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Remote learning – the cause of an increase in health symptoms in students during the COVID-19 pandemic

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ABSTRACT

Introduction: The multitude of changes related to remote learning during a pandemic pose a risk of increased effects on the psychophysical health of students. The main objective was to assess the increase in health symptoms in students during a pandemic and the association between the increase in these symptoms and problems with remote learning.

Material and methods: Analyses were conducted on a sample of 340 parents (92% were mothers) of second-grade students (51% girls) attending 11 primary schools. Logistic regression analysis was used to estimate the risk of increased health symptoms in the context of the difficulties experienced with remote learning.

Results: During the pandemic almost 2/3 of students had an increase in irritability (64%) and outbursts of anger (65%). In nearly half of the students (43%) their parents noticed an increase in headaches, and in every third child (38%) increased abdominal pain. Children who had difficulties with remote learning were statistically more likely to experience increased sleep problems (34.3% vs. 11.4%, $p = 0.001$), decreased appetite (35.5% vs. 15.2%, $p = 0.001$), and increased abdominal pain (47.9% vs. 32.9%, $p = 0.001$) as well as all analysed emotional symptoms: increased fear/anxiety (44.8% vs. 25.4%, $p = 0.007$), sadness/apathy (56.5% vs. 38.0%, $p = 0.003$), irritability (70.0% vs. 49.3%, $p = 0.009$), and outbursts of anger (71.0% vs. 53.2%, $p = 0.008$). Difficulties with remote education increased the risk of sleeping problems [OR = 4.54; CI (OR): 2.05-10.04; $p < 0.001$], the risk of abdominal pain [OR = 3.45; CI (OR): 1.81-6.60; $p < 0.001$], and risk of the decreased appetite [OR = 3.039; CI (OR): 1.49-6.19; $p = 0.002$]. For increased symptoms of headache, fear/anxiety, sadness/apathy, irritability, and outbursts of anger, the risk was 2-fold greater, and nearly double while students had remote learning problems.

Conclusions: Problems with remote learning increased in children, primarily risk of physical health problems such as sleep problems, increased abdominal pain, and decreased appetite. Students experiencing distance learning difficulties and their parents are important beneficiaries of prevention and intervention programs.

KEY WORDS: COVID-19, health complaints, children, remote education.

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INTRODUCTION

In March 2020, the World Health Organization declared the outbreak of COVID-19 a pandemic [1]. In Poland, similarly to other countries, during the pandemic, the government made decisions about periodic school closures and the introduction of remote learning [2]. The time of schooling is important for the holistic development of children and youths. In addition to the educational functions of the school, one of the important aspects of its care and educational tasks is to ensure the safety of stu-

dents at school, to protect their health, and to support their physical development [3]. The modern-day school is not only a place for learning, but also a space for recreation, a place providing opportunities for various activities to support the development of students, including physical activity and healthy eating [4]. In light of the research on the school environment in physical activity and nutrition in Poland, almost all primary schools surveyed have adequate infrastructure for sports activities [5]. The majority of them fulfil the compulsory weekly hours of physical education, and most also provide after-school sports activities. The sports area around the school and canteen are often available to pupils outside school hours. Schools are the optimal space for interventions to improve children's diets, which is important for eating habits in adult life. In Poland, under the educational law, from 1 September 2022, all schools are obliged to provide students with one hot meal a day and to give them the opportunity to eat it during their stay at school, the meal is voluntary and payable (Article 106a par. 1 of the Act – Education Law; Journal of Laws 2023.900).

School is also an extremely important environment for socialisation, establishing contact and relationships with peers, and socio-emotional development, such as the development of communication skills, the ability to co-operate, resolve conflicts, and develop empathy [6].

In light of the international HBSC study (Health Behaviour in School-aged Children. A WHO Collaborative Cross-national Study), which has also been carried out in Poland since 1990, the adaptation of pupils to the school environment, as measured by indicators such as satisfaction with school, pupils' academic achievement, and the level of stress associated with school, influences, among other things, self-assessment of health and the frequency with which subjective somatic and psychological complaints are experienced [7]. Students' positive perception of their school is associated with their higher self-esteem of health, experiencing less frequent subjective health complaints, such as depression, irritability and bad mood, nervousness, difficulty sleeping, and dizziness. In this context, however, it is worrying that, according to nationwide data from before the COVID-19 pandemic, between 2010 and 2018 an increase in school stress in pupils aged 11-15 years and the percentage of pupils who do not like their school, as well as a decrease of the percentage of pupils who like their school very much, was observed [8, 9]. On the other hand, unpublished data from the study presented in this publication suggest that pupils who are still in the early stages of their school education (II grade of primary school) have a positive perception of their school. According to information from the parents surveyed, the majority of pupils (94%) like their school, with almost two-thirds liking it very much (64%).

The additional elements presented above, associated with the traditional school model, which have an impact on health and the development of healthy lifestyle habits, were severely lacking in students during the pandemic. Remote learning changed the main model of education, where learning took place in a stationary form, at a school, in a peer group, and was based on face-to-face contact with the teacher [10]. The rhythm of children's days has changed, and their school-based physical activities have been replaced by constantly being at home [11]. School attendance largely organises the rhythm of the child's day, including their sleep-wake cycle, it ensures regular physical activity, and sometimes provides part of their daily meals, all of which account for a documented mechanism that protects the psychophysical health of children [6]. A systematic review of research by Viner *et al.* [12] indicated that remote learning in school-age children could be associated with an increase in emotional difficulties and the regulation of behaviour and attention, as well as deterioration in healthy behaviour, including problems with sleep regulation, a decline in physical activity, and an increase in the amount of time spent in front of a computer monitor or other electronic devices. In view of this knowledge, children who started their education at the beginning of the pandemic present a particular group. In the Polish educational system, students of the first grades of primary school are mainly 7 and less often 8 years old. Eight-year-old children, i.e. students attending II grade, who already have over a year of experience in school education, are a group of children who should be more independent, and have greater needs for peer-related classes and school-related activities than younger children, while their maturity and developmental needs cannot yet be compared with those of teenagers. At this age, pupils are still in the early stages of schooling and therefore do not have a well-established educational experience.

Pupils' functioning, including their physical, mental, and social well-being, as well as the fulfilment of their school duties, can also be affected by chronic illnesses [13]. To the best of our knowledge there are no recent, precise, complex data on the prevalence of chronic diseases in schoolchildren, but it can be determined from partial data that this problem refers on average to one in four children in Poland (not including obesity) [14].

Taking into account selected health indicators and the lifestyle of 8-year-olds, a survey conducted in Poland periodically since 2016, in cooperation with the World Health Organization, has indicated deficiencies in healthy behaviours in this age group, including, e.g., low levels of physical activity, frequent sedentary behaviours such as watching TV or screen time, as well as inappropriate eating behaviours [15, 16]. During the pandemic, an increase in these problems was observed in 8-year-olds, as well as some negative changes in selected health indicators – a significant increase in the percentage of children with elevated blood pressure values and excessive body weight [17].

Available research that considers 8-year-olds shows that remote learning within this group of children can be associated with the risk of occurrence or exacerbation of psychophysical health problems [6, 18]. According to the authors' knowledge, similar studies among children of early school age have not been conducted in Poland.

The main aims of this study were as follows: (1) assess the subjective increase in health (physical and emotional) symptoms in students during a pandemic, and (2) assess the association between the increase in health symptoms and problems encountered with remote learning.

MATERIAL AND METHODS

Analyses were conducted on a sample of 340 parents (92% were mothers) of second-grade students attending 11 primary schools in Poland. This anonymous survey was conducted in 2021 by the Institute of Mother and Child (IMC), and the methodology of the study was based on the WHO European Childhood Obesity Surveillance Initiative (COSI) 2018/2019 research protocol, containing areas of questions related to biological and social determinants of health status, supplemented by additional scales and new questions related to the epidemiological situation [19]. Anthropometric measurements, blood pressure, and pulse measurements of 409 students were also taken within the scope of this project. A positive opinion of the Bioethics Committee was received on the adherence of this research to ethical principles (decision no. 29/2021 from 18 March).

RESEARCH TOOLS AND INDICATORS

The intensity of health problems experienced by students during the pandemic.

The question about physical problems (sleep problems; decreased appetite; increased appetite; headache; abdominal pain) was as follows: *In your opinion, have the child's difficulties in at least one of the below mentioned areas increased during the pandemic? Please mark the answer with an X in each line.* The question pertaining to emotional problems (fear/anxiety; sadness/apathy; irritability; outbursts of anger) was as follows: *Do you think that at least one of the below feelings and behaviours have increased in your child during the pandemic? Please mark the answer with an X in each line.* The same categories: *Not at all, A little, Significantly, Very strongly*, were given in those 2 questions, and for the purpose of the analysis the last 2 categories: *Significantly* and *Very strongly,* were combined into one category: *Strongly*.

Problems associated with remote learning

Parents also assessed 10 areas related to difficulties associated with remote learning experienced by their children during the pandemic in the school year 2020/2021 by answering the question: *How big a problem were the following remote learning situations for the child?* and marking their opinion on a scale from 1 (*not a problem at all*) to 5 (*a very big problem*). A similar question, but addressed to adolescents, was used in earlier research also conducted by the Institute of Mother and Child, the results of which, along with the presentation of all categories were described in another publication [20].

The scale of remote learning difficulties experienced by students

In order to investigate the overall level of problems with remote education experienced by students in the opinion of parents, and taking into account parents' answers to the statements in the above question, a remote learning difficulties (RLD) scale was devised. Responses were assigned a score from 0 to 4. Based on a preliminary psychometric analysis of the scale, one of the 10 statements was excluded from further interpretations: *The lack of conditions for online studies,* because it lowered the scale's properties and distorted the single-factor nature of the scale. After removing this scale item, the Cronbach's α coefficient increased slightly from $\alpha = 0.83$ do $\alpha = 0.84$, and the researched area related to problems with learning constitutes one factor and explains 46% of the total variability of the scale. The 9 statements that constitute the overall index of the final RLD scale show adequately high correlation with the total score of the entire scale, which ranges from 0.408 to 0.640. The overall index of the scale equalled 0 to 36 points, and the higher the score, the greater the increase in problems with remote learning. The mean of the overall level of problems with remote education experienced by students in the opinion of parents measured on the scale RLD was 9.0 points and standard deviation 7.37. Dependencies between gender and place of residence and the overall level of problems with remote education were not noted. For the purpose of analysis, a dichotomous variable was used, assuming the occurrence of difficulties with remote learning when the obtained result is in the range 6-36 points (64% of students). The range of 0-5 points was considered as a lack of difficulties.

DEMOGRAPHIC VARIABLES

The analyses took into account the division by gender and place of residence. The question about the *Child's place of residence,* had the following categories of answers: *Large city (over 100,000 inhabitants; Small town (less than 100,000 inhabitants);* and *Village (rural area).* Within the researched group, 51% were girls; 67% of students lived in small towns and 33% in rural areas.

CHRONIC DISEASES

We asked parents the question *Does your child have a chronic disease?*. The question had 3 response categories: *yes*, *no*, and *I don't know*. There were 12.7% of pupils ($n = 43$) with a chronic illness in the study group. For the purpose of the analysis the last 2 categories were combined into

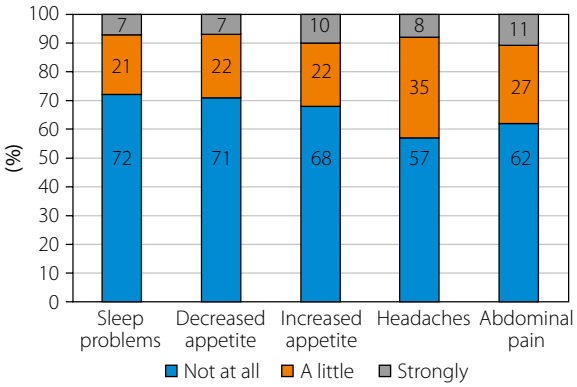

FIGURE 1. The level of increase in physical symptoms in students during the pandemic

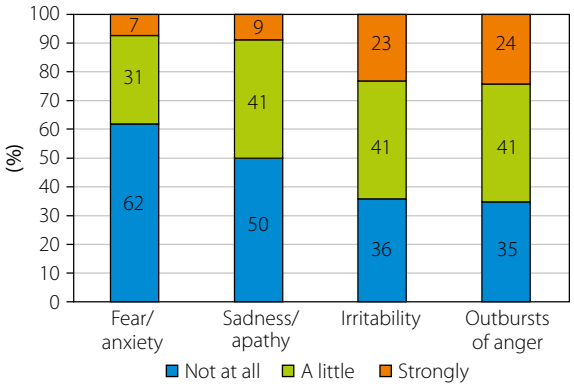

FIGURE 2. The level of increase in emotional symptoms in students during the pandemic

one category "*No*", because only 7 parents answers "*I don't know*". The type of illness was indicated by 23 of the surveyed parents, and these were mostly allergic diseases.

STATISTICAL ANALYSIS

The association between the assessment of an increase in particular physical and emotional symptoms and gender and place of residence was investigated using the chi-square test. Furthermore, descriptive statistics regarding the level of burden of students with difficulties resulting from remote learning were presented based on the RLD scale: mean values and standard deviations. Due to the different distribution of the above scale compared to a normal distribution, the Mann-Whitney *U* test for independent samples was used to compare the mean values by gender and place of residence (*urban-rural*). Logistic regression analysis was used to estimate the risk of increased health symptoms in the context of the difficulties experienced with remote learning (independent variable, reference category – the lack of the difficulties experienced with remote learning), gender (reference category – boys), and place of residence (reference category – rural). The results of the multivariate analysis were presented as odds ratios (OR) along with 95% confidence intervals (CI). In total, 9 logistic regression models were estimated, one for each health symptom. The significance level of $p < 0.05$ was assumed in the study. Analyses were carried out with the use of the IBM SPSS Statistics v25 software.

RESULTS

THE INCREASE IN HEALTH PROBLEMS IN THE PHYSICAL AND EMOTIONAL ASPECT IN STUDENTS DURING THE PANDEMIC

Regarding physical and emotional symptoms observed by parents in children during the pandemic, in each of the mentioned areas an increase was noted (Figures 1 and 2). The most common physical symptoms that increased in students during the pandemic was headache, followed by abdominal pain. In almost every second child (43%) the parents observed increased headaches and in every third child (38%) increased abdominal pain. Almost every third child also experienced changes in appetite during pandemic. More than 1/4 of the students had increased sleep problems (28%).

The main emotional symptoms that parents perceived to have increased in students during the pandemic were irritability and anger outbursts, and less frequently sadness/apathy and anxiety (Figure 2). Almost 2/3 students had increase in irritability and outbursts of anger, and almost every fourth parent observed a strong increase in these emotions in their child (22.4% and 24%, respectively). Considerable dependencies between gender and place of residence and an increase in the analysed physical and emotional health problems were not noted.

THE LINK BETWEEN AN INCREASE IN STUDENTS' HEALTH PROBLEMS AND CHRONIC DISEASES AND REMOTE LEARNING

After analysing an increase in particular health problems in the context of remote learning, a significant link was found in 3 out of the 5 researched areas relating to physical health and in each area of the group of emotional problems (Table 1). The increased health problems were significantly more frequent and more intense in those students who had difficulty with remote learning, compared to students who did not have difficulty with this form of learning. The biggest difference was seen in sleep problems and abdominal pain. Considerable dependencies between the occurrence of chronic diseases and an increase in the analysed physical and emotional health problems in students was not noted. However, it was observed that some of the analysed complaints, mainly increased headaches, increased irritability, and outbursts of anger, were clearly more frequent in students with chronic illnesses, although this was not a statistically significant relationship.

THE RISK ASSESSMENT OF INCREASED HEALTH SYMPTOMS AMONG STUDENTS DURING THE COVID-19 PANDEMIC IN THE CONTEXT OF PROBLEMS WITH REMOTE EDUCATION

The multivariate logistic analysis parameters showed that the difficulties with remote learning had a statistically

TABLE 1. Increase in health symptoms in students depending on the difficulties experienced with remote learning and the presence of chronic diseases in pupils (%)

Increase in heath symptoms	Difficulties with remote learning		Chronic diseases	
	Yes	No	Yes	No
Sleep problems	p^* = 0.001		p = 0.990	
Not at all	65.7	88.6	71.4	71.9
A little	25.7	10.1	21.4	20.6
Strongly	8.6	1.3	7.2	7.5
Decreased appetite	p^* = 0.001		p = 0.793	
Not at all	64.5	84.8	71.4	70.4
A little	25.4	15.2	23.8	21.9
Strongly	10.1	0.0	4.8	7.7
Increased appetite	p^* = 0.126		p = 0.881	
Not at all	71.0	70.9	65.1	69.0
A little	16.7	24.1	23.3	20.8
Strongly	12.3	5.1	11.6	10.2
Headache	p^* = 0.076		p = 0.352	
Not at all	51.4	67.1	47.6	59.1
A little	40.7	26.6	40.5	33.3
Strongly	7.9	6.3	11.9	7.6
Abdominal pain	p^* = 0.001		p = 0.465	
Not at all	52.2	78.5	54.8	62.8
A little	34.1	15.2	28.5	26.6
Strongly	13.8	6.3	16.7	10.6
Fear/anxiety	p^* = 0.007		p = 0.134	
Not at all	55.1	74.7	56.1	62.7
A little	36.0	24.1	29.3	31.6
Strongly	8.8	1.3	14.6	5.7
Sadness/apathy	p^* = 0.003		p = 0.990	
Not at all	43.5	62.0	48.8	49.2
A little	44.2	36.7	41.5	41.7
Strongly	12.3	1.3	9.8	9.0
Irritability	p^* = 0.009		p = 0.370	
Not at all	30.0	50.6	26.8	38.3
A little	46.4	35.4	46.3	40.3
Strongly	23.6	13.9	26.8	21.4
Outburst of anger	p^* = 0.008		p = 0.129	
Not at all	29.0	46.8	21.4	37.8
A little	43.5	40.5	50.0	39.8
Strongly	27.5	12.7	28.6	22.4

p – χ^2 test; the significance level $p < 0.05$ ($df = 2$)

significant impact within 8 of the 9 analysed variables describing the increased health problems in students (Table 2). Difficulties with remote learning heightened more than 4 times the risk of increased sleeping problems, OR = 4.54 (2.05-10.04), more than 3 times risk of increased abdominal pain, OR = 3.45 (1.81-6.60), and risk of the decreased appetite, OR = 3.03 (1.49-6.19). For all other symptoms (except increased appetite), the risk was twice as much, and nearly double while students had remote learning problems. Compared to boys, girls pre-

TABLE 2. The multivariate logistic regression results for risk assessment of increased health symptoms among students during a pandemic

Dependent variables	B	Standard error	Wald	*p*	OR	95% CI (OR)
Increased sleep problems						
Difficulties with remote learning: Yes*	1.513	0.405	13.956	< 0.001	4.54	2.05-10.04
Gender: Girls**	0.896	0.335	7.164	= 0.007	2.45	1.27-4.72
Decreased appetite						
Difficulties with remote learning: Yes*	1.111	0.363	9.373	= 0.002	3.03	1.49-6.19
Gender: Girls**	0.236	0.315	0.562	= 0.453	1.26	0.68-2.34
Increased appetite						
Difficulties with remote learning: Yes*	–0.009	0.312	0.001	= 0.976	0.99	0.53-1.82
Gender: Girls**	–0.086	0.302	0.080	= 0.777	0.91	0.50-1.65
Increased headaches						
Difficulties with remote learning: Yes*	0.677	0.297	5.197	= 0.023	1.96	1.10-3.52
Gender: Girls**	0.447	0.282	2.523	= 0.112	1.56	0.90-2.71
Increased abdominal pain						
Difficulties with remote learning: Yes*	1.241	0.330	14.163	< 0.001	3.45	1.81-6.60
Gender: Girls**	0.631	0.300	4.415	= 0.036	1.87	1.04-3.38
Increased fear/anxiety						
Difficulties with remote learning: Yes*	0.905	0.314	8.342	= 0.004	2.47	1.33-4.57
Gender: Girls**	0.258	0.291	0.789	= 0.374	1.29	0.73-2.28
Increased sadness/apathy						
Difficulties with remote learning: Yes*	0.744	0.290	6.571	= 0.010	2.10	1.19-3.71
Gender: Girls**	0.137	0.279	0.240	= 0.624	1.14	0.66-1.98
Increased irritability						
Difficulties with remote learning: Yes*	0.841	0.292	8.285	= 0.004	2.32	1.30-4.11
Gender: Girls**	–0.158	0.288	0.301	= 0.584	0.85	0.48-1.50
Increased outbursts of anger						
Difficulties with remote learning: Yes*	0.728	0.296	6.063	= 0.014	2.07	1.16-3.69
Gender: Girls**	–0.291	0.293	0.986	= 0.321	0.74	0.42-1.32

**Reference category: Lack of difficulties with remote learning*
*** Reference category: Boys*

sented more than twice the risk of increased sleep problems, OR = 2.45 (1.27-4.72), and nearly twice the risk of increased abdominal pain, OR = 1.87 (1.04-3.38).

DISCUSSION

In their research, the team of the Institute of Mother and Child studied a group of 8-year-old second-grade students, who, since the middle of first grade, experienced alternating between remote and hybrid learning. The time of isolation during COVID-19 was particularly difficult for the youngest pupils, who had managed to start their education just before the pandemic, and it was a stage for them to get to know the school environment. However, considering the time of the conducted study, due to the outbreak of the pandemic and the related changes in school organization (remote and hybrid learning), pupils of this age did not have the opportunity to be educated in the traditional (classroom) way for the entire school year. Parents of 8-year-olds who were asked about an increase in their children's health symptoms during the pandemic observed it in each of the areas mentioned in the question. They were asked about health symptoms – physical (sleep problems; decreased appetite; increased appetite; headache; abdominal pain) and emotional (fear/anxiety; sadness/apathy; irritability; outbursts of anger). Health is a very complex, multidimensional concept [21, 22], and a contemporary, holistic understanding of health was adopted as the starting point for the analyses, following the WHO definition [23], which refers to well-being not only in the physical aspect, but also in the mental and social and even spiritual meaning. The analyses

presented in the paper therefore took into account not only health symptoms in the physical aspect, but also the mental (emotional). Indeed, dealing with emotions such as anxiety, sadness, as well as anger and aggression are an important component of emotional health. Sleep problems analysed among physical symptoms, negatively affects the functioning of the whole body, including the endocrine and nervous systems [24, 25]. A deficit of night-time rest is also associated with an increased risk of obesity due, among other things, to hormonal changes occurring during sleep [26, 27]. Sleep deprivation can cause a decrease in blood levels of leptin, responsible for reducing appetite, and an increase in another hormone, ghrelin, which increases appetite. It is also associated with risk factors for metabolic syndrome, including abdominal obesity, high levels of lipoprotein [28], and reduced glucose tolerance and insulin resistance [24]. Sleep deprivation also negatively affects cognitive processes in students – memory problems and difficulty in concentrating may occur [29].

The increase in health symptoms among students was noted most frequently for headaches and abdominal pain. Abdominal pain is one of the common symptoms of stress in children [30]. Studies among Pakistani adolescents also point to problems associated with increased abdominal pains related to social distancing during the pandemic in a slightly older group (13-17 years) [31]. In our study every 4th parent observed an increase in sleep problems in their child. Sleep problems during the pandemic are also indicated by studies conducted in other countries [32-34]. On the other hand, in a study conducted in the Subcarpathian voivodeship in Poland before and during the pandemic, parents indicated that the quality of their children's sleep improved during the pandemic [35]. A number of parents participating in the IMC study also noted a significant increase in their child's appetite or, conversely, a noticeable decrease. The source of both problems can be found in the unusual pandemic situation and the restrictions related to it, which may also indirectly impact the level of children's appetite [36]. Sleep disturbances and changes in appetite in children during the pandemic were also indicated by the authors of a systematic review conducted in 2021 [37]. Apart from an increase in physical symptoms, parents also pointed to the occurrence of greater emotional problems in children during the pandemic. Similar observations were made by many parents across the world [6, 33]. The results of our study suggest that, during the pandemic, children's moods deteriorated. Such problems as increased sadness or apathy have also been pointed out by other European and American studies [34, 38]. Difficult emotions that accompanied children during that time led to an increase in outbursts of anger. In this study, as many as one in four parents indicated a strong increase in outbursts of anger during the pandemic. The occurrence of this phenomenon was also emphasized by Belgian researchers [39]. Another symptom, frequently indicated by the surveyed parents who observed its increase, was irritability. This is a problem affecting not only younger children during the pandemic but also youths [34, 40, 41]. In the research conducted at the Institute of Mother and Child, in basic analyses no statistically significant differences were observed between boys and girls. However, in light of in-depth analysis, the girls in our study group had a significantly higher risk than the boys of increased physical symptoms: sleep problems and abdominal pain. According to another Polish study conducted during the pandemic, girls, compared to boys, had higher levels of fear and anxiety and a higher frequency of experiencing various difficulties during this period [42, 43]. Similar conclusions were presented by the authors of a review that covered 51 articles on mental health during the pandemic, examining the occurrence of anxiety, depression, and post-traumatic stress disorder [44]. The correlation between their occurrence and gender (to the disadvantage of girls) was noted only in teenagers.

In the described study, significant differences in the increase of health problems between children who live in rural areas and those in urban areas were not noted. A relationship between an increase of emotional problems and place of residence was also not observed by Swedish researchers who studied the 4-18-year-old age group [45]. However, in a group of Chinese teenagers between 12 and 18 years of age, it was observed that, during the pandemic, residents from rural areas experienced depression and anxiety symptoms more frequently than their urban peers [46]. From the first months of the pandemic, researchers dealing with child and adolescent development emphasized that the multitude of changes related to the implementation of remote learning could pose a risk of long-term effects on the psychophysical health of students [47, 48]. Current knowledge confirms this assumption. As indicated by longitudinal studies conducted in Germany, the overall mental health and quality of life of children and adolescents deteriorated during the pandemic compared with the pre-pandemic period [33]. Furthermore, the level of problems in terms of mental health of children and adolescents, including the level of anxiety, depression, somatization disorders (e.g. headaches, abdominal pain), sleep problems, behavioural problems, and irritability, increased with each wave of the pandemic, while the opinion on the quality of life of children and adolescents decreased [33]. Our research confirmed the negative association of the pandemic with the children's quality of sleep, which is also emphasized by many researchers [32-34] who analysed the effect of lockdown and closures of schools on children's quality of sleep. Similarly to our analyses, a study by Cost *et al.* [6] conducted in Canada, showed that there was an increase in anxiety and irritability in children aged 6-9 years

during the period of remote learning. A study by Caldwell *et al.* [19] conducted in Nova Scotia showed that, according to parents of younger school children (5-11-year-olds), school closures were associated with new feelings such as boredom, loneliness, worry, stress, and anxiety. Studies conducted in France [49] concluded that changes in the mode of teaching, in children aged 8-9 years, were associated with sleep problems, problems with focusing attention, and hyperactivity (inattention and hyperactivity), and with an increase in emotional problems, including mood deterioration. A detailed look at the link between an increase in specific physical and emotional symptoms and the occurrence of difficulties with remote learning showed a significant association in 3 of the 5 physical problems and in all of the emotional symptoms. Children who had difficulties with remote learning, at the same time, were statistically more likely to experience increased sleep problems, decreased appetite, and increased abdominal pain and all analysed emotional symptoms. It should be emphasized that the link between difficulties with remote learning and the increased health problems in students was confirmed by the results of the regression analysis. Distance learning problems increased the risk of sleep problems to the greatest extent. Students who had problems with remote learning had 4 times the risk of more sleeping problems and also more than 3 times risk of increased abdominal pain and risk of the decreased appetite. For other symptoms, the risk was twice more, and nearly double while students had remote learning problems. Our study also showed that the severity of the health complaints analysed was not significantly related to the presence of the chronic disease in pupils.

Based on data from the Central Statistical Office in Poland, almost one in three children aged 5-9 years (30%) had a chronic disease diagnosed by a doctor, mainly an allergy, less commonly bronchial asthma and eye disease, and this was the highest percentage considering the population of children under the age of 14 years [50]. In our surveyed group, a lower percentage of pupils with a chronic disease was found; according to information from parents, this problem affected only one in eight pupils.

The problems presented in this study could be an essential benchmark for further in-depth analyses of this area, also taking into account the socioeconomic factors of the family. Many authors indicate that the situation of children and parents faced with the need to meet new challenges during the COVID-19 pandemic, including the organisation of remote learning, was associated with factors such as place of residence of the family, employment status, and the education and income of the parents [51]. The closure of schools creates a risk of deepening educational and economical inequalities [48]. The data discussed in this publication come from 2 voivodeships participating in a pilot study. Conducting a similar analysis on the basis of nationwide data should be considered. Children's psychophysical problems were described based on the assessment of parents; therefore, it is a parental perception of the child's state of health and behaviours rather than their direct measure. It constitutes a limitation for both the interpretation of results and the direction for future study. Furthermore, studies show that the level of increase in problems pertaining children's mental health depends on the family context, e.g. the emotional atmosphere in the family [33]. Such variables were not controlled in this study.

At the time of the COVID-19 pandemic, during the closure of schools, the family environment was often the only space in which students functioned, so in this context parents were the closest and main observers of the child. The aim of the research presented was to determine whether parents perceived a change in their children's health symptoms, precisely in the context of the change in lifestyle caused by the implementation of remote and hybrid schooling. The pandemic and the restrictions introduced at the time, including the periodic closure of schools, resulted in pupils being limited in their access to important healthcare services, including preventive healthcare for school-age children and adolescents, which resulted in an exacerbation of the problems already signalled before the pandemic in this area, especially before the entry into force of the Pupil Health Care Act (Journal of Laws 2019, item 1078) [52-54].

Reports indicate that during the pandemic, the percentage of pupils diagnosed with health problems and having positive results in screening tests, who received active health care by the school nurse, decreased [55]. In the 2019/2020 school year, when the pandemic began, 16% of pupils received this form of care and 11% of pupils during the next school year later.

Among the youngest pupils who are required to undergo screening tests (grade III of primary school), similar in age to the group of 8-year-olds we surveyed, in the 2020/2021 school year the percentage was the highest considering all age groups, although lower than the year before (93% and 97.7%, respectively) [56]. On the other hand, it is worrying that only 39.6% of third-grade pupils had a preventive medical examination, confirmed by handing over a medical examination card completed by the doctor to the school nurse.

However, taking into account the psychological (emotional) condition of pupils, the audit of schools conducted by the Supreme Audit Office shows that in the 2020/2021 school year, despite the difficult organizational situation resulting from the pandemic, the inspected schools tried to provide assistance to pupils in need of psychological and educational support. Schools provided such assistance, e.g. by individual consultations with the school pedagogue for pupils and parents and by referring and assisting in obtaining support from institutions supporting the work of the school (e.g. psychological and pedagogical counselling centres, social welfare

centres), as well as by supporting hospitalized pupils and pupils with disabilities [57]. At the same time, the need to advance the implementation of systemic solutions for psychological and pedagogical assistance for pupils was emphasised, based also on the results of a report prepared in 2021 by the Institute of Integrated Prevention (Instytut Profilaktyki Zintegrowanej), which pointed to the deterioration of the mental condition of pupils in the successive phases of the epidemic and the need to intensify activities aimed at improving the psychophysical condition of the youngest generation [58].

CONCLUSIONS

In light of the discussed research conducted during the COVID-19 pandemic in Poland, remote learning difficulties are a significant factor that increased the risk of intensified health complaints (both physical and emotional symptoms) in the youngest students during this period. It is noteworthy, however, that the risk of aggravation of the studied health symptoms in students in the context of difficulties with remote learning was more related to physical ailments than emotional ones. Distance learning problems primarily increased the risk of sleep problems and the risk of increased gastrointestinal (digestive) health symptoms – abdominal pain and decreased appetite in children. Students experiencing distance learning difficulties, as well as their parents, are important beneficiaries/recipients of targeted prevention and intervention programs/actions. In this context, psychological and organizational support during remote learning are also important for reducing the risk of health complaints in students. During remote learning, in addition to technical/organizational facilities, the provision of support to parents in the form of health education on how to deal with children's health symptoms will be helpful in minimizing the adverse health effects associated with the difficulties experienced by students with this form of learning. It is also important to provide effective post-pandemic systemic solutions for the medical care of pupils in Poland, including pupils with identified health problems, as well as the performance of overdue medical examinations and screening tests to detect possible developmental abnormalities and to provide psychological support for students.

DISCLOSURE

The authors report no conflict of interest.

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AUTHORS' CONTRIBUTIONS

ZI, AK, JM prepared research concept and design of the publication. All authors took part in data collection. AK, JM analysed and interpreted data. ZI and JM prepared the first draft of the article. AK, SM, MB i JM critically revised it. All authors approved the final text of the publication.