to the Coronavirus infection. Although it is still relatively unknown whether and to what extent children in schools can be carriers of the infection, appropriate measures have been taken worldwide to prevent the spread of the infection among children in schools. A whole set of measures was implemented, starting from disinfection at the entrance to schools, wearing protective masks by students and teachers, maintaining a safe distance between students, frequent disinfection of rooms, over a hybrid modality of teaching (in school and online), all the way to suspension of work in schools and a complete transition to online teaching over a period of time. All these measures were strictly applied in the vast majority of cases, which undoubtedly gave good results, because schools did not become places that would be formally characterized as a significant source of infection (at least not to the extent that it could be the case if they were not applied prevention measures).

The organization of work in schools in a pandemic directly depends on the number (percentage) of infected students and teachers, as well as on the possibility for children to spread the infection among themselves. In addition, special health risk is the possibility of children transmitting the infection to the household, as well as other parts of the population. For that reason, it is of special importance to obtain a realistic picture of the state of infection of students under the age of 18 in schools. However, the current way of testing children for the Covid-19 virus does not allow the formation of any reliable picture of the state of infection of children in schools. The entire organization of the educational process is not based on the existence of an objective picture and knowledge about the real state of students' infection with Coronavirus. It all comes down to assessments of the current situation and predictions about the future course of the spread of the infection.

Given that part of the population of workers in education, health workers and the public is still convinced that children do not pose a considerable risk in terms of getting disease and transmission of Covid-19 virus, the aim of this paper is to come to an unequivocal conclusion about the presence of Coronavirus in schools and the possibility of transmission of this virus between children. Also, the aim is to create conditions that will contribute to the forming of as objective as possible viewpoint related to the seriousness of the situation related to work in schools, based on the results and analysis of previous research on this topic and presentation of certain new data. Part of the consideration will focus on the possibility of transmitting the infection from children to adults. Finally, the goal is to propose a solution for testing students in schools, which will in a simple way contribute to creating a more realistic picture of the level of infection of students in schools.

2. POSSIBILITY OF INFECTION OF CHILDREN AND TRANSMISSION OF COVID-19 VIRUS

There is a general belief that school outbreaks have not been a prominent aspect in the COVID-19 pandemic, mainly due to the fact that when infected with the virus, most children do not show symptoms or develop a very mild form of the disease. However, below will be explained, how and when such a standpoint could be generally misleading. Also, such statements could be potentially dangerous.

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Despite the previously mentioned standpoint, according to the European Centre for Disease Prevention and Control, "research has shown that children can become infected, and spread the virus to adults while they are symptomatic" [1]. Although this statement can be considered as true in general, below will also be explained why this information is not complete.

From March 1 through July 25, in 2020, 576 pediatric cases of COVID-19 were reported to the COVID-19 Associated Hospitalization Surveillance Network (COVID-NET), a surveillance system that collects data on COVID-19 associated laboratory-confirmed hospitalizations in 14 US states. Based on these data, the cumulative rate of hospitalization associated with COVID-19 among children aged less than 18 years between March 1 and July 25, 2020, was 8.0 per 100,000 inhabitants, with the highest rate (24.8) among the children aged <2 years [2].

Between January 2 and January 8, 2020, the Covid-19 virus was detected in 6 children [3], in the territory of central Wuhan (at three branches of Tongji Hospital). The median age of these six patients was 3 years (in range 1 to 7). All six children had previously been completely healthy, which indicates that Coronavirus does not attack primarily children with a history of some chronic disease (which was the initial belief among many health workers). Common clinical characteristics in all six patients included high fever (>39°C) with cough, and vomiting (in four children). This indicates that children below 7 years of age, as the adults, can also develop a typical clinical picture. In esence, according to [4], it is possible to divide all pediatric patients into five groups, based on their clinical features:

1. Simple infection
2. Mild pneumonia
3. Severe pneumonia
4. Acute respiratory distress syndrome (ARDS)
5. Septic shock.

According to Yang et al., in terms of symptoms, in a study that involved 416 children (<10 years old) in China, 76.1% of infected children had a fever, while 70.4% of those showed viral pneumonia-like changes in their chest imaging [4]. According to Matthai et al., fatigue, fever, dry cough, and upper respiratory symptoms (running nose and nasal congestion), as well as occasionally gastrointestinal symptoms such as nausea, vomiting, and diarrhea have been the main clinical symptoms of COVID-19 among children [4].

Unfortunately, although in a smaller percentage than in adults, severe forms of the disease caused by Coronavirus, also can be manifested in children. Noticed states, which have characteristics that look like the pediatric multisystem inflammatory syndrome, in many cases, have been connected with the COVID-19 virus. According to Rowley, these states have been noticed in more than 1000 children and adolescents in multiple countries during the first wave of COVID-19 [5]. Among others, these conditions are characterized by myocarditis.

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In addition, unfortunately, the fact is that there have been fatal outcomes in children, as a consequence of COVID-19 virus. Accoding to Swann et al., fortunately, the case fatality of hospitalized children is relatively low at 1% (compared with 27 percent across all ages) [5]. As an example, only in England and Wels by 19 June 2020, there were 2 deaths of children under 1 year of age attributed to COVID-19 infection and 4 deaths of children in the interval 1 to 14 years (while in the interval of 15 - 44 year of age were recorded 531 deaths) [6]. However, it is very dangerous if this mortality rate is considered negligible.

Having the above in mind, the general standpoint that most children do not show symptoms or develop a very mild form of the disease should not be a conclusion, based on which we should develop and apply measures for the prevention of spreading the virus in schools. The people who make decisions about the work in schools always should have in mind that there are serious cases of this disease, even with the possibility of a fatal outcome.

In addition, if parents are not aware of the fact that the COVID-19 virus can seriously endanger their children's health or even cause death, they will not pay enough attention to their children's health and the possibility of children transmitting the infection to school or family. In that case, parents can interpret a mild form of change in the child's health caused by Coronavirus as a simple sneeze, without any idea that any such change in the child's health should be taken seriously in the period of the pandemic. Such an attitude can also endanger themselves, and especially older members of the household with a disturbed immune system. Unfortunately, there is an increasing number of families in which all members of the household are infected.

Contrary to the initial belief from the beginning of the pandemic that children do not get the COVIID-19 virus, all the above examples clearly indicate that children can also get and transmit the Coronavirus. In addition, the course of the disease, as in adults, can be fatal. All this indicates that the situation in schools must be continuously monitored, because the easing of measures in schools, or changes in the activity of the virus, can have unforeseeable consequences for children, and thus for the rest of the population.

3. ASYMPTOMATIC CHILDREN - INCLUDING THE COMPARISON WITH ASYMPTOMATIC ADULTS

Children shed the virus when they have symptoms in equal amounts as adults, and can infect others in a manner similar to adults. It is unclear how contagious are children when they are asymptomatic [7]. Among 2914 pediatric patients from several countries (China, United States, Spain, Iran, Republic of Korea) that were tested and positive for infection with SARS-CoV-2, there were 14.9% asymptomatic patients [8]. Other studies also confirmed existance of asymptomatic cases in children, and their percent went up to 28 % [7].

Before consideration of the possibility of asymptomatic children to transmit the Coronavirus, it is interesting to compare asymptomatic children with asymptomatic adults. Is any difference between them? For that purpose, we can start from two well known adult persons who were asymptomatic.

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First is very well known tennis player Novak Djokovic, who has been voted the best athlete on the planet several times. Novak Djokovic was found to be positive for Coronavirus during the 2020 Adria Tour. He was tested for the virus because he was in contact with a person with a previously confirmed Coronavirus. However, neither before nor after testing in Novak, no symptoms characteristic of this virus were observed. From the moment the virus was detected, Novak was in isolation. The recovery lasted a very short time and Djokovic quickly returned to the sports fields, ending the 2020 year at first place on the world tennis players list.

Figure 1. Correlation with asymptomatic adults. Novak Djokovic during Adria Tour (2020) where it was assumed and after that confirmed that Novak is Coronavirus positive (photo from https://novakdjokovic.com/).

Another example is footballer Cristiano Ronaldo, who has been voted the best footballer on the planet several times. In 2020, the presence of the Coronavirus was confirmed to this athlete by testing. However, as with Djokovic, the course of the disease was asymptomatic. What's more, Ronaldo spent time during isolation doing physical exercises (video about that can be seen at https://www.youtube.com/watch?v=PEs2AaHknlQ).

These two examples do not only point to the well-known fact that adults can be as asymptomatic as children. These examples clearly indicate the treatment to be carried out in the case of asymptomatic disease, regardless of the age of the infected person. It's isolation. As long as the virus is present in the throat, nose and lungs of an asymptomatic person, it can transmit the infection. The mechanism of infection transmission in both symptomatic and asymptomatic individuals is the same, via droplets. This means that an asymptomatic child with the virus still in the throat, nose, and/or lungs by sneezing, coughing, nasal discharge, and touching the object with the hand on which the secretion is located can transmit the Coronavirus to another person (or object). All this indicates the danger of spreading the infection that exists if testing does not involve the determination of the number of asymptomatic children attending classes.

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4. PRESUMPTIONS WHY CHILDREN ARE LESS SUSCEPTIBLE TO THE SARS-CoV-2 VIRUS THAN ADULTS

First of all, the ascertainment that children are less susceptible to infection with the SARS-CoV-2 virus is debatable. If a child does not show easily noticeable symptoms, it does not mean that it is not infected and cannot transmit the virus. However, several assumptions can currently be found in the literature where are stated the potential reasons for the lower susceptibility of children and the lower level of infection compared to adults. These reasons can be divided into two categories, physiological, as well as those that are conditioned by the factors of the child's environment.

As one of the crucial physiological arguments used in most cases to explain why children suffer less from Coronavirus than adults is the immaturity of angiotensin converting enzyme 2 (ACE2) receptors in children, which are considered as sites for COVID-19 binding [4]. In other words, it should mean that the functioning of the ACE2 protein is not at an optimal level, so, due to that, ACE2 does not act as a receptor for the SARS-CoV-2 virus to the extent in which it acts in adults. Due to that, according to this presumption, children are less susceptible to Coronavirus infection.

On the other hand, in [9] it is concluded that we can speculate that high ACE2 receptor concentrations in children may partially explain the mild disease that has been observed in this population. In addition, it should be said that ACE2 is the protein that has a very important role in the human organism. Probably the most important role it has is in controlling the work of the heart and blood pressure. ACE2 also has an important role in the prevention of inflammation processes. It can be found on the surface of many types of cells. The list of organs that contain ACE2 is very long. ACE2 expression levels are the highest in the heart, kidneys, small intestine, reproductive organs, thyroid and adipose tissue. Medium expression of ACE2 levels can be found in the lungs, liver, bladder, colon, and adrenal gland. The lowest expression it has in the blood, spleen, bone marrow, brain, blood vessels, and muscle [10]. Skin also contains ACE2. In all those organs, ACE2 has certain useful functions. However, considering that ACE2 also acts as a receptor (entrance) for the SARS-CoV-2 virus, it means that all those organs may become the targets of the attack of Coronavirus, which as a consequence may have their temporary dysfunction, or in certain cases may be caused permanent damage of organs.

Unfortunately, to the list of "organs" that can be infected by Coronavirus, it should be added human embryo also. French media reported that a coronavirus was identified in a baby who was born prematurely by cesarean section due to her mother's infection. There was a viral inflammation of the baby's brain [11]. The recent case of a newborn born by cesarean section in Serbia who was confirmed to be infected with the SARS-CoV-2 virus (source RTS) confirms the aforementioned possibility. This also could mean that newborns have enough active ACE2 receptors to become ill due to the Coronavirus.

More ACE2 receptors also could mean more possibility to the SARS-CoV-2 to enter the organs. ACE2 is produced by the X - chromosome [6]. However, it does not exist a unique standpoint does children have more or less ACE2 receptors than adults. According to [6], ACE2 availability is also affected by age, with the highest levels observed in younger patients, appearing to be counterintuitive to infection rates and disease severity that have been recorded in older patients. Contrary to that, in [9]

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was not observed a statistically significant difference in ACE2 expression levels in any tissue between the younger (ages ⩽ 49 years) and older (ages > 49 years) population (besides, ACE2 was not differentially expressed between males and females). According to this research, if we take into account the availability of ACE2 receptors as a criterion for the possibility of the appearance of Coronavirus disease, then younger and older populations have almost equal probability to become ill. However, there are several other factors that influence this possibility. The most important of them will be mentioned below.

The second important reason that could contribute to the difference in the number of recorded cases in the younger and older population is an immune response. In connection with that, some studies have shown that, relative to adults, the amount of lymphocytes in infected children's blood is high [4]. One more physiological explanation for a lower prevalence of COVID-19 in children is the production of less severe cytokine storms, as a result of the response of their immune system [4].

Several environmental factors are mentioned in the literature as possible reasons for the lower prevalence of COVID-19 in children. Compared to their parents, lower exposure of children to cigarette smoke and air pollution decreases their risk of development of underlying disorders. Lower exposure of children in public areas could be also one of the reasons for the mentioned phenomenon [4].

An additional criterion for determining the difference in the level of infection between the younger and older population can be the number of contacts, the duration of contacts, as well as the possibility of protection during those contacts. Although it is not known that such an analysis has been done before, it is not difficult to assume that the number of contacts is higher in the older population compared to children in schools, and that the possibility of protection is often lower. However, in the oldest population, the number of contacts is certainly not the highest, but the duration of individual contacts can be very significant.

5. FAILURES IN TESTING CHILDREN IN SCHOOLS ON COVID-19

Children who show symptoms of Coronavirus in most cases do not pose a problem in terms of detection of this virus. However, the problem is asymptomatic children, who attend classes without knowing that they are ill. Thus, if at some point there is a failure in the school related to the application of prevention measures, there is a high risk that an asymptomatic child will transmit the infection to other students.

In most countries of the world, the necessary measures have been taken at the beginning of the pandemic to prevent the spread of the infection in schools. The main measures that are still applied have been mentioned earlier in this paper. There is no significant difference between countries in the implementation of these measures. The only difference is in the modalities of applying the same measures. The modalities mainly differ depending on the levels of infection in schools.

One of the most drastic measures of protection is the complete transition to online teaching. This measure is implemented when it is estimated that there is a high risk of spreading the infection. In most cases, this measure is applied when an increase in the number of infected children is noticed, by

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testing them in health care institutions. However, this assessment is based only on those children who showed symptoms, and for that reason, they were sent to a health institution for testing. Although a good indicator, such an approach is not a reliable indicator of the prevalence of Coronavirus in schools. The reliability of this approach is diminished, because the percentage of infected asymptomatic children in schools is completely unknown.

The most reliable method for estimating the prevalence of Coronavirus in schools would be to test all students in schools for the SARS-CoV-2 virus. However, in this situation, such a thing is not possible, because the capacities of health systems in almost all countries are overloaded, due to the existence of a large number of elderly patients who need to be taken care of. For that reason, it is necessary to apply a testing approach that will enable a more realistic picture of the level of infection in schools, without overloading the health system.

Having in mind the need for more reliable determination of the number of infected students in schools, as well as the mentioned limitations, a method of testing students for the SARS-CoV-2 virus will be proposed here, which can be a solution to the described problem. Basically, this method is simple. It comes down to determining the school in the larger city environment on the principle of random sampling, in which ALL students, teachers and other staff working in the school will be tested. Thus, such testing will cover all potential cases, symptomatic and asymptomatic. If it turns out that the percentage of infected students is higher than expected, the same testing procedure should be repeated in other schools in a particular city. Initially, all larger urban areas should conduct such initial testing, and the test results will indicate whether there is a need to continue with this type of testing in smaller urban areas also, ie to expand the scope of testing on the basis of application of this methodology. This approach, basically based on the principle of random sampling, can in a relatively fast and efficient way provide a more realistic picture of the presence of the Covid-19 virus in schools and the potential for students to further spread the virus to households and other environments.

6. CONCLUSION

In this paper, it is emphasized that children in schools can not only get Coronavirus, but can also develop a severe clinical picture as adults. Unfortunately, cases with fatal outcomes of children are also a reality. In addition, it has been confirmed that children under the age of 18 can be a significant carrier of the SARS-CoV-2 virus. They can transmit this virus to each other, but they can also spread the infection to households and the rest of the populationCarriers of the virus can be not only symptomatic children, but also asymptomatic. The paper explains how asymptomatic children can be carriers of the virus. It was especially emphasized that the number of asymptomatic children in schools is a complete unknown. It was pointed out that the current way of testing school children, only in cases when they show symptoms or when there is a suspicion of infection due to their contact with an infected person, is not reliable. This does not allow the creation of a realistic picture of the state of Coronavirus infection in schools. This can result in delays in the implementation of certain measures, or failure to take appropriate protective measures in schools.

In most cases, children under the age of 18 develop a moderate or mild clinical picture. There are also a number of asymptomatic children who are commonly believed to be safe, while they are unable to be affected by the virus in a way that leaves serious consequences. Such circumstances influenced

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the expansion of the belief in the professional population, and especially in the public, that the population of school-age children has been spared the serious effects of the pandemic. However, such a belief can be dangerous, especially given the existing impreciseness in determining the number of asymptomatic cases in schools. Easily noticeable symptoms of coronavirus infection in children are manifested only in the case of respiratory infection. However, the paper points out that the SARS-CoV-2 virus can attack any organ in the body, due to the presence of ACE2 receptors on the surface of the organs. These receptors have been shown to be the primary target of Coronavirus attacks, in order to infiltrate a human organ. Since the detection of dysfunction of certain organs is a complex diagnostic task (especially if we take into account the possible existence of minor dysfunction, which is often characterized by the absence of clearly recognizable symptoms), some "asymptomatic" cases in children can mask a potential damage to an infected internal organ. Such consequences can become noticeable only in later years.

This paper also discusses the reasons for the lower susceptibility of children in relation to adults to Coronavirus. Although the assumption of the existence of the generally lower susceptibility of children to this virus is debatable, potential reasons for the appearance of this phenomenon have been considered. In this regard, in this paper have been presented new potential reasons for this phenomenon. Those new causes for the existence of the difference in the level of infection between the younger and older population can be the number of contacts, the duration of contacts, as well as the possibility of protection during those contacts. It is not difficult to assume that younger people have less frequent contacts, that these contacts last shorter, and that children in schools are better protected than adults during those contacts. This may be the reason for the lower rate of infection of children and the lower rate of occurrence of a severe clinical picture.

It is extremely important to apply a multidisciplinary approach to the prevention and treatment of Coronavirus patients. In [12] has been highlighted the role of ergonomics in preventing the spread of infection caused by the Covid-19 pandemic. However, it is also very important to apply a multidisciplinary approach to the treatment of patients with Coronavirus. In practice, it is often the case that one patient is treated by one doctor (which is probably a consequence of the lack of staff in the conditions of a pandemic). Such an approach in the case of treatment of the Covid-19 virus is not the best solution, considering that this virus can attack any organ in the body, including bones. For that reason, if it is noticed that there is a change in the functioning of any organ during the treatment, it is necessary to engage a specialist for the appropriate organ that has been attacked by the virus, as well as to coordinate the therapy.

As previously stated, it is not known what percentage of children go to school without showing any symptoms, whereby they are carriers of the infection. In connection with that, in order to gain a more realistic picture of the number of children infected with Coronavirus in schools, regardless of whether they show symptoms or not, this paper presents a new proposal for the methodology of testing children for Covid-19 in schools. The essence of this method is to initially select schools in larger urban areas on the principle of random sampling, in which all students, teachers and other employed staff will be tested for Coronavirus. If it turns out that the number of infected students after such initial testing is higher than expected, the scope of testing can be extended to other schools in a particular city. The results of testing with this methodology will indicate whether there is a need for testing in other smaller environments as well. By applying this methodology, a more realistic picture

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of the level of sick students in schools can be obtained in a fast and economically viable way, the spread of the infection can be prevented and the teaching process can be adequately organized.

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