SARS-CoV-2 Epidemiology and Well-Being of Children and Workers in French-Speaking Primary Schools during and after the COVID-19 pandemic in Belgium

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"*Logic will get you from A to B, imagination will take you everywhere*" – Albert Einstein

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Summary

COVID-19 worldwide has had and still has numerous consequences for the population. Limiting the spread of the SARS-CoV-2 virus was a priority from the outset of the pandemic, and preventive measures such as social distancing, lockdown, quarantine of positive cases and contact cases, face masks, and many others were put in place. Children are one of the vulnerable groups regarding these measures. The major concern during the pandemic was whether or not to leave schools open. The different objectives of our thesis were to document the SARS-CoV-2 transmission within primary schools and to document the well-being during and after the pandemic crisis.

We collected transmission data in French-speaking primary schools in Belgium during the COVID-19 pandemic crisis. We also collected well-being data during and after the COVID-19 pandemic crisis. Analysis were conducted after data collection due to organizational factors.

Findings showed that children were not the most important transmitters during the SARS-CoV-2 pandemic crisis. Nevertheless, anxiety prevalence in children was high during and after the COVID-19 pandemic crisis. As social desirability prevalence was also high during and after the COVID-19 pandemic crisis, anxiety prevalence was underestimated in our results.

Children in primary schools are frail. Keeping schools open as long as possible is a major consideration to preserve children as much as possible for future pandemics. The COVID-19 pandemic and its consequences have influenced children's well-being. Prevention of the deterioration in well-being should be reinforced in order to limit the risk of mental illness in the future. Mental health education should be implemented for children to prevent complications in adult life.

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List of abbreviations

Adj OR:	Adjusted Odds ratio
ANOVA:	Analysis of Variance
CI:	Confidential Interval
COVID-19 :	Coronavirus disease
CPAS :	Centre Public d'Action Sociale
CPMS:	Centre Psycho-Médico-Social
CT:	Threshold Cycle
DSM-IV:	Diagnostic and Statistical Manual of Mental Disorders
DYNAtracs:	DYNAmic of TRAnsmission of Coronavirus in Schools
E.G :	Exempli Gratia
FWB:	Fédération Wallonie-Bruxelles
HAD :	Hospital Anxiety and Depression scale
ICC:	Intraclass correlation coefficient
IgG, IgM :	Immunoglobulin of type G or M
INAMI:	Institut National d'Assurance Maladie-Invalidité
NASEM:	National Academies of Sciences, Engineering, and Medicine
ONE :	Office de la naissance et de l'enfance
OR:	Odds Ratio
PCR:	Polymerase Chain Reaction
PSE :	Service de Promotion de la Santé à l'École
RCMAS :	Revised Children's Manifest Anxiety Scale
RDT:	Rapid Detection Test
RDTs:	Rapid Diagnostic Tests
RNA:	Ribonucleic Acid
SARS:	Severe Acute Respiratory Syndrome

SARS-CoV-2 :	Severe Acute Respiratory Syndrome Coronavirus 2
SD:	Standard Deviation
SES :	Socioeconomic Status
SHPD	School Health Promotion Department
SPF	Service Public Fédéral (belge)
SSR :	Stastistical Sector of Residence
TAG :	Technical Advisory Group
VAS:	Visual Analogic Scale
WHO:	World Health Organization

Chapter 1: Introduction

1. Preamble

In December 2019, the first case of a new coronavirus disease (COVID-19) caused by the novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) was detected in Wuhan, China. The virus rapidly spread worldwide, leading to a global pandemic and prompting countries to implement preventive measures to curb its transmission [1].

In Belgium, the first confirmed case of COVID-19 was reported on February 3rd, 2020, followed by a second case on March 11th, 2020. The virus spread rapidly, with the number of confirmed cases rising rapidly across the country [2].

Controlling the pandemic was particularly challenging as transmission could occur even before symptoms appeared, or in the absence of symptoms altogether. In addition to the general population, vulnerable groups, including children, were particularly concerned by certain preventive measures. A major debate revolved around whether schools should remain open, as school closures disrupted the scholarship of about 1.57 billion students worldwide (91%) [3]. However, evidence regarding the role of young children in schools in the spread of SARS-CoV-2 was limited [4]. Early studies suggested that children were not major vectors of SARS-CoV-2 transmission, with very few confirmed cases of COVID-19 among children. An early study in Iceland showed that the incidence of SARS-CoV-2 infection was lower in children under the age of 10 [5]. Preliminary results from primary schools in France indicated that transmission was mainly from home. Infection was most commonly mild or asymptomatic in younger children [6]. The severity of symptoms appeared to play an important role in the degree of infectivity, and asymptomatic individuals seemed to be less involved in the transmission of SARS-CoV-2 [7]. As most children were asymptomatic, their contribution to transmission in society might be low [8].

Countries that kept primary schools open but implemented strict protective measures reported limited transmission in school settings [9–11]. However, prolonged school closures and other restrictive measures had profound effects on children's well-being, exacerbating existing inequalities and increasing risks of mental health issues, scholarship setbacks, and domestic violence [12–15]. A study in the United States investigated the impact of previous pandemics on children, indicated that nearly a third of children experienced post-traumatic stress disorder symptoms [16]. Past school closures revealed that pupils who missed a long period of school were more unlikely to return once schools had reopened [3]. Most recently, other studies suggested that school closures and reactional activities affected the physical, mental, and social well-being of children, as well as their schooling, particularly for those from disadvantaged backgrounds [12–14]. In addition, the interruption of social contact and other preventive measures had catastrophic consequences for children's well-being, including domestic violence [15]. The pandemic has also led to economic instability, and children's well-being also appeared to deteriorate as the economy declined [17].

Preliminary results from China showed an increase in levels of anxiety and depression in children and adolescents during the COVID-19 pandemic crisis [18].

A systematic review of the impact of social isolation on children's mental health during COVID-19 found a direct link between isolation and mental health issues, with consequences that could persist up to nine years [19].

Given these concerns, this study aimed to document the transmission dynamics of SARS-CoV-2 in French-speaking primary schools in Belgium, focusing on children aged 6 to 12 years and school workers. Additionally, we examined the well-being of children and school workers during and after the COVID-19 pandemic crisis.

2. Overview of COVID-19

Coronaviruses belong to a virus family that infects both animals and humans. These viruses can cause a range of complications in humans, from the common cold to

severe acute respiratory syndrome (SARS). COVID-19 is caused by the latest virus in this family, known as SARS-CoV-2 [1]. SARS-CoV-2 is a respiratory ribonucleic acid (RNA) virus with a high potential. It has a genetic length of 30,000 bases, making it one of the longest viruses and enabling many mutations.

2.1 Transmission

SARS-CoV-2 is primarily spread through close contact and respiratory droplets. Infected individuals release small liquid particles from their mouth or nose when they talk, breathe, cough, or sneeze. These particles can vary in size from large respiratory droplets to smaller aerosols. Most people infected with the virus experience mild to moderate respiratory disease and recover without special treatment (about 85%). However, around 15% of individuals become severely sick and require medical attention. Older adults and individuals with underlying medical conditions such as cardiovascular disease, chronic respiratory disease, diabetes, immunodeficiency conditions, or cancer are at higher risk of developing a severe disease [1].

Transmission of the virus can occur before the onset of symptoms, which makes controlling the pandemic particularly challenging. Since transmission occurs through close contact, limiting social interactions became a central focus of preventive measures to curb the spread of the virus.

At the pandemic onset, knowledge of the virus was limited. As the situation evolved, preserving public health became paramount, leading to several preventive actions. Among the challenges were the increasing number of positive cases, which overwhelmed hospitals and required prioritizing patients for intensive care. To manage this overload and ensure that as many patients as possible could receive care, several measures were introduced.

One such measure was to quarantine individuals who tested positive for the virus. The serial interval, or the time between the infection of a person and the onset of symptoms in those infected, was used to model transmission patterns. Initially,

positive distributions were considered, but none fit the data well. Zhanwei Du proposed using a truncated normal distribution to model these intervals. A negative value implies that an infected patient could show symptoms before the infectors (Figure 1).

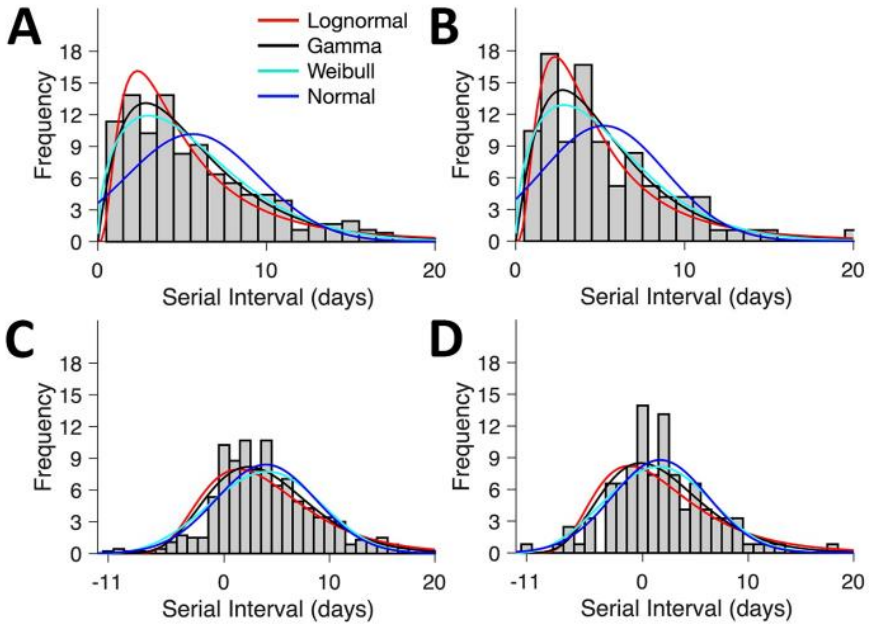

Figure 1: Serial interval representations
Source: Du Z, et al. US Centers for disease control and prevention (CDC), 2020 [20]
https://wwwnc.cdc.gov/eid/article/26/6/20-0357_article

The study estimated the distribution based on 468 confirmed cases of COVID-19 reported in China by February 8th, 2020.

The mean serial interval was 3.96 days (95% CI [3.53-4.39]), with a standard deviation (SD) of 4.75 days (95% CI [4.46-5.07]). It was found that 13% of the cases involved presymptomatic transmission [20]. This data helped estimate quarantine periods, as summarized in Table 1:

Area to the right of the x-value on a Normal distribution

= Prob (X > x | X~Gauss(μ=3.96 σ=4.39))

	x	Pr (X > x)		
Negative	0.00	0.81648	18.4% of individuals may show symptoms before the infecting person	
Mean μ	3.96	0.50000		
μ + 1 σ	8.35	0.15866	16% of individuals still transmit after 8 days from symptoms onset	-> Quarantine period of 8 days in some countries
μ + 2 σ	12.74	0.02275	2.3% of individuals still transmit after 13 days	-> Quarantine period of 14 days in some countries
μ + 3 σ	17.13	0.00135	1/1000 individuals may still transmit after 17 days	

Table 1: Estimated quarantine period

2.2 Symptoms

People infected with COVID-19 can experience different symptoms. These typically appeared 5-6 days after infection, although they could take up to 14 days to develop. The most common symptoms included fever, cough, fatigue, and loss of taste or smell. Less frequent symptoms included pain, sore throat, body aches, headache, diarrhea, red or irritated eyes, or discoloration of fingers or toes. Serious symptoms requiring medical attention included difficulty breathing, chest pain, loss of speech or mobility, and confusion [1].

As many diseases present with similar symptoms, diagnostic tests were necessary for confirmation.

Individuals with mild symptoms were advised to stay home. Early on, not everyone in Belgium with symptoms was tested; only individuals with severe symptoms (such

as difficulty breathing or fever a ≥ 38°C) were tested, leading to an underestimation of the actual number of COVID-19 cases.

2.3 Testing

Testing strategies evolved throughout the pandemic.

The most accurate test for diagnosing SARS-CoV-2 infection was the molecular test called the polymerase chain reaction (PCR), which amplifies viral material in a sample to a detectable level. These tests must be analyzed in laboratories.

Faster, more accessible testing options were also introduced. Rapid detection tests (RDTs) for antigens, which detect viral proteins (antigens), were developed to be used by professionals or by individuals themselves. These were simpler and quicker than PCR tests [1].

C_t threshold

Real-time PCR (qPCR) quantifies the viral load by measuring the cycle threshold (C_t) — the point at which amplification of viral RNA becomes detectable [21]. The lower the C_t value, the higher the viral load, indicating that less amplification is needed to detect the virus. Individuals with lower C_t values are more likely to transmit the virus. The viral load typically decreases over time, as shown in Figure 2.

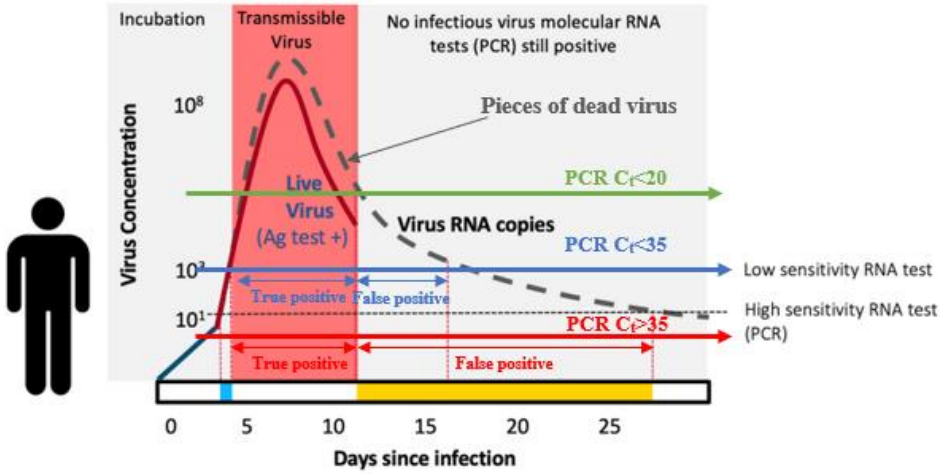

Figure 2 : SARS-CoV-2 virus concentration according to days since the infection
Source: Time, 2020 [22] https://time.com/5912705/covid-19-stop-spread-christmas/

2.4 Protective measures

To reduce transmission, a range of protective measures were implemented. These measures varied by region and the viral spread at any given time, but generally included maintaining a physical distance of 1.5 meters from others, wearing properly fitted face masks, washing hands regularly with soap and water or using a hydroalcoholic solution, and covering the mouth and nose when coughing or sneezing [1].

A particularly debated measure was the requirement for children under 12 to wear the facial masks, in addition to the closure of schools.

Other preventive measures, such as limits on social activities, restrictions on public gatherings, and travel restrictions, varied depending on the pandemic's status.

2.5 Rules implemented in schools during the study period in the year 2021

Different measures were taken globally during the COVID-19 pandemic. The Belgian Concertation Committee outlined protective measures for primary schools on January 25th, 2021 (Figure 3). If a child tested positive, parents were required to

inform the school, and the child had to isolate. If two children, or one child and a teacher in the same classroom, tested positive, the entire class was closed, and all individuals were asked to stay home for quarantine [23,24].

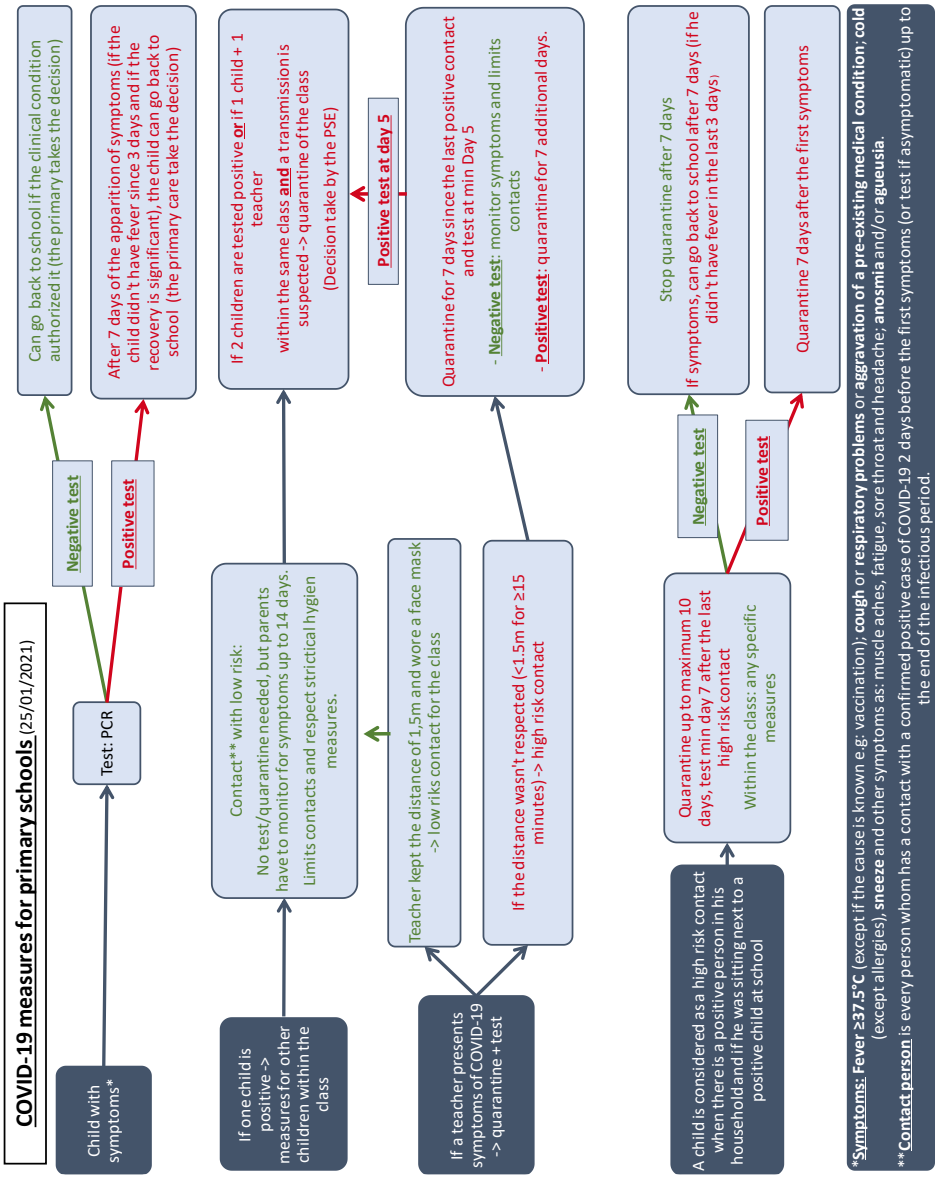

Figure 3: Management strategy in case of infection with COVID-19 in a Belgian primary school, on January 25, 2021
Adapted from: Sciensano [23] https://covid-19.sciensano.be/fr/procedures/archives
Sciensano, 2020 [24]
https://covid-19.sciensano.be/sites/default/files/Covid19/ARCHIVE_COVID-19_procedure_children_FR.pdf

3. Well-being

While the COVID-19 pandemic significantly impacted various aspects of daily life, it was crucial to consider the broader factors influencing the well-being of individuals, particularly in the context of the changes it brought to school environments and daily routine.

The WHO (World Health Organization) defines health as :

> "*Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity*" [25]. Also a "… *a state of well-being in which the individual realizes his or her own abilities, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to his or her community*" [26].

Well-being can be analyzed in several forms: physical, mental, and social.

Mental health does not correspond to the absence of mental disabilities or disorders [27]. Mental health is defined as:

> "*Mental health is an integral part of our general health and well-being and a basic human right* […] *Mental health exists on a complex continuum, with experiences ranging from an optimal state of well-being to debilitating states of great suffering and emotional pain*" [28].

Well-being is not a permanent state; it evolves for everyone, so it is important to monitor well-being. According to the Human Rights, Article 25:

> "*Everyone has the right to a standard of living adequate for the health and well-being of himself and his family, including food, clothing, housing and medical care and necessary social services, and the right*

> *to security in the event of unemployment, sickness, disability, widowhood, old age or other lack of livelihood in circumstances beyond his control*" [29].

Each person has a distinct vulnerability and will react differently to the stressors encountered. The relationship between this vulnerability and the stressors can lead to a deterioration in well-being (Figure 4). Furthermore, both vulnerability and stress factors evolve over time.

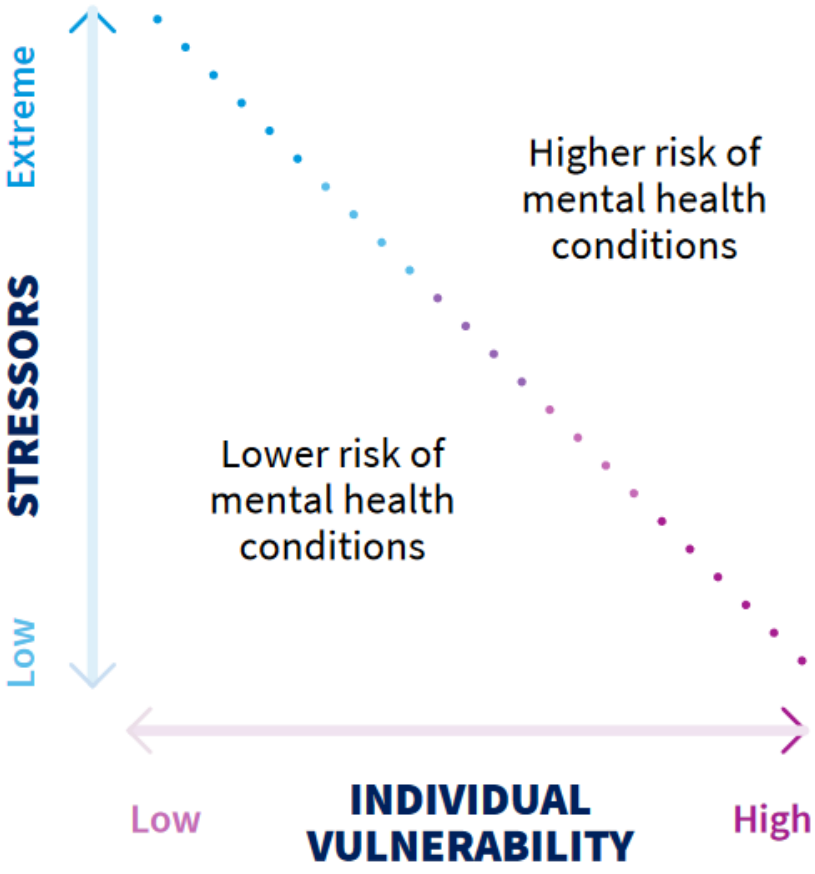

Figure 4: Relationship between individual vulnerability and stress factors that can lead to mental health conditions
Source: World Health Organization, 2022 [28]
https://www.who.int/publications/i/item/9789240049338

3.1 Determinants of well-being

The determinants of well-being are (1) individual psychological and biological factors, (2) family and community-based factors, and (3) structural factors (Figure 5).

(1) Individual psychological factors are related to the inherent and acquired abilities and habits of an individual to cope with their emotions by participating in responsibilities, relationships, and activities.
(2) Family and community represent the direct environment of an individual, considering his or her ability to interact with others, but also the socioeconomic component.
(3) Structural factors are related to the socio-cultural, geopolitical, and environmental factors, such as inequalities, social stability, infrastructure, and quality of the environment. Access to basic products and services (health, housing, water, food) is important for well-being [28].
Variations in these determinants lead to an improvement or a deterioration in well-being. The interrelationships between these determinants are important to understanding and maintaining well-being. This balance or imbalance evolves over time at each stage of life, which makes its management complex and unique to each individual

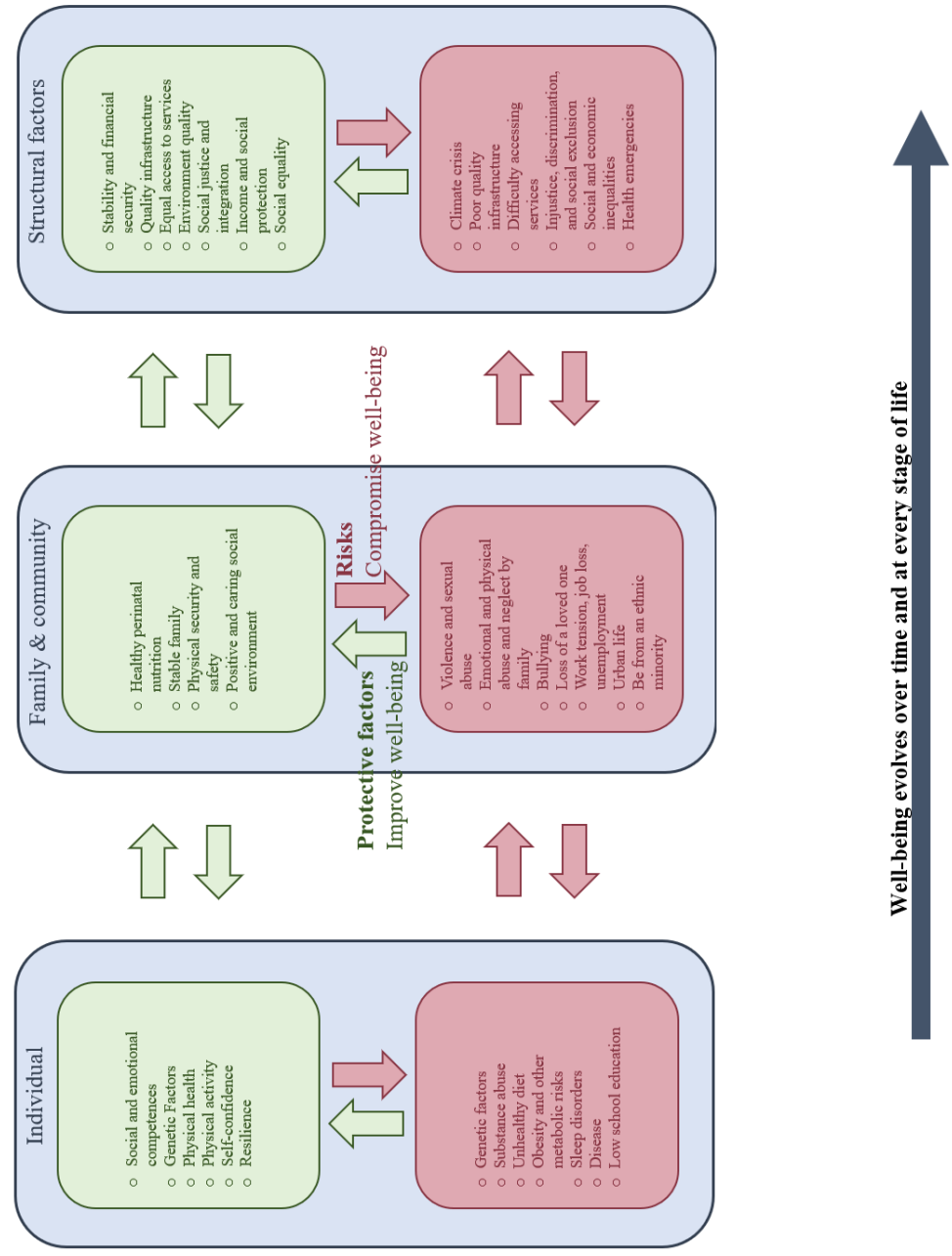

Figure 5: Well-being determinants and their relationships
Adapted from: World Health Organization, 2022 [28]
https://www.who.int/publications/i/item/9789240049338
World Health Organization, 2012 [30]
https://iris.who.int/bitstream/handle/10665/112828/9789241506809_eng.pdf
Arago, et al. 2021 [31] https://onlinelibrary.wiley.com/doi/abs/10.1002/wps.20894

3.2 Anxiety

The higher the anxiety, the lower the chances of experiencing well-being. Anxiety can interfere with quality of life, social relationships, and cognitive function, affecting overall satisfaction and inner calm.

The Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) describes anxiety as an emotional response characterized by worry, unease, or tension about a situation perceived as threatening. This response can be accompanied by physical symptoms such as restlessness, palpitations, hyperventilation, or muscle tension.
For children, anxiety manifests differently, often through behavioral signs rather than verbal expression. Symptoms include excessive worry, reluctance to engage in social activities, dependency behaviors, and physical complaints like stomach aches or sleep disturbances [32].
The environment plays a crucial role in regulating anxiety levels, and disruptions caused by preventive measures during the health crisis may have affected children's and school staff's well-being. Additionally, changes in routine, reduced social interactions, and uncertainty about the future may have boosted anxiety levels.

3.3 Depression

Depression impacts well-being in adults, but is rarer in children.
The WHO defined depression as:

> *"Depressive disorder, or depression, is a common mental health condition that can happen to anyone. It is characterized by a low mood or loss of pleasure or interest in activities for long periods of time"* [33].

The DSM-IV further describes it as a persistent loss of interest in nearly all activities, accompanied by changes in sleep, appetite, and cognitive function [32].

This study examines both the transmission dynamics of SARS-CoV-2 in primary schools and the broader consequences of the pandemic on children's and school staff's well-being, emphasizing the long-term repercussions of the crisis.

4. Conceptual framework

Figure 6 illustrates the conceptual framework that guides this thesis. Inspired by a socio-ecological perspective, the model emphasizes the multiple levels of influence on children's health and well-being during and after the COVID-19 pandemic. These levels include individual (e.g., age, activities, long COVID), family (e.g., precarity, environment, emotional support), school (e.g., school-based health services, socio-economic status), health system, and health policy.

Elements addressed in the thesis are reported in Figure 6 and the corresponding chapter. Aspects that are not explored in detail are explicitly mentioned. This framework helps delineate the scope of the thesis and clarify its boundaries.

Given the importance of understanding both the transmission dynamics and well-being impacts of COVID-19 in school settings, the following chapter outlines the specific aims and objectives of this thesis.

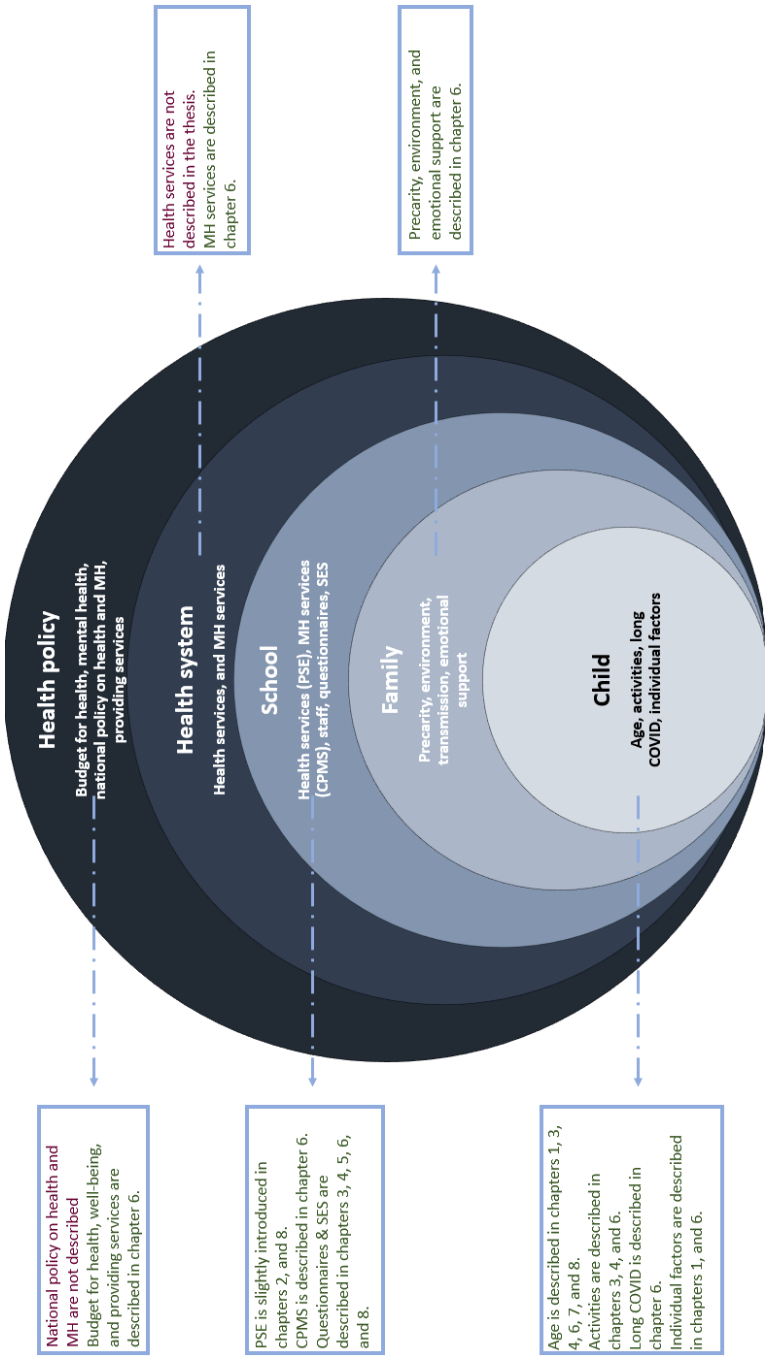

Figure 6: Conceptual framework
Text color legend: green indicates elements discussed in the thesis and references the relevant chapters; red indicates elements not covered

Chapter 2: Aim of the thesis

In the preceding theoretical background, the general objective was to document the transmission dynamics of SARS-CoV-2 in primary schools of the Fédération Wallonie-Bruxelles (FWB) during the pandemic in the year 2021.

To achieve this overall goal, several specific objectives were identified to document the transmission of the SARS-CoV-2 virus. These included evaluating the seroprevalence of SARS-CoV-2 among children and comparing it with local incidence rates. The seroprevalence of the participants is described in Chapter 4, Section 2.

Another key focus was to explore the transmission of the virus from infected children to other children within the same school. Additionally, the study aimed to examine the transmission of the virus from infected children to adults and teachers, and vice versa. The objective was then to determine whether the occurrence of cases was associated with an increase in the number of cases in subsequent weeks. The transmission dynamics are documented in Chapter 4, Section 3.

Finally, the last specific objective—and the major orientation of this thesis—was to document the well-being of children and staff during and after the COVID-19 crisis. Well-being during the pandemic crisis in 2021 is discussed in Chapter 4, Section 4, while well-being after the pandemic crisis is described in Chapter 4, Section 5.

Chapter 3: Methods

1. Study design

The study named DYNAtracs (DYNAmic TRAnsmission of Coronovirus in Schools) to document the SARS-CoV-2 transmission in primary schools of FWB was conducted from January 14 to May 18, 2021; it was completed before the start of the vaccination campaign for the general population (≤65 years in June 2021).

We used a purposive sampling of schools for the study, according to three criteria: (1) either a school with a low or a high local incidence level, (2) either a small or a large size of the school, and (3) a school with a low or a high socioeconomic status (SES).

In 2023, the study, which documented the well-being in primary schools after the COVID-19 pandemic, was conducted from March 14 to April 13. According to their agreement, we returned to the same selected schools.

The calendar of the study according to the world and Belgium timeline is represented in Figure 7 below.

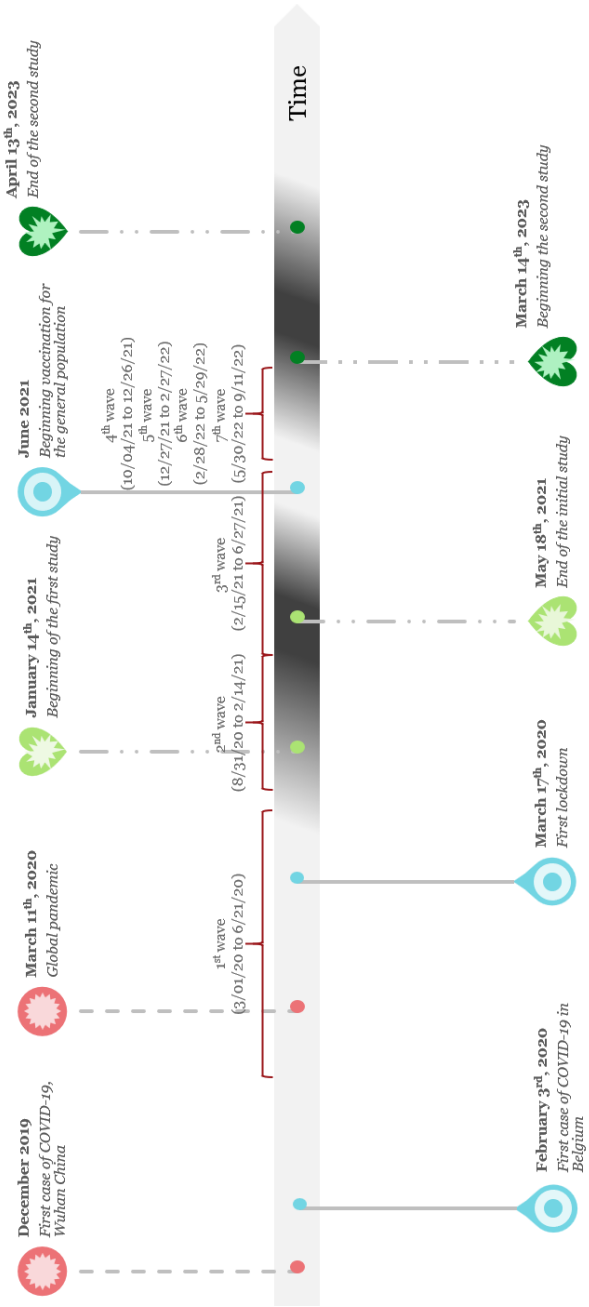

Figure 7: Timeline of the studies according to important dates in the management of COVID-19 pandemic crisis
Source: Sciensano, 2023 [34]
https://www.sciensano.be/sites/default/files/epidemiologie_de_la_mortalite_covid-19_en_belgique_de_la_vague_1_a_7.pdf

2. Eligible criteria

Schools were selected according to 3 criteria (Table 2).

(1) The first criterion was either a low or a high local incidence of SARS-CoV-2. A city was considered to be in a low local incidence area of SARS-CoV-2 if the incidence was between 1.5 and 4.9 per 1,000 persons, and it was considered high if the incidence was between 5.0 and 7.5 per 1,000 persons. The local incidence was based on the cumulative incidence of SARS-CoV-2 communicated by the Belgian public health institute, named Sciensano, during the first wave in Belgium, May 6th, 2020, and the total number of people living in the locality [35,36]. The median of data was used as a cut-off to define a low or a high incidence of SARS-CoV-2.

(2) The second criterion was a small or a large size of the school, which can reflect the number of social contacts. The number of children in a primary school of FWB varies from 12 to 600 children [37]. The cut-off in the definition of a small or a large school was based on the maximum total number of children in primary schools in Belgium. A school was considered small when the total number of children was under 230 (first tertile), and large when the number of children was equal to or above 230.

(3) The third criterion was the socioeconomic (SES) of the school, which corresponds to the background of the children. In Belgium, each school is classified on a 20-point scale index called SES, where 1 corresponds to the lowest SES school, and 20 to the highest SES school. The SES of a school is calculated by the FWB and is used as a tool for manpower or financial support to the school. By law, each school has to report yearly to the FWB aggregate data over 7 years on 7 variables for all schoolchildren. The 7 variables are the household income, the number of persons with a superior education degree, the number of persons with a nursery or primary degree, the number of persons with a job, the number of persons with social

assistance, the number of persons with a manual job and the number of persons with a job in the lowest level of the tertiary sector.

Then, for these 7 aggregated variables, a mean (A) and a standard deviation (B) are calculated across schools in a so-called statistical sector residence (SSR). For each school within a SSR, the 7 variables are standardized (Z=(x-A)/B), and a principal component analysis is performed on their correlation matrix to extract loadings for each of the 7 variables to calculate the first principal component, namely the SES [38]:

$$SES_i = \sum_{j=1}^{7} C_j \frac{(x_{ij} - A_j)}{B_j}$$

$i = school\ implantation\ (a\ SSR)$;
$j = variable\ number$;
$C_j = loading\ of\ the\ first\ prinicipal\ component,$
$which\ allows\ to\ weight\ the\ contribution\ of\ variable\ number\ j$;
$A_j = mean\ of\ variable\ across\ schools\ within\ a\ SSR$;
$B_j = standard\ deviation\ of\ the\ variable\ accross\ schools\ within\ a\ SSR$

The SES is an official implementation attached to the school, available from the FWB.

In our study, this SES was used to select schools. A school with an SES less than or equal to 7 (the first tertile) was identified as a low SES school, and a school with a SES equal to or greater than 13 (the upper tertile) was identified as a high SES school.

Based on these three criteria, each level was used to define eight strata for the sampling of schools within each stratum.

(I) SARS-CoV-2 cumulative incidence ≥5.0 : High <5.0 : Low (per 1 000 persons)	(S) Size of the School ≥230 : Large <230 : Small	(SES) Socioeconomic status ≥13 : High ≤7 : Low	School location	Designation I|S|SES H=High L=Low
High	Large	High	Angleur	H|H|H
		Low	Berchem	H|H|L
		Low	Jette	H|H|L
		Low	Koekelberg	H|H|L
	Small	High	Herve	H|L|H
		Low	Seraing	H|L|L
Low	Large	High	Beauraing	L|H|H
		Low	Châtelineau 2	L|H|L
	Small	High	La Hulpe	L|L|H
		Low	Châtelineau 1	L|L|L
		Low	Farciennes	L|L|L

Table 2: Schools selected according to the inclusion criteria

3. Study planning

In each stratum, schools were selected with the help of medical doctors and nurses of the Office de la naissance et de l'enfance (ONE) and Service de Promotion de la Santé à l'École (PSE), two organizations responsible for health in schools. They provided a list of schools fulfilling each of the selection criteria. Principals of each school were contacted to obtain their agreement to participate in the study (Figure 8).

At the same time, we designed flyers to inform schools and parents about the SARS-CoV-2 pandemic, its transmission, and the study we want to conduct with their help. At the same time, principals, teachers, and parents were invited to take part in a videoconference organized by the medical doctors of the DYNAtracs team, where the study was explained in detail and where they could ask any questions they might have.

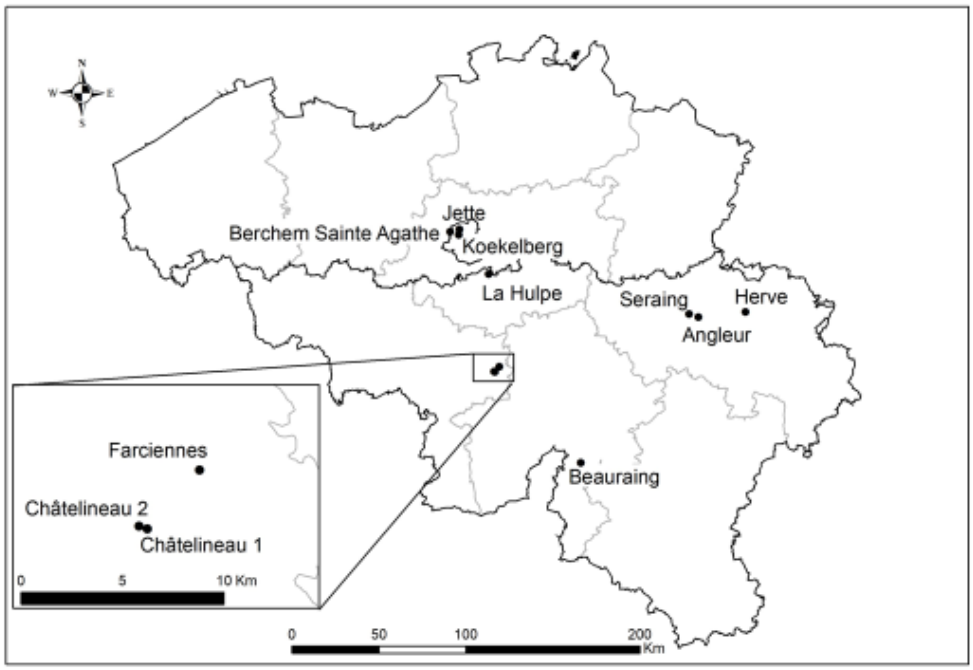

Figure 8: Geographic distribution of schools in Belgium

Besides creating the informative documents, we hired working students to make the study possible.

We agreed on a date with the principal of each school to deliver the consent forms and information flyers, divided according to the number of children per class and the number of staff working in the school. The flyers were translated into four languages in addition to French: Arabic, Italian, Romanian, and Turkish. 159 class boxes for children and 13 boxes for the staff were delivered to the schools, with a total of 2932 consent forms distributed.

A website (Figure 9) was also created (https://www.sesa.ucl.ac.be/Dynatracs/) with all the informative documents. Three pediatric physicians, involved in the training and supervision of the schools, have produced videos explaining the procedure for the various tests we performed, such as how to collect saliva samples for PCR. On the website, there was also a tab where the parents and/or the staff could log in to

complete the inclusion and follow-up questionnaires. We also created two email addresses in case parents or staff members had any questions.

Figure 9: Website home page for the study DYNAtracs

Each participant was included in the study if the informed consent was signed by both parents and the child or by the staff member. The participant had the right to withdraw throughout the study for any reason, even if he or she had given their consent beforehand.

These signed consents were then collected by the principal of each school within the next week. Anonymized individual codes were created based on the lists provided by each principal.

In order to address the question of transmission, we planned to visit each school 6 times, once a week for 6 consecutive weeks, if possible.

Only at the inclusion visit, each participant was tested with a rapid detection test (RDT) by finger-prick (AVIOQ®) to determine the seroprevalence for the virus SARS-CoV-2 under the supervision of the medical investigators.

At each visit, each participant was tested with a salivary sampling test by Polymerase Chain Reaction (PCR) for SARS-CoV-2 under the supervision of the investigators.

At the end of the visit, each participant was invited to fill in an individual-specific questionnaire based on the profile of the participant, with the help of the team. Teachers and the director of the school received a specific supplementary questionnaire.

The study schedule for the six visits per school (Figure 10) was based on the calendar of each school, the location of the school, government measures to limit transmission of the virus, and protective measures in place at the time of the study (Figure 3).

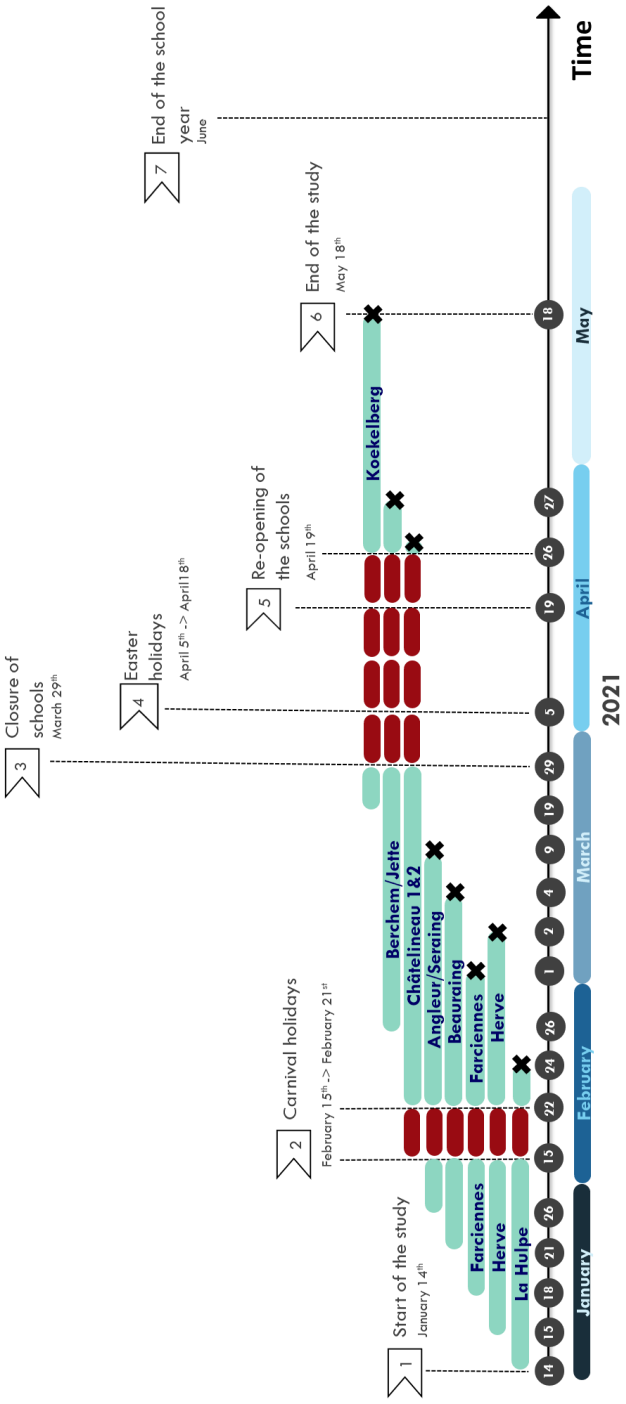

Figure 10: Study schedule by school

We contacted a bus company (Figure 11) to reach the schools, brought all the necessary materials, and transported the students to each planned visit.

Figure 11: Picture of the bus

3.1 Manpower to conduct the study

We contacted the dean of each faculty at the university to call for students who were willing to work. We recruited 155 working students. An official work contract from UCLouvain with a clear salary was signed with each of them. We trained them to perform rapid detection tests, collect saliva samples in tubes for saliva sampling for PCR testing, and fill in questionnaires.

Boxes containing the rapid detection tests, PCR tubes, and questionnaires were prepared and anonymously identified for each participant. In addition, each child received a booklet at the inclusion visit.

For each visit, the bus, with all the investigators, working students, and equipment, left the Faculty of Public Health at 7 am and returned at around 5 pm. Around 15 to 30 working students were planned, depending on the school and the number of participants. Before each visit, and for each school, each working student was allocated a job based on their preferences, but also on their studies. For example, we chose medical students to carry out the rapid detection test for the presence/absence of antibodies of SARS-CoV-2.

3.2 Back to school in 2023

After the COVID-19 pandemic crisis, we went back to each previously selected school to document the well-being of children. The children invited to participate in 2023 were not automatically the same children as in 2021 because we worked with classes (see Table 3). As a consequence, a child in grade 1 in 2021 is expected to be in grade 3 in 2023, but this will not be the case if the child has moved to another school or failed a grade.

		2023					
		1	2	3	4	5	6
2021	1			■			
	2				■		
	3					■	
	4						■
	5						
	6						

Table 3: Distribution of children in 2021 and 2023
In grey, the child's class in 2023 according to the child's class in 2021

We contacted the principal of each school to obtain their agreement to participate.

If we obtained their agreement to participate, we agreed on a date to deliver the consent forms and information flyers, divided according to the number of children per class and the number of staff. The flyers were translated into six languages in addition to French: Arabic, Italian, Romanian, Spanish, Turkish, and Ukrainian. 108 class boxes for children and 9 boxes for the staff were delivered to the schools, with a total of 2593 consent forms distributed.

The website was then updated (https://www.sesa.ucl.ac.be/Dynatracs/) with all the informative documents.

Each participant was included in the study if the informed consent was signed by both parents and the child or by the staff member.

These signed consents were then collected by the principal of each school within the following week. Anonymized individual codes were created based on the lists provided by each principal.

We planned a first visit to deliver consent forms and a second visit for the survey itself.

The final study schedule (Figure 12) was based on the calendar of each school and the location of the school.

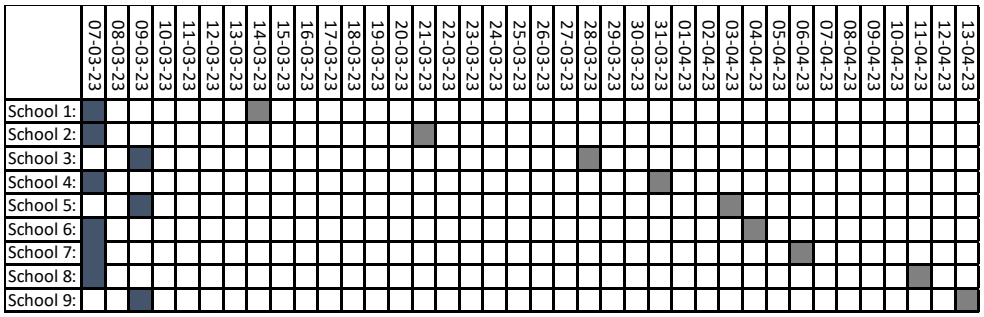

Figure 12: Schedule by school in 2023
First dark box: delivery of consent forms; Second dark box: visit to the school for the study

We contacted a bus company to reach the schools, brought all the necessary materials, and transported the students to the school for the survey itself.

We contacted the students who had previously taken part in our study, as well as the specific recruitment services of the UCLouvain, to recruit working students and were willing to work. We hired approximately 60 working students.

Boxes containing the questionnaires were prepared and anonymously identified for each participant.

For each visit, the bus, with all the investigators, working students, and equipment, left the Faculty of Public Health at 7 am and returned at around 5 pm. Around 5 to 25 working students were planned, depending on the school and the number of participants.

4. Eligibility criteria

Participants were enrolled in the study if the consent form was signed by both parents and the child or by the staff.

5. Rapid detection test

The presence of antibodies to SARS-CoV-2 was assessed using the Novel Coronavirus test, a lateral flow test antibody immunoglobulin M/G (IgM/IgG) assay (colloidal gold) (Avioq) (AVIOQ, Bio-Tech, Shandong, China) CE-labeled. Sensitivity for IgM/IgG was 68.8% (95% CI [60.3-76%]) and specificity was 95.8% (95% CI [88.5-98.6%]) [39]. Two blinded and independent readings by two different experts were performed on the lateral flow test antibody. In the school, the rapid detection test was performed at the first visit. The test result was read directly 15 minutes after the test procedure. The second reading was planned when back at the university. In case of discrepancy, a third reading was conducted by a microbiologist, and his reading was considered as the final result.

6. Saliva sampling for PCR

The saliva sampling for PCR tests was performed at each of the six visits. Each participant was invited to not drink or eat 1 hour before testing. A saline gargle sample was performed to collect saliva.

Saline mouth/gargle samples showed 98% (39/40) sensitivity for the detection of SARS-CoV-2 by Polymerase Chain Reaction (PCR) compared to saliva sampling with 79% (26/33) sensitivity. Mouth rinse/gargle and saliva samples showed stable detection of viral RNA after 2 days of storage at room temperature [40]. By the first time point, the highest percentages of positive SARS-CoV-2 samples were reported for nasopharyngeal samples (84%), for throat washing (74%), for oracol-collected saliva (68%), for oropharyngeal (59%), and for rectal samples (4%) [41].

During the saliva test, each participant was provided with a mask to perform the test in order to limit the transmission of the virus. The investigation team supervising the saliva test wore protective equipment consisting of plastic safety goggles, an FFP2 facial mask, fabric coveralls, and latex gloves.

Saliva was extracted by using the MagMAX Viral/pathogen Nucleic Acid Isolation kit on a KingFisher automated platform (ThermoFisher). An unbound MS-2-phage RNA sequence was added to each sample to demonstrate the efficiency of the process. Purified RNA was retro-transcribed and amplified on a QuantStudio5 real-time PCR platform with the TaqPathTM COVID-19 RT-PCR kit (ThermoFisher), that targeted the ORF1ab, N, and S coding sequences using three different primer and probe sets.

The PCR samples were analyzed by three university laboratories, UCLouvain, ULiège, and ULB. In order to avoid overloading the laboratories, the analyses were postponed and anonymized.

The ONE provided us with data for each school so that we could identify and compare positive cases between our visits to each school.

7. Dyna, the character created especially for this study

Dyna is a character (Figure 13) that has been created to accompany children throughout the study. He was created from the name of the DYNAtracs study. Dyna is a special dinosaur whose crown represents the coronavirus.

Figure 13: Dyna, the character created by Dr. Julie Frère for the DYNAtracs study

Dyna explained the study and the booklet in a simple way to the children.

All the children were given Dyna to color on their inclusion day. We received drawings from children in different schools and published them on the website.

On the back of the booklet, the postal address of Dyna was indicated in case any children wanted to send us their drawings.

8. Questionnaires

Different questionnaires were available according to the participant's profile.

The questionnaires and booklets were in paper format. To build our database and minimize errors, we used double encoding by different teams. Each participant was given an identifier, which was used to identify the corresponding questionnaires. A

verification between the first and the second encoding was needed to correct encoding errors.

8.1 Children

Children received a specific questionnaire at each visit, one at the inclusion and then five for the follow-up. In addition, every child received a booklet to complete at home.

The inclusion questionnaires included demographic issues, social life, and exposure to COVID-19 issues.

The follow-up questionnaires included exposure to COVID-19 issues and were updated due to school closures during the study. Questions on well-being and exposure to COVID-19 were asked.

In the booklet, each child was invited to write every activity he or she had done and with whom for each day (Figure 14). The objective was to monitor the potential exposure of the child in case of transmission of the virus. This booklet was also translated into the native language of the child (Arabic, Italian, Romanian, and Turkish). After the planning, the child was invited to answer a well-being questionnaire, using the Revised Children's Manifest Scale (RCMAS). Inside the booklet, there were fact sheets describing emotions and pieces of advice on how to manage them (Figure 15). Then, there was a happiness scale, with the different perceptions of the body, emotions, and desires according to this scale (Figure 16). We collected these booklets at our final visit.

In 2023, the same RCMAS questions were used to document children's well-being.

Dyna a rencontré une/des personne(s)…

Semaine 1	Qui?
Lundi	Son grand-père
Mardi	Ses 5 copains
Mercredi	Sa tante
Jeudi	/
Vendredi	Sa voisine
Samedi	Son frère et sa sœur
Dimanche	Sa grand-mère

Dyna et … ont fait…

Semaine 1	Activités
Lundi	Ils ont joué aux cartes
Mardi	Ils ont joué au foot dans la rue
Mercredi	Ils ont lu des histoires et préparé un gâteau
Jeudi	/
Vendredi	Ils ont préparé des cookies
Samedi	Ils sont partis à vélo
Dimanche	Ils ont fait de la soupe

Figure 14: Examples of booklets

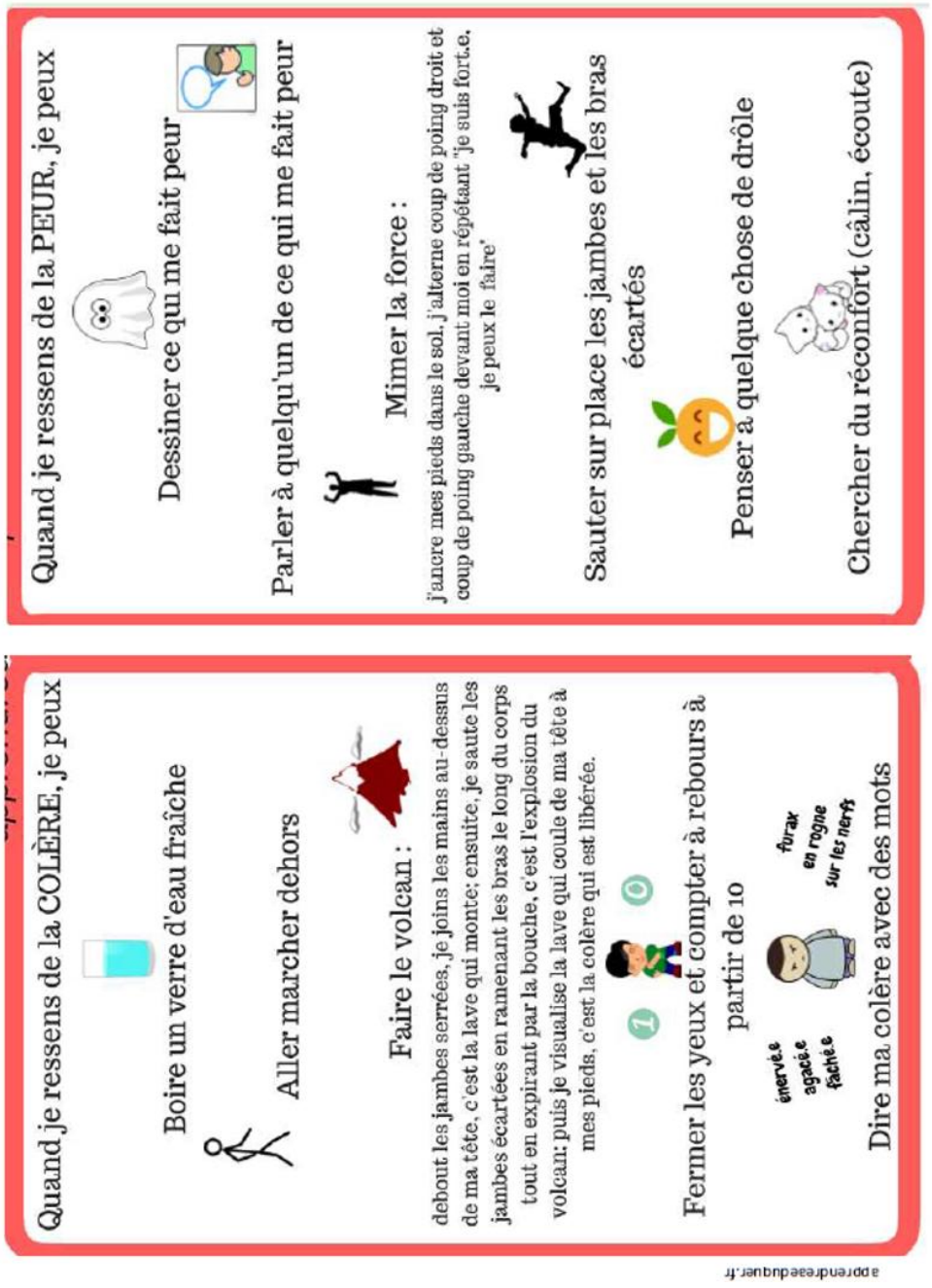

Figure 15: Example of the factsheets describing emotions
Source: Jambon C, 2018 [42] https://apprendreaeduquer.fr/echelle-de-mon-bien-etre-enfants/

Figure 16: Scale of well-being
Source: Jambon C, 2017 [43] https://apprendreaeduquer.fr/echelle-de-mon-bien-etre-enfants/

8.2 Staff

The staff has received one questionnaire at inclusion and five at follow-up questionnaires.

The inclusion questionnaire included questions about general health, demographic issues, social life, exposure to COVID-19, well-being issues using the Hospital Anxiety and Depression (HAD) scale, and perception of their general life using the Visual Analogic Scale (VAS).

The follow-up questionnaires cover exposure to COVID-19 issues.

In 2023, the same HAD questions were used to document the staff's well-being two years later.

Teachers

In addition to the staff questionnaires, members of staff who were teachers in charge of a class also received a specific questionnaire.

The questionnaires focused on the layout of the classroom and measures implemented within the classroom.

Principals

In addition to the staff questionnaire, members of staff who were the principal of the school also received a specific questionnaire at inclusion and five at follow-up questionnaires.

The inclusion questionnaires contained questions on the number of pupils, the number of staff, protective measures put in place within the school, and the number of COVID-19-positive cases in children and staff.

Follow-up questionnaires included questions on school closure, classroom closure, number of positive cases of COVID-19 in children and staff.

9. Scales

9.1 Revised Children's Manifest Scale (RCMAS)

The Revised Children's Manifest Scale (RCMAS) is a valid questionnaire for children 8 to 13 years of age. The RCMAS questionnaire consists of 37 questions (Figure 17 to Figure 19) with "Yes" or "No" as answers (rated 1 or 0). A total anxiety score is then calculated using 28 items.

The anxiety dimension is calculated by analogy and by summing responses to the 28 corresponding items, with 0 as minimum and 28 as maximum. A score under 10 is defined as an absence or minimum anxiety symptoms, between 11 and 13 is defined as an anxious state, and 14 or more is defined as a definite anxious state.

The remaining 9 items allow us to estimate the social desirability. The social desirability score was calculated by summing responses to the 9 corresponding items. This score has 0 as a minimum and 9 as a maximum. A score under 3 is defined as an absence or low social desirability, a score above 4 is defined as a social desirability suspicion, and a score equal to or above 5 is defined as a definite state of social desirability [44,45]. Social desirability in the self-questionnaire consists of answering questions to be perceived by others in a favorable image and to prevent embarrassing responses [46]. For example, one of the questions related to social desirability was "I never lie". If the child answers "yes", this means that the child tends to answer what he or she thinks is the answer we expect of him or her, not the truth, since everyone lies.

From these 28 items relative to anxiety, 3 subscales of anxiety can also be calculated:

(1) Physiological manifestations based on 10 items. This dimension refers to the difficulties in falling asleep, fatigue, and nausea. Physiological manifestations were calculated by summing responses to the 10 corresponding items. It ranges from 0 to 10. A score under 3 is defined as an absence or minimum physiological

manifestation, a score above 4 suggests physiological manifestations, and a score equal to or above 5 corresponds to a definite state of physiological manifestations.

(2) Worry and hypersensitivity based on 11 items. This second dimension relates to mental ruminations linked to emotional injury and isolation fear. The worry and hypersensitivity dimension were calculated by summing responses to the 11 corresponding items. It ranges from 0 to 11. A score under 4 is defined as an absence or minimum worry and hypersensitivity, a score equal to 5 suggests worry and hypersensitivity symptoms, and a score of 6 or more corresponds to a definite state of worry and hypersensitivity.

(3) Concentration and social anxiety based on 7 items. This third dimension refers to school problems. The concentration and social anxiety dimension are the sum of responses to the 7 corresponding items, ranging from 0 to 7. A score under 2 is defined as an absence or minimum difficulties of concentration and social anxiety, a score of 3 suggests difficulties in concentrating and social anxiety, and a score of 4 or more corresponds to a definite state with difficulties in concentrating and social anxiety.

Questionnaire Bien-être :

Lis chaque question attentivement. Encercle ensuite le mot OUI si tu penses que c'est vrai pour toi. Encercle le mot NON si tu penses que ce n'est pas vrai pour toi. S'il y a des mots que tu ne comprends pas, n'hésite pas à demander des explications.

1. J'ai du mal/des difficultés à me décider.	OUI	NON
2. Je deviens nerveux(se) quand les choses ne sont pas comme je voudrais.	OUI	NON
3. Les autres ont l'air d'avoir plus de facilité que moi à faire les choses.	OUI	NON
4. J'aime tout le monde que je connais.	OUI	NON
5.Il m'arrive souvent d'avoir de la difficulté à retrouver mon souffle.	OUI	NON
6. Je suis inquiet(ète) la plupart du temps.	OUI	NON
7. J'ai peur de plusieurs choses.	OUI	NON
8. Je suis toujours gentil(le).	OUI	NON
9. Je me fâche facilement.	OUI	NON
10. Je m'inquiète à propos de ce que mes parents vont me dire.	OUI	NON

Figure 17: Revised Children's Manifest Anxiety Scale questionnaire in the booklet

11. J'ai l'impression que les autres n'aiment pas la façon dont je fais les choses.	OUI	NON
12. J'ai toujours de bonnes manières.	OUI	NON
13. J'ai de la difficulté à m'endormir.	OUI	NON
14. Je m'inquiète de ce que les gens pensent de moi.	OUI	NON
15. Je me sens seul(e) même quand il y a des gens avec moi.	OUI	NON
16. Je suis toujours aimable.	OUI	NON
17. Il m'arrive souvent d'avoir mal au ventre.	OUI	NON
18. Je me sens facilement blessé(e) dans mes sentiments.	OUI	NON
19. J'ai les mains moites (en sueur).	OUI	NON
20. Je suis toujours gentil(le) avec tout le monde.	OUI	NON
21. Je suis souvent fatigué(e).	OUI	NON
22. Je m'inquiète de ce qui va arriver.	OUI	NON
23. Les autres enfants sont plus heureux que moi.	OUI	NON
24. Je dis toujours la vérité.	OUI	NON
25. Je fais de mauvais rêves.	OUI	NON
26. Je suis facilement blessé(e) quand on m'embête trop.	OUI	NON
27. J'ai l'impression que quelqu'un va me dire que je ne fais pas les choses comme il faut.	OUI	NON

Figure 18: Revised Children's Manifest Anxiety Scale questionnaire in the booklet

28. Je ne me fâche jamais.	OUI	NON
29. Il m'arrive parfois de me réveiller effrayé(e).	OUI	NON
30. Je m'inquiète quand je me couche le soir.	OUI	NON
31. J'ai de la difficulté à me concentrer sur mes travaux scolaires.	OUI	NON
32. Je ne dis jamais des choses que je ne devrais pas dire.	OUI	NON
33. Je bouge beaucoup sur ma chaise.	OUI	NON
34. Je suis nerveux(se).	OUI	NON
35. Plusieurs personnes sont contre moi.	OUI	NON
36. Je ne mens jamais.	OUI	NON
37. Je m'inquiète souvent à propos de mauvaises choses qui pourraient m'arriver.	OUI	NON

Figure 19: Revised Children's Manifest Anxiety Scale questionnaire in the booklet

9.2 Hospital Anxiety and Depression (HAD)

The adult questionnaire included 14 questions based on the Hospital Anxiety and Depression (HAD) scale to assess the staff's well-being. HAD is a valid questionnaire for hospitalized people and refers to anxiety and depression symptoms, using 7 questions for each dimension. Each question has a 4-point response with a value from 0 to 3. A total anxiety and a total depression score can be calculated with a maximum of 21 points each. A score under or equal to 7 is defined as an absence of both anxiety and depression, a score between 8 and 10 is defined as a suspected anxious or depressive state, and a score equal to or greater than 11 is defined as a definite state of anxiety or depression [47].

9.3 Visual Analogic scale

WHO defines the Quality of Life as:

> "*An individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns*" [48].

Based on this definition, the staff were invited to report their perception of their quality of life and their future life in 5 years on a VAS. This score has 0 as a minimum and 10 as a maximum. A value of 0 corresponds to the worst possible life, and a value of 10 represents the best possible life according to the individual's perception.

10. Drawings

We invited each child from the 3rd and 6th grades to create one drawing according to 3 periods, before, during, and after the COVID-19 pandemic, in addition to the well-being questionnaire. We adapted the 3-drawing method to analyze the representation of well-being in the school environment for each child [49]. We supplied sheets where each child was invited to draw his or her perception of the school and himself or herself before, during, and after the COVID-19 pandemic. The child could then add whatever he or she wished. We provided colored pencils for the children to use while they produced their drawings. To interpret the drawings, we adapted the scale used in the 3-drawing method and the scale used in a study conducted on the representation of lockdown in children before, during, and after the COVID-19 pandemic [49,50].

Drawings were analyzed with a personalized scale regarding the school, well-being, and COVID-19 pandemic (Table 4).

Content	Coding	Description
Expressive content(s)		
Positive facial expression	0=absence/1=presence	Open eyes, smiling faces, laugh
Positive content	0=absence/1=presence	Sun, flowers, rainbows, butterfly, birds, stars, animals.
Negative facial expression	0=absence/1=presence	Sad, tears, isolation, anger, fears
Negative contents	0=absence/1=presence	Clouds, rain, thunder, broken objects,
Movements	0=absence/1=presence	Body in movements?
Items classification		
COVID-19 references	0=absence/1=presence	People wearing masks, confinement, isolation, test positive, sick, virus
School references	0=absence/1=presence	Teachers, school, recreation
Child itself	0=absence/1=presence	Represents him/herself
Friends	0=absence/1=presence	Represents friend(s)
Parents	0=absence/1=presence	Represents parent(s)
Family	0=absence/1=presence	Represents family
House	0=absence/1=presence	Represents the house
Structure		
Colours	Numbers	Use colors other than black and how many
People	Numbers	How many
Elements related to COVID-19	Numbers	How many
Elements related to wellbeing	Numbers	How many
Use of different sizes	Numbers	
	0=absence/1=presence	How many
School	Characters	How is the structure of the school?

Table 4: Drawing scale

Double encoding was carried out for each drawing. Each drawing was encoded according to this scale by one person. Then, a second encoding was made according to this scale by another person. In the event of discordance, a decision was made by a third person.

Each drawing was analyzed in detail and summarized in a document to retain as much information as possible.

11. Incentives to participating schools

We offered a gift to all the participating schools. We created a personalized deck of cards with Dyna on the back (Figure 20). Every child and staff member received a deck of cards. Even children and staff who did not take part to the study received a deck of cards in 2021 and in 2023.

Figure 20: Deck of cards

12. Feedback

During the planning of the study, the feedback for the different results was not planned.

There were various reasons for this refusal to provide feedback.

First, the reading of the rapid antibody detection test was directly made on the field, but the theoretical waiting time was 15 minutes between the test realization and the reading. There was a double-blind reading, and the results could not have been transmitted on the day the rapid antibody detection test was carried out.

Second, the analysis for the saliva sampling for PCR made by the different laboratories was postponed to avoid overloading due to the amount of testing during the pandemic crisis. The results of these analyses could not be sent directly to the participants. In addition, each participant was identified anonymously.

Third, all questionnaires were paper-based. Double encoding was necessary to create a database. Consequently, the creation of the final database was very time-consuming. The analyses for well-being were postponed after the end of the study. The well-being of children was in the booklet, and children were asked to return this booklet at the 6th visit.

Following this, it was decided that there would be no personalized feedback to each participant.

13. Statistical analysis

13.1 Participation

Participation of children and staff in the study was reported as numbers and proportions. Participation rates were correlated with the incidence of SARS-CoV-2 in the local school area, school size, and socioeconomic status of the school, using Pearson's correlation (r, [95% CI]).

13.2 Seroprevalence with rapid detection tests

The first specific objective was to assess the seroprevalence in children compared to the incidence of SARS-CoV-2 in the local school area.

The second, third, and fourth specific objectives were to document the transmission from infected children to other children, from infected children to adults and teachers, and whether cases were associated with an increased number of cases in the following weeks. Seroprevalence, PCR results, and responses to the questionnaires have been used to document the results of these specific objectives.

SARS-CoV-2 seroprevalence was calculated based on the total number of positive cases (IgG+) for each school for both children and staff.

The incidence of SARS-CoV-2 in the local school area was computed based on the ratio between the cumulative cases reported by Sciensano for the school area and the total population number residing in the locality from national demography [35,36]. Seroprevalence and incidence of SARS-CoV-2 in the local school area were reported per 1,000 persons.

The cluster effect between classes in each school was computed using the Pearson intraclass correlation coefficient.

Multiple logistic regressions were carried out to assess the relationship between seroprevalence and explanatory variables.

Seroprevalence and prevalence

There is a link between the seroprevalence and the prevalence (Table 5). Serological tests measure the seroprevalence or the positive test proportion. The link between seroprevalence and prevalence depends on the sensitivity and the specificity of the test used, by the relationship:

	D+	D-	
Test +	Sensitivity * Prevalence	(1-Specificity)*(1-Prevalence)	Seroprevalence
Test -	(1-Sensitivity)*Prevalence	Specificity*(1-Prevalence)	1-seroprevalence
	Prevalence	1-Prevalence	1

D+: Presence of disease ; D-: Absence of disease; Test+: Test positive ; Test-: Test negative
Table 5: Link to seroprevalence and prevalence

$$Seroprevalence = Prevalence \times Sensitivity + (1 - Prevalence) \times (1 - Specificity)$$

Then we can deduce:

$$Prevalence = \frac{Seroprevalence + Specificity - 1}{Sensitivity + Specificity - 1}$$

Using this method, the prevalence was obtained from the seroprevalence calculated during the study.

13.3 Saliva sampling for PCR

PCR results were reported weekly for each participant according to the proper test date per class and per school in an Excel file. Negative results were reported as "NEG", and positive results were reported with the threshold cycle (C_t) value (C_t is the measure of the target concentration within the PCR reaction, it is the intersection between the amplification curve and the threshold line [21]). Positive C_t values were reported with N-protein. Then, we classified the C_t values according to three categories <25, 25-30, and >30.

13.4 Questionnaires

Each response to every questionnaire was reported as numbers and proportions. Some responses were linked in the analyses of seroprevalence and well-being. Other responses were represented on bar graphs.

13.5 Well-being

The fifth specific objective was to document the well-being of children during the COVID-19 pandemic crisis.

The internal consistency of the questionnaire's domains was evaluated using Cronbach's α to assess the consistency between items. The closer Cronbach's α to 1, the better the internal consistency of the questionnaire.

The well-being was analyzed using the RCMAS scale for children and the HAD scale for the staff. Each score obtained was categorized according to a calculated cut-off (Table 6).

For each dimension of the RCMAS score, a cut-off was calculated. RCMAS anxiety score between 10 to 13, was considered as a suspicion state, and a score equal to or above 14 was considered as a definite state of anxiety. RCMAS physiological manifestations score of 4 was considered as a suspicion state, and a score equal to or above 5 was considered a definite state of physiological manifestations. RCMAS worry and hypersensitivity score of 5 was considered as a suspicious state, and a score equal to or above 6 was considered as a definite state of worry and hypersensitivity. RCMAS concentration and social anxiety score of 3 was considered as a suspicion state, and a score equal to or above 4 was considered as a definite state of worry and hypersensitivity. RCMAS social desirability score of 4 was considered as a suspicion state, and a score equal to or above 5 was considered as a definite state of social desirability.

HAD scores for anxiety and depression between 8 to 10 were considered as a suspicion state, and a score equal to or above 11 was considered as a definite state of anxiety or depression.

			Presence	
	Range	Absence	Suspicion state	Definite state
Children (37 questions 0-1)				
RCMAS	0-37			
Anxiety	0-28	≤ 9	10-13	≥ 14
Physiological manifestations	0-10	≤ 3	4	≥ 5
Worry and hypersensitivity	0-11	≤ 4	5	≥ 6
Concentration and social anxiety	0-7	≤ 2	3	≥ 4
Social desirability	0-9	≤ 3	4	≥ 5
Adults				
HAD (14 questions 0-3)				
Anxiety	0-21	≤ 7	8-10	≥ 11
Depression	0-21	≤ 7	8-10	≥ 11
VAS (2 questions 0-10)				
Quality of life perceived now	0-10			
Quality of life perceived in 5 yrs	0-10			

RCMAS: revised children's manifest anxiety scale; HAD: hospital anxiety and depression; VAS: visual analogic scale

Table 6: Revised Children's Manifest Anxiety Scale, Hospital Anxiety and Depression scale, and Visual Analogic Scale

Results were represented as mean ± standard deviation (SD) for continuous variable and number with proportion for categorical variable. Student t-test and Analysis of Variance (ANOVA) with F-test were used to compare several groups.

Associations between continuous variables were assessed using the Pearson r correlation coefficient.

Multiple logistic regressions were carried out to assess the relationship between suspicious or definite states and explanatory variables.

All these dimensions of the RCMAS were analyzed, considering sex, age, participation in organized fixed activities (such as sports, music lessons, scouting, etc.), and participation in outdoor/street activities of children. School inclusion criteria were also included, such as local SARS-CoV-2 incidence, size, and the socioeconomic status of the school for the analysis. Age was calculated from the date of birth and the date of the inclusion study and three categories were considered according to school level: 6-7, 8-9, and 10-12. For school inclusion criteria, extremes were used: low (<5.0/1,000 persons) or high (≥5.0/1,000 persons) local incidence of SARS-CoV-2, small (<230 children) or large (≥230 children) school and low (SES≤7) or high (SES≥13) socioeconomic status.

HAD anxiety and depression scores were assessed according to sex, age, and school inclusion criteria. For the age of the staff, 4 categories were considered 18-29, 30-39, 40-49, and above 50.

In 2023, as it took place after the COVID-19 pandemic crisis, we did not use the same methods for analyzing well-being. Results were represented as mean ± standard deviation (SD) for continuous variable and number with proportion for categorical variable. Student t-test and Analysis of Variance (ANOVA) with F-test were used to compare several groups.

The correlation between RCMAS scores was assessed using the Pearson r correlation coefficient.

Proportions derived from RCMAS scores and its four dimensions were compared between the two periods using Pearson chi-square tests because participants were not the same (it was not a matched sample).

RCMAS anxiety and social desirability scores were compared between 2021 and 2023 for all children who took part in both studies.

13.6 Drawings

The fifth objective was to document the well-being of children after the COVID-19 pandemic.

Results were represented as numbers with proportions for categorical variables.

Changes in items on the drawing scale over the three periods, before, during, and after the pandemic, were assessed using McNemar's test.

Data analysis was performed with R 4.1.2.

14 Study registration

The protocol (see Annex 1, p.162-183), informed consent forms, and questionnaires of the DYNAtracs study were approved by the Hospital-Faculty Ethics Committee Saint-Luc ("Commission d'Ethique Hospitalo - Facultaire des Cliniques Universitaires Saint-Luc") – UCLouvain, in Brussels, approval number: 2020/16NOV/552 (see Annex 2, p.184-185). It was registered on clinicaltrials.gov on 16/09/2021, identifier number: NCT05046470, and on ISRCTN on 20/04/2022, identifier number: ISRCTN16837012. Written informed consent was obtained from all participants before participation and/or from their legal guardians.

The protocol (see Annex 3, p.186-196), informed consent forms, and questionnaires of the study were approved by the Hospital-Faculty Ethics Committee Saint-Luc ("Commission d'Ethique hospitalo -facultaire des Cliniques universitaires Saint-Luc") – UCLouvain, approval number: 2022/06DEC/469 (see Annex 4, p.197-198). It was registered on clinicaltrials.gov on 28/02/2023, identifier number: NCT05747638.

Chapter 4: Results

The first part of the results corresponds to responses to questionnaires from children and staff in 2021. Initially, the questionnaires were intended for transmission analyses, specifically for the rapid detection of test results. These results did not lead to an emergence of factors between positive and negative results, suggesting that other factors play a role in the presence of antibodies.

Nevertheless, the results of the questionnaires corresponding to the symptoms, social contacts, and places of the participants, as well as the answers to the updated questionnaires of the children, are reported below.

1. Questionnaires

1.1 Children

During the 6 visits, the majority of symptoms were under 10%, headache (between 9% and 11%), and runny or stuffy nose (between 17% and 18%). The majority of children reported that they did not have signs or symptoms (between 21% and 28%). Some did not respond to the question: 2% (18/842) for the second visit, 1% (11/854) for the third visit, 2% (13/832) for the fourth visit, 4% (36/838) for the fifth visit, and 2% (13/565) for the last visit. The study was done during the winter; these signs and symptoms may not be directly linked to COVID-19, as other diseases may be the cause. These signs and symptoms are represented in Figure 1a (see Annex 6, p.200).

During the follow-up, contacts were in majority with the family: parents (between 27% and 30%), brother(s) and/or sister(s) (between 24% and 26%), and grandparents (between 12% and 15%). The majority of the children in close contact with their grandparents did not wear facial masks (between 42% and 56%), and some did not respond to the question if they wore a facial mask or not (between 9% and 18%). Some children did not respond to the question if they had contacts outside the school: <1% (3/842) for the second visit, <1% (3/854) for the third visit, <1% (4/832) for

the fourth visit, <1% (3/838) for the fifth visit, and <1% (5/565) for the sixth visit. Close contacts outside the school are represented in Figure 2a (see Annex 7, p.201).

Children had visited some places outside the school during the study period. The most visited place during the study period was their activity after school (between 27% and 33%). Then, the second most visited place was shops (between 18% and 21%). Finally, the third most visited place was their grandparents (between 16% and 19%). Some children did not respond to the question if they visited a place outside their school: 2% (20/842) for the second visit, 3% (24/854) for the third visit, 3% (24/832) for the fourth visit, 3% (21/838) for the fifth visit, and 2% (12/565) for the sixth visit. The places visited outside the school are represented in Figure 3a (see Annex 8, p.202).

As described earlier, some children from schools received an adapted questionnaire because of the closure by the government.

For these children, feelings experienced were in the majority very happy or happy (between 41% and 60%). Only 1% (3/314) did not answer this question for the last visit. The feelings experienced by the children are represented in Figure 4a (see Annex 9, p.203).

For these children who received the adapted questionnaire, the majority of them had close contact with the brother(s) and/or sister(s) (between 39% and 48%). Some of them did not answer the question: 8% (2/25) for the fourth visit, 4% (1/25) for the fifth visit, and 6% (19/314) for the sixth visit. Close contacts outside the school are represented in Figure 5a (see Annex 10, 204).

The places most visited by the children who received the adapted questionnaire were the shops (between 21% and 30%). Then, their cousins were the place where the children visited the second most (between 13% and 21%). Some children did not answer the question: 8% (2/25) for the fourth visit, 4% (1/25) for the fifth visit, and

<1% (2/314) for the sixth visit. The places visited by the children are represented in Figure 6a (see Annex 11, p.205).

1.2 Staff

During the six visits, the staff reported their symptoms. The majority of them reported that headache (between 12% and 18%), runny or stuffy nose (between 9% and 15%), and sore throat (between 6% and 8%) were the most reported symptoms. The study was done during the winter; these signs and symptoms may not be directly linked to COVID-19, as other diseases may be the cause. Some staff did not respond to the question: 14% (33/233) for the first visit, 18% (35/191) for the second visit, 14% (25/184) for the third visit, 12% (25/201) for the fourth visit, 15% (27/175) for the fifth visit, and 19% (36/188) for the sixth visit. Signs and symptoms of staff are represented in Figure 7a (see Annex 12, p.206).

During the sixth visit, the staff reported that most close contacts were with their children (between 30% and 35%). Then, the second most cited were with their parents (between 21% and 23%). Of the staff who reported having close contact with their parents, the majority of them reported they did not wear a facial mask during these close contacts (between 64% and 81%), and some of them avoided responding to the question if they wore a facial mask or not (between 5% and 16%). Some staff avoided responding to the question: 2% (3/191) for the second visit, 2% (4/184) for the third visit, 2% (4/201) for the fourth visit, 1% (2/175) for the fifth visit, and 1% (2/188) for the last visit. Close contacts for the staff during the follow-up are represented in Figure 8a (see Annex 13, p.207).

During the follow-up, the staff assessed that they visited the shops (between 44% and 49%) in the majority of places. Then, they reported that the second most places visited were their friends/family (between 29% and 34%). Some of them avoided answering the question: <1% (1/201) for the fourth visit, <1% (1/175) for the fifth

visit, and <1% (1/188) for the last visit. The different places visited by the staff during the follow-up period are represented in Figure 9a (see Annex 14, p.208).

2. Objective n° 1

SARS-CoV-2 antibody seroprevalence in children and workers from Belgian French-speaking primary schools

Abstract

Purpose

During the COVID-19 pandemic, closing schools was discussed to limit the virus transmission, despite a lack of evidence on the role of young children in the virus spread. We undertook a study among Belgian primary schools to assess the SARS-CoV-2 antibody seroprevalence and its relationship with local incidence, school size, and socioeconomic status (SES).

Methods

Schools were purposively selected using three criteria: an area with either a low or a high COVID-19 incidence, either a small or a large size, and either a low or a high SES. 932 (/2488, 38%) children and 242 (/444, 55%) staff signed informed consent. COVID-19 antibodies were tested using rapid finger prick tests.

Results

Children participation was positively correlated with staff (r=+0.33;95%CI[-0.34;0.78]), and strongly with SES (r=+0.81;95%CI[0.40;0.95]). Seroprevalence was 21% in children (191/922) and 25% in staff (61/240). Seroprevalence did not correlate with local cumulative incidence (children: r=+0.06;95%CI[-0.59;0.67]; staff: r=+0.26;95%CI[-0.40;0.74]). In staff, seroprevalence was higher in schools with higher SES (r=+0.37;95%CI[-0.29;0.79]), but not in children (r=-0.10;95%CI[-0.66;0.53]).

Conclusion

The lower seroprevalence in children suggests they are lower transmitters than adults, but poor socioeconomic levels were less representative.

Keywords

SARS-CoV-2; Children; Schools; Seroprevalence; Socioeconomic status; Belgium

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SARS-CoV-2 Antibody Seroprevalence in Children and Workers from Belgian French-Speaking Primary Schools

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Abstract

Purpose: During the COVID-19 pandemic, closing schools was discussed to limit the virus transmission, despite a lack of evidence on the role of young children in the virus spread. We undertook a study among Belgian primary schools to assess the SARS-CoV-2 antibody seroprevalence and its relationship with local incidence, school size, and socioeconomic status (SES). **Methods:** Schools were purposively selected using three criteria: an area with either a low or a high COVID-19 incidence, either a small or a large size, and either a low or a high SES. 932 (/2488, 38%) children and 242 (/444, 55%) staff signed informed consent. COVID-19 antibodies were tested using rapid finger prick tests. **Results:** Children participation was positively correlated with staff (r = +0.33; 95% CI [−0.34; 0.78]), and strongly with SES (r = +0.81; 95% CI [0.40; 0.95]). Seroprevalence was 21% in children (191/922) and 25% in staff (61/240). Seroprevalence did not correlate with local cumulative incidence (children: r = +0.06; 95% CI [−0.59; 0.67]; staff: r = +0.26; 95% CI [−0.40; 0.74]). In staff, seroprevalence was higher in schools with higher SES (r = +0.37; 95% CI [−0.29; 0.79]), but not in children (r = −0.10; 95% CI [−0.66; 0.53]). **Conclusion:** The lower seroprevalence in children suggests

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they are lower transmitters than adults, but poor socioeconomic levels were less representative.

Keywords

SARS-CoV-2, Children, Schools, Seroprevalence, Socioeconomic Status, Belgium

1. Introduction

In 2020, the rapid spread of a new coronavirus disease (COVID-19) due to a new virus, the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), led many countries to take preventive measures to limit the virus spread. Because it can occur before the first symptoms of the disease or even without symptoms, the control of this pandemic was particularly complex. Many countries decided to close schools, disrupting the scholarship of about 1.57 billion students (91%) worldwide [1]. However, there was a lack of evidence on the role of young children in schools in the SARS-CoV-2 spread [2].

A first study in Iceland showed that the incidence of SARS-CoV-2 infection was lower in children below the age of 10 [3]. Preliminary results within primary schools in France indicate that transmission occurred mainly at home. Infection was most often mild or asymptomatic in young children [4]. Symptoms severity plays an important role in the infectiousness degree and the asymptomatic person appears to contribute less to the SARS-CoV-2 transmission [5]. As the majority of children appeared asymptomatic, their contributions to transmission in society can be lower [6]. Some countries didn't close their schools, but maintained strict protective measures. Their results pointed out that transmission in primary schools was limited [7] [8] [9].

Many consequences of the pandemic such as school closures and lockdowns can have a significant impact on children's development, independently of SARS-CoV-2 risk. An American study analyzed the effects of previous pandemics on children, and nearly a third of them showed symptoms of post-traumatic stress disorder [10]. Previous school closures have shown that students who do not attend school for a long period are more likely not to return once schools reopen [1]. More recently, other studies showed that the physical, mental, and social well-being of children, as well as their scholarship, are affected by school closures and reactional activities, especially those with disadvantaged backgrounds [11] [12] [13]. In addition, interruption of social contact and other preventive measures has catastrophic consequences for children's well-being including domestic violence [14].

We investigated whether SARS-CoV-2 antibody seroprevalence was as high in children as in school staff, whether it was related to the local SARS-CoV-2 incidence, whether seroprevalence was related to the school size, and whether seroprevalence was higher in disadvantaged background.

2. Methods

2.1. Study Design and Population

A prospective, non-interventional study, named DYNAmic TRAnsmission of Coronavirus in Schools (DYNAtracs), was conducted from January 14th to May 18th 2021 in primary schools of the Federation Wallonia Brussels in Belgium.

Schools were selected using purposive sampling to build the sample according to three inclusion criteria (Table 1). These three criteria were based on three surrogate markers.

The first surrogate marker was the local level of SARS-CoV-2. We wanted schools in low-infection areas as well as high-infection areas. The local level of SARS-CoV-2 was reflected by the cumulative incidence of SARS-CoV-2 during the first wave on May 6th 2020 in Belgium, based on data from the Belgian public health institute, Sciensano [15]. The median of data was used as a cut-off to define a low or high incidence area. A region/city with a low SARS-CoV-2 incidence corresponded to an incidence strictly below 5.0 per 1000 persons. A region/city with a high SARS-CoV-2 incidence corresponded to an incidence equal to or greater than 5.0 per 1000 persons.

The second surrogate marker was the number of social contacts within schools. A low or high number of social contacts in a school was substituted by the school size. The cut-off for a small/large school size was based on the estimated maximum total number of children in Belgian primary schools. A school was considered small when its size was below the first tertile (<230 children). A school with more than 230 children was defined as large.

Table 1. Schools according to 3 inclusion criteria.

Cumulative Incidence of SARS-CoV-2 High ≥ 5.0 Low < 5.0 (Per 1000 Persons)	Size of the School Large ≥ 230 Small < 230	Socioeconomic Status High ≥ 13 Low ≤ 7	School Location
High	Large	High	Angleur
		Low	Berchem-Ste-Agathe
		Low	Jette
		Low	Koekelberg
	Small	High	Herve
		Low	Seraing
Low	Large	High	Beauraing
		Low	Châtelineau 2
	Small	High	La Hulpe
		Low	Châtelineau 1
		Low	Farciennes

The third surrogate marker was the disadvantaged background of children. The disadvantaged background was substituted by a low socioeconomic status (SES) of the school. In Belgium, all schools are classified on a 20-point scale index called SES. This SES aggregates the average data of all students and is calculated with 7 variables of the child's household over 7 years: the median of the household income, the proportion of people in the household with a superior education degree, the proportion of people with a nursery or primary school degree, the proportion of people with a job, the proportion of persons with social assistance, the proportion of people with manual work and the proportion of people working in the lowest level of the tertiary sector. More specifically, individual values are collected for each child. Then, an aggregation of individual variables by school implantation, institution, and statistical sector of residence is performed. The mean and standard deviation are computed and each variable is standardized to have a mean of 0 and a variance equal to 1. Principal component analysis is performed on the correlation matrix to extract loadings for each of the 7 variables for calculating the first principal component, which is SES [16].

$$SES_i = \sum_{j=1}^{7} C_j \frac{\left(x_{ij} - A_j\right)}{B_j}$$

i = school implantation;

j = variable number;

C_j = loading of the first principal component,

which allows to weight of the contribution of variable number j.

A_j = mean of the variable across schools;

B_j = standard deviation of the variable across schools.

According to this index, a value lower or equal to 7 (the first tertile) was defined as a low SES and a value greater or equal to 13 (the upper tertile) was defined as a high SES.

The two levels of each of the three criteria led to defining eight strata for sampling schools within each stratum.

Schools were selected in each stratum, with the help of two administrations in charge of health at school, ONE ("Office de la Naissance et de l'Enfance") and PSE ("Promotion de la Santé à l'École"). Principals of selected schools were contacted to participate in the study.

In that case, they sent us a list with the number of children per class and the number of workers. A box per class was then prepared for parents with flyers and an informed consent to sign. Flyers were translated into languages requested by the principal: Arabic, Italian, Romanian, and Turkish. All children (6 - 12 years) and all staff were invited to participate and received a consent form to sign.

In parallel, principals, teachers, and parents were invited to take part in a videoconference.

A website was also created (https://www.sesa.ucl.ac.be/Dynatracs/) where parents could consult the information about the study. It contained the study proto-

col, videos explaining the two testing procedures and flyers translated into different languages.

Participants were enrolled in the study if the consent was signed by both parents and the child or by the staff.

In each school, the principal collected these signed forms within the week, and individual anonymized identification numbers were generated according to these lists of participants. The school location, the school calendar, the protective measures at the time of the study, and the government measures to limit the virus transmission were considered in the planning and field study organization (Figure 1).

Each school was visited six times. Each participant was tested by a rapid serological antibody test by finger prick only at inclusion. A saliva antigen test of SARS-CoV-2 was performed in the first week and repeated the following ones. Each week, the participant filled in a face-to-face questionnaire about possible COVID-19 exposure and with demographic factors at inclusion. Each child received a notebook where he/she wrote down the exposure risk during the study period and answered a well-being questionnaire during this SARS-CoV-2 pandemic. Teachers and principals filled in different questionnaires regarding protective measures set up in the school. Each test and questionnaire was identified by the participant's anonymized code during the entire study.

The Belgian concertation committee had provided some protective measures for schools when children showed symptoms or tested positive. When a child tested positive, the parents were asked to warn the school and to isolate the child for a period of quarantine. When two children tested positive within the same classroom, the classroom was closed and all the children were asked to stay at home for a quarantine period (see **Additional file 1**) [17] [18].

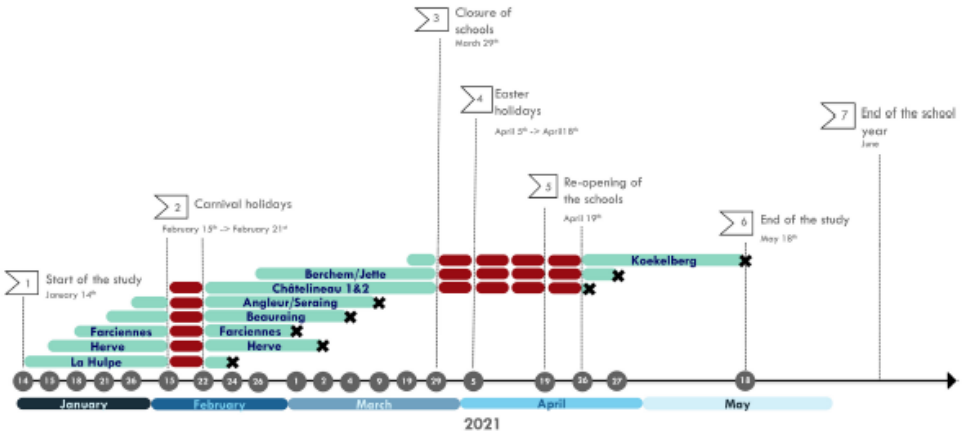


Figure 1. Calendar for the study organization. Green zone: study period within the school; red zone: school vacations, closing period, or study break; black cross: end of the study for the school.

2.2. Study Registration

Human data were performed in accordance with the Declaration of Helsinki. The protocol, informed consent forms, and questionnaires were approved by the Hospital-Faculty Ethics Committee Saint-Luc ("Commission d'Ethique Hospitalo-Facultaire des Cliniques Universitaires Saint-Luc")—UCLouvain, approval number: 2020/16NOV/552.

2.3. Technical Procedures

The presence of antibodies for SARS-CoV-2 was evaluated by using the Novel Coronavirus test, a lateral flow test antibody immunoglobulin M/G (IgM/IgG) assay (colloidal gold) (Avioq) (AVIOQ, Bio-Tech, Shandong, China) CE-labeled. Sensitivity for IgM/IgG was 68.8% (95% CI [60.3% - 76%]) and specificity was 95.8% (95% CI [88.5% - 98.6%]) [19]. Two blind and independent readings by two different experts were performed on the lateral flow test antibody. In the case of discordance, a third reading was carried out by an expert supervisor, and his reading was considered the final result.

A saline mouth gargle sample was performed to collect the saliva. This method showed a sensitivity of 98% to detect SARS-CoV-2 by Polymerase Chain Reaction (PCR) compared to nasopharyngeal swabs [20]. Saliva was extracted by using the MagMAX Viral/pathogen Nucleic Acid Isolation kit on a KingFisher automated platform (ThermoFisher). An unbound MS-2-phage ribonucleic acid (RNA) sequence was added to each sample to show the efficiency of the process. Purified RNA was retro-transcribed and amplified on a QuantStudio5 real-time PCR platform with the TaqPathTM COVID-19 RT-PCR kit (ThermoFisher) that targeted the ORF1ab, N, and S coding sequences by utilizing three different primers and probes sets.

2.4. Data Analysis

Participation of children and staff is reported as number and proportion. Pearson's correlation (r, [95% CI]) was used to assess the relationship between participation or seroprevalence of children and staff, incidence level of SARS-CoV-2 within the school area at inclusion, school size, and socioeconomic status.

SARS-CoV-2 seroprevalence was calculated for each school based on positive IgG. The local cumulative incidence of SARS-CoV-2 was defined as the ratio between the cumulative cases reported by Sciensano for the area and the population number from national demography [15]. Seroprevalence among children and staff, as well as the communal cumulative incidence of SARS-CoV-2, are reported per 1000 persons. The cluster effect between classes within schools was assessed using the Pearson intraclass correlation coefficient (ICC).

Data analysis was performed with R 4.1.2.

2.5. Spatial Distribution

The spatial distribution of participation and seroprevalence in children and staff across Belgium has been performed using the ArcGIS program 10.8 version.

3. Results

Among the 8 schools initially selected, 2 schools were excluded from the study because of a refusal from the principal in one and a high refusal participant rate (up to 40%) in the other. Five additional schools were then proposed, leading to 11 schools enrolled in the study (among 13 invited schools). Additional analysis was conducted to document the low participation.

From these 11 schools, 1174 individuals participated in the study, including 932 children and 242 staff.

3.1. Participation in the Study

The global participation rate was about 37.5% for children (932/2488) and 54.5% for staff (242/444) (see **Additional file 2** for more details).

Participation of children was positively correlated (r = 0.33; 95% CI [−0.34; 0.78]) with the participation of staff.

The participation was higher in areas with a lower incidence level of SARS-CoV-2 at that time (children: r = −0.17; 95% CI [−0.70; 0.48]; staff: r = −0.52; 95% CI [−0.85; 0.11]).

Participation in children and staff was negatively correlated with the school size (children: r = −0.39; 95% CI [−0.80; 0.27]; staff: r = −0.50; 95% CI [−0.85; 0.15]); the bigger the school the lower the participation rate.

Participation among children was lower (<50%) in schools with a lower socioeconomic status (SES ≤ 7) (r = 0.81; 95%CI [0.40; 0.95]), but among staff, there was no relationship between participation rate and SES (r = 0.05; 95% CI [−0.56; 0.63]) (Figure 2).

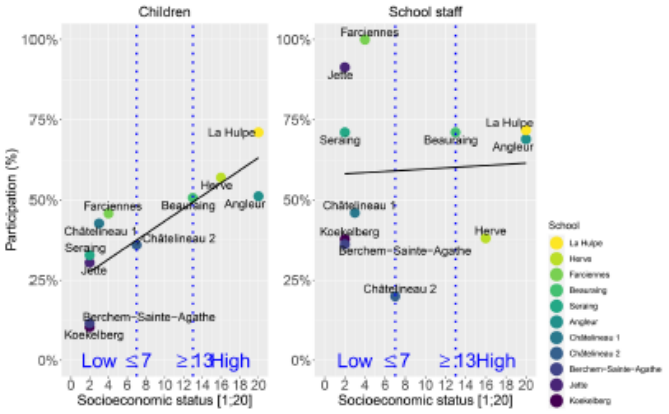


Figure 2. Participation of children and school staff according to the socioeconomic status. The participation of children and school staff is represented by percentages (%). Socioeconomic status (Belgian 20-point-scale SES index) is represented from 1 to 20. The two extremes value, ≤7 and ≥13 are represented by the two blue dashed lines. The correlation between participation and the socioeconomic status of the school is represented by the black lines. Schools are represented by a colored dot.

3.2. Seroprevalence in Children and Staff

There was 10.3% of discordance between the double-blind readings of the SARS-CoV-2 lateral flow antibody test, and there were 12 cases with negative IgG but positive IgM that were considered as negative in our results.

Out of 1174 participants, 1162 serological tests (6 unreadable and 6 missing) were performed throughout all schools (see **Additional files 3 and 4** for more details). 20.7% of children (191/922) and 25.4% of staff (61/240) were positive for IgG.

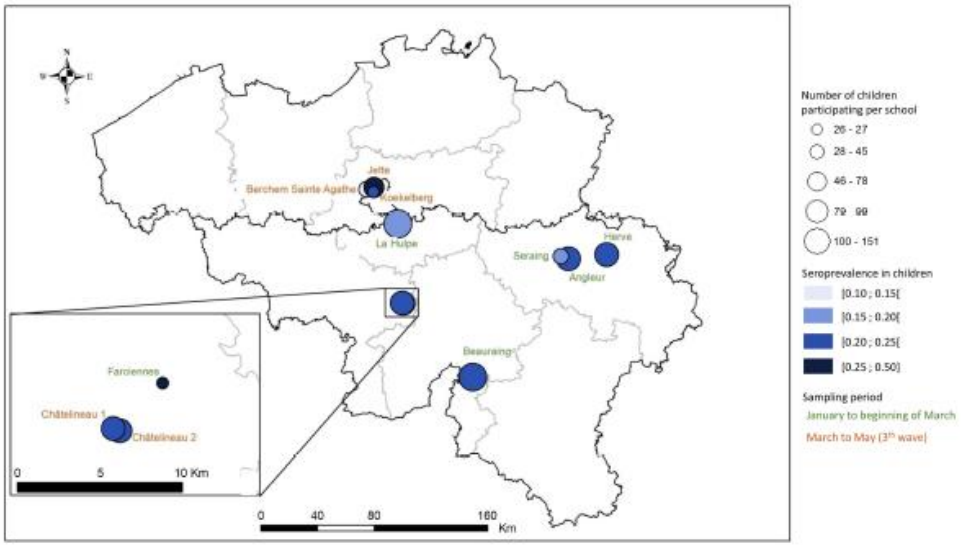
Seroprevalence and participation in the study are represented geographically specifically for children and staff (Figure 3). In the different schools (Figure 3 and see **Additional file 5** for more details), the rate of children with antibodies was highest around Brussels and Farciennes. But in staff, the positivity rate was highest in Brussels, Herve, Beauraing, and Farciennes.

Seroprevalence in children was higher in schools where the seroprevalence in staff was high (r = 0.33; 95% CI [−0.34; 0.77]).

Between schools, the seroprevalence was comparable (p-value = 0.17). We obtained a weak intraclass coefficient correlation (children: ICC = 0.08; children with staff: ICC = 0.12).

Seroprevalence in staff (Figure 4) was slightly associated with local cumulative incidence (r = 0.26; 95% CI [−0.40; 0.74]), but there was no correlation in children (r = 0.06; 95% CI [−0.59; 0.67]). Seroprevalence in children and staff is generally above the dotted line, meaning that most of the estimated seroprevalence was higher than the communal cumulative incidence at the time of the study.

Children participating per school and seroprevalence in children



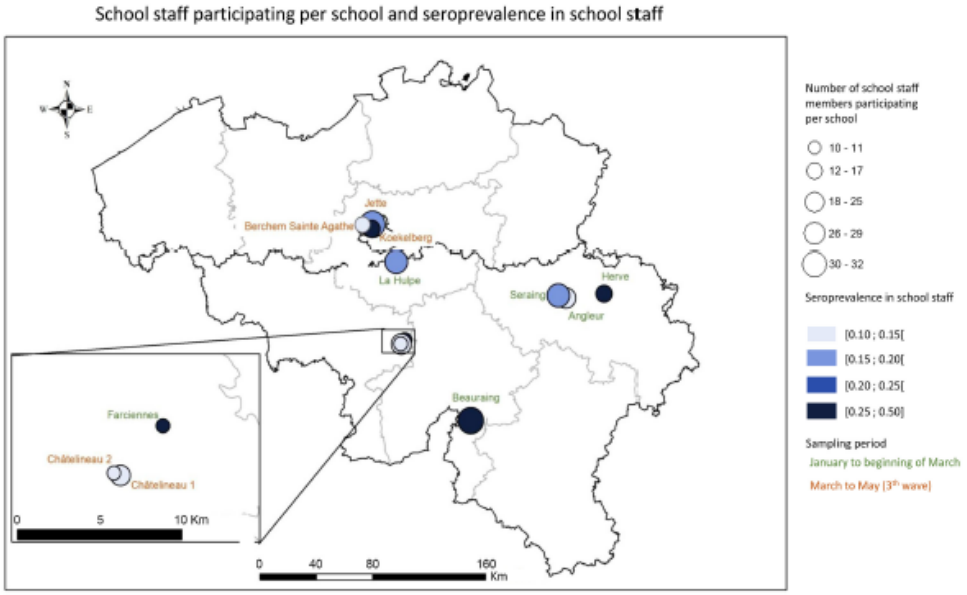


Figure 3. Geographic representation of participation and seroprevalence of children and school staff in Belgium. Participation (n total) is represented by the circle size. Seroprevalence (n IgG+/n total) in children and school staff is represented by the blue color scale.

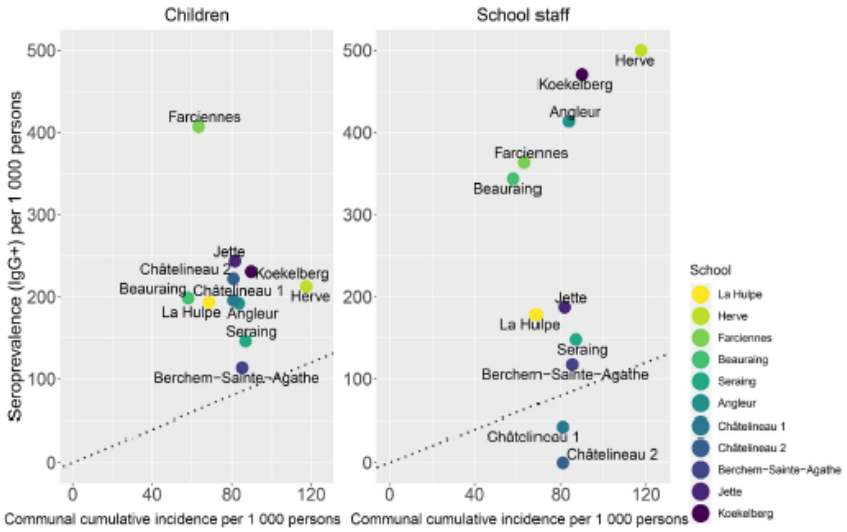


Figure 4. Seroprevalence in children and school staff according to communal cumulative incidence. Seroprevalence (IgG+) in children, school staff, and communal cumulative incidence are reported per 1000 persons. The identity line is represented by the black dashed line. Schools are represented by a colored dot.

Seroprevalence in children and staff was lower in larger schools (≥230 children) (children: r = −0.63; 95% CI [−0.89; −0.04]); staff: r = −0.28; 95% CI [−0.76; 0.38]). Seroprevalence in staff (Figure 5) was higher in schools with a high socioeconomic status (SES ≥ 13) (r = +0.37; 95% CI [−0.29; 0.79]), but it wasn't correlated in children (r = −0.10; 95% CI [−0.66; 0.53]).

4. Discussion

4.1. Participation in the Study

Children's participation in the study was lower than expected and may be partly explained by the problem of the recruitment period, which occurred during the lockdown. Reaching parents and children was difficult, resulting in misunderstandings and fears about the study. The two excluded schools because of a low participation rate had also a low socioeconomic status. Some parents did not speak French, and even if we translated flyers into different languages, they refused to let their children participate. The consent form was the only way to inform parents in detail about the study, but it was written in complicated terms as requested by our ethical committee and led to some fears.

Most parents expressed their refusal to let their child participate, using arguments that showed a lack of understanding of how the study was being conducted (e.g. "we do not want our child to be vaccinated"). Investigators tried to explain the study process in simple terms, suitable for the general population, to reluctant parents. Some parents subsequently agreed to their child's participation, others did not.

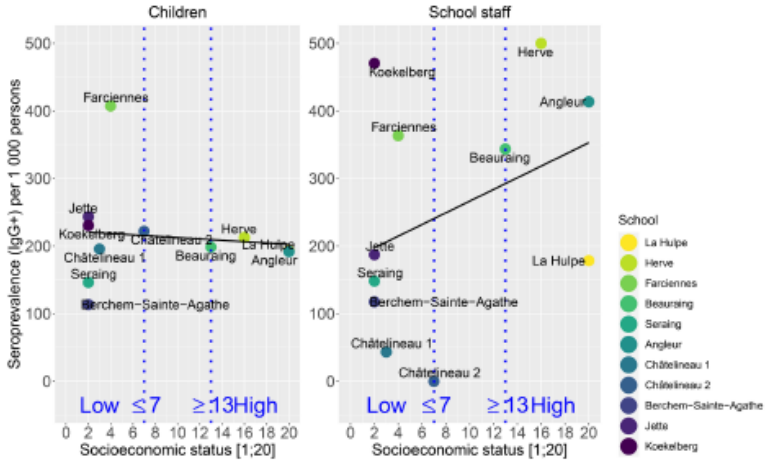


Figure 5. Seroprevalence in children and school staff according to the socioeconomic status. Seroprevalence (IgG+) in children and school staff is reported per 1 000 persons. Socioeconomic status (Belgian 20-point-scale SES index) is represented from 0 to 20. The two extremes value, ≤7 and ≥13 are represented by the two blue dashed lines. The correlation between seroprevalence and socioeconomic status is represented by a black line. Schools are represented by a colored dot.

Participation of children was higher in schools where staff participation was high. The only person available to explain the study simply was the teacher or the principal. When the teacher was motivated to participate, children were perhaps more motivated to participate. Staffs were mostly motivated to participate in every school. Not every worker could be present on the day we conducted the test, which may explain some refusals. Adherence to the study to know the presence or absence of antibodies to the SARS-CoV-2 virus was one of the reasons that motivated staff members to participate. Contrarily, of those who had been infected by COVID-19, some did not wish to participate because they already knew the presence or absence of antibodies.

In the protocol, we decided to establish three inclusion criteria to select schools. One was the incidence level of SARS-CoV-2 based on May 6th, 2020. When we computed the participation according to the incidence level of SARS-CoV-2, we estimated the incidence based on the inclusion day. Participation of children and staff was higher whereas the incidence level of SARS-CoV-2 was lower. The fear of the virus can explain the lower participation where the incidence was higher.

Participation of children and staff was lower in large schools. Small schools are known to have more social contact and therefore, as children and staff participated, others were more inclined to participate.

Children's participation was the lowest (<50%) in schools with low socioeconomic status (SES ≤ 7), but it wasn't true for staff. The socioeconomic environment seems to influence children's participation. Although we needed written consent from children and parents, the information should be more accessible and understandable, with simple terms suitable for children and parents. Every staff didn't come from the same area. SES was calculated for every child within the school and children usually come from the same area as the school. As a result, the socioeconomic status and the participation of staff were not correlated.

A low socioeconomic status shows that the different variables that decrease this index are more important in these schools. The different variables that decrease the socioeconomic status of schools are the proportion of people with a nursery or primary school degree, the proportion of persons with social assistance, the proportion of people with manual work, and the proportion of people working in the lowest level of the tertiary sector [16].

One of the variables concerns the abstention of social assistance, to determine socioeconomic status. In Belgium, the CPAS ("Centre Public d'Action Sociale") is a social assistance that aims to ensure the right to social integration for people who do not have sufficient income. To benefit from this social assistance, the person must meet the six legal conditions, which are: Belgian nationality, permanently living in Belgium, being of legal age, insufficient resources, willingness to work, and having used up all the different social rights (the CPAS only operates as a last resort) [21].

4.2. Seroprevalence in Children and Staff

SARS-CoV-2 seroprevalence in staff was higher than in children, with 25.4% and

20.7% respectively. Seroprevalence among children was higher in schools with high seroprevalence among staff. The weak intraclass coefficient correlation suggests that seroprevalence didn't present a classroom cluster. The classroom size did not appear to have an impact on the SARS-CoV-2 seroprevalence among children in this study. Similar results were obtained in the PCR analysis. The most positive samples came from isolated cases and did not lead to clusters or increased cases [22].

An initial study in Iceland showed that 6.7% (38/564) of children under 10 years of age tested positive for SARS-CoV-2, compared to 13.7% (1183/8635) of individuals older than 10 years [3].

In England, a study in primary schools reported a seroprevalence of 11.2% (91/816; 95% CI [7.9; 15.1]) in children and 15.1% (209/1381; 95% CI [11.9; 18.9]) in staff. The weekly transmission of SARS-CoV-2 in children was 4.1 per 100,000 persons (12.5 in adults) [23]. A prospective cross-sectional study analyzed infection clusters and outbreaks in staff and students. Staff had a higher incidence than children and the risk of an outbreak increased by 72% for every 5 cases per 100,000 in community incidence [24]. Children appear to be more likely mild or asymptomatic and then are less being tested for the virus [23] [24].

In another small study conducted in a Belgian primary school, 20.6% (13/63; 95% CI [10.6; 30.6]) of children tested positive with a throat washing sample, and the majority of them were asymptomatic. In that study, the positivity rate in adults was 27.1% (32/118; 95% CI [19.1; 35.7]), also higher, as in our results [25].

COVID-19 had often a milder course with a better prognosis in children than in adults, and deaths were exceptionally rare in children [26] [27] [28]. The difference between adults and children developing COVID-19 remains unexplained, even if immunity and innate responses may play a role [29] [30] [31]. Children can develop an immune response to the virus without virologic confirmation of SARS-CoV-2 infection, suggesting the possibility that immunity prevents the onset of SARS-CoV-2 infection [32].

Children less than 10 years old were estimated to be significantly less infected by SARS-CoV-2 [33]. It seems important to make a distinction between children and adolescents, as the results do not appear to be entirely similar. Several studies have shown that seroprevalence in children and adolescents would differ.

Two Belgian studies compared seroprevalence in Belgian primary schools to secondary schools. In the first study, 6.6% (95% CI [1.2; 12.1]) were seropositive in primary schools compared to 12.2% (95% CI [7.2; 17.1]) in secondary schools [34]. The second study performed this comparison over 3 periods: from December 2020 to January 2021, in March 2021, and from May to June 2021. Seroprevalence was comparable in both groups but lower in primary schools. Seroprevalence was: 11.0% (95% CI [7.6; 15.9]) in primary schools versus 13.6 (95% CI [9.9; 18.5]) in secondary schools, 17.1% (95% CI [13.3; 21.9]) in primary schools versus 18.0% (95% CI [13.6; 23.8]) in secondary schools for the second period; 15.4% (95% CI [12.2; 19.6]) in primary schools versus 17.2% (95% CI [13.1; 22.7]) in secondary schools for the third period [35].

4.3. Seroprevalence and Local Cumulative Incidence

During the study, only healthcare workers or people aged over 65 had access to COVID-19 vaccination in Belgium. COVID-19 vaccination in Belgium for the general population (over 12 years of age) began in June 2021, after the end of the study [36].

Throughout the lockdown period, investigators worked closely with the local health promotion teams and schools. Before, during, and after the study, the local physicians provided data concerning infected children and staff. Specific measures against COVID-19 were set up for primary schools (see **Additional file 1** for more details) [17] [18].

Previous studies reported that children do not appear to play a major role in the transmission of SARS-CoV-2. [3]-[9] Results of our study show that the seroprevalence among children and staff within schools was higher than the incidence of COVID-19-positive cases in the area, because the communal cumulative incidence was underestimated. At the beginning of the pandemic in Belgium, only people with severe symptoms (e.g. temperature ≥ 38˚C) were tested. All possible contacts in adults were tested after mid-June 2020 [17].

The lateral flow test that we used during our study had a sensitivity of 68.8% and a specificity of 95.8% [19]. The positive predictive value is expected to be high, but we have no way to estimate the seroprevalence itself.

The serological test in children and staff was operated at inclusion but a second test one week after was not allowed per protocol, so positive IgM with negative IgG couldn't be assessed for new infections.

The presence of antibodies reflects a previous virus infection/contact. It doesn't show the actual number of persons with SARS-CoV-2 infection at that time. This might also explain why seroprevalence in children wasn't correlated to the local cumulative incidence.

4.4. Seroprevalence and School Size

School size was considered as a way to evaluate social contact in children, which is an important factor in virus transmission [6]. The findings suggest that SARS-CoV-2 antibody seroprevalence was lower in larger schools, both in children and staff. These results suggest that close contacts are maybe more important in small schools, even if number of contacts is expected to be higher in larger schools.

4.5. Seroprevalence and Socioeconomic Status

Seroprevalence in staff was higher in schools with high socioeconomic status, and seroprevalence wasn't correlated with SES in children. The first reason is that SES is calculated from children's data and not from staff data. Another reason is that most teachers and staff live outside the local area. For children, seroprevalence didn't correlate with socioeconomic status as opposed to participation rates that were highly correlated with SES.

5. Limitations

Our study has some limitations. Study information was only provided in paper forms with complicated terms and maybe not adapted to the general population, leading to low participation. Recruitment was made thanks to principals because of the restriction distance measures at that time. Distance recruitment increased the misunderstanding of parents and children about the purpose of the study.

Seroprevalence was only analyzed at the beginning of the study, based on the protocol. A comparison between the beginning and another time point during the study would allow us to analyze the evolution of the situation, but also during the different measures taken at that time against COVID-19.

Another limitation is that the SES is linked to a school and not a child; we don't know if all participant children from low-SES schools are living in poverty or not.

Nevertheless, our results are consistent with other studies.

6. Conclusions

Our main findings are that children from schools with low socioeconomic status were less allowed to participate. Children had a lower seroprevalence than staffs and there was no classroom cluster, suggesting that they are not SARS-CoV-2 transmitters. Our results strongly suggest that information strategies have to be more oriented to low socioeconomic status to increase their participation in disease control. The well-being and mental health of children should be at the center of our decisions to limit further consequences in their development and scholarship. Data on the virus infection and transmission are important for decision-making to control the disease while considering the numerous consequences that may result from these decisions.

Children have been and are still being strongly affected by the COVID-19 pandemic. Understanding SARS-CoV-2 transmission in schools could limit the long-term consequences on children's scholarship, development, and well-being. Taking socioeconomic status into consideration is an important notion to analyze the virus transmission as the pandemic has reinforced social inequalities. By integrating all the lessons learned from this pandemic, we will be better prepared to deal with future health problems.

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Compliance with Ethics Guidelines

This study was carried out in accordance with relevant guidelines and regulations (e.g. the Declaration of Helsinki). The protocol, informed consent forms, and questionnaires were approved by the Hospital-Faculty Ethics Committee Saint-Luc ("Commission d'Ethique Hospitalo—Facultaire des Cliniques Universitaires Saint-

Luc")—UCLouvain, in Brussels, approval number: 2020/16NOV/552. It was registered on clinicaltrials.gov on 16/09/2021, identifier number: NCT05046470, and on ISRCTN on 20/04/2022, identifier number: ISRCTN16837012. Written informed consent was obtained from all participants before participation and/or from their legal guardians.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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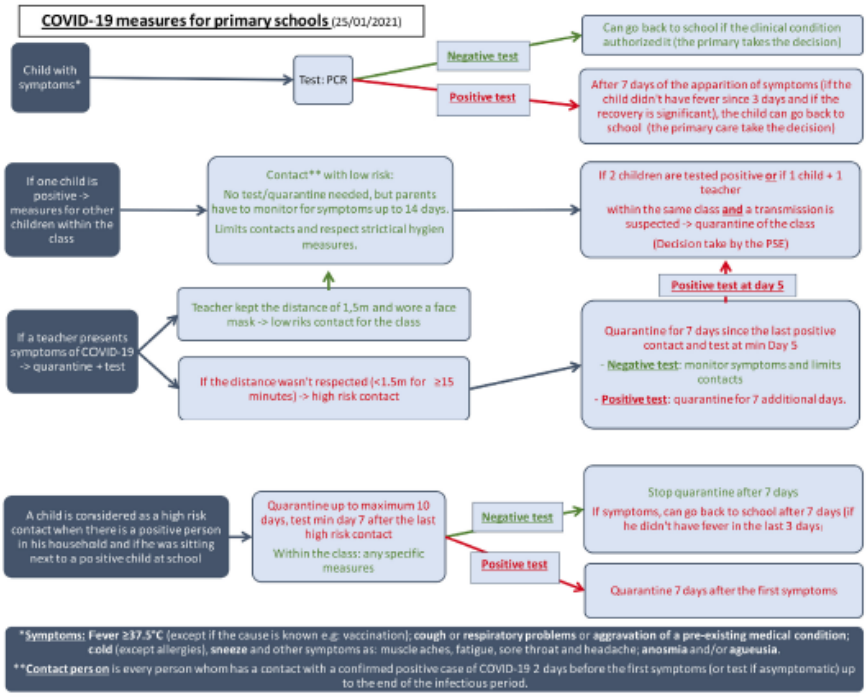
Additional_File_1



Additional_File_2

Table A1. Participation of children and school staff by school.

School	Children		School Staff	
	Participants n (%)	Number of Children n	Participants n (%)	Number of School Staff n
La Hulpe (PC: 1310)	150 (71.1)	211	28 (71.8)	39
Herve (PC: 4650)	94 (57.0)	165	16 (38.1)	42
Farciennes (PC: 6240)	27 (45.8)	59	11 (100.0)	11
Beauraing (PC: 5570)	151 (50.7)	298	32 (71.1)	45
Seraing (PC: 4100)	41 (32.8)	125	27 (71.1)	38
Angleur (PC: 4031)	125 (51.2)	244	29 (69.0)	42
Châtelineau 1 (PC: 6200)	97 (42.7)	227	23 (46.0)	50
Châtelineau 2 (PC: 6200)	99 (36.0)	275	10 (20.0)	50
Berchem-Sainte-Agathe (PC: 1082)	44 (11.6)	379	17 (36.2)	47
Jette (PC: 1090)	78 (30.5)	256	32 (91.4)	35
Koekelberg (PC: 1081)	26 (10.4)	249	17 (37.8)	45

Participation of children and school staff are represented by the participants' number and percentages, n (%). Number of children and school staff designates the total number presents in the school. PC: postcode.

Additional_File_3

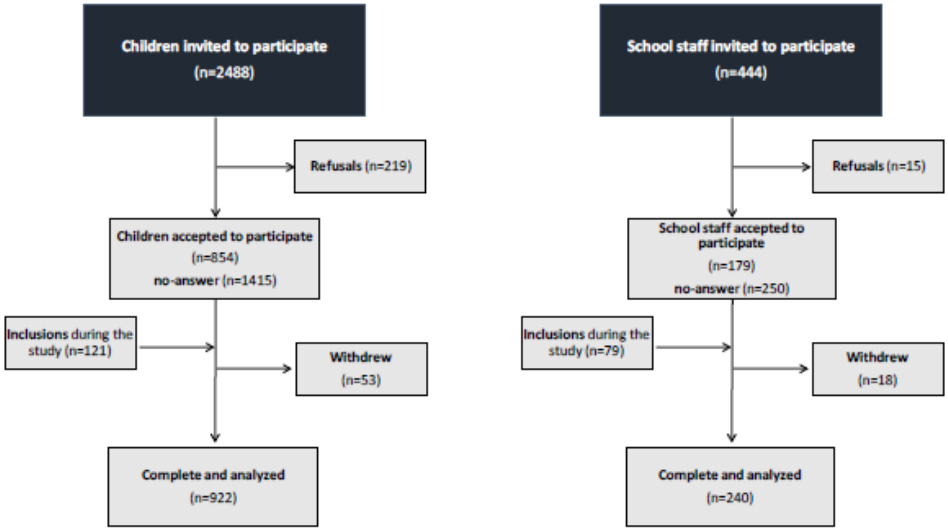


Figure A1. Flowchart: flow participant during the study. Children and school staff flowchart who participated in a rapid serological test by finger prick (AVIOQ®). Children flow chart is on the left and school staff flow chart is on the right. No-answer indicates a person who did not return the written consent with a "Yes" or a "No". Inclusions designates a person who decided to participate after the 1st day of inclusion within the school. Withdrew specifies a person who no longer wanted to participate or the AVIOQ result is missing/unreadable.

Additional_File_4

Table A2. Frequency of serological tests.

	AVIOQ		
	Children	School Staff	Total
	(N = 932)	(N = 242)	(N = 1174)
++ n(%)	183 (19.8)	59 (24.6)	242 (20.8)
[95% CI]	[17.3 - 22.6]	[19.3 - 30.5]	[18.5 - 23.3]
−+ n(%)	8 (0.9)	2 (0.8)	10 (0.9)
[95% CI]	[0.4 - 1.7]	[0.1 - 3.0]	[0.4 - 1.6]
+− n(%)	5 (0.5)	7 (2.9)	12 (1.0)
[95% CI]	[0.2 - 1.3]	[1.2 - 5.9]	[0.5 - 1.8]
−− n(%)	726 (78.7)	172 (71.7)	898 (77.3)
[95% CI]	[76.0 - 81.3]	[65.5 - 77.3]	[74.8 - 79.7]
Unreadable	6	0	6
Missing	4	2	6

Frequency of serological tests in children and school staff. ++: IgM+ IgG+; −+: IgM− IgG+; +−: IgM+ IgG+; −−: IgM− IgG−, Unreadable: result was unreadable.

Additional_File_5

Table A3. Frequency of serological tests by school.

School	Children n(%)							School Staff n(%)						
	++	−+	+−	−−	Unreadable	Missing	Total	++	−+	+−	−−	Unreadable	Missing	Total
La Hulpe (PC: 1310)	28 (18.9)	1 (0.7)		119 (80.4)	2		150	5 (17.9)		2 (7.1)	21 (75.0)			28
Herve (PC: 4650)	20 (21.5)		1 (1.1)	72 (77.4)	1		94	7 (43.8)	1 (6.3)	1 (6.3)	7 (43.8)			16
Farciennes (PC: 6240)	11 (40.7)			16 (59.3)			27	4 (36.4)			7 (63.6)			11
Beauraing (PC: 5570)	30 (20.3)			118 (79.7)	3		151	11 (34.4)			21 (65.6)			32
Seraing (PC: 4100)	3 (7.3)	3 (7.3)		35 (85.4)			41	4 (16.0)			21 (84.0)		2	27
Angleur (PC: 4031)	23 (18.4)	1 (0.8)		101 (80.8)			125	12 (41.4)			17 (58.6)			29
Châtelineau 1 (PC: 6200)	18 (18.8)	1 (1.0)	1 (1.0)	76 (79.2)		1	97	1 (4.3)		1 (4.3)	21 (91.3)			23
Châtelineau 2 (PC: 6200)	20 (20.4)	2 (2.0)	1 (1.0)	75 (76.5)		1	99				10 (100.0)			10
Berchem-Sainte-Agathe (PC: 1082)	5 (11.4)			39 (88.6)			44	2 (11.8)		1 (5.9)	14 (82.4)			17
Jette (PC: 1090)	19 (24.4)		2 (2.6)	57 (73.1)			78	6 (18.8)		1 (3.1)	25 (78.1)			32
Koekelberg (PC: 1081)	6 (25.0)			18 (75.0)		2	26	7 (41.2)	1 (5.9)	1 (5.9)	8 (47.1)			17

Frequency of serological tests in children and school staff. ++: IgM+IgG+; −+: IgM− IgG+; +−: IgM+ IgG+; −−: IgM− IgG−, Unreadable: result was unreadable. PC: Postcode.

3. Objective n° 2

SARS-CoV-2 Transmission in Belgian French-Speaking Primary Schools: An Epidemiological Pilot Study

Abstract

Purpose

Schools have been a point of attention during the pandemic, and their closure one of the mitigating measures taken. A better understanding of the dynamics of the transmission of SARS-CoV-2 in elementary education is essential to advise decision-makers. We conducted an uncontrolled non-interventional prospective study in Belgian French-speaking schools to describe the role of attending asymptomatic children and school staff in the spread of COVID-19 and to estimate the transmission to others.

Methods

Each participant from selected schools was tested for SARS-CoV-2 using a polymerase chain reaction (PCR) analysis on saliva sample, on a weekly basis, during six consecutive visits. In accordance with recommendations in force at the time, symptomatic individuals were excluded from school, but per the study protocol, being that participants were blinded to PCR results, asymptomatic participants were maintained at school.

Results

Among 11 selected schools, 932 pupils and 242 school staff were included between January and May 2021. Overall, 6449 saliva samples were collected, of which 44 came back positive. Most positive samples came from isolated cases.

Conclusion

We observed that asymptomatic positive children remaining at school did not lead to increasing numbers of cases or clusters. However, we conducted our study during

a period of low prevalence in Belgium. It would be interesting to conduct the same analysis during a high prevalence period.

Keywords

SARS-CoV-2; schools; children; COVID-19; saliva testing; transmission

viruses

MDPI

Article

SARS-CoV-2 Transmission in Belgian French-Speaking Primary Schools: An Epidemiological Pilot Study

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Abstract: Schools have been a point of attention during the pandemic, and their closure one of the mitigating measures taken. A better understanding of the dynamics of the transmission of SARS-CoV-2 in elementary education is essential to advise decisionmakers. We conducted an uncontrolled non-interventional prospective study in Belgian French-speaking schools to describe the role of attending asymptomatic children and school staff in the spread of COVID-19 and to estimate the transmission to others. Each participant from selected schools was tested for SARS-CoV-2 using a polymerase chain reaction (PCR) analysis on saliva sample, on a weekly basis, during six consecutive visits. In accordance with recommendations in force at the time, symptomatic individuals were excluded from school, but per the study protocol, being that participants were blinded to PCR results, asymptomatic participants were maintained at school. Among 11 selected schools, 932 pupils and 242 school staff were included between January and May 2021. Overall, 6449 saliva samples were collected, of which 44 came back positive. Most positive samples came from isolated cases. We observed that asymptomatic positive children remaining at school did not lead to increasing numbers of cases or clusters. However, we conducted our study during a period of low prevalence in Belgium. It would be interesting to conduct the same analysis during a high prevalence period.

Keywords: SARS-CoV-2; schools; children; COVID-19; saliva testing; transmission

1. Introduction

Schools have been the subject of many controversies during the COVID-19 pandemic. Local infection prevention and control (IPC) measures differed between countries. While some countries chose for a zero-COVID strategy from the beginning [1], others (such as

many European countries) took public health measures aiming at controlled circulation of the virus. Those countries had to find the right balance between the competing risks for society of hospitals, and especially intensive care units, under pressure; the risks related to the lockdown of several sectors (e.g., culture); and that of a more genuine focus on the wellbeing of children by keeping schools open [2].

In some parts of the world, on the contrary, school closure was chosen as a major strategy to slow down the epidemic. Most reviews show, however, the major downside of this mitigation measure [3], because it dramatically impacts education and both the physical and mental health of millions of children. Many therefore concluded that schools should be the last institutions to close [4,5].

Schools are complex, open, and interconnected systems with the outside world and its communities. By consequence, the dynamic of transmission of SARS-CoV-2 within schools is highly dependent on several factors, such as: virus incidence in the community [6], circulating virus variants (i.e., variants of concern), household transmission [7,8], transport use [9], population density [10], traveling, environmental factors (e.g., temperature), participation in extracurricular activities, social determinants of participants (e.g., ethnicity) [11] and the application of mitigations measures such as mask use (by teachers and/or pupils) [12], ventilation [13] and vaccination coverage [14].

Both our knowledge and the dynamics themselves of SARS-CoV-2 transmission between children and from children to adults have evolved during the crisis, especially with the emergence of new variants. Although children were initially considered as super-spreaders in similitude to influenza epidemics [15], accumulating data suggest that they did not play a major role early in the pandemic [16]. However, a study performed in a primary school during the second wave in Belgium shows a similar pattern of transmission (i) between children and (ii) between children and teachers or employees, suggesting that transmission from children might have been higher at later stages than suspected [17].

The general objective of this study is to describe the dynamics of transmission of SARS-CoV-2 in elementary education in the French community (named Fédération Wallonie-Bruxelles (FWB)), Belgium, during winter and spring 2021.

2. Materials and Methods

An uncontrolled non-interventional prospective study, named DYNAtracs, DYNAmic of TRAnsmission of Coronavirus in Schools, was conducted between January 2021 and May 2021, in Belgian French-speaking elementary schools (children between 6 and 12 years old) from the FWB. This sub-study is part of a larger study exploring the dynamics of transmission of SARS-CoV-2 in elementary schools and the wellbeing of children during the pandemic. The specific objectives of this sub-study were to describe, during the second (i.e., starting on week 36, 2020) and third (week 7 to week 25, 2021) waves (Figure 1) [18] of the pandemic when the Alpha variant dominated, the role of asymptomatic children attending primary schools in the spread of SARS-CoV-2, and to estimate the incidence of children who were infected through contact with an index case outside of the school environment. In addition, the study was designed to assess the acceptability of a salivary sample taken with a swish/gargle technique in children.

2.1. Study Setting and Participants Enrolment

Among Belgian elementary schools from the FWB, we identified a representative sample using purposive sampling according to three surrogate markers: (i) school size, (ii) socio-economic status (SES) of the pupils attending the schools, and (iii) cumulative incidence of SARS-CoV-2 infection in the geographic province of the school during the first wave of the pandemic (spring 2020).

More specifically, we applied the FWB's definition of a small versus large school, i.e., a school with a lower hosting capacity, or of more than 230 pupils, in order to consider the contacts within the school. A value for SES, measured using the FWB's official 20-point-scale index for all schools, equal or greater than 13 (upper tertile) was defined as high, and

a value lower or equal to 7 (first tertile) was defined as low. A low versus high incidence region was described as a province with a cumulative municipal incidence of less than 5.0/1000 persons versus more than 5.0/1000 persons, on 6th May 2020. Investigators refer to the publicly available Belgian epidemiological reports from Sciensano, the Belgian institute of health [19]. Crossing the three criteria resulted in the definition of eight categories of schools, from which the sample was selected. Schools were included sequentially, and upon acceptance, if an invited school declined, another school meeting the same criteria was invited to participate.

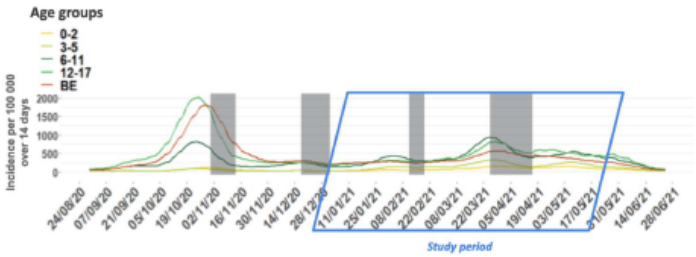

Figure 1. Fourteen-day incidence of COVID-19 cases per 100,000 persons by age group and for the general population, from 1 September 2020 to 30 June 2021, Belgium. The incidence is represented by the sum of the number of cases in the previous 14 days over the number of people in that age group. "BE" indicates the whole population in Belgium (all age groups). Shaded areas indicate school holiday periods.

All children registered and attending the participating schools, along with all adults working inside the schools, were then invited to participate through a letter. For each school, investigators provided information about the nature of the study to the children's legal representatives—parents or guardians—and to school staff, during an online live meeting. A website with details about the study design, study information, informed consent, and videos on how to perform a mouth rinse/gargle specimen was available for all (potential) participants (https://www.sesa.ucl.ac.be/Dynatracs/, accessed on 25 August 2022). The informative letters were translated from French into the most encountered languages in the school communities.

Only children who provided informed consent signed by their legal guardian and staff who signed the consent were included in the study.

2.2. *Study Design, Sample Collection and Laboratory Analysis*

Pupils and staff included in the study population were followed-up during six weekly visits over subsequent weeks, according to the school calendar. Therefore, school breaks were not included in the study time. The start date differed between schools due to differences in timeline for obtaining consents, school location, and field planning. On the first visit corresponding to the inclusion visit, a blood sample was taken from all participants by finger prick to perform a rapid serological test (Avioq®, Bio-Tech, Shandong China). The CE-labeled Avioq® test is a lateral-flow antibody IgG/IgM test (colloidal gold) that targets the SARS-CoV-2 N-protein. The combined sensitivity for IgM and IgG was 68.8% (CI 95% 60.3–76%) with a specificity of 95.8% (CI 95% 88.5–98.6%) [20]. After collection, serological tests were first read on site by one of three designated study staff and sequentially sent for secondary reading to one single laboratory (Department of Microbiology, Cliniques universitaires Saint-Luc, Brussels) by one experienced microbiologist. During that same first visit, a mouth rinse/gargle specimen for SARS-CoV-2 detection by quantitative real-time reverse transcriptase PCR (RT-qPCR) was also collected. On subsequent weekly visits, all participants provided a mouth rinse/gargle specimen for a total duration of six weeks. Adult participants were invited to self-collect their mouth rinse/gargle specimens while pupils' specimens were collected under supervision of study staff. All samples were

collected on site and in a well-ventilated room or outside depending on the facilities and the meteorological conditions. The supervising study staff was wearing personal protective equipment (PPE) including a FFP2 mask. For each collection, a 5 mL vial of sterile 0.9% saline was squeezed into the participant's mouth. They were then asked to swish the content for 5 s followed by tilting their heads back and gargling for 5 s. This swish/gargle cycle was repeated two more times and then the saline was expelled into a dedicated device designed by the University of Liège, commercialized by Diagenode (4100 Seraing, Belgium). The sampling kit was equipped with a dosing funnel that permitted the collection of exactly 1.2 mL of saliva, which was subsequently mixed with 2 mL of lysis buffer, inactivating the virus [21]. The self-collected swish/gargle sampling technique was previously evaluated in adults and school-aged children and compared to nasopharyngeal swabbing. It had a better acceptability with a good sensitivity of 97.5% (95% CI 86.8–99.9%) [22].

Participants were asked to not drink or eat within the 1 h preceding sampling. In case of sampling failure, a second attempt was not allowed. Saliva samples were directly dispatched to one of the three participating laboratories, attached to the three French-speaking universities, i.e., Department of Microbiology of Cliniques universitaires Saint-Luc, Federal testing platform COVID-19 of the Université Libre de Bruxelles, and the COVID-19 laboratory of the University of Liège. On reception, all samples were stored at −80 °C while awaiting processing. All RT-qPCR tests were performed according to directions from the laboratory of the University of Liège, which elaborated the collecting device and technique, as described in Saegerman et al. [21]. RT-qPCR results are reported as values of cycle threshold (Ct value, i.e., as defined by Public Health England, a semi-quantitative indicator of the concentration of viral genetic material in a sample [23]). In the study, positive samples were arbitrarily classified into three categories of Ct Values as follows: <25, 25–30, >30.

Phylogenetic analysis was performed on positive saliva samples presenting Ct values < 25 to investigate transmission of virus between participants. Total nucleic acid was extracted using the MagMAX™ Viral/Pathogen II Nucleic Acid Isolation Kit according to the manufacturer instructions (Cat. No. A48383, ThermoFisher Scientific, Waltham, MA, USA). The amplicon-based Illumina COVIDSeq protocol (Illumina Inc., San Diego, CA 92122, USA) in combination with the ARTIC v4 primers pools (https://artic.network/, accessed on 25 August 2022) was used for sequencing according to manufacturer's instructions. The pooled library was diluted to a final concentration of 100pM for a single read (1 × 150 bp) sequencing on a NextSeq 1000 instrument. Generated fastq files were uploaded on the cloud-based ASP-IDNS®−5 analysis software (SmartGene, 1015 Lausanne, Switzerland). For analysis we used the "SARS-CoV-2 full genome" pipeline version 2.5.0_COV_v0.2. Online Nextclade version 2.3.0 software as a first sequence aligner, allowing comparison to the Wuhan-hu-1/2019 (MN908947) SARS-CoV-2 reference genome and permitting a clade assignment (https://clades.nextstrain.org, accessed on 25 August 2022). FASTA sequences were also submitted to the Pangolin (4.1.1) COVID-19 Lineage Assigner. Phylognentic Tree was generated by submitting the Fasta files to the NG-Phylogeny web interface [24]. The workflow included: sequence alignment using the MAFFT software, curation of the sequences with the block mapping and gathering with entropy (BMGE) software, tree generation using the fast distance-based phylogeny inference program FastME 2.0, and tree output formatted with the Newick display. A detailed description of SARS-CoV-2 whole-genome sequences method is available in the Supplementary file S1.

All participants as well as study staff were blinded to RT-qPCR results, until the end of the study, as per protocol. Therefore, participation in the study and PCR test results had no impact on school attendance. During the study period, school attendance was, however, subject to health measures dictated by the Belgian government for all participants. These mitigation measures changed over time. At the time of the study, sanitary measures in elementary schools were as follows: frequent hand hygiene, mask wearing for adult staff when in close contact with pupils or other staff, quarantine measures for symptomatic individuals and high-risk contacts until PCR results from samples taken by the individual's healthcare provider, and finally, closure of classes if two pupils or the teacher had confirmed SARS-CoV-2 cases. Therefore, no symptomatic individuals should have been tested in this study.

In addition, we cross-referenced positive PCR results with the cases reported to the school health promotion department (SHPD) in the participating schools. During the pandemic, the SHPD was designated to carry out surveillance of COVID-19 cases in schools and perform contact tracing in agreement with the regional public health units. SHPD reported the weekly numbers of pupils and staff with confirmed SARS-CoV-2 infections and collected data on the suspected source of infection (index case inside or outside the school) and counted probable secondary cases, i.e., having been infected in the school environment.

2.3. Statistical Analysis

Because this was a pilot study, no formal sample size determination was performed. Categorical variables are described by counts and percentages and continuous variables by means and standard deviations or median and interquartile ranges (IQR) for non-normal distributions. Data were analyzed using STATA software (version 14.1 StataCorp LP, College Station, TX, USA).

The protocol was approved by the Ethical Committee of the Cliniques universitaires Saint-Luc, UCLouvain (approval number 2020/16NOV/552, approved on the 20/11/20) and was registered on clinicaltrial.gov (Number NCT05046470) and on ISRCTN (Number ISRCTN16837012).

3. Results

We conducted this study between 14 January 2021 and 18 May 2021.

All schools were selected according to the above-mentioned criteria. Among eight schools that were invited to participate, two schools were excluded due to a high rate of refusal from either the staff or both the pupils and staff. Subsequently, five new schools were invited, resulting in a total of 11 included schools out of 13. The geographical distribution of the 11 schools included is depicted in Figure 2.

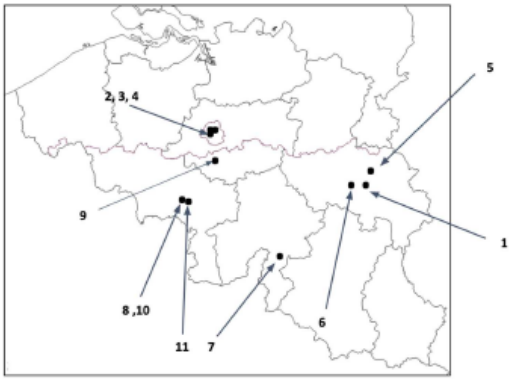

Figure 2. Geographical distribution of primary schools included in the study.

In total, 932 children and 242 school staff were included and completed the study, which corresponds to an overall participation rate of 37.5% and 54.7%, respectively (Figure 3, Table 1). Participation varied between schools, ranging from 10.4% to 71.1% and from 20.0% to 100% in children and school staff, respectively (Table 1).

The different schools were included sequentially over time. Six schools participated from January week 2 2021 to March week 10 2021, including one week of school break. Four schools started in February on week 8 of 2021 and ended in April on week 17 of 2021, with a 4-week period of school break, and finally one school participated from week 11 March 2021 to May week 20 2021 (Figure 4).

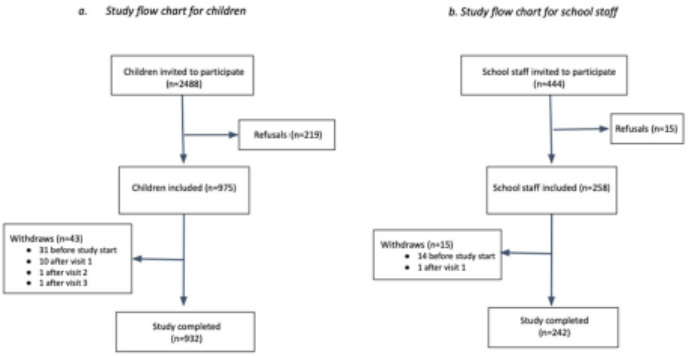

Figure 3. Study flowchart.

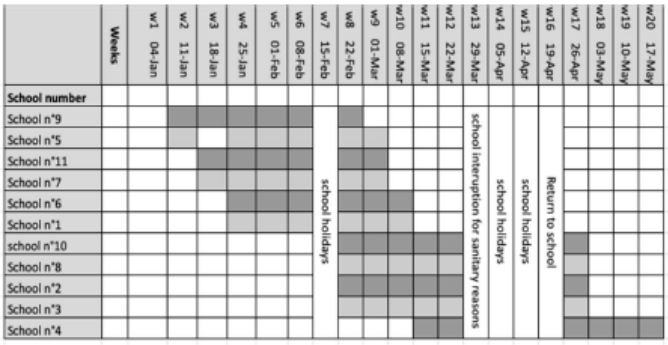

Figure 4. Study timeline. Sequentially inclusion of schools in the study. The weeks mentioned correspond to the calendar weeks of the year 2021. Shaded areas indicate the weeks of school visits. School n°5 was closed (optional school holiday) on the day of the study staff's visit in week 3.

Among 1162 available serological tests (6 missing and 6 invalid) performed once on study inclusion, 191 children and 61 staff tested seropositive, which corresponds to a positivity rate of 20.7% (95% CI 18.2–23.4) and 25.4% (95% CI 20.5–31.5), respectively, in children and school staff (Table 1) for whom a valid result is available.

Over the whole study period which included six weekly visits to each of the schools, a total of 6449 saliva samples were obtained; 5226 from children and 1217 from school staff, which corresponds to an average of 5.6 tests per child and 5.0 tests per adult. Some samples are missing due to absenteeism of participants on the collection date or due to invalid samples (swallowing or wrong execution) (Table 2). During the entire study period, 44 (0.7%) SARS-CoV-2 PCR tests were positive, 29 in children and 6 in school staff, which corresponds to a positivity rate of 3.11% in children and 2.46% in school staff. Of these children, nine had a positive test for two consecutive weeks (Table 3). Among all PCR-positive tested participants, 27/29 children (93.1%) and 2/6 (33.3%) school staff had a negative serological test at the beginning of the study. In four schools, we did not detect any positive PCR tests, and in 8 out of 11 schools, there were no positive PCR tests in school staff.

Table 1. Description of schools, participation rate, seropositivity rate at inclusion and number of positive SARS-CoV-2 PCR tests.

School Number	Cumulative Incidence of SARS-CoV-2	School Size	SES	Children Participation Rate *n* (%)	School Staff-Participation Rate *n* (%)	Cases with a Positive SARS-CoV-2 PCR (*n*)	Seropositivity Rate at Study Onset *n* (%)
1	High	Large	High	125/244 (51.2)	29/42 (69.0)	0/125 children 0/29 Staff	Children 24/125 (19.2) Staff 12/29 (41.4)
2			Low	44/379 (11.6)	17/47 (36.2)	4/45 children 2/17 Staff	children 5/44 (11.1) Staff 2/17 (11.8)
3				78/256 (30.5)	32/35 (91.4)	0/78 children 0/32 Staff	children 19/78 (24.4) Staff 6/32 (18.8)
4				26/249 (10.4)	17/45 (37.8)	0/26 children 0/17 Staff	children 6/24 (25.0) Staff 8/17 (47.1)
5		Small	High	94/165 (57.0)	16/42 (38.1)	1/94 child 0/16 Staff	children 20/93 (21.5) Staff 8/16 (50.0)
6			Low	41/125 (32.8)	27/38 (71.1)	0/41 children 0/27 Staff	children 6/41 (14.6) Staff 4/25 (16.0)
7	Low	Large	High	151/298 (50.7)	32/45 (71.1)	6/151 children 2/32 Staff	children 30/148 (20.3) Staff 11/32 (34.4)
8			Low	99/275 (36.0)	10/50 (20.0)	12/99 children 0/10 Staff	children 22/98 (22.5) Staff 0/10 (0.0)
9		Small	High	150/211 (71.1)	28/39 (71.8)	1/150 child 2/29 Staff	children 29/148 (19.6) Staff 5/28 (17.9)
10			Low	97/227 (42.7)	23/50 (46.0)	3/97 children 0/23 Staff	Children 19/96 (19.8) Staff 1/23 (4.3)
11				27/59 (45.9)	11/11 (100)	2/27 children 0/11 Staff	children 11/27 (40.7) Staff 4/11 (36.4)

Description of participating schools according to 3 criteria: (i) school size (small < 230 pupils), (ii) socio-economic status (SES) of the population attending the school (high level score ≥ 13), and (iii) cumulative incidence of SARS-CoV-2 infection in the geographic province of the school during the first wave of pandemic, in spring 2020 (low incidence < 5/1000 persons). Participation of children and school staff are represented by total number and percentages. Positive SARS-CoV-2 PCR are represented by total numbers with the distinction between children and school staff (SS). Positive serological tests of children and school staff are represented by total number and percentages. Missing data or invalid tests are excluded from the analyses. SES: socio-economic status; Staff: school staff.

Table 2. Summary table of SARS-CoV-2 PCR results for each school.

School Number/Participants (n)		Visit 1			Visit 2			Visit 3			Visit 4			Visit 5			Visit 6		
		PCR−	PCR+	M	PCR−	PCR+	M	PCR−	PCR+	M	PCR−	PCR+	M	PCR−	PCR+	M	PCR−	PCR+	M
1/154	Week n°		w4			w5			w6			w8			w9			w10	
	Pupils	116	0	1	119	0	4	117	0	6	123	0	2	119	0	6	119	0	6
	SS	29	0	0	29	0	0	29	0	0	28	0	1	25	0	4	28	0	1
	Total	145	0	1	148	0	4	146	0	6	151	0	3	144	0	10	147	0	7
	Total		146			152			152			154			154			154	
2/62	Week n°		w8			w9			w10			w11			w12			w17	
	Pupils	42	1	0	41	2	2	43	0	2	26	1	18	30	0	15	36	0	9
	SS	11	0	0	17	0	0	13	2	2	9	0	8	5	0	12	10	0	7
	Total	53	1	0	58	2	2	56	2	4	35	1	26	35	0	27	46	0	16
	Total		54			62			62			62			62			62	
3/110	Week n°		w8			w9			w10			w11			w12			w17	
	Pupils	77	0	0	71	0	7	77	0	1	74	0	4	69	0	9	75	0	3
	SS	31	0	0	28	0	4	26	0	6	23	0	9	16	0	16	17	0	15
	Total	108	0	0	99	0	11	103	0	7	97	0	13	85	0	25	92	0	18
	Total		108			110			110			110			110			110	
4/43	Week n°		w11			w12			w17			w18			w19			w20	
	Pupils	22	0	0	24	0	0	20	0	6	26	0	0	24	0	2	24	0	2
	SS	15	0	0	14	0	3	4	0	13	12	0	5	8	0	9	8	0	9
	Total	37	0	0	38	0	0	24	0	19	38	0	5	32	0	11	32	0	11
	Total		37			41			43			43			43			43	
5 /110	Week n°		w2			w4			w5			w6			w8			w9	
	Pupils	90	0	0	67	0	27	87	0	7	89	0	5	94	0	0	92	1	1
	SS	16	0	4	12	0	4	13	0	3	13	0	3	15	0	1	13	0	3
	Total	106	0	4	79	0	31	100	0	10	102	0	8	109	0	1	105	1	4
	Total		110			110			110			110			110			110	
6/68	Week n°		w4			w5			w6			w8			w9			w10	
	Pupils	41	0	0	39	0	2	39	0	2	40	0	1	39	0	2	40	0	1
	SS	24	0	2	24	0	3	24	0	3	25	0	2	24	0	3	25	0	2
	Total	63	0	2	63	0	5	63	0	5	65	0	3	63	0	5	65	0	3
	Total		65			68			68			68			68			68	
7/183	Week n°		w3			w4			w5			w6			w8			w9	
	Pupils	148	1	1	144	2	5	150	0	1	136	0	15	140	2	9	138	1	12
	SS	32	0	0	30	0	2	32	0	0	29	0	3	25	2	5	29	0	3
	Total	180	1	1	174	2	7	182	0	1	165	0	18	165	4	14	167	1	15
	Total		182			183			183			183			183			183	
8/109	Week n°		w8			w9			w10			w11			w12			w17	
	Pupils	91	1	1	91	3	4	88	7	4	81	5	13	84	1	14	88	1	10
	SS	10	0	0	9	0	1	10	0	0	9	0	1	8	0	2	7	0	3
	Total	101	1	1	100	3	5	98	7	4	90	5	14	92	11	16	95	1	13
	Total		103			108			109			109			109			109	
9/179	Week n°		w2			w3			w4			w5			w6			w8	
	Pupils	149	0	1	145	0	5	142	0	8	144	1	5	143	0	7	143	0	7
	SS	26	0	1	21	0	7	21	1	7	24	0	5	23	0	6	19	1	9
	Total	175	0	2	166	0	12	163	1	15	168	1	10	166	0	13	162	1	16
	Total		177			178			179			179			179			179	
10/120	Week n°		w8			w9			w10			w11			w12			w17	
	Pupils	91	1	0	89	1	6	88	1	7	92	0	5	89	0	8	84	1	12
	SS	23	0	0	20	0	3	23	0	0	22	0	1	21	0	2	22	0	1
	Total	114	1	0	109	1	9	111	1	7	114	0	6	110	0	10	106	1	13
	Total		115			119			119			120			120			120	
11/38	Week n°		w3			w4			w5			w6			w8			w9	
	Pupils	26	0	0	27	0	0	24	2	1	14	1	11	23	0	4	26	0	1
	SS	9	0	1	10	0	1	10	0	1	8	1	3	6	0	5	9	0	2
	Total	35	0	1	37	0	1	34	2	2	22	2	14	29	0	9	35	0	3
	Total		36			38			38			38			38			38	

N: total number; M: missing or invalid sampling; SS: school staff. The weeks mentioned correspond to the calendar weeks of the year 2021.

Table 3. Description of positive SARS-CoV-2 PCR cases in the study population by week of the study.

Children									
Case Number	School Number	Serology Result	School Level	SARS-CoV-2 PCR					
				Visit 1	Visit 2	Visit 3	Visit 4	Visit 5	visit 6
1	school 9	neg	3C	-	-	-	$C_t < 25$	-	-
2	school 5	neg	4A	-	-	-	-	-	$C_t \geq 30$
3	school 11	neg	1A	-	-	$C_t \geq 30$	$C_t \geq 30$	-	-
4	school 11	neg	5A	-	-	C_t 25–30	$C_t \geq 30$	-	-
5	school 7	neg	1A	-	-	-	-	-	$C_t \geq 30$
6	school 7	neg	2B	-	$C_t < 25$	-	-	-	-
7	school 7	neg	3B	-	-	-	-	C_t 25-30	-
8	school 7	neg	4B	-	$C_t < 25$	-	-	-	-
9	school 7	pos	4B	-	-	-	-	$C_t \geq 30$	-
10	school 7	pos	6B	$C_t \geq 30$	-	-	-	-	-
11	school 10	neg	1B	$C_t < 25$	$C_t \geq 30$	-	-	-	-
12	school 10	neg	4B	-	-	-	-	-	$C_t \geq 30$
13	school 10	neg	6A	-	-	C_t 25–30	-	-	-
14	school 8	neg	1A	-	-	C_t 25–30	$C_t \geq 30$	-	-
15	school 8	neg	1A	-	-	C_t 25–30	$C_t \geq 30$	-	-
16	school 8	neg	1A	-	-	C_t 25–30	missing	-	-
17	school 8	neg	1A	missing *	-	$C_t \geq 30$	$C_t < 25$	missing	-
18	school 8	neg	3A	$C_t \geq 30$	-	-	-	-	-
19	school 8	neg	3B	-	-	-	$C_t < 25$	-	-
20	school 8	neg	4A	-	$C_t < 25$	C_t 25–30		-	-
21	school 8	neg	4A	-	$C_t < 25$	missing	Invalid test	C_t 25–30	-
22	school 8	neg	4A	-	$C_t < 25$	C_t 25–30	-	-	-
23	school 8	neg	4B	-	-	$C_t \geq 30$	-	-	-
24	school 8	neg	6A	-	-	-	C_t 25–30	missing	-
25	school 8	neg	6B	-	-	-	-	-	$Ct < 25$
26	school 2	neg	1A	-	$C_t < 25$	-	missing	missing	-
27	school 2	neg	2C	-	$C_t \geq 30$	-	missing	-	-
28	school 2	neg	4C	-	-	-	C_t 25–30	-	-
29	school 2	neg	5A	C_t 25–30	-	-	-	-	missing
School Staff									
1	school 9	neg	NA	-	-	-	-	-	C_t 25–30
2	school 9	pos	NA	-	-	$C_t \geq 30$	-	-	-
3	school 7	neg	NA	-	-	-	-	C_t 25–30	-
4	school 7	pos	NA	-	-	-	-	C_t 25–30	-
5	school 2	neg	NA	missing *	-	$C_t < 25$	missing	missing	-
6	school 2	neg	NA	missing *	-	$C_t < 25$	missing	missing	missing

Numbers were assigned chronologically according to the dates of sample collection, separating positive samples from pupils and school staff. Results are categorized into 3 categories of C_t value: $C_t < 25$, C_t: 25–30, C_t >30. Missing data correspond either to the fact that the participant was absent on the day of the visit or that the sample could not be taken for technical reasons (swallowed sample or inability to spit). * Inclusion at visit 2, NA: not applicable, C_t: cycle threshold.

In school n°8, four cases were detected concomitantly in the same class (first grade) and had a positive PCR SARS-CoV-2 for 2 weeks during visits 3 and 4. In the same school, three other positive cases were detected in the same class (4th grade), on visit 2. No school

staff member participating in the study tested positive in this school during the study period (Table 3). In school n°7, two cases were also detected in the same 4th grade class. All the other positive cases were isolated.

Cross-referencing the data from our study with information from the SHPD, there was no detectable increase in cases during the study period or in a 2-week time span after the end of the study period in all schools except in school n°2 (Figure 5). In school n°2, the SHPD declared a total of 36 cases between week 9 and week 18 of year 2021; 32 pupils and 4 school staff members (Figure 5, supplementary data Table S1). Among the 32 pupils detected, 14 who were considered as index cases for secondary cases within the school were themselves infected outside the school area, and 18 were considered as secondary cases, i.e., having been infected themselves in the school environment. The four school staff members who tested positive are considered as index cases. Due to the large number of cases detected in the school, first-grade classes were closed during weeks 11 and 12, the second grade on week 12, as well as one class of the third grade.

		Weeks	w52 28-Dec	w1 04-Jan	w2 11-Jan	w3 18-Jan	w4 25-Jan	w5 01-Feb	w6 08-Feb	w7 15-Feb	w8 22-Feb	w9 01-Mar	w10 08-Mar	w11 15-Mar	w12 22-Mar	w13 29-Mar	w14 05-Apr	w15 12-Apr	w16 19-Apr	w17 26-Apr	w18 03-May	w19 10-May	W20 17-May	W21 24-May	w22 31-May
School number										*						**	*	*	***						
School n°9	Study cases (P/SS)						0/1	1/0			0/1														
	SHPD cases (P/SS)										2/0	1/0	1/0		1/0										1/0
School n°5	Study cases (P/SS)											1/0													
	SHPD cases (P/SS)					2/0	2/1														1/0				
School n°11	Study cases (P/SS)							2/0	2/0																
	SHPD cases (P/SS)								1/0											1/0	1/0	1/0			
School n°7	Study cases (P/SS)					1/0	2/0				2/2	1/1													
	SHPD cases (P/SS)								2/0		1/0	1/0	2/0	0/2	1/1					1/0			4/0	0/1	4/0
School n°6	Study cases (P/SS)																								
	SHPD cases (P/SS)															1/0									
School n°1	Study cases (P/SS)																								
	SHPD cases (P/SS)									1/0				0/1	1/0							2/0	3/2	6/0	1/0
school n°10	Study cases (P/SS)										1/0	1/0	1/0							1/0					
	SHPD cases (P/SS)														0/1					0/1	1/0		2/0		
School n°8	Study cases (P/SS)										1/0	3/0	7/0	5/0	1/0					1/0					
	SHPD cases (P/SS)							0/1				2/1	1/0		0/1	0/1									
School n°2	Study cases (P/SS)										1/0	2/0	0/2	1/0	0/0					0/0					
	SHPD cases (P/SS)											1/0		8/3	16/0		2/0		0/1	4/0	1/0				
School n°3	Study cases (P/SS)										0/0	0/0	0/0	0/0	0/0					0/0					
	SHPD cases (P/SS)																			1/0			2/0	5/1	1/0
School n°4	Study cases (P/SS)													0/0	0/0					0/0	0/0	0/0	0/0		
	SHPD cases (P/SS)						3/0	3/2			1/0		1/0	2/0						1/0					

Figure 5. Reported cases of positive SARS-CoV-2 PCR during the study period detected by the study samples and reported by health promotion department from each school. SARS-CoV-2 cases detected by the study DynaTracs (first line) and reported by the school health promotion department (second line). Distinction was made between pupils (p) and adults school staff (SS). The weeks mentioned correspond to the calendar weeks of the year 2021. Shaded areas indicate the weeks of school visits. * School holidays, ** School Interruption for sanitary reasons, *** Return to school. p: pupils, SS: school staff, SHPD: school health promotion department.

Next-generation-sequencing analyses of the positive PCR results could be performed in 10 positive PCR with a Ct of less than 25. Unfortunately, only 57% of the genome analyzed was common to all 10 samples, allowing phylogenetic analyses to be performed on a very fragmented genome. The results obtained under these conditions suggested that the ten strains differ, as shown on Figure 6. Only two viruses seemed close, but participants came from different schools.

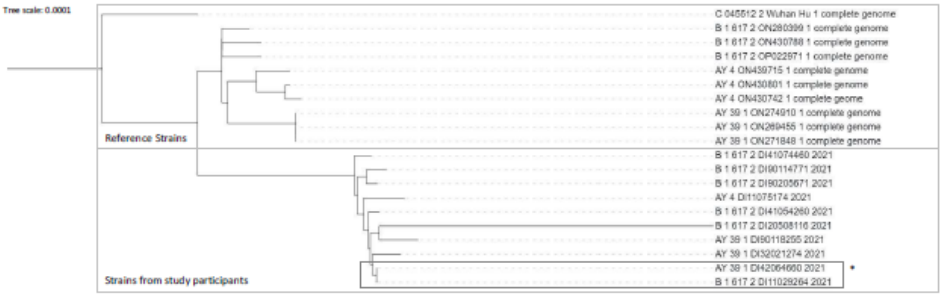

Figure 6. Phylogenetic tree comparing reference strains including Wuhan strain and strains from 10 participants. The upper part of the diagram represents the results from reference strains. The shaded part of the diagram represents results from the study samples. * Two strains with similarities, - participants coming from different schools.

4. Discussion

A better understanding of SARS-CoV-2 transmission in schools is of the utmost importance to guide future decisionmakers on school closures and educational disruptions, actions that have implications far beyond physical health. As mentioned above, the role of children in the dynamics of transmission SARS-COV-2 during the different stages of the pandemic and under the different variants of concern remains controversial. Since the circulation of more transmissible variants, it seems clear that children and young adolescents are as prone as older individuals to infection but less likely to develop a symptomatic or severe infection [1–3,25]. The question of whether these young populations are naturally less infectious than older age groups is still debated [25]. Moreover, as they experience less symptomatic disease, they can more easily escape testing strategies and are considered as potential silent drivers of the infection [26]. The singular design of this study, being weekly sampling during consecutive weeks with no exclusion of positive but asymptomatic pupils and adult staff is suited to estimate the potential and effective role of asymptomatic cases in transmission within the classes and the schools of elementary education.

Overall, the literature shows that the risk of transmission to and from children in schools seems to be low, especially in elementary education [27–29]. Our observational uncontrolled prospective study supports a low secondary transmission in schools. Among 11 selected schools, only 44 (0.7%) repetitively performed SARS-CoV-2 RT-qPCR tests came back positive, in 29 children and 6 school staff. These data are in line with similar observations made in schools. Vogel and colleagues, in Germany, reported that 8 out of 23,905 samples were positive in 17 elementary schools despite high community incidence rates [30]. In the UK, Ladhani and colleagues concluded that SARS-CoV-2 infection rates were low in primary schools following partial and full reopening of schools [31].

Our study detected silent cases, being asymptomatic cases that escaped the detection system in place in Belgium at that time. Indeed, they were not picked up through the School Health Promotion Department (SHPD). Among our positive cases, 20/29 pupils were isolated cases in a class and 2 were isolated cases in the school. There was no increase in the number of cases detected in the following weeks, either. One can argue that not all individuals attending the different schools were participating in the study. However,

even if we could have missed secondary cases, data do not support silent transmission in school resulting in apparent ill cases, as no increase in cases was detected by SHPD, up to a 2-week period after the end of the study. Furthermore, we did not observe many clusters, as only one school (school n°8) had two classes with, respectively, four and three pupils who tested positive on the same visit. Inside these classes, the classmates participating in the study did not become infected on the following visits. When we cross-referenced our data with the SHPD, we found that their data are in line with our observation. No school staff from this school had a positive test during the study period. This could have contributed to low secondary transmission, as transmission is more likely to occur if the index case is a teacher rather than a child, other factors being equal [29]. According to these results, we estimate that over-testing of asymptomatic children who have been in contact with confirmed SARS-CoV-2-positive individuals is probably not necessary. Indeed, most cases detected in our study were isolated cases (except for school 8).

The size of the study was not formally calculated but it had enough power to detect a significant transmission rate. Using a purposive sampling, the aim of the study was to find an index case in a class and then at least one new case in the same class at the next visits. With 932 children across 119 classes, the mean number of children per school class was 8. We observed at least one case in 18 school classes before visit 6, and there was no new case in the same class in subsequent visits in 17 out of these 18 classes. Only school class 4B in School 7 had a case at visit 2 followed by a new case at visit 5, one month later (Table 3 and Figure 4). To observe 0 new cases in 7 classmates, 17 times out of 18, and 1 new case in 7 classmates 1 time out of 18 leads to a likelihood over 95% that the transmission probability is lower than 0.009. The size of our study was large enough to detect such a low transmission rate.

Unfortunately, due to low viral loads (low Ct values) and due to technical issues, phylogenetic analyses could be performed only in 10 positive saliva samples and concerned just 57% of the genome, a percentage common to all 10 samples. The results obtained in these limiting conditions suggested that individuals were infected outside the school, but we do not have the power to confirm that.

Additionally, schools seem to reflect the evolution of transmission in society [32]. During our study period, the dominant strain was the variant of concern B.1.1.7 (Alpha), and SARS-CoV-2 circulation in Belgium was low. The positivity rate in our study was 0.7%. In one school, we observed two clusters, in March 2021. These results might simply reflect the multitude of factors involved in the transmission, including the intertwined relationship between community cases and school-acquired cases. Indeed, data from Sciensano, assessing the weekly incidence of SARS-CoV-2 in Belgium at that time, showed an ongoing increase in the number of positive SARS-CoV-2 in the whole country during that period, starting on February the 26th.

In our study protocol, a salivary test was preferred over nasopharyngeal swabbing. This non-invasive method seems better accepted for repeated testing in children, as highlighted by Vogel and colleagues [30]. On site, salivary tests for weekly surveillance were well accepted by participants. Sampling was performed in the setting of a scientific study and, therefore, was supervised by study staff. As the weeks went by, children were used to the method and only a few tests were lost due to swallowing or spitting wrongly outside the container. We propose that this less invasive method should be the norm when testing is performed in the pediatric population.

Our study has limitations. First, the participation rate in schools varied widely between schools and was never exhaustive. Recruitment is always a challenge; however, in the time of the pandemic, sanitary measures further complicated recruitment. Access to information was not uniform in the population, and the virtual communication with the targeted population impeded participation. Second, the phylogenetic analysis was inconclusive due to the limited number of analyzed samples and the limitations of the technique as well as of the obtained results. The lack of this information prevents us from asserting the circulation of the same virus within a class or a school. Third, this study took place during

a low incidence period of COVID-19 cases in Belgium, and therefore, of low circulation of the virus. In January 2021, at the beginning of our study, the incidence rate for the last 14 days, in Belgium, was 205 for 100,000 inhabitants, with a positivity rate of 6.7%. In May 2021, at the end of our study period, the incidence was 355 for 100,000 inhabitants, with a positivity rate of 6.3%. In May 2021, the immunization rate for all individuals of more than 18 years of age was 12.4%, and, for the population of more than 65 years old, this was 27.7%. The dynamics of COVID-19 transmission changed quickly after the end of this study, with the appearance of the Delta variant inducing a wave from late July 2021 until early December 2021, followed by the Omicron wave [33]. As consequence, due to the higher transmissibility of those variants, the incidence of COVID-19 in Belgium also increased significantly [19]. During the wave of Fall 2020, the COVID-19 incidence in the school population was considerably lower than in the general population [18,33]. This figure has changed during the wave of Fall 2021 with a recorded incidence in children aged 0–9 years old 5.3 times higher than during the same period 1 year before [33].

5. Conclusions

Globally, in elementary schools, the positivity rate of repetitive weekly PCR sampling for SARS-CoV-2 in asymptomatic individuals was low during our study period. While asymptomatic positive cases were detected, children remaining present in class during the Alpha variant wave of the pandemic did not lead to an increased number of secondary cases or clusters in their class or school. These data strengthen the view that keeping elementary education open at that point was a balanced decision, especially when we counterbalance the detrimental effect of disrupting education and the negative impact on the well-being of children of school closure. However, it would be interesting to conduct the same study during a period of high incidence, or during the circulation of other VOCs.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/v14102199/s1, Table S1: Weekly reporting of COVID-19 cases by the school health promotion department (SHPD). Supplementary File S1: Detailed description of SARS-CoV-2 whole-genome sequences method.

Author Contributions: J.F., O.C., J.M., N.R., J.R., B.K., L.G., D.V.d.L. and A.R. participated in the protocol conceptualization. F.M., J.R., B.K., H.R.-V., B.B., M.-L.D., C.H., F.B. and L.G. participated in the elaboration of analytical tools and performance of microbiological analyses. J.F., O.C., K.C., M.D.K., F.R., D.V.d.L. and A.R. participated in the collection data. J.F., O.C., K.C., J.M., M.D.K., B.K., H.R.-V., B.B., A.R. and D.V.d.L. interpreted the results. J.F., O.C., J.M. and D.V.d.L. participated in the writing—original draft preparation. All authors have read and agreed to the published version of the manuscript.

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4. Objective n° 3

Children and Workers Well-Being in Belgian French-Speaking Primary Schools during the COVID-19 Pandemic

Abstract

Purpose

During the COVID-19 pandemic, a significant number of measures were taken worldwide to limit the transmission of SARS-CoV-2, and in many ways changed human's life. All these measures had harmful consequences and have impacted the well-being of many people. Children were one of the most vulnerable groups. We conducted the present study to assess children and staff well-being in French-speaking primary schools in Belgium during the COVID-19 pandemic.

Methods

A 37-question questionnaire for each child based on the Revised Children's Manifest Anxiety Scale (RCMAS), and a 14-question questionnaire for each staff based on the Hospital Anxiety and Depression scale (HAD) were undertaken in order to assess the well-being. Multiple logistic regressions were performed to assess the relationship between RCMAS or HAD and other explanatory variables. Staff reported their perception of their current life and their future life in 5 years on a Visual Analogue Scale (VAS).

Results

A total of 231 children and 221 staff in 11 primary schools answered the well-being questionnaire between January and May 2021. 53% (122/231) of children had symptoms of anxiety. Girls reported more anxiety symptoms than boys (≥10: 59%; Adj OR=2.25; 95%CI[1.28;4.03]). 52% (120/231) of children had a definite state of social desirability. According to age, youngest (6-7 years) children were more likely to have social desirability (≥5: 71%; Adj OR=3.44; 95%CI[1.53;8.09]) compared to oldest (10-12 years). Children who did not practice outdoors/street activities were

more likely to have social desirability (≥5: 60%; Adj OR=2.59; 95%CI[1.38;4.99]). In schools with a higher local incidence of SARS-CoV-2, children were more likely to have social desirability (≥5: 64%; Adj OR=2.15; 95%CI[1.13;4.17]). In schools with a lower socioeconomic status, children were more likely to have social desirability (≥5: 72%; Adj OR=2.74; 95%CI[1.23;6.37]). Higher RCMAS anxiety ($r=-0.18$; $p<0.05$), physiological manifestations ($r=-0.23$; $p<0.05$), concentration and social anxiety ($r=-0.20$; $p<0.05$) scores were associated with a lower social desirability score. 16% (35/221) of staff had a definite state of anxiety. Staff working in larger schools reported less anxiety (≥11: 10% OR=0.34; 95%CI[0.15;0.77]). Staff reported lower scores for the perceived life in general during the pandemic than the perceived life in 5 years ($r=+0.35$).

Conclusion

Our results showed that the well-being of children was impacted during the COVID-19 pandemic. Special attention must be focused on the most vulnerable groups, as the consequences can be catastrophic in the long term.

Keywords

COVID-19, well-being, children, schools

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Children and Workers Well-Being in Belgian French-Speaking Primary Schools during the COVID-19 Pandemic

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Abstract

Purpose: During the COVID-19 pandemic, a significant number of measures were taken worldwide to limit the transmission of SARS-CoV-2, and in many ways, changed human life. All these measures had harmful consequences and impacted the well-being of many people. Children were one of the most vulnerable groups. We conducted the present study to assess children's and staff's well-being in French-speaking primary schools in Belgium during the COVID-19 pandemic. **Methods:** A 37-question questionnaire for each child based on the Revised Children's Manifest Anxiety Scale (RCMAS), and a 14-question questionnaire for each staff based on the Hospital Anxiety and Depression (HAD) scale was undertaken in order to assess the well-being. Multiple logistic regressions were performed to assess the relationship between RCMAS or HAD and other explanatory variables. Staff reported their perception of their current life and their future life in 5 years on a Visual Analogue Scale (VAS). **Results:** A total of 231 children and 221 staff in 11 primary schools answered the well-being questionnaire between January and May 2021. 53% (122/231) of children had symptoms of anxiety. Girls reported more anxiety symptoms than boys (≥10: 59%; Adj OR = 2.25; 95% CI [1.28; 4.03]). 52%

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(120/231) of children had a definite state of social desirability. According to age, the youngest (6 - 7 years) children were more likely to have social desirability (≥5: 71%; Adj OR = 3.44; 95% CI [1.53; 8.09]) compared to the oldest (10 - 12 years). Children who did not practice outdoor/street activities were more likely to have social desirability (≥5: 60%; Adj OR = 2.59; 95% CI [1.38; 4.99]). In schools with a higher local incidence of SARS-CoV-2, children were more likely to have social desirability (≥5: 64%; Adj OR = 2.15; 95% CI [1.13; 4.17]). In schools with a lower socioeconomic status, children were more likely to have social desirability (≥5: 72%; Adj OR = 2.74; 95% CI [1.23; 6.37]). Higher RCMAS anxiety ($r = -0.18$; $p < 0.05$), physiological manifestations ($r = -0.23$; $p < 0.05$), concentration and social anxiety ($r = -0.20$; $p < 0.05$) scores were associated with a lower social desirability score. 16% (35/221) of staff had a definite state of anxiety. Staff working in larger schools reported less anxiety (≥11: 10% OR = 0.34; 95% CI [0.15; 0.77]). Staff reported lower scores for the perceived life in general during the pandemic than the perceived life in 5 years ($r = +0.35$). **Conclusion:** Our results showed that the well-being of children was impacted during the COVID-19 pandemic. Special attention must be focused on the most vulnerable groups, as the consequences can be catastrophic in the long term.

Keywords

COVID-19, Well-Being, Children, Schools

1. Introduction

During the COVID-19 pandemic, a significant number of measures were taken worldwide to limit the transmission of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), and in many ways, changed human life. Interruption of social activities, social distancing, lockdown, curfew, and mask policies were measures taken to limit the virus transmission. Unfortunately, all these measures had harmful consequences, such as isolation, misinformation, fear, and violence, which impacted the well-being of many people. Children were one of the most vulnerable groups to these measures.

Preliminary results in China assessed that the anxiety and depression levels in children and adolescents were higher during the COVID-19 pandemic [1].

School closures, lockdowns, and interruptions of social activities had an important impact on children's development. School closures in the past had shown that students who had been absent for a long period of time were more likely not to return when schools reopened [2]. Several studies indicated that the physical, mental, and social well-being of children are affected by reactional activities and school closures [3] [4] [5]. In particular, the pandemic has reinforced social inequalities among disadvantaged backgrounds [6]. The pandemic has also led to economic instability, and children's well-being also appeared to deteriorate as the economy declined [7].

Interruption of social contact resulting from preventive measures had catastrophic consequences for adults' and children's well-being, including violence [6]. A study conducted in the USA investigated the various effects of historical pandemics on children and showed that almost a third had symptoms of post-traumatic disorder [8].

In a systematic review addressing the impact of social isolation on mental health in children, authors found a direct association between social isolation and mental health, leading to future mental health problems even up to 9 years later [9].

Another study showed that restrictions on activities and on access to school had a huge negative impact on the well-being of children with some disabilities during the COVID-19 pandemic; most respondents felt a deterioration in their well-being [10].

We conducted the present study to assess the well-being of children in French-speaking primary schools in Belgium during the pandemic of COVID-19. In order to help professional policymakers to take actions that protect children's development.

2. Methods

2.1. Study Design

We conducted the study DYNAtracs, DYNAmicTRAnsmission of Coronavirus in Schools, from January 14 to May 18, 2021, in 11 primary schools of the Federation Wallonia-Brussels in Belgium. Schools were selected using purposive sampling based on the extremes of three inclusion criteria.

The first criterion was the local incidence level of SARS-CoV-2 during the first wave on May 6, 2020 in Belgium, based on the Belgian Public Health Institute data, Sciensano [11]. The median of data was used as a threshold to define a low or a high local incidence. Schools with a local cumulative incidence strictly below 5.0 per 1000 persons were considered as a low incidence of SARS-CoV-2. Schools with a local cumulative incidence equal or greater than 5.0 per 1000 persons were considered as a high incidence level of SARS-CoV-2. The second criterion was the size of the school. According to the Federation Wallonia-Brussels definition, schools with less than 230 children were considered as small and above 230 as large. The third criterion was based on the school's Socioeconomic Status (SES). This SES is a scale used to classify all schools in Belgium on a 20-points index [12]. According to this index, schools with a SES lower than 7 (the first tertile) were considered as low and those with a SES above 13 (the upper tertile) were considered as high. Schools were selected within each of the eight categories defined by containing two levels of three criteria. The study design and population are described in more detail in a previous publication related to DYNAtracs [13] [14].

Schools were selected with the help of two administrations in charge of health at school, ONE ("Office de la Naissance et de l'Enfance") and PSE ("Promotion

de la Santé à l'École"). Investigators contacted the directors of selected schools to participate to the study.

Within each school, participants were tested by a rapid serological test by finger prick on the inclusion day. The results were analyzed according to the 3 inclusion criteria in a previous publication related to DYNAtracs [13]. A saliva antigen test of SARS-CoV-2 was performed at each visit and results are reported in another publication [14].

Each participant received an inclusion questionnaire with demographic, and virus exposition questions. Additional specific questions were addressed to teachers and principal of the different schools, concerning the specific measures implemented in their school.

Additionally, each child received a booklet to record the virus exposure during the study period. At the end of the booklet, the child was invited to answer a 37-question well-being questionnaire based on the Revised Children's Manifest Anxiety Scale (RCMAS), at any time of his/her choice.

Depending on the native language of the child, the booklet was translated into 5 languages: French, Italian, Arabic, Romanian and Turkish.

2.2. Study Population and Inclusion Criteria

All children and staff in selected primary schools were invited to participate. Participants were included if the consent was signed by both parents and the child or by the staff.

2.3. Exclusion Criteria

Refusal to provide written informed consent before enrolment.

2.4. Data Collection

Human data were performed in accordance with the Declaration of Helsinki. The protocol, informed consent forms, and questionnaires were approved by the Hospital-Faculty Ethics Committee Saint-Luc ("Commission d'Ethique Hospitalo-Facultaire des Cliniques Universitaires Saint-Luc")—UCLouvain, approval number: 2020/16NOV/552.

The study investigators visited each school and interviewed each participant. The booklets were collected at the end of the study. All questionnaires and booklets were in paper format. Each response to the questionnaires was encoded in a double database and each data was encoded in an anonymized way. A verification of the double encoding was carried out. The database was then converted into an Excel file.

2.5. Well-Being Questionnaires

2.5.1. Revised Children's Manifest Anxiety Scale

RCMAS is a scale based on 37 questions (Table 1) with "Yes" or "No" as answer. Regarding the quotation, a "Yes" response receives 1 point and a "No" response

Table 1. Scales.

			Presence		
	Range	Score	Absence	Suspicion state	Definite state
Children					
RCMAS	0 - 37	0 - 37			
Anxiety	0 - 28	0 - 28	≤9	10 - 13	≥14
Physiological manifestations	0 - 10	0 - 10	≤3	4	≥5
Worry and hypersensitivity	0 - 11	0 - 11	≤4	5	≥6
Concentration and social anxiety	0 - 7	0 - 7	≤2	3	≥4
Social desirability	0 - 9	0 - 9	≤3	4	≥5
Adults					
HAD	0 - 14				
Anxiety	0 - 7	0 - 21	≤7	8 - 10	≥11
Depression	0 - 7	0 - 21	≤7	8 - 10	≥11
VAS					
Perceived life now	0 - 10	0 - 10			
Perceived life in 5 years	0 - 10	0 - 10			

Note: RCMAS: Revised Children's Manifest Anxiety Scale; HAD: Hospital Anxiety and Depression; VAS: Visual Analogue Scale.

receives 0 point. A total anxiety score is then calculated using 28 items. From these 28 items, 3 subscales of anxiety can also be calculated, 1) physiological manifestations based on 10 items, 2) worry and hypersensitivity based on 11 items, 3) concentration and social anxiety based on 7 items. The first dimension, physiological manifestations, refers to difficulties in falling asleep, fatigue, and nausea. The second dimension, worry and hypersensitivity, relates to mental ruminations linked to the emotional injury and the isolation fear. The third dimension, concentration and social anxiety, refers to school problems. From the remaining 9 items, a fourth dimension allows to estimate the social desirability [15] [16].

The anxiety dimension is calculated by analogy and by summing responses to the 28 corresponding items, with 0 as minimum and 28 as maximum. A score under 10 is defined as an absence or minimum anxiety symptoms, between 11 and 13 it is defined as an anxious state and 14 or more is defined as a definite anxious state.

Physiological manifestations were calculated by summing responses to the 10 corresponding items. It ranges from 0 to 10. A score under 3 is defined as an absence or minimum physiological manifestation, a score above 4 suggests physiological manifestations and a score equal or above 5 corresponds to a definite state of physiological manifestations.

Worry and hypersensitivity dimension was calculated by summing responses

to the 11 corresponding items. It ranges from 0 to 11. A score under 4 is defined as an absence or minimum worry and hypersensitivity, a score equal to 5 suggests worry and hypersensitivity symptoms and a score of 6 or more corresponds to a definite state of worry and hypersensitivity.

Concentration and social anxiety dimension is the sum of responses to the 7 corresponding items, ranging from 0 to 7. A score under 2 is defined as an absence or minimum difficulties of concentration and social anxiety, a score of 3 suggests difficulties to concentrate and social anxiety, and a score of 4 or more corresponds to a definite state with difficulties to concentrate and social anxiety.

Social desirability score was calculated by summing responses to the 9 corresponding items. This score has 0 as minimum and 9 as maximum. A score under 3 is defined as an absence or low social desirability, a score above 4 is defined as a social desirability suspicion and a score equal or above 5 is defined as a definite state of social desirability.

2.5.2. Hospital Anxiety and Depression Scale

The adult inclusion questionnaire included 14 questions based on the Hospital Anxiety and Depression (HAD) scale (Table 1) in order to assess the staff well-being. HAD refers to the anxiety and depression symptoms using 7 questions for each dimension. Each question has a 4-points response with a value from 0 to 3. A total anxiety and a total depression score can be calculated with a maximum of 21 points each. A score under or equal 7 is defined as an absence of both anxiety and depression, a score between 8 and 10 is defined as a suspected anxious or depressive state, and a score equal or greater to 11 is defined as a definite state of anxiety or depression [17].

Staff were also invited to report their perception of their current life and their future life in 5 years on a Visual Analogue Scale (VAS) (Table 1). This score has 0 as minimum and 10 as maximum. A value of 0 corresponds to the worst possible life and a value of 10 represents the best possible life.

2.6. Statistical Analysis

Results are represented as mean ± Standard Deviation (SD) for continuous variables and number with proportion for categorical variables. Student t-test and Analysis of Variance (ANOVA) with F-test were used to compare means between subgroups.

Association between continuous variables was assessed using Pearson r correlation coefficient.

Multiple logistic regressions were performed to assess the relationship between suspected or definite state in the well-being analysis and other explanatory variables.

All these RCMAS scores were analyzed considering sex, age, participation in organized fixed activities (such as sports practicing, music lessons) and participation in outdoor/street activities of children. School inclusion criteria were also considered, such as local incidence of SARS-CoV-2, size and the socioeconomic

status for this analysis. The age was computed by the birth date and the inclusion study date and 3 categories were considered based on the school level as 6 - 7, 8 - 9 and 10 - 12. For the school inclusion criteria, the extremes were used: a low (<5.0/1000 persons) or a high (≥5.0/1000 persons) local incidence of SARS-CoV-2, a small (<230 children) or a large (≥230 children) school and a low (SES ≤ 7) or a high (SES ≥ 13) socioeconomic status.

HAD anxiety and depression scores were analyzed considering sex, age, and school inclusion criteria. For the age of the staff, 4 categories were considered as 18 - 29, 30 - 39, 40 - 49 and above 50.

Statistical significance level was set to 0.05. Data analysis was performed with R 4.2.2.

3. Results

3.1. Inclusion

3.1.1. Children

Inclusion questionnaires were completely or partially answered by 99.7% (929/932) of children (Table 2). Mean age of responders was 9.0 ± 1.7 years, and 52% (479/929) were girls. 79% (731/924) lived with both parents. 85% (777/917) lived in a house, and 81% (746/929) had a garden. 67% (618/922) had their own bedrooms, and the remaining 33% shared bedroom with at least one relative. 56% (514/912) had at least one parent teleworking at least once a week.

62% (565/914) had at least once a week an organized fixed activity (such as dance, music lessons, soccer team, scout). 38% (347/917) had at least once a week an outdoor/street activity (such as playing soccer in the street, going to the playground).

3.1.2. School Staff

Inclusion questionnaires were completely answered by 96% (233/242) of school staff (Table 3).

The mean age of school staff was 42 ± 11.8 years, and 86% (198/230) were women. 95% (218/229) staff reported having a good health, but 10% (22/218) of them recognized having a disease problem. Among the eleven who didn't feel in good health, 1 had diabetes, 4 had asthma, 2 had lupus, 2 had a heart disease, 1 had multiple sclerosis, and 1 have a crohn's disease. In the school, 4% (9/227) were directors, 67% (152/227) were teachers, 4% (9/227) were secretarial staff, 13% (30/227) were supervisors or daycare, 4% (10/227) were in the school maintenance, and 8% (17/227) had another function, such as childcare, invigilator. Staff had sometimes multiple functions in the school. 42% (94/223) staff had a family budget above 3000€.

3.2. Well-Being Analysis

3.2.1. Revised Children's Manifest Anxiety Scale

30% (281/932) of children have answered to at least one of the 37 questions and 25% (231/932) answered completely to the 37 questions. Among these 231

Table 2. Characteristics of children interviewed in schools during COVID-19 pandemic (January-May 2021).

	Children (n = 929)		
Sex		**Housing**	
Girls	479 (52.0)	Apartment	140 (15.3)
Missing (n)	8	House	777 (84.7)
		Missing (n)	12
Age, mean ± SD	9.0 ± 1.7	**Own bedroom**	
Missing (n)	72	Yes	618 (67.0)
		No	304 (33.0)
		Missing (n)	7
Participate in organized fixed activity (per week)		**Living with**	
Yes, ≥3 times	171 (18.7)	Both parents all the time	731 (79.1)
Yes, 2 times	168 (18.4)	Part-time with one or the other	177 (19.2)
Yes, 1 time	226 (24.7)	Other	16 (1.7)
No	349 (38.2)	Missing (n)	5
Missing (n)	15		
Participate in outdoor/street activity (per week)		**Teleworking of parents**	
Yes, ≥3 times	51 (5.6)	Yes, partially (at least one parent)	296 (31.6)
Yes, 2 times	67 (7.3)	Yes, all the time (at least one parent)	161 (17.2)
Yes, 1 time	229 (25.0)	Yes, both of them	82 (8.7)
No	570 (62.2)	No	399 (42.5)
Missing (n)	12	Missing (n)	17

Note: n: number; SD: Standard Deviation.

children, mean age was 9.0 ± 1.7, and 58% (135/231) were girls.

Among RCMAS anxiety score, no significant mean difference was observed between categories of sex, age, social activities, local incidence, school size and SES.

There was however a significant difference between those who practiced outdoor/street activity and those who did not (11.8 ± 6.1 versus 9.8 ± 5.8; $p < 0.05$).

53% (122/231) had symptoms of anxiety (RCMAS anxiety ≥ 10), and 31% (72/231) had a definite state of anxiety (RCMAS anxiety ≥ 14).

Girls reported more anxiety symptoms (≥10: 59%; Adj OR = 2.25; 95% CI [1.28; 4.03]) than boys (Table 4). Younger children had more often anxiety symptoms (6 - 7 years: ≥10: 59%; Adj OR = 1.38; 95% CI [0.66; 2.91] 8 - 9: ≥10: 54%; Adj OR = 1.37; 95% CI [0.73; 2.60]). There was no difference between children who participated in organized fixed activity and those who did not (≥10: 57%; Adj OR = 1.06; 95% CI [0.54; 2.09]). Children who did not participate in outdoor/street activity were less likely to have anxiety symptoms (≥10:

Table 3. Characteristics of school staff interviewed in schools during COVID-19 pandemic (January-May 2021).

	School staff (n = 233)		
Sex		**Family budget**	
Women	198 (86.1)	Under 1500€	12 (5.4)
Missing (n)	3	1500€ - 3000€	60 (26.9)
		Above 3000€	94 (42.2)
Age, mean ± SD	41.9 ± 11.8	Do not wish to answer	41 (18.4)
Missing (n)	13	Don't know	16 (7.2)
		Missing (n)	10
Health status			
Yes	218 (95.2)		
No	11 (4.8)		
Missing (n)	4		
Profession in the school		**Declared financial situation**	
Director	9 (4.0)	Very difficult	6 (2.7)
Teacher	152 (67.0)	Difficult	15 (6.8)
Secretary	9 (4.0)	Average	99 (44.8)
Surveillance/daycare	30 (13.2)	Easy	84 (38.0)
School maintenance	10 (4.4)	Very easy	17 (7.7)
Other	17 (7.5)	Missing (n)	12
Missing (n)	6		

Note: n: number; SD: Standard Deviation.

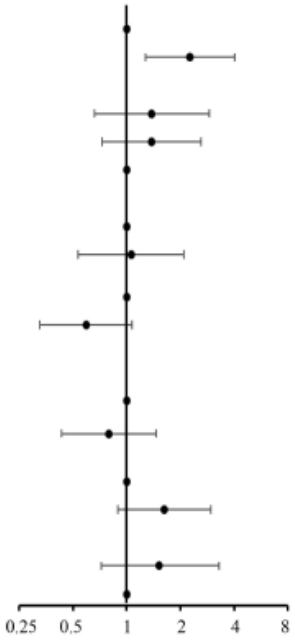
49%; Adj OR = 0.60; 95% CI [0.33; 1.07]). There was no difference between children in schools with a low or a high incidence level of SARS-CoV-2 (≥10: 52%; Adj OR = 0.79; 95% CI [0.43; 1.46]). Symptoms of anxiety were more frequent in larger schools (≥10: 57%; Adj OR = 1.62; 95% CI [0.90; 2.97]) compared to smaller schools. Children in lower SES schools were more likely to have anxiety symptoms (≥10: 61%; Adj OR = 1.52; 95% CI [0.72; 3.28]).

In the 3 subscales of anxiety, girls had a higher hypersensitivity score (5.20 ± 2.96 versus 4.27 ± 2.93; $p < 0.05$). According to social activity, children who practiced outdoor/street activity (physiological manifestations score: 4.26 ± 2.18, concentration score: 2.33 ± 1.92) had a lower score than those who did not (physiological manifestations score: 3.46 ± 2.24, concentration score: 1.74 ± 1.76; $p < 0.05$).

Girls were more likely to have hypersensitivity (≥5: 52%; Adj OR = 2.42; 95% CI [1.35; 4.41]). Children between 6 and 7 years were less likely to have difficulties to concentrate and to have social anxiety (≥4: 10%, Adj OR = 0.33; 95% CI [0.10; 0.91]). Outdoor/street activity were associated with RCMAS physiological

Table 4. Association between RCMAS anxiety and characteristics using logistic regression.

	n	RCMAS anxiety ≥ 10	Adj OR	(95%CI)
Child				
Sex of the child				
Boys	96	44.8%	1	
Girls	135	58.5%	2.25	(1.28 ; 4.03)
Age of the child (years) †				
6-7	48	58.3%	1.38	(0.66 ; 2.91)
8-9	79	54.4%	1.37	(0.73 ; 2.60)
10-12	92	50.0%	1	
Organized fixed activity ††				
Yes	149	50.3%	1	
No	77	57.1%	1.06	(0.54 ; 2.09)
Outdoors/street activity ‡				
Yes	85	60.0%	1	
No	142	49.3%	0.60	(0.33 ; 1.07)
School inclusion criteria				
Local incidence				
Low	154	53.2%	1	
High	77	51.9%	0.79	(0.43 ; 1.46)
Size of the school				
Small	93	46.2%	1	
Large	138	57.2%	1.62	(0.90 ; 2.97)
Socioeconomic status				
Low (≤ 7)	57	61.4%	1.52	(0.72 ; 3.28)
High (≥ 13)	174	50.0%	1	



Note: n: number; Adj OR: Adjusted Odds Ratio in multiple logistic regression; CI: Confidence Interval; †12 missing values; ††5 missing values; ‡4 missing values.

manifestations (≥5: 31%; Adj OR = 0.52; 95% CI [0.29; 0.94]), and RCMAS hypersensitivity (≥5: 42%; Adj OR = 0.49; 95% CI [0.27; 0.89]). In larger schools, children were more likely to have hypersensitivity (≥5: 51%; Adj OR = 1.87; 95% CI [1.02; 3.46]).

3.2.2. Social Desirability

Girls had a higher RCMAS social desirability score over boys (4.76 ± 2.41 versus 4.07 ± 2.35; $p < 0.05$). According to the age of the child, youngest children (6 - 7 years) had a higher RCMAS social desirability score (5.08 ± 2.33) than other children (8 - 9: 4.63 ± 2.29; 10 - 12: 4.05 ± 2.47; $p < 0.05$). According to social activity, children who practiced a social activity (organized fixed: 4.23 ± 2.49, outdoor/street: 3.96 ± 2.48) had a lower score than those who did not (organized fixed: 5.00 ± 2.15, outdoor/street: 4.79 ± 2.31; $p < 0.05$). According to socioeconomic status, children in schools with a lower SES (SES ≤ 7) had a higher RCMAS social desirability score (5.26 ± 2.16) over higher SES (SES ≥ 13) (4.22 ± 2.43; $p < 0.05$).

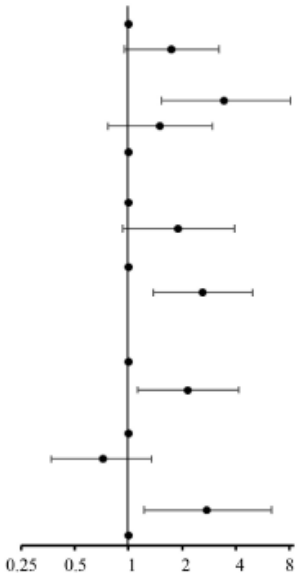
65% (150/231) of children had a suspicion of social desirability (RCMAS social desirability ≥ 4), and 52% (120/231) had a definite state of social desirability (RCMAS social desirability ≥ 5).

Girls had more social desirability (≥5: 57%; Adj OR = 1.74; 95% CI [0.95; 3.23]) compared to boys (Table 5). According to age, youngest (6 - 7 years) and middle aged (8 - 9 years) children had more social desirability (≥5: 6 - 7: 71%; Adj OR = 3.44; 95% CI [1.53; 8.09] 8 - 9: 51%; Adj OR = 1.50; 95% CI [0.77; 2.96]) than oldest (10 - 12 years). Children who did not practice a social activity had more social desirability (≥5: organized fixed: 64%; Adj OR = 1.90; 95% CI [0.93; 3.93]—outdoor/street: 60%; Adj OR = 2.59; 95% CI [1.38; 4.99]). In schools with a higher local incidence of SARS-CoV-2, children had more social desirability (≥5: 64%; Adj OR = 2.15; 95% CI [1.13; 4.17]). In schools with a lower SES, children had more social desirability (≥5: 72%; Adj OR = 2.74; 95% CI [1.23; 6.37]).

Higher RCMAS anxiety ($r = -0.18$; $p < 0.05$), physiological manifestations ($r = -0.23$; $p < 0.05$), concentration and social anxiety ($r = -0.20$; $p < 0.05$) scores were associated with a lower social desirability score.

Table 5. Association between RCMAS social desirability and characteristics using logistic regression.

	n	RCMAS social desirability ≥ 5	Adj OR	(95%CI)
Child				
Sex of the child				
Boys	96	44.8%	1	
Girls	135	57.0%	1.74	(0.95 ; 3.23)
Age of the child (years) †				
6-7	48	70.8%	3.44	(1.53 ; 8.09)
8-9	79	50.6%	1.50	(0.77 ; 2.96)
10-12	92	43.5%	1	
Organized fixed activity ††				
Yes	149	46.3%	1	
No	77	63.6%	1.90	(0.93 ; 3.93)
Outdoors/street activity ‡				
Yes	85	38.8%	1	
No	142	59.9%	2.59	(1.38 ; 4.99)
School inclusion criteria				
Local incidence				
Low	154	46.1%	1	
High	77	63.6%	2.15	(1.13 ; 4.17)
Size of the school				
Small	93	51.6%	1	
Large	138	52.2%	0.72	(0.37 ; 1.35)
Socioeconomic status				
Low (≤ 7)	57	71.9%	2.74	(1.23 ; 6.37)
High (≥ 13)	174	45.4%	1	



Note: n: number; Adj OR: Adjusted Odds Ratio in multiple logistic regression; CI: Confidence Interval; †12 missing values; ††5 missing values; ‡4 missing values.

3.2.3. Hospital Anxiety and Depression Scale

96% (233/242) of staff have answered to at least one of the 14 questions and 91% (221/242) answered completely to the 14 questions. Among these 221 staff, mean age was 41.7 ± 11.9, and 86% (190/221) were women.

3.2.4. Anxiety

Among HAD anxiety score, no significant mean difference was observed between categories of sex, age, local incidence, and SES.

There was however a significant difference between those who worked in small schools and in large schools (7.90 ± 4.08 versus 6.53 ± 3.28; $p < 0.05$).

42% (92/221) staff were susceptible to have anxiety symptoms (HAD ≥ 8), and 16% (35/221) had a definite state of anxiety (HAD ≥ 11).

Women reported less anxiety (≥11: 15% Adj OR = 0.44; 95% CI [0.17; 1.26]) than men. Staff aged between 18 to 29 (≥11: 20% Adj OR = 1.46; 95% CI [0.47; 4.53]), and 40 to 49 years (≥11: 19% Adj OR = 1.29; 95% CI [0.45; 3.83]), had more anxiety than the others. There was no difference between staff working in low or high local incidence level of SARS-CoV-2 (≥11: 14% Adj OR = 0.98; 95% CI [0.43; 2.28]). Staff working in larger schools reported less anxiety (≥11: 10% OR = 0.34; 95% CI [0.15; 0.77]). In schools with a lower SES, staff had more anxiety (≥11: 19%; OR = 1.72; 95% CI [0.77; 4.07]).

3.2.5. Depression

Among HAD depression score, no significant mean difference was observed between categories of sex, age, local incidence, school size, and SES.

13% (29/221) of staff were susceptible to have depression symptoms (HAD ≥ 8) and 5% (12/221) had depression symptoms (HAD ≥ 11).

Women reported being less depressed (≥11: 5% Adj OR = 0.62; 95% CI [0.14; 4.32]) than men. Staff aged between 18 to 29 years (≥11: 5% Adj OR = 1.41; 95% CI [0.16; 12.40]), 40 to 49 years (≥11: 7% Adj OR = 2.05; 95% CI [0.36; 16.00]), and above 50 years (≥11: 6% Adj OR = 2.19; 95% CI [0.40; 16.60]), reported being more depressed than the others. Staff working in high local incidence level of SARS-CoV-2 reported being more depressed (≥11: 6% Adj OR = 1.40; 95% CI [0.37; 5.61]). Staff working in larger schools reported being less depressed (≥11: 4% Adj OR = 0.43; 95% CI [0.11; 1.57]). In schools with a lower SES, staff reported being more depressed (≥11: 6%; Adj OR = 1.48; 95% CI [0.42; 6.17]).

3.2.6. Perceived Life

Lower scores in the perception of life during the COVID-19 pandemic were reported by staff compared to the perception of life in 5 years (Figure 1). Higher perception life in 5 years was associated with higher perception life now ($r = +0.35$; $p < 0.05$).

4. Discussion

Anxiety symptoms take a severe burden on children, which can lead to serious consequences and can have a significant impact on their present and future lives.

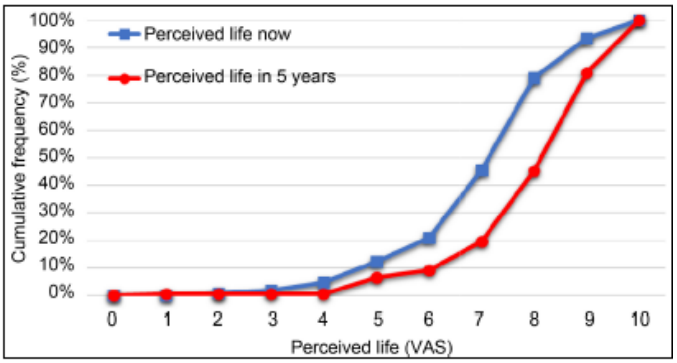


Figure 1. Perceived life on visual analogue scale now and in 5 years according to staff.

Alongside this, previous research into past pandemics has shown several consequences for children's well-being. The pandemic reinforced social inequalities, social contacts, activities interruption, isolation and confinement, and it led to an imbalance in the well-being of children. This study is the first to our knowledge to investigate self-reported children's well-being, especially in the primary schools during COVID-19 pandemic in Belgium.

In 2019, before the COVID-19 pandemic, the prevalence of anxiety and depressive disorders in children aged between 0 and 9 years were <1% and <0.1% worldwide, and 2% and 0.2% in Belgium, respectively. In adults (over 20 years old), the prevalence of anxiety and depressive disorders were 5% worldwide, 6% and 5% in Belgium, respectively [18].

Our results showed that anxiety and depression in children and staff were higher during the pandemic than before. 53% of children were susceptible to developing anxiety (RCMAS anxiety ≥10), and 31% had a definite state of anxiety (RCMAS anxiety ≥14). 52% had a high score of social desirability (RCMAS social desirability ≥5), suggesting that the anxiety may be underestimated.

Children between 4 to 11 years of age reported that their most common symptoms of COVID-19 were concentration and mood swings [19].

Anxiety is influenced by the entourage of the child. The well-being of relatives and other adults surrounding her/him has a significant impact on the actual well-being of the child. On the contrary, a happy child whose well-being is balanced becomes a generator of balance for those around her/him [20]. When an adult is anxious, she/he shares unconsciously this anxiety with the child, and this is reinforced during isolation and lockdown.

In staff, anxiety was more frequent than depression. 42% of school staff had a possible anxiety (HAD ≥ 8), and 16% had a definite state of anxiety (HAD ≥ 11). For depression, 13% had a possible depression and 5% had a definite state of depression. A study in China reported that 16% had anxiety and 27% suffered from depression [21]. In a systematic review of the long-term effects of COVID-19 on mental health, 18% of those tested with COVID-19 experienced at least mildly

severe anxiety symptoms [22].

The COVID-19 pandemic was very anxiety-inducing. All the changes in the protective's measures and all the information worldwide given in order to limit the virus transmission have reinforced the anxiety and isolation. Children who did not practice outdoor/street activities were less anxious, hypersensitive, less tired, and more concentrated than the others, but the social desirability suggested that the RCMAS scores were probably underestimated in those children.

During COVID-19 pandemic, social activities were highly impacted because of the different protective measures and social distancing. In the United Kingdom, a study among 125 children with some disabilities reported that 61% changed negatively their physical activities during the lockdown period. 42% of children rated their well-being as worsening and 23% had worsened a little, as a result of the various distancing measures [10].

A systematic review found that existing evidence of well-being appears to be impacted by psychological factors, such as confinement, lockdown, and interruption of social activities, in contrast to the limited association between long-term effects and the virus itself [22]. It can also explain that in our results, there was no difference in anxiety and other scores regarding low or high local incidence of SARS-CoV-2. Social desirability was higher in high local SARS-CoV-2 incidence, suggesting that the RCMAS scores were underestimated in children. This suggests that difficulties at school were not necessarily related to the fear of the virus itself.

In large schools, children seemed to develop more anxiety symptoms, to have more physiological manifestations, to be more worried and hypersensitive than in small schools. School size was not related to social anxiety in our results. Anxiety in large schools can be explained by a greater number of measures to limit social contact and the virus transmission, and it can lead to a fear of isolation and anxiety. Due to the increasing number of social contacts, the probability of being in contact with the virus was higher in large schools, which led to a sense of reassurance in isolation.

Staff were more anxious in small schools than in large ones. This can be explained by the number of staff working in the school. In larger schools, there are more staff workers, so it may be easier for everyone to relate to certain co-workers and it results in more emotional support.

As the pandemic reinforced social inequalities, the well-being of children and staff deteriorated. Anxiety, hypersensitivity and schools' problems were higher in schools with a low SES. Social desirability was strongly higher in schools with a lower SES (SES $\leq$ 7). A negative correlation between anxiety, physiological, concentration and social desirability score indicates that children with a high desirability score reported a lower anxiety score, and therefore anxiety was probably underestimated in schools with a low SES.

Staff reported a higher score about their future life (in 5 years) than during the COVID-19 pandemic. These results suggest that staff are experiencing some in-

securities during the pandemic, but these insecurities may disappear once the situation improves.

The COVID-19 pandemic has weakened the life of adults, and has caused problems other than the well-being of the child, and these problems have a direct impact on the well-being of the child.

In Belgium, the Centre PMS ("Centre Psycho-Medico-Social") is a service composed of psychologists, social assistants and nurses. This service offers support to children and adolescents in primary and secondary schools. Its missions are essentially to provide assistance in the harmonious development of children and adolescents, but also to ensure that everyone has equal opportunities for personal emancipation [23]. The school can ask them for support to help the child and raise awareness among parents. This was already in place long before the pandemic, but with the imbalance caused by the sanitary crisis, the resources provided might not be sufficient to effectively support every child. With the COVID-19 pandemic, the demand for support from PMS has strongly increased. The government has established a special unit called "COVID support" to help the Centre PMS respond to the increasing demand. This unit was initially scheduled for a 3-months period of time, but the demand didn't decrease and the period was extended until November 30th, 2022 [24] [25]. Unfortunately, the demand did not decrease and the Centre PMS was overloaded.

In Belgium, besides the PMS, the INAMI ("Institut National d'Assurance Maladie-Invalidité") is a social security structure that ensures access to health care for everyone. During the COVID-19 pandemic, to ensure that everyone can access to emotional support, they set up a system of first-line psychologists with a set up number of sessions at a low-cost [26]. Since the "COVID support", in order to help the Centre PMS, was not extended after November 30th, 2022, the government proposed a collaboration between the first-line psychologists and the center PMS. This collaboration would aid children who are not yet in care [27].

Anxiety can be indirectly linked to the inaccessible health care during the pandemic. At the beginning of the pandemic, a person with susceptible COVID-19 symptoms (e.g. temperature at 38˚C) was asked to stay at home. Hospital and physician's consultations were maintained for urgencies only. Video consultations were recommended to limit the virus transmission [28]. Indirectly, the inaccessibility to health care induced the incapacity of individuals to improve their health and well-being.

RCMAS scale is an interesting tool, because it does not only compute children's anxiety. The different related dimensions, physiological manifestations, hypersensitivity, and concentration give us information such as fatigue, isolation fears, concentration problems, and social anxiety. In addition, the dimension of social desirability, which can be an important bias in self-reported questionnaires, is interesting information in understanding the other dimensions of this scale.

5. Limitations

Our study presents some limitations. Well-being questionnaires were answered by 30% of children and 96% of staff at least partially. Non-respondents' well-being may be more altered than responders. This figure is, however, unconvincing. 25% of children have answered this questionnaire completely. This low percentage can be explained by the well-being questionnaire distribution; well-being questionnaire was introduced within a booklet with tips and the child had 6 weeks to answer and give it back to the interviewer. A lot of booklets were lost (≈70%). Such a missing process can be ignorable, but the well-being questionnaire was completed by children back home. The results may be influenced by the degree of understanding, especially for the youngest children who may require support from a relative.

As a cross-sectional study, some other factors can play a confounding role in the well-being. Analysis was made on COVID-19 and related factors. COVID-19 and its consequences are not the only factors that have impacted the well-being of children and workers. Family situations, personal situations and many other factors can have an impact on the well-being of the child and staff.

6. Conclusions

Nevertheless, our findings demonstrated a loss in the well-being of children during the COVID-19 pandemic. COVID-19 has caused many imbalances in many sectors and has changed the routine of every human being. Special attention must be focused on the most vulnerable groups, as the consequences can be catastrophic in the long term. Our results showed that the well-being of children was impacted during the COVID-19 pandemic. It is important to evaluate and document children's well-being after the COVID-19 pandemic in order to assess if the decrease in well-being maintains and set up interventions in order to limit consequences later in life.

In order to detect signs of imbalance in children's well-being, the school environment should receive more appropriate training to improve their consciousness of this issue. Appropriate questionnaires could be developed so that teachers and school directors can easily help children who need specific help and refer them to the right services.

Acknowledgements

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Compliance with Ethics Guidelines

Study Registration: The protocol, informed consent forms, and questionnaires were approved by the Hospital-Faculty Ethics Committee Saint-Luc ("Commission d'Ethique Hospitalo-Facultaire des Cliniques Universitaires Saint-Luc")— UCLouvain, approval number: 2020/16NOV/552. It was registered on clinicaltrials.gov on

16/09/2021, identifier number: NCT05046470, and on ISRCTN on 20/04/2022, identifier number: ISRCTN16837012.

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Conflicts of Interest

The authors declare that they have no conflict of interest.

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5. Objective n° 4

The well-being of children and workers in Belgian French-speaking primary schools after the COVID-19 pandemic crisis

Abstract

Purpose

During the COVID-19 pandemic crisis, many measures were taken around the world to limit the SARS-CoV-2 transmission that disrupted people's day-to-day lives in many ways. Unfortunately, most of these measures had detrimental consequences, such as isolation, misinformation, fear, and violence, inducing a loss of well-being for many people. One of the most vulnerable groups to these pandemic consequences was children.

Methods

We conducted a study to assess children and staff well-being in French-speaking primary schools in Belgium after the COVID-19 pandemic crisis. A 37-question questionnaire based on the Revised Children's Manifest Anxiety Scale (RCMAS) was used for each child and a 14-question questionnaire based on the Hospital Anxiety and Depression scale (HAD) was used for each staff to assess their well-being. The three-drawing method was used to assess children's representation of well-being before, during, and after the COVID-19 pandemic, respectively.

Results

A total of 282 children and 33 staff answered the well-being questionnaire. 63% of children (174/276) had symptoms of anxiety, and 38% (104/276) had a definite state of anxiety. 65% of children (178/276) had symptoms of social desirability, and 55% (151/276) had a definite state of social desirability. The well-being representation was impacted by the COVID-19 pandemic during and after the pandemic. Very few staff accepted to participate in the study. A total of 102 children created drawings. The representation of children's well-being in their drawings showed that the

pandemic had had an impact on their life, which was reflected in different ways in the drawings during the pandemic, such as isolation, negative content, negative facial expressions, or sadness.

Conclusion

After the COVID-19 pandemic crisis, the well-being of children remained affected; anxiety was still as high as it was during the COVID-19 pandemic crisis. Particular attention must be devoted to children as a vulnerable group, to avoid consequences in the long term.

Keywords

COVID-19, well-being, children, schools, socioeconomic status

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The Wellbeing of Children and Workers in Belgian French-Speaking Primary Schools After The COVID-19 Pandemic Crisis

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Abstract

During the COVID-19 pandemic crisis, many measures were taken around the world to limit the SARS-CoV-2 transmission that disrupted people's day-to-day lives in many ways. Unfortunately, most of these measures had detrimental consequences, such as isolation, misinformation, fear, and violence, inducing a loss of wellbeing for many people. One of the most vulnerable groups to these pandemic consequences was children. We conducted a study to assess children and staff wellbeing in French-speaking primary schools in Belgium after the COVID-19 pandemic crisis. A 37-question questionnaire based on the Revised Children's Manifest Anxiety Scale (RCMAS) was used for each child and a 14-question questionnaire based on the Hospital Anxiety and Depression scale (HAD) was used for each staff to assess their wellbeing. The three-drawing method was used to assess children's representation of wellbeing before, during, and after the COVID-19 pandemic, respectively.

A total of 282 children and 33 staff answered the wellbeing questionnaire. 63% of children (174/276) had symptoms of anxiety, and 38% (104/282) had a definite state of anxiety. 65% of children (178/276) had symptoms of social desirability, and 55% (151/276) had a definite state of social desirability. The wellbeing representation was impacted by the COVID-19 pandemic during and after the pandemic. Very few staff accepted to participate in the study. A total of 102 children created drawings. The representation of children's wellbeing in their drawings showed that the pandemic had had an impact on their life, which was reflected in different ways in the drawings during the pandemic, such as isolation, negative content, negative facial expressions, or sadness. After the COVID-19 pandemic crisis, the wellbeing of children remained affected; anxiety was still as high as it was during the COVID-19 pandemic crisis. Particular attention must be devoted to children as a vulnerable group, to avoid consequences in the long term.

Keywords: COVID-19, wellbeing, children, schools, socioeconomic status

Introduction

During the COVID-19 pandemic crisis, many measures were taken around the world to limit the transmission of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) which disrupted the daily lives of people in many ways. The interruption of social activities, social distancing, confinement, curfews, and mask policies were measures taken to limit the transmission of the virus. Unfortunately, all these measures have had harmful consequences, such as isolation, misinformation, fear, and violence, which have affected

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the wellbeing of many people. One of the most vulnerable groups to these consequences of this pandemic was children. In 2019, the WHO (World Health Organization) estimated 301 million people worldwide were suffering from anxiety and 280 million from depressive disorders [1]. In 2020, a study conducted in 204 countries and territories showed that 298 million people had suffered from anxiety disorders and 193 million from depressive disorders. After adjusting for the COVID-19 pandemic, 374 million people were affected by anxiety disorders and 246 million by depressive disorders. Between the two years, there was an increase of 26% and 28% respectively. The increase was greater among women than among men, and prevalence also showed a more marked change in younger groups, that might reflect an impact of social restrictions and school closures [2]. Results in China also showed that anxiety and depression levels in children and adolescents increased during the COVID-19 pandemic crisis [3].

School closures, lockdowns, isolation, fear, and interruption of social activities had an important impact on the development of children. In the past, school closures have shown that pupils who have been absent for a long period were more likely not to return when schools reopened. In addition, previous health crises have shown that children are at a greater risk of violence and abuse [4]. Several studies have shown that the physical, mental, and social wellbeing of children were affected by interrupted reactional activities and the closure of schools [5–7]. The pandemic has reinforced social inequalities among disadvantaged backgrounds [8]. It also led to economic instability, and the wellbeing of children appeared to deteriorate as the economy declined [9, 10]. Long-term effects shouldn't be underestimated. A study in the USA on the different effects of historical pandemics on children showed that almost a third of them suffered from symptoms of post-traumatic disorder [11]. A systematic review of the impact of social isolation on the mental health of children showed a direct association between social isolation and mental health, resulting in future mental health problems even up to 9 years later [12]. In Belgium, primary schools were not closed during the COVID-19 pandemic crisis. However, the interdiction of reactional activities, physical distances, and limitation of social contacts were maintained to limit the transmission of the virus. In a study conducted in primary schools during the COVID-19 pandemic crisis at the beginning of 2021 during the lockdown period, 53% of children expressed symptoms of anxiety and 31% were anxious [13]. As wellbeing is an evolving state, and keeping in mind the many emerging consequences of the pandemic, the monitoring of the wellbeing after the COVID-19 pandemic remains essential, particularly in children, knowing that anxiety problems can persist into adulthood and evolved to serious health problems. We conducted the present study to assess the wellbeing of children in French-speaking primary schools in Belgium after the COVID-19 pandemic crisis. We aimed to learn lessons for future health crises and to help professional decision-makers take measures to protect the development of children.

Methods

We conducted a first study DYNAtracs, DYNAmic TRAnsmission of Coronavirus in Schools, from January 14 to May 18, 2021, in 11 primary schools of the Federation Wallonia-Brussels in Belgium. Schools were selected using a purposive sampling based on the extremes of three inclusion criteria. The first criterion was the local incidence level of SARS-CoV-2 during the first wave on May 6th, 2020 in Belgium [14]. Schools with a local cumulative incidence below 5.0 cases per 1,000 persons were considered as a locally low incidence of SARS-CoV-2. Schools with a local cumulative incidence equal to or greater than 5.0 cases per 1,000 persons were considered as a locally high incidence level of SARS-CoV-2. The second criterion was the size of the school which ranges between 12 and 600 pupils in Belgium [15]. Schools with less than 230 children were considered as small and as large if above 230.

The third criterion was based on the school's socioeconomic status (SES). SES is a national scale qualifying all French-speaking schools in Belgium [16]. SES is a 20-point index based on 7 data of the child's household over 7 years: the household income, the number of persons with a superior education degree, the number of persons with a nursery or primary degree, the number of persons with a job, the number of persons with social assistance, the number of persons with a manual job and the number of persons with a job in the lowest level of the tertiary sector. Individual values are collected from each child. For this criterion, schools with a SES lower than 7 were considered as low and those with a SES above 13 were considered as high. Schools were selected within each of the eight categories defined by crossing the two levels of the three criteria. The full study design is described in more detail in previous publications related to DYNAtracs [13, 17, 18]. In each school, participants were tested using a rapid serological test by finger prick on the inclusion day and then followed with at least 6 visits over at least 6 weeks. A saliva antigen test of SARS-CoV-2 was performed at each visit. Results are reported in other publications [17, 18]. The wellbeing of children was also assessed and results were reported in another publication [13]. We went back to the same schools after the COVID-19 pandemic crisis to analyze the wellbeing of children and workers, between March 14th and April 13th, 2023. We invited children to answer a paper-format questionnaire using the Revised Children's Manifest Scale (RCMAS). Children in 3rd (8 years old) and 6th grade (12 years old) were also asked to produce 3 drawings of themselves and their school before, during, and after the COVID-19 pandemic.

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Revised Children's Manifest Scale

RCMAS is a scale based on 37 questions (Table 1) with "Yes" or "No" as an answer, coded as 1 or 0, respectively. A total anxiety score is then calculated using 28 items. The total anxiety dimension is the sum of answers to the 28 items, ranging from 0 to 28. A score lower than 10 is defined as an absence or minimum of anxiety symptoms, between 11 and 13 it is defined as an anxious state, and a score equal to or higher than 14 is defined as a definite anxious state.

From these 28 items, three anxiety subscales are also calculated, (1) physiological manifestations, based on 10 items, (2) worry and hypersensitivity, based on 11 items, (3) concentration and social anxiety, based on 7 items. The first dimension, physiological manifestations, refers to difficulties in falling asleep, fatigue, and nausea. The physiological manifestations dimension is the sum of responses to the 10 corresponding items. The score ranges from 0 to 10. A score lower or equal to 3 is defined as an absence or minimum physiological manifestation, a score higher than 4 suggests physiological manifestations, and a score of at least 5 corresponds to a definite state of physiological manifestations. The second dimension, worry, and hypersensitivity, refers to mental ruminations linked to emotional injury and fear of isolation fear. The worry and hypersensitivity dimension is the sum of responses to the 11 corresponding items. It ranges from 0 to 11. A score below 4 is defined as an absence or minimum of worry and hypersensitivity, a score of 5 suggests symptoms of worry and hypersensitivity and a score of 6 or more corresponds to a definite state of worry and hypersensitivity.

The third dimension, concentration, and social anxiety, relates to problems at school. The cIoncentration and social anxiety dimension is the sum of responses to the 7 corresponding items, ranging from 0 to 7. A score under 2 is defined as an absence or minimal difficulties with concentration and social anxiety, a score of 3 suggests difficulties with concentration and social anxiety, and a score of 4 or more corresponds to a definite state with difficulties with concentration and social anxiety. The remaining 9 items are used in a fourth dimension to estimate the social desirability. The social desirability score is the sum of responses to the 9 remaining items. This score has a minimum of 0 and a maximum of 9. A score under 3 is defined as an absence or low social desirability, a score above 4 is defined as a social desirability suspicion, and a score equal to or greater than 5 is defined as a definite state of social desirability [19, 20]. Social desirability corresponds to the desire to answer questions according to what the respondent thinks is most favorable about the interviewers, to make a good impression. For example, one of the questions is "I never lie". If the child answers "Yes", even though everyone lies, it means that he or she is trying to make himself or herself look good.

Hospital Anxiety and Depression scale

The adult questionnaire included 14 questions based on the Hospital Anxiety and Depression scale (HAD) (Table 1) to assess staff wellbeing. The HAD scale refers to symptoms of anxiety and depression using 7 questions for each dimension. Each question has a 4-point response with a value from 0 to 3. A total anxiety score and a total depression score can be calculated with a maximum of 21 points each. A score lower or equal to 7 is defined as an absence of anxiety or depression, a score between 8 and 10 is defined as a suspected state of anxiety or depression, and a score equal to or greater than 11 is defined as a definite state of anxiety or depression [21].

Table 1: Wellbeing scales

	Range	Absence	Presence	
			Suspicion state	Definite state
Children				
RCMAS (37 questions 0-1)				
Anxiety	0-28	≤ 9	10-13	≥ 14
Physiological manifestations	0-10	≤ 3	4	≥ 5
Worry and hypersensitivity	0-11	≤ 4	5	≥ 6
Concentration and social anxiety	0-7	≤ 2	3	≥ 4
Social desirability	0-9	≤ 3	4	≥ 5
Adults				
HAD (14 questions 0-3)				
Anxiety	0-21	≤ 7	8-10	≥ 11
Depression	0-21	≤ 7	8-10	≥ 11

RCMAS: Revised children's manifest anxiety scale; HAD: Hospital anxiety and depression

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Drawings

Each child in 3rd and 6th grade was asked to make 3 drawings in addition to the wellbeing questionnaire. We adopted the 3-drawing method to analyze the representation of children's wellbeing in the school environment before, during, and after the pandemic of COVID-19 [22]. We provided sheets with a box where each child was invited to draw his or her school and him or herself before, during, and after the COVID-19 pandemic. Beyond these instructions, the child could add whatever he or she wished to draw. We provided a box of colored pencils for the children to use while they produced their drawings. To interpret the drawings, we adapted the scale used in the 3-drawing method, and the adapted scale used in a study on the representation of lockdown in children before, during, and after the COVID-19 pandemic [22, 23]. Drawings were analyzed with a personalized scale concerning the school, wellbeing, and the COVID-19 pandemic (Table 2). To ensure that the drawings can be interpreted as accurately as possible, each drawing has been analyzed and briefly described to retain as much information as possible.

Statistical Analysis

RCMAS and HAD scores

As the present study took place after the COVID-19 pandemic crisis period, there was no evident matching with the sample of the first study. Results are reported as mean ± standard deviation (SD) for continuous variables and numbers with proportion for categorical variables. Student's t-test and analysis of variance (ANOVA) with F-test were used to compare subgroups. Correlations between RCMAS scores were assessed using Pearson's correlation coefficient r. Prevalence based on RCMAS scores during the COVID-19 pandemic crisis and after were compared using the chi-square tests. A comparison of RCMAS anxiety and social desirability scores between the first study and the second study was performed using only children who participated in both studies. The scatter plot was used to represent the changes over the two periods in the anxiety score and in the social desirability score.

Table 2: Scale drawings adapted scale to wellbeing before, during, and after the COVID-19 pandemic

Content		Coding	Description
Expressive content(s)			
	Positive facial expression	0=absence/1=presence	Open eyes, smiling faces, laugh
	Positive content	0=absence/1=presence	Sun, flowers, rainbows, butterfly, birds, stars, animals.
	Negative facial expression	0=absence/1=presence	Sad, tears, isolation, angry, fears
	Negative contents	0=absence/1=presence	Clouds, rain, thunder,
			broken objects,
	Movements	0=absence/1=presence	Body in movements?
Items classification			
	COVID-19 references	0=absence/1=presence	People wearing masks, confinement, isolation, test positive, sick, virus
	School references	0=absence/1=presence	Teachers, schools, recreation
	Child itself	0=absence/1=presence	Represents him/herself
	Friends	0=absence/1=presence	Represents friend(s)
	Parents	0=absence/1=presence	Represents parent(s)
	Family	0=absence/1=presence	Represents family
	House	0=absence/1=presence	Represents the house
Structure			
	Colours	Numbers	Use others colours than black and how many
	People	Numbers	How many
	Elements related to	Numbers	How many
	COVID-19		
	Elements related to	Numbers	How many
	wellbeing		
	Use of different sizes	Numbers	How many
	School	Characters	How is the structure of the school?

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Drawings

Differences between items on the drawing scale over the three periods (before, during, and after the pandemic) were assessed using the McNemar test. The statistical significance level was set to 0.05. Data were analysed with R 4.2.2.

Study population and inclusion criteria

All children and staff in previously selected primary schools were invited to participate. Participants were included if the consent was signed by both parents and the child or by the staff.

Exclusion criteria

Absence or refusal to provide written informed consent before enrolment.

Data collection

Human data were collected following the Declaration of Helsinki. The protocol, informed consent forms, and questionnaires were approved by the Hospital-Faculty Ethics Committee Saint-Luc ("Commission d'Ethique hospitalo -facultaire des Cliniques universitaires Saint-Luc") – UCLouvain, approval number: 2022/06DEC/469. The study investigators visited each school and interviewed each participant. Every questionnaire was in paper format. Each response to the questionnaires was encoded in a double database and each data was encoded in an anonymized way. A verification of the double encoding was carried out. The database was then converted into an Excel file.

Results

Of the 11 schools selected for the primary study, two were excluded because their principals refused to participate. Among the 9 remaining schools, 13% of children (282/2247) and 10% of staff (33/346) participated in the study giving back a signed consent form.

Revised Children's Manifest Anxiety Scale

The wellbeing questionnaire was completed by 98% (276/282). The mean age was 9.0 ± 1.7 years and 59% (164/276) were girls. After the pandemic crisis, 63% of children (174/276) had symptoms of anxiety, and 38% (104/276) had a definite state of anxiety. During the COVID-19 pandemic crisis, symptoms of anxiety were observed in 53% of children (122/231), and a definite state of anxiety was observed in 31% of children (72/231). The increase in the prevalence of anxiety symptoms was significant (p-value=0.03). Girls had a higher anxiety score compared to boys (12.2 ± 6.0 versus 10.6 ± 5.5; p-value=0.02). Social desirability scores were still high after the COVID-19 pandemic crisis, with 65% of children (178/276) with symptoms of social desirability and 55% (151/276) having a definite state of social desirability. Similar results were found during the COVID-19 pandemic crisis, with 65% of children (150/231) having symptoms of social desirability, and 52% (120/231) having a definite state of social desirability. Youngest children had a higher RCMAS social desirability score (6-7 years: 5.2 ± 2.2) than older children (8-9 years: 4.6 ± 2.7; 10-12 years: 4.2 ± 2.4; p-value=0.02). Higher social desirability correlated with lower anxiety scores (r=-0.31; 95% CI [-0.41;-0.20]). Symptoms of physiological manifestations were observed in 67% of children (184/276), and a definite state in 53% (145/276) after the pandemic crisis. Compared to 49% of children (114/231) and 36% of children (82/231) during the pandemic crisis, the two increases in prevalence were significant (p-value<0.001, and p-value<0.001, respectively). Symptoms of worry and hypersensitivity were observed in 54% of children (148/276), and 42% (115/276) had a definite state of worry and hypersensitivity. Similar results were observed during the pandemic crisis, with 46% (107/231) showing symptoms of worry and hypersensitivity, and 37% (86/231) showing a definite state of worry and hypersensitivity. Symptoms of concentration difficulties and social anxiety were observed in 39% of children (108/276) had, and a definite state in 24% (66/276) after the pandemic crisis. Similar results were observed during the pandemic crisis, with 36% (82/231) having symptoms of concentration difficulties and social anxiety, and 20% (47/231) having a definite state of concentration difficulties and social anxiety.

Table 3: Prevalences in complete sample and matched subset over time

		Complete sample		Matched subset	
		During	After	During	After
		n=231	n=276	n=27	
Anxiety	≥ 10	53%	63%	44%	52%
	≥ 14	31%	38%	26%	37%
Social	≥ 4	65%	64%	74%	44%
desirability	≥ 5	52%	55%	67%	41%

VA total of 27 children completed the wellbeing questionnaires in the first study and in the present study. In this matched subset the prevalence of anxiety symptoms increased from 44% of children during the COVID-19 pandemic crisis to 52% of children after the COVID-19 pandemic crisis, and the prevalence of a defined anxiety state increased from 26% to 37% after the pandemic crisis. Suspected social desirability decreased from 74% to 44% after the pandemic crisis. The defined social desirability state also decreased from 67% to 41% after the pandemic crisis. Anxiety during the COVID-19 pandemic crisis and anxiety after the COVID-19 pandemic crisis are shown in Table 3 and on Figure 1.

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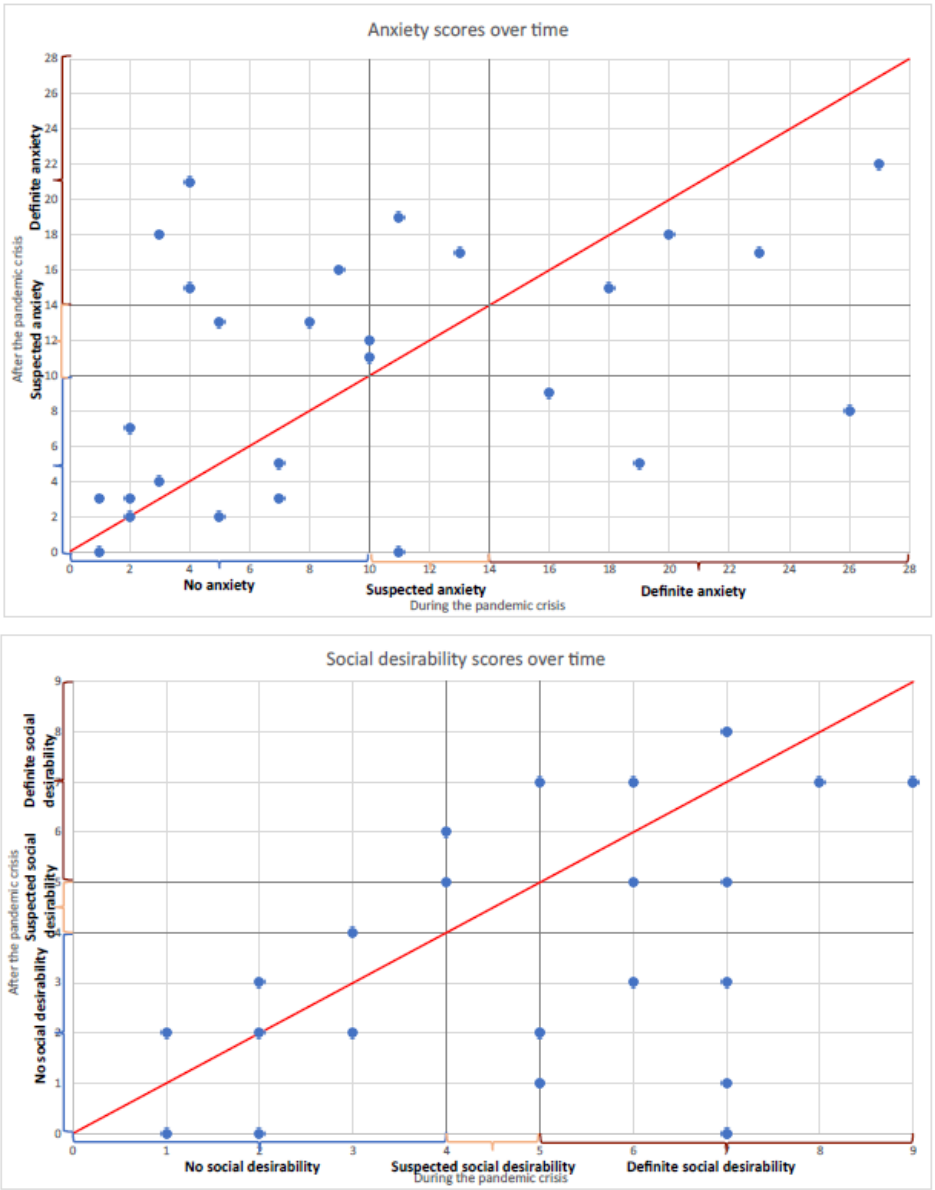

Figure 1: Representation of anxiety and social desirability for the matched subset over time

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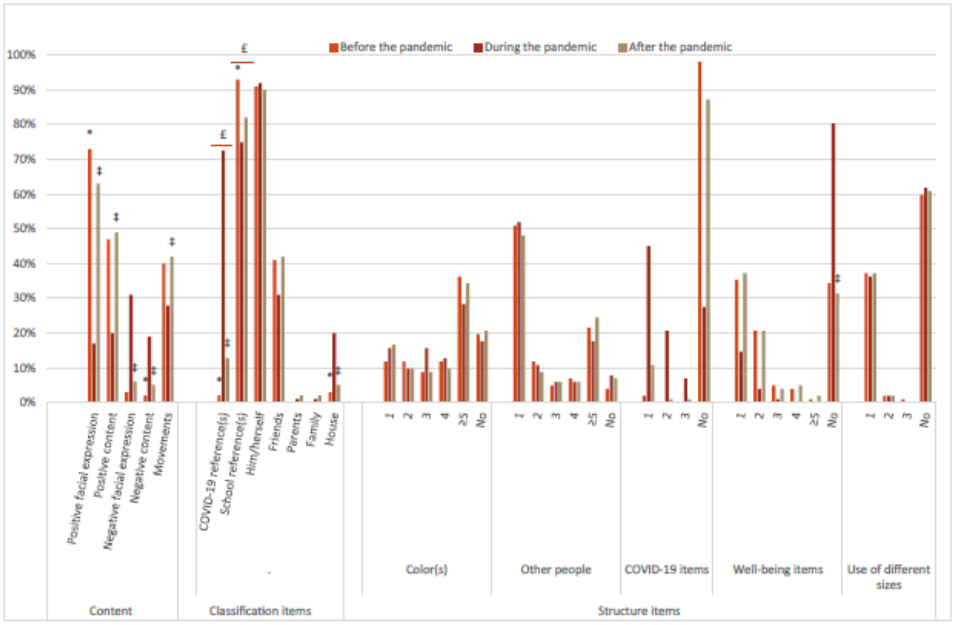

Figure 2: Drawings contents
p-value significant <0.05: * before versus during; £ before versus after; ‡ during versus after

Hospital Anxiety and Depression scale

The questionnaire was completed by 94% of staff (31/33). The mean age was 44.4 ± 12.0 years, and 84% (26/31) were women. There were 65% of teachers (20/31), 13% of directors (4/31), 13% of caretakers (4/31), 7% of secretaries (2/31), and 3% were childcare workers (1/31). Symptoms of anxiety was 42% of staff (13/31), and 16% (5/31) had a definite anxiety state after the pandemic crisis. Similar results were assessed during the pandemic crisis, with symptoms of anxiety in 42% (92/221), and 16% (35/221) had a definite state of anxiety. Symptoms of depression were present in 13% of staff (4/31), and 7% (2/31) had a definite state of depression after the pandemic crisis. Similar results were observed during the pandemic crisis, with 13% of staff (29/221) with symptoms of depression, and 5% (12/221) with a definite depression state.

Drawings

A total of 102 children produced drawings, of whom 67% were girls (68/102) and 83% (85/102) reported that they liked drawing. The longest time taken to complete the drawings was 1 hour and 26 minutes. Contents are presented on Figure 2.

Expression content

Positive facial expression

Representations of facial expression by children were 73% (74/102) before, 17% (17/102) during, and 63% (64/102) after the COVID-19 pandemic. The proportion during the COVID-19 pandemic was significantly lower than before (p-value<0.001), and then after (p-value<0.001).

Positive content

The representation of positive content in children's drawings was 47% (48/102) before, 20% (20/102) during, and 49% (50/102) after the COVID-19 pandemic. The lowest positive content observed during the COVID-19 pandemic was significant compared to after (p-value=0.004).

Negative facial expression

The representation of negative facial expressions in children's drawings showed an opposite trend, with 3% (3/102) before, 31% (32/102) during, and 6% (6/102) after the COVID-19 pandemic. The representation of negative facial expressions was higher during the COVID-19 pandemic compared to after (p-value=0.004).

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Negative content

The representation of negative content in children's drawings showed also an opposite trend, with 2% (2/102) before, 19% (19/102) during, and 5% (5/102) after the COVID-19 pandemic. The representation of negative content was higher during the COVID-19 pandemic compared to before (p-value<0.001) and after (p-value=0.006).

Movements

Movement representation in children's drawings showed also an opposite trend, with 40% (41/102) before, and a significant increase from 28% (29/102) during the COVID-19 compared to 42% (43/102) after the COVID-19 pandemic (p-value=0.03).

Classification items

COVID-19 references

The representation of references to COVID-19 in children's drawings was 2% (2/102) for the period before the COVID-19 pandemic.

In general, COVID-19 elements were present in almost all the drawings for the pandemic time. Children represented at least one element of the COVID-19 pandemic in 73% of drawings (74/102), such as face masks, distance, school or governmental measures, closed schools, houses, hydro-alcoholic gel, etc. After the pandemic, 13% of children (13/102) kept items related to the COVID-19 pandemic in their drawings. The representation of COVID-19 references was higher during (p-value<0.001) and after COVID-19 (p-value=0.009) compared to before. The representation of COVID-19 was also higher during COVID-19 compared to after the pandemic (p-value<0.001).

School references

The representation of a school in children's drawings was 93% (95/102) before, 75% (76/102) during, and 82% (84/102) after the COVID-19 pandemic. The representation of the school was higher before the COVID-19 pandemic compared to the other periods (p-value<0.001, and p-value=0.006).

Self-representation

Self-representation in children's drawings was unchanged, with 91% (93/102) before, 92% (94/102) during, and 90% (92/102) after the COVID-19 pandemic.

Friends

The representation of friends in children's drawings had also a V shape across time, with 41% (42/102) before, 31% (32/102) during, and 42% (43/102) after the COVID-19 pandemic.

The house

The representation of home in children's drawings was only 3% (3/102) before; it increased to 20% (20/102) during the pandemic, and returned to 5% (5/102) after the COVID-19 pandemic.

Structure items

Color(s)

The use of color(s) has been represented in 80% of children's drawings (82/102) before the pandemic, 82% (84/102) during the pandemic, and 79% (81/102) after the pandemic. Before the pandemic, 36% of them (37/102) used at least 5 different colors. During the COVID-19 pandemic, this proportion fell to 28% of them (29/102), and it went back to 34% (35/102) in drawings for after the pandemic.

Other persons

The representations of person(s) were used in 96% of children's drawings (98/102) before the pandemic. Similar proportions were reported for the other periods.

COVID-19 item(s)

The representation of a COVID-19 element in children's drawings was 2% (2/102) before the COVID-19 pandemic. It increased to 73% (74/102) for the pandemic period, but it remained at 13% (13/102) for the post-pandemic time.

Wellbeing item(s)

The representations of wellbeing element(s) were 66% in children's drawings (67/102) before the pandemic. This proportion fell drastically to 20% during the pandemic and went back to 69% after the pandemic. The representation of wellbeing items was lower during the COVID-19 pandemic compared to after the pandemic (p-value<0.001).

Size

The representation of different sizes in drawing elements over the period in the children's drawings was 40% (41/102) before, 38% (39/102) during, and 39% (40/102) after the COVID-19 pandemic.

Some particularities in drawings deserved attention

One child remembered the previous study and represented the survey team in his drawings (see supplementary material N°1). Some children drew items associated with sadness (tears, sad faces, clouds, dark colors) and items associated with joy (butterflies, flowers, sunshine, etc.). For example, in this drawing, the child has drawn a sun that is crying, rain, self-representation with one tear, but also a rainbow, which is a representation of joy, and peace (see supplementary material N°2). Isolation was represented in some of the drawings. For example, one child drew himself or herself behind the bars of a prison (see supplementary material N°3). One child was happy to stay at home during the COVID-19 pandemic and then return to school as normal (see supplementary material N°4). One child integrated the war in Ukraine after

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the pandemic. He or she also integrated the problem of the large quantity of waste generated by the pandemic, with the overturned dustbins full of masks (see supplementary materials N°5). Many children remembered the protective measures implemented at school during the pandemic. He or she represented the distance measures, the masks, and the separated break time per grade (see additional materials N°6). A child has represented the government meetings (see additional materials N°7).

Discussion

The COVID-19 pandemic has disrupted daily life around the world, with many consequences for everyone. It is important to monitor the wellbeing of the population after the epidemiological crisis, to document developments, and to take action if necessary. Documenting changes in children's wellbeing is essential, as most mental health problems develop during childhood. The pandemic has had consequences that extend beyond the end of the lockdown, such as the economic crisis, heightened feelings of insecurity and uncertainty about the future. Children's participation rate in this study was low in all schools except one, with a participation rate of 50%, which represented 44% of the total sample. Staff participation was very low in our study, with only 10% of adults accepted to join. Such a low proportion reflected maybe the overpressure of the pandemic period.

Wellbeing

Before the COVID-19 pandemic, the prevalence of anxiety and depression in children aged 0-9 years were <1% and <0.1% worldwide, 2% and 0.2% in Belgium respectively. In adults (aged over 20 years old), they were 5% each worldwide, 6% and 5% in Belgium respectively [24]. The Institute For Health Metrics And Evaluation has estimated that 15% of the total number of years lived with disability worldwide were due to mental disorders in 2019. In 2020, anxiety and depressive disorders due to the COVID-19 pandemic were 28%, nearly two times higher than in 2019 [25]. In 2020, a study conducted in 204 countries and territories reported a 26% increase in anxiety disorders and a 28% increase in depressive disorders after adjusting for the COVID-19 pandemic. The prevalences also revealed a bigger change in younger age groups, which could indicate the impact of social restrictions and school closures [2].

We investigated anxiety during COVID-19 crisis in a previous study, in the same schools. During the COVID-19 pandemic crisis, 53% had anxiety symptoms, and 31% had a definite state of anxiety [13]. After the COVID-19 pandemic crisis, 63% had anxiety symptoms, and 38% had a state of definite anxiety. A comparison between the two studies for the same participating children suggested that anxiety levels have worsened after the COVID-19 pandemic crisis. These results are in line with literature. In the World Health Organization report, many people became more anxious with the SARS-CoV-2 virus and, for some, the pandemic amplified serious mental health problems [1]. The long COVID-19 or post-acute sequelae of SARS-CoV-2 may be one of the reasons for the deterioration in wellbeing. Mood changes are typical symptoms described in these post-acute sequelae [26]. A study conducted in UK addressed the effect of SARS-CoV-2 infection on cognitive functions. It showed that infection with the SARS-CoV-2 virus led to cognitive dysfunction depending on the severity of the COVID-19 disease and whether the symptoms were persistent and unresolved [27, 28]. Two-thirds of children had symptoms of social desirability and 55% had a definite state of social desirability. The high social desirability score and the negative correlation between social desirability and anxiety scores suggest that anxiety scores were underestimated. Especially in younger children (6-7 years old) the social desirability scores were the highest. Regarding the comparison of scores for children who participated in both studies, anxiety scores were higher after the pandemic crisis than during. In contrast, social desirability scores were lower after the COVID-19 pandemic crisis. One principal was very interested in an adapted questionnaire for children. She expressed the need to adapt questionnaires according to the age of the child with relevant questions. A specific questionnaire on school premises can help school staff monitor children's wellbeing and refer them to the appropriate people in order to limit the consequences in the future. Wellbeing has deteriorated over time. Even though schools were not closed during the lockdown period in Belgium, the COVID-19 pandemic and its consequences have left their mark on the children. A comparison between anxiety scores and depression scores over time was not possible due to the low staff participation rate in this study. One possible answer to this could be that staff wish to move on and not think about the pandemic. For example, one of the school's principals said that the majority of his staff did not want to take part in the survey because they were so tired of hearing about the pandemic. Which is also a sign of wellbeing and personal development, to want to move on and look to the future.

Wellbeing in drawings

Expressing themselves orally in the right words is not always easy for children. Children express themselves more easily through drawings, and most of them enjoy drawing. The wellbeing expressed in drawings can be a challenge to interpret, as every child is different. The drawings are in some way a representation of their world, and the investigators need appropriate tools to interpret the drawings. A school is a place of learning in terms of knowledge, but also of interaction with others and personal development. The COVID-19 pandemic has compromised these different aspects with various protective measures, confinement, limitation of outdoor activities, etc. By comparing the three drawings,

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the investigators were able to investigate the children's perception of their wellbeing over different temporalities. A specific scale was adapted to be as accurate as possible in terms of interpretation. At the same time, each drawing was carefully analyzed to identify specific indications and interpretations.

The representation of isolation and the absence of green spaces suggest a deterioration in wellbeing. The period of the COVID-19 pandemic crisis was a time of confinement and restricted movement. Studies have shown the benefits for wellbeing and mental health of access to green and blue spaces [29–33]. Only 16% of children did not like drawing and were minimalist in their drawings (almost no use of varied colors, few additional elements apart from the instructions, few elements relating to wellbeing, etc.). This limits misinterpretation as the drawings did not provide contradictory information. Conversely, it may also indicate social desirability and that the children are responding to what is expected of them. Only 3% of children admitted they never drew and 17% admitted to rarely drawing. The representation of positive facial expressions was 17% in their drawings during the pandemic, against 73% before, and 63% after the pandemic. Positive contents were included in 20% of drawings during the pandemic, against 47% before and 49% after. Negative facial expressions were reported in 31% during the pandemic, against 3% before and 6% after. Negative contents were included in 19% of their drawings during the pandemic, against 2% before and 5% after. During the COVID-19 pandemic, the protective mask covered the face, so the children depicted masks on people's faces, illustrating the difficulty of interpreting facial expressions in real life, but also in their drawings with masks. Some children expressed their feelings in tears, rainy days, signs, isolation, etc. Overall, the pandemic was a difficult period, which was reflected in the drawings as isolation, sadness, anger, sickness, etc. These results are similar to those of the study using the three-drawing method, where children drew more positive facial expressions before and after confinement, and where sadness was included during the period [23]. COVID-19 items were represented in 73% of drawings "during the COVID-19 pandemic". More than one item was represented in 28% of drawings. There was confusion in using COVID-19 items before the pandemic period in 2% of the drawings. In the majority of "during the COVID-19 pandemic" drawings, the elements of COVID-19 were represented by the child himself or other people wearing face masks. The physical distance was expressed in some drawings by 1.5 meters, and the coronavirus itself was expressed in rare drawings, by the sign or figure of the coronavirus. In a few drawings, we observed the representation of a hydroalcoholic gel. In almost all the drawings, the children represented other persons. In most of the drawings, the other persons appeared to be their friends or classmates. In some cases, the children represented their teachers. Parents were practically absent from the drawings. References to school, which were one of the instructions given for the three drawings, were mostly represented in the drawings. Representations of the school were more frequent in the drawings "before the COVID-19 pandemic", at 93% compared with 75% in the drawings "during the COVID-19 pandemic" and 82% in the drawings "after the COVID-19 pandemic". This may suggest that children felt more comfortable and secure with school before the pandemic.

The house was represented in 20% of "during the COVID-19 pandemic". However, almost no children drew their parents. One study suggested that the lack of representation of parents during the confinement was due to the incertitude and lack of adult control over the situation, which could lead children to represent their home as a place where they felt relatively safe [23]. The representation of wellbeing in the drawings varied. The wellbeing items were represented in 20% of drawings "during the COVID-19 pandemic" compared to 66% in drawings "before the COVID-19 pandemic" and 69% in drawings "after the COVID-19 pandemic". The COVID-19 pandemic was a period of confinement, of staying at home, of sickness, and of being away from people, which is reflected in the lower number of items listed under wellbeing. Some of the drawings depicted solitude, showing them alone in front of the window of their house, lying in bed, behind bars, etc. One child represented his school with its windows barricaded with nailed wooden planks in the drawing "during the COVID-19 pandemic".

One child remembered the precedent study we led in 2021 and represented us in the drawing. Another child represented a bin full of face masks, suggesting the waste problems caused by the pandemic. The same child drew a sign saying "war in Ukraine", suggesting new insecurity. Colors play an important role in the meaning of the drawings [34]. During the different drawing periods, the majority of children used colors, from 79% up to 82%. Monitoring changes in wellbeing over time is important, particularly for children. Most mental health problems in adulthood arise from difficulties encountered in childhood. School is an environment where children need to feel secure to develop their full potential. However, they can encounter difficulties during their school journey, such as learning difficulties, dropping out, and bullying by other children, which can affect their short- and long-term wellbeing. Wellbeing is not a static state and evolves as a function of the family situation, the child's environment, the child's entourage, as well as the child himself, which makes it even more important to monitor wellbeing over time.

Limitations

Our study had certain limitations. Wellbeing questionnaires

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were answered by 13% of children and 10% of staff. Some teachers expressed their feelings towards the direction of the school and explained they were tired of hearing about COVID-19. This can be interpreted as a wellbeing response in that they want to move out. The questionnaire was entirely completed by 98% of the participating children. To calculate the RCMAS scores, all the questions must be answered to calculate scores correctly. Factors other than COVID-19 are involved in the wellbeing evolution, such as the environment, the social environment, the family situation, etc. One school was more represented than the others in this sample. The drawings are subjective and can be difficult to interpret. Care must be taken when interpreting the drawings. The problem of inconsistent wellbeing in some drawings makes interpretation difficult. Some children drew elements linked to sadness (tears, sad faces, clouds, dark colors) and elements linked to happiness (butterflies, flowers, sun, etc.) in the same drawing. Oral explanations of the drawings by the children would have been interesting to add to the interpretations. However, 102 children took part in the drawings and adding this aspect to the organization of the study would have been complicated.

Conclusion

In conclusion, the COVID-19 pandemic has had a huge impact on children, both in terms of their wellbeing and their perception of the pandemic. Anxiety has increased, urging to limit further consequences later in life.

Abbreviations

COVID-19: Coronavirus disease

DYNAtracs: DYNAmic of TRAnsmission of Coronavirus in Schools

HAD: Hospital Anxiety and Depression scale

SES: Socioeconomic status

RCMAS: Revised Children's Manifest Anxiety Scale

SARS-CoV-2: Severe acute respiratory syndrome coronavirus 2

SD: Standard deviation

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Availability of Data and Materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Compliance with Ethics Guidelines

Study registration

The protocol, informed consent forms, and questionnaires were approved by the Hospital-Faculty Ethics Committee Saint-Luc ("Commission d'Ethique hospitalo -facultaire des Cliniques universitaires Saint-Luc") – UCLouvain, approval number: 2022/06DEC/469. It was registered on clinicaltrials.gov on 28/02/2023, identifier number: NCT05747638.

Conflict of interest

The authors declare that they have no conflict of interest.

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Chapter 5: Challenges encountered during the process

1. In 2021

Organizing the study was fastidious and did not proceed as initially planned.

The protocol was submitted to the ethics committee for approval to begin the study. After review, the ethics committee only agreed if we updated the protocol considering their remarks. One of these remarks was the use of complicated terms to explain the study. As a result, some parents were more reluctant to let their children take part in the study, as these complicated terms increased confusion about the aim of the study. However, good clinical practice stipulates that all oral and written communication and information provided must be expressed clearly and without technical terms [51]. Another remark, based on the requirement of the ethics committee was to ask for the signatures of both parents for their children to take part in the study. Some children did not live with both parents which reduced the possibility of involving them in the study, resulting in a lower participation rate.

The lockdown period forced us to contact and inform the selected schools remotely. This might explain why some parents refused to allow their children to participate.

The native language was also one of the challenges in this study. In schools with a lower SES, a lot of parents did not speak a word of French. We had to translate the informative documents into 4 languages: Arabic, Italian, Romanian, and Turkish. Even with translated documents, some parents refused to let their children participate.

In the protocol, 8 primary schools were initially scheduled to participate in the study. Two schools refused to participate. The principal of one school refused because the PSE in charge of this school and teachers were reticent. They thought that parents would not let their child participate, mainly because the majority of them did not

have access to the technological equipment and the internet to inform them properly. For the second school, the principal was very motivated to participate in the study, but the teachers were not. When we received the participant lists, almost all the classes refused to participate, which led the principal to refuse to participate. As a result, we contacted additional schools to participate, 13 schools were invited and 11 accepted.

Initially, in addition to transmission within primary schools, we planned to study the transmission within households. For the participating children, we provided a specific login with a specific password for the parents. We wanted to address specific questions regarding the possible transmission within the participating child's household. However, less than 5% (45/932) of parents answered the questionnaire online. We decided to abandon this method and concentrate on the paper questionnaire given to the children during the visits.

The principal of each school sent us the list of participants by class. However, when arriving at the school for our first visit, the layout of some class disposal was mixed up. For example, in the list, each level was separated, but in reality, some levels were together (e.g. first with the second grade). On the first visit, we had to reassign each child to the right level, to make sure the right class was assigned to each child.

For the study, a specific anonymous code was created, with the school, class, and date corresponding to our visit, with a specific and unique identification number and barcode to stick on the rapid detection test, PCR tubes, and questionnaires. These codes were created and printed by one of the laboratories to facilitate reading the labels when analyzing the PCR samples. Depending on the school, the time between dispatching the consents and the return of the participant lists was sometimes very short. This was one of the reasons why, during the first visit to some schools, we ran out of labels and we had to use available bonuses or even bonuses from other classes. The appropriate codes were reallocated to the preparation room at UCLouvain. However, it happened that labels were missing when preparing the boxes, and did

not have time to ask for a printout of the labels with the correct dates, so the labels with different dates were used. When we created the database, we took these changes into account.

In one school, one of the material boxes had been left behind in the university preparation room. In order to remedy this situation, bonus materials from the other boxes were used. In the preparation room, the correct allocation with the right identification number to the right samples and questionnaires were then completed.

During the study process, one school planned a pedagogical day on the date of the visit. The principal asked the child's parents if they agreed to come and participate in the study. Some came specifically on that day and others did not.

Not all the children were present when the visit to each school was planned. They were either absent, ill, or in quarantine. In one school, an entire class was considered absent, regardless of the health measure. The school had forgotten that the visit was planned for this date, and one of their classes was taking part in a school activity outside the school. As their return was planned at the end of the day, they neither took the saliva test nor completed the questionnaire.

The questionnaires were sometimes a source of discomfort, as the questions could be considered intrusive for the participants. One child told his or her parents that he or she wanted to stop the study because the questions bothered him or her. We suggested to the child that he or she could continue with the study and perform the saliva tests only, and he or she agreed to continue the study. This discomfort was also reflected in the non-responses to certain questions in the answers reported in the results for the various questionnaires.

In one school, all the staff questionnaires for the staff were accidentally replaced by child questionnaires. This inconvenience had to be rectified. To maximize the chances of completing the questionnaires, we also made the questionnaire available online for all staff. The working students assigned to this specific position quickly

adapted to the situation and used tablets and/or computers so that each member of staff could complete the questionnaire.

Some staff members were not present when the visit to the school was scheduled. They asked our team to leave the identified tubes, and they were collected during the next visit. As the questionnaire was available via their login, they completed the questionnaire directly online.

To conduct this study, we decided to hire some students from UCLouvain. At the end of this process, 155 working students were hired in 2021. Many of them were highly motivated and meticulous, but some were careless and made mistakes. So, it was important to check all the work that had been done.

In the design of the study, we planned to perform the rapid detection test first. However, during our first visit, some children felt nauseous, unwell, or even refused to continue the study before the PCR test was performed. The organization was revised according to this event. In the following inclusion visits, participants began with the PCR test, the rapid antibody detection test, and then the questionnaire. This method helped to reassure the children. However, it did present some additional challenges: it was the beginning of January, and starting with the PCR test in the cold weather complicated the subsequent rapid antibody detection test, given the vasoconstriction of the blood vessels in the hand.

The rapid detection test was read directly during the first visit to each school. The reading of the test was supposed to occur at least 15 minutes after the test had been performed. A specific investigator was assigned to this task and it was really difficult to respect the exact time, especially in schools with a high participation rate.

The PCR samples could not be analyzed directly when we submitted them to the different laboratories. The laboratories were very busy with the PCR analysis of the population and the samples for this study were analyzed on the side, when they had time to process them.

Different methods were used to limit errors in collecting samples and questionnaires. When preparing the material, each questionnaire was directly identified with the identifier corresponding to the child's bag. Several labels were placed in the bags of each participant in case of loss, and the labels were stapled to the packaging of each test, which had to be taped when each test was performed. A sheet of paper was prepared for each class to stick the different labels. Each saliva tube had its unique identification label. The specific label was stuck on the test and the sheet of paper, the label initially present on the tube, which corresponds to a unique identification was stuck opposite the label created especially for this study. Some mistakes were made in the schools, and with this method, some corrections were made (189 tubes, 3% of tubes) but not all. Some tubes' unique identification labels were illegible. Some tubes had lost both identification labels, making it impossible to find the corresponding tube. Some tubes were lost by the laboratory, making it impossible to know the exact result. Some sheets of paper with tube labels from one school were thrown away by students, making it impossible to verify some tubes with missing labels. Some questionnaires were identified by the wrong number. Fortunately, they used a "bonus" identification label, making it easier to reassign the right questionnaires.

The laboratories provided different results in Excel files. One laboratory indicated both labels attached to the tube sample, which facilitated the identification if one label was missing. The other laboratories only used the labels made for this study to identify the tubes, making it impossible to identify them correctly if one of the labels was missing.

During the creation of the database with the PCR results, many mistakes were made. Some identifications were very similar and it was very easy to inadvertently confuse them. A double verification was then installed to minimize the errors. From the different Excel files to the database and vice versa.

In the protocol, the PCR-positive tubes were supposed to be analyzed additionally to undergo further analysis for genome sequencing. Unfortunately, between the time of the first results analyzed and the decision to analyze all the PCR-positive tubes, one of the laboratories lost some tubes (15 tubes). As a result, more detailed analyses were not carried out on all the positive tubes.

Not all the selected schools were visited during the same period. The study began in some schools and ended in others. The government decided to close all schools one week before the Easter holidays. As the study was not complete in some schools yet, the follow-up questionnaire was updated. After this break, children in the remaining schools were asked to express their current mood. At least five of the eleven schools received this questionnaire at least once. Then, these data were not available for all schools that took part in the study.

The various questionnaires were in paper format and needed to be encoded electronically to obtain the complete database. To achieve this, each questionnaire had to be encoded twice to minimize encoding errors. Each participant was identified with a unique identification code. All identification numbers, both existing numbers and bonus numbers, have been activated so that they could be encoded. However, using this method, some questionnaires were incorrectly encoded with the wrong identification. A third control verified these errors.

During the encoding process, a few questionnaires were encoded once, but could not be encoded the second time because they had been lost (19 questionnaires, 0.3% of the total questionnaires encoded). As a result, double-checking was not possible.

Answers to questionnaires relating to the various scales must be completed entirely, to obtain the accurate score. However, some questions requiring only a single response were not answered. Scores for these participants could not be calculated (50 children, 18% of the total children answering the well-being questionnaire), as

they would have resulted in an underestimation of the score and hence a misinterpretation.

Due to the organization and the feasibility of the study, the questionnaires on the children's well-being were completed at home. Young children may have been helped by an adult or sibling to fill in the questionnaires. This may constitute a bias, as the questions may be oriented towards certain answers. We performed some analyses to check whether the results could change if we removed the small children (Figures 10a and 11a, see in Annex 15 & Annex 16, p.209-210). The results did not change if we removed the young children from our analyses.

Initially, the responses to the questionnaires would have been analyzed based on transmission of the virus. As we didn't have transmission cases, the responses to the questionnaires were analyzed based on the results of the seroprevalence. However, analysis of the association between seroprevalence and explanatory variables did not provide decisive results.

2. In 2023

All schools in 2021 were contacted to participate in 2023. However, 2 schools refused to participate, without explanations. Instead of 11 schools, 9 schools were visited.

The native language was also one of the challenges in this study. In schools with a lower SES, a lot of parents did not speak a word of French. The informative documents were translated into 6 languages: Arabic, Italian, Romanian, Spanish, Turkish, and Ukrainian. Even with translated documents, some parents refused to let their children participate.

Depending on the school and the demand of the principal, the time between dispatching the consents and the unique visit was sometimes very short, leading to a possible lower participation rate in some schools.

Teachers were less motivated to participate in 2023, which could lead to a lower participation rate among children.

To achieve this study, some students were hired from UCLouvain. At the end of this process, around 53 working students were hired.

Two working students were planned to evaluate the child, in the case of a child from 3rd or 6th grade, during the drawing process. During the visit, the principal of each participating school, sent us the participating children by grade. However, to limit waiting time and delay the day's lessons, it happened that in some schools, participation was so high that the working students could not be two per child.

Answers to questionnaires related to the various scales must be completed entirely, to obtain the right score. However, some questions requiring only a single response were not answered. Scores for these participants could not be calculated (6 children, 2% of the total participating children), as they would have resulted in an underestimation of the score and hence a misinterpretation.

A discordance of 21% (1192/5562) was observed between the double encoding of the drawings. Based on these discordances, every response was analyzed a third time by a third person to decide on the appropriate response.

Chapter 6: Discussion

1. Summary of key findings

One of the most striking findings of this study was the significant variation in participation rates, which were strongly associated with the socio-economic status (SES) of the schools (r=+0.81). In 2021, participation was 38% among children and 55% among staff, considerably lower in disadvantaged schools. These disparities highlight the ongoing challenge of reaching vulnerable populations in population-based health research, especially under pandemic-related constraints.

In terms of SARS-CoV-2 transmission, our results suggest that the virus circulated only marginally in primary schools. Seroprevalence was 21% in children and 25% in staff, and PCR positivity remained low (3% in children and 2% in staff), with no clear evidence of significant in-school transmission or clustering.

In terms of well-being, 53% of children showed anxiety symptoms in 2021, increasing to 63% in 2023. Anxiety was higher in schools with low SES, among younger children, and among those with non-organized activities. Among staff, 42% reported anxiety and 13% reported depressive symptoms, with a perception of better quality of life in the future than at the time of the study.

These findings reflect not only the biological but also the profound social and psychological impact of the COVID-19 pandemic and other factors on school communities, especially among the most vulnerable school populations.

2. Participation and access barriers

Recruitment and participation were among the most critical challenges faced in this study. While overall participation rates in 2021 were higher than expected for a population-based study under pandemic conditions (38% of children and 55% of

staff), they varied greatly across schools and were strongly associated with the socioeconomic status (SES) of the school (r=+0.81).

2.1 Socioeconomic disparities

Participation was lower in schools with low SES, reflecting the broader difficulty of engaging disadvantaged populations in research. These schools were more likely to face a combination of barriers: lack of internet access, limited digital literacy, and lower trust in health research. A low socioeconomic status indicates that the variables that reduce this index are more important in these schools. The variables that reduce the socioeconomic status of schools are, within the household of the child, the proportion of people with a nursery or primary school degree, the proportion of persons with social assistance, the proportion of people with manual work, and the proportion of people working in the lowest level of the tertiary sector [38]. One of the variables concerns the abstention or the need for social assistance, to determine socioeconomic status. In Belgium, there is a social assistance called the Centre Public d'Action Sociale (CPAS), which is intended to ensure the right to social integration for people with insufficient income. To be eligible for this social assistance, the person must meet the six legal conditions, namely: Belgian nationality or assimilated, permanently living in Belgium, being of legal age, insufficient resources, willingness to work, and having used up all the different social rights (the CPAS only operates as a last resort) [52].

2.2 Communication barriers

One major issue was a limited access to information. Some parents lacked of technological resources to view explanatory materials, which were shared through online videos. In many cases, families did not understand the study's objectives or procedures. Language was another barrier. Although the information sheets were translated into four languages in 2021 and six in 2023, comprehension was still limited due to the complexity of the language and the length of the informed consent documents (up to 10 pages for parents).

These ethical requirements—designed for clinical studies involving patients—were not adapted to community-based public health research involving healthy participants. This likely contributed to confusion, reluctance, and refusal.

2.3 Role of school staff

Motivation among school staff played a crucial role in children's participation. When staff members were well informed and motivated—often thanks to proactive school principals—participation among children was significantly higher. Due to pandemic restrictions, direct contact with families and children was not possible, and most communication occurred via videoconference or printed materials. Teachers became key intermediaries, highlighting the need to involve school personnel more actively in future studies.

2.4 Drop in participation in 2023

In 2023, participation among staff dropped dramatically to 10% overall (Table 1a in Annex 17, p.211), with some schools showing no participation at all. This decline may reflect pandemic fatigue, as well as the increased workload of school staff during that period. In one school, the director reported to the investigators that the majority of the staff explicitly stated they were tired of hearing about COVID-19, but we have no notion of how many expressed this opinion.

2.5 The impact of the COVID-19 infodemic

Another critical barrier to participation was the overwhelming and often contradictory flow of information during the pandemic—what the WHO termed an *infodemic*. This overexposure to complex, changing, and sometimes false or misleading information created confusion and mistrust among the general population.

Even for health professionals, understanding the evolving science around SARS-CoV-2 was challenging. For the general population, frequent changes in preventive measures and lack of clarity about testing and transmission contributed to skepticism

and disengagement. Studies have shown that belief in COVID-19 misinformation was more prevalent among individuals with lower education levels [53]. This may explain part of the reluctance to participate in our study—especially in schools with lower SES.

This emphasizes the need for clear, accessible, and culturally adapted health communication strategies, especially in times of crisis. Public trust in science and institutions must be reinforced through transparency, consistency, and inclusion.

Even in 2024, SARS-CoV-2 has not revealed all its secrets. In April 2024, Nederland's researchers answered that a 72-year-old man died after a COVID-19 lasting record 613 days (nearly two years), despite several vaccine doses. Because of an immunodepression system, the patient didn't respond to vaccines. Repeated sequencing over time showed 50 mutations of SARS-CoV-2 in his body. Specimens collected from the nose and swabs showed that SARS-CoV-2 evolved in a few weeks up to resistance to sotrovinab®, a COVID-19 antibody treatment. The patient didn't respond to treatment as a consequence. Some of the 50 mutations found suggested an enhanced ability to evade immune defenses. SARS-CoV-2 can easily escape from the human immune system [54].

2.6 Lessons for future research

Our findings underline the importance of designing simplified, accessible, and inclusive recruitment strategies, particularly in disadvantaged communities. Ethical procedures should be adapted for population studies, using plain language and possibly face-to-face communication where feasible. Equitable access to information and trust-building with communities are essential for successful participation in public health research.

3. SARS-CoV-2 transmission in schools

Understanding how SARS-CoV-2 spreads within school settings is essential for guiding decisions about closures, testing policies, and public health interventions.

Our study suggests that primary schools were not significant sources of transmission, even during active waves of the pandemic in Belgium.

3.1 Seroprevalence

SARS-CoV-2 seroprevalence in staff was higher than in children, with 25% and 21% respectively. Seroprevalence among children was higher in schools with high seroprevalence among staff. The weak intraclass correlation coefficient suggests that seroprevalence didn't present a classroom cluster.

These findings are consistent with other studies.

Research from Iceland conducted in 2020, showed that 7% of children under 10 years tested positive for SARS-CoV-2, compared to 14% older than 10 years [5].

In another small study conducted over a 15-week period in a Belgian primary school, as well as among adults in child's household, 25% of individuals (45/181) tested positive with a throat-washing sample. Furthermore, 21% of children (13/63) of children tested positive, the majority of them were asymptomatic. In adults, the positivity rate was 27% (32/118), also higher than in children. Clustering analyses of individuals were performed in classrooms and households, and there was no significant difference in infection rates between children and adults. The intraclass correlation was 0.39 for households and 0.15 for classrooms. The authors concluded that their study suggests that the incidence of COVID-19 in children may be higher than it actually was [55].

The difference between adults and children developing COVID-19 remains unclear, although immunity and innate responses may be involved [56–58]. Children may develop an immune response to the virus without virologic confirmation of SARS-CoV-2 infection, suggesting the ability of immunity to prevent the onset of SARS-CoV-2 infection [59]. It appears that the adaptive immune response to SARS-CoV-2 is higher in children than in adults [60].

Children less than 10 years of age were assessed to be significantly less infected by SARS-CoV-2 [61]. It appears important to distinguish children from adolescents, as

the results do not appear to be entirely similar. Several studies have indicated that seroprevalence in children and adolescents differs [62,63].

The sensitivity is 69% and the specificity is 96% for the rapid detection test used in this study. Moreover, cross-reactivity is rare for this test [39]. The positivity rate was not high; if there was a cross-reaction, it would be low and seroprevalence would also be lower.

Using the relationship between seroprevalence and prevalence, we can estimate that the prevalence was:

In children:

$$Prevalence = \frac{0.21 + 0.96 - 1}{0.69 + 0.96 - 1}$$

$$Prevalence => 26\%$$

In adults:

$$Prevalence = \frac{0.25 + 0.96 - 1}{0.69 + 0.96 - 1}$$

$$Prevalence => 32\%$$

The prevalence of the SARS-CoV-2 virus is 26% in children and 32% in adults.

With a highly specific test, the seroprevalence underestimates the prevalence. However, the correlations remain unchanged.

One argument could be that some participants were covered by the vaccination. At the time of our study, the vaccination campaign had not yet been launched. The vaccination campaign for the general population in Belgium began in June 2021 [64]. The presence of antibodies is therefore not linked to vaccination in our results.

Seroprevalence in children and staff was higher than the official local incidence at that time. At the start of the pandemic, the policy recommended testing only people

with important symptoms (e.g., fever ≥38°C). The incidence was therefore underestimated at the beginning of the pandemic because it was based only on symptomatic people. So, all local incidences reported by official structures for Belgium were lower than the actual incidence.

Another consideration is the choice of test. The Belgian official structures used tests with a higher specificity, which could lead to differences in testing strategies, but also in incidences.

Analysis of the association between seroprevalence and the explanatory variables did not lead to any decisive results. This means that seroprevalence in children was not determined by the potential exposure variables and that other factors seem to play a role and need to be considered. Another reason for this could be that this study used a purposive sample, and only the extremes of the 3 inclusion criteria would have shown different results.

An analysis between seroprevalence, urban, and rural schools would have been interesting, but only 2 schools were considered in a rural area. Furthermore, due to purposive sampling, this analysis was not feasible.

3.2 Saliva sampling for PCR

A better understanding of SARS-CoV-2 transmission in schools is of the utmost importance to guide future decision-makers on school closures and educational disruptions, actions that have implications far beyond physical health. The role of children in the dynamics of transmission SARS-CoV-2 during the different stages of the pandemic and under the different variants of concern remained controversial. Since the circulation of more transmissible variants, it seems clear that children and young adolescents were as prone as older individuals to infection but less likely to develop a symptomatic or severe infection [14,65–67]. The question of whether these young populations were naturally less infected than older age groups is still debated [67]. Moreover, as they experienced disease with less symptoms, they could more easily escape testing strategies and were considered potential silent drivers of the

infection [68]. The singular design of this study, being weekly sampling during consecutive weeks with no exclusion of positive but asymptomatic pupils and adult staff, was suited to estimate the potential and effective role of asymptomatic cases in transmission within the classes and the schools of elementary education.

Transmission Results and Comparison to Other Studies

Overall, the literature shows that the risk of transmission to and from children in schools seems to be low, especially in elementary education [69–71]. Our observational non-randomised prospective study showed a low secondary transmission in schools. Among 11 selected schools, only 44 out of 6449 (0.7%) repetitively performed SARS-CoV-2 RT-qPCR tests came back positive, in 29 children and 6 school staff.

These data are in line with similar observations made in schools. Vogel and colleagues, in Germany, reported that 8 out of 23,905 samples were positive in 17 elementary schools despite high community incidence rates [72]. In the UK, Ladhani and colleagues concluded that SARS-CoV-2 infection rates were low in primary schools following partial and full reopening of schools [73].

During the study, we visited 119 classrooms. 10 classrooms were closed because of the presence of positive cases in the class; 7 during one week and 3 during two weeks.

Silent Cases and Viral Load

Another reason for the low transmission in the schools in our study was that the viral load detected in the PCR was low. Most of the positive cases detected had a Ct value above 30, meaning that the positive cases were no longer infectious and could not result in transmission to others.

A counter-argument could therefore be that we were at a low point in the epidemic. However, when we look at the evolution of the pandemic, our study took place

during the second and third waves of the virus, meaning that the number of positive cases in the population was high.

Our study detected silent cases, being asymptomatic cases that escaped the detection system in place in Belgium at that time. Indeed, they were not picked up through the School Health Promotion Department (SHPD). Among our positive cases, 20/29 pupils were isolated cases in a class, and 2 were isolated cases in the school. There was no increase in the number of cases detected in the following weeks, either.

One can argue that not all individuals attending the different schools were participating in the study. However, even if we could have missed secondary cases, data do not support silent transmission in school resulting in apparent ill cases, as no increase in cases was detected by SHPD, up to a 2-week period after the end of the study.

Furthermore, we did not observe many clusters, as only one school (Châtelineau 2) had two classes with, respectively, four and three pupils who tested positive on the same visit. Inside these classes, the classmates participating in the study did not become infected during the following visits. When we cross-referenced our data with the SHPD, we found that their data were in line with our observation. No school staff from this school had a positive test during the study period. This could have contributed to low secondary transmission, as transmission is more likely to occur if the index case is a teacher rather than a child, other factors being equal [71].

According to these results, we estimate that over-testing of asymptomatic children who have been in contact with confirmed SARS-CoV-2-positive individuals is probably not necessary. Indeed, most cases detected in our study were isolated cases (except for Châtelineau 2).

Variants and Statistical Power

The epidemiological situation of the SARS-CoV-2 virus has evolved due to different variants (Figure 21). Variants in the second and third waves had a higher transmission rate but a lower clinical aggressiveness. This might change the chances

of children becoming an important vector in the transmission of the virus, but we didn't observe that.

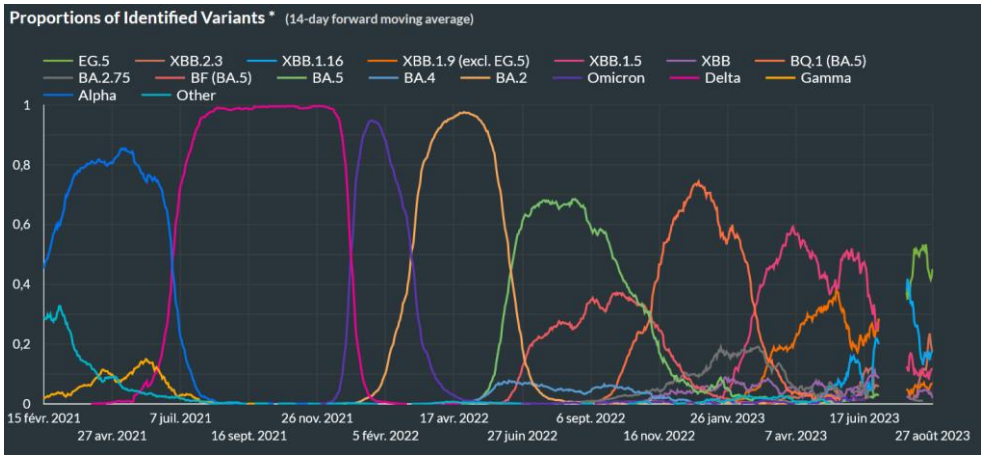

Figure 21: Variants over time
Source : Sciensano [74] https://lookerstudio.google.com/embed/u/0/reporting/c14a5cfc-cab7-4812-848c-0369173148ab/page/urrUC

Comparing the data over time and between the different variants, children do not appear to be the age category with the highest number of positive cases compared to other categories (Figure 22). In contrast, the 30-40 age group had always had a higher number of positive cases over time than the under-10 age group [75].

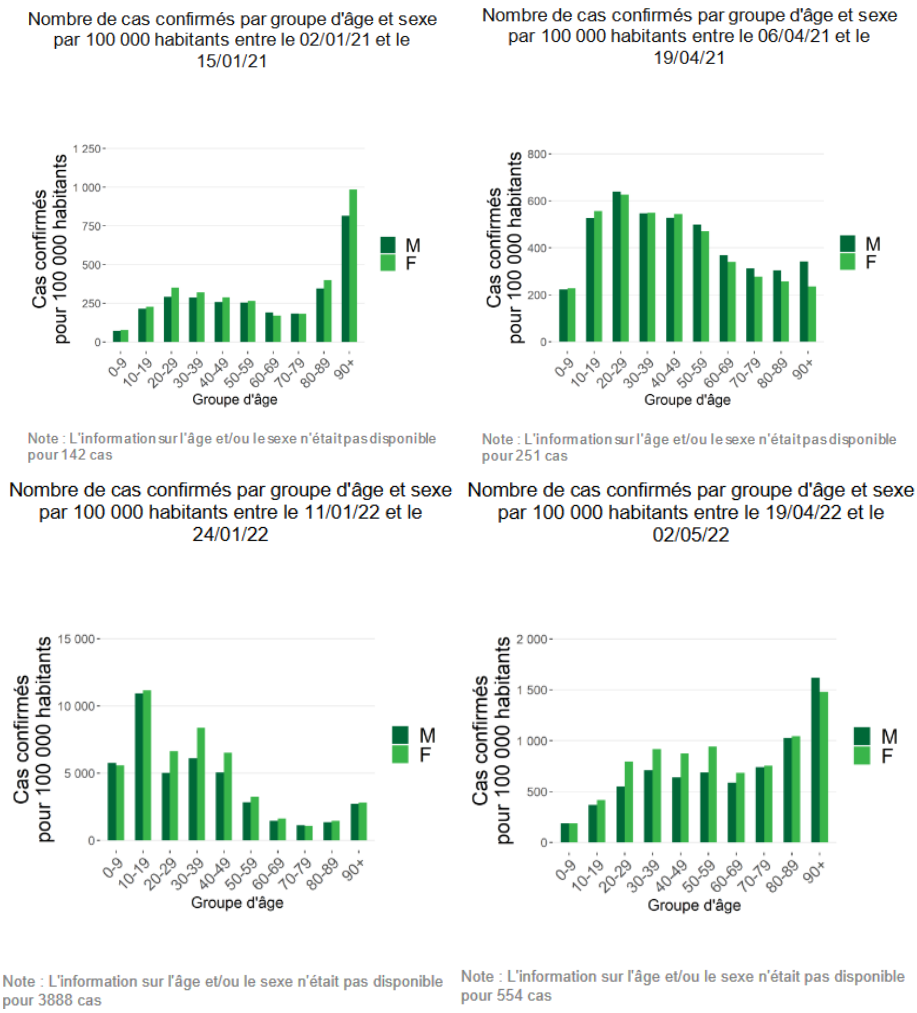

Figure 22 : Confirmed cases by age group over time
Source : Sciensano [75] https://covid-19.sciensano.be/fr/covid-19-situation-epidemiologique

One of the arguments for this was that children were tested less than adults; this argument might have been plausible at the start of the pandemic, as the population was not systematically tested, but the population was soon systematically tested and the results showed that children were not the most important vector in the transmission of the SARS-CoV-2 virus.

The size of the study was not formally calculated, but it had enough power to detect a significant transmission rate. Using purposive sampling, the aim of the study was to find an index case in a class and then at least one new case in the same class at the next visits. With 932 children across 119 classes, the mean number of children per school class was 8.

We observed at least one case in 18 school classes before visit 6, and there was no new case in the same class in subsequent visits in 17 out of these 18 classes. Only school class 4B in Beauraing had a case at visit 2 followed by a new case at visit 5, one month later (see Table 3 and Figure 4 in Results, Objectives n°2). To observe 0 new cases in 7 classmates, 17 times out of 18, and 1 new case in 7 classmates 1 time out of 18 leads to a likelihood over 95% that the transmission probability is lower than 0.009. The size of our study was large enough to detect such a low transmission rate.

Phylogenetic Analysis and Broader Context

Unfortunately, due to low viral loads (high CT values) and due to technical issues, phylogenetic analyses could be performed only in 10 positive saliva samples and concerned just 57% of the genome, a percentage common to all 10 samples. The results obtained in these limiting conditions suggested that individuals were infected outside the school, but we do not have the power to confirm that.

Additionally, schools seem to reflect the evolution of transmission in society [76]. During our study period, the dominant strain was the variant of concern B.1.1.7 (Alpha), and SARS-CoV-2 circulation in Belgium was low. The positivity rate in our study was 0.7%. In one school, we observed two clusters, in March 2021.

These results might simply reflect the multitude of factors involved in the transmission, including the intertwined relationship between community cases and school-acquired cases. Indeed, data from Sciensano (the Belgian official public health structure), assessing the weekly incidence of SARS-CoV-2 in Belgium at that

time, showed an ongoing increase in the number of positive SARS-CoV-2 cases in the whole country during that period, starting on February 26th.

Acceptability of Saliva Testing

In our study protocol, a salivary test was preferred over nasopharyngeal swabbing. This non-invasive method seems better accepted for repeated testing in children, as highlighted by Vogel and colleagues [72]. On-site, salivary tests for weekly surveillance were well accepted by participants. Sampling was performed in the setting of a scientific study and, therefore, was supervised by study staff.

As the weeks went by, children were used to the method, and only a few tests were lost due to swallowing or spitting wrongly outside the container. We propose that this less invasive method should be the norm when testing is performed in the pediatric population.

Interpretation and Public Health Implications

Our seroprevalence results are in line with those published for PCR. Few positive PCR results were obtained, and the positive results obtained did not lead to positive cases in the class or the school in the following weeks [77].

Obviously, at the start of the pandemic, we didn't know much about the virus, and we still don't know everything about it today. Testing strategies have evolved over time, but also vary from country to country; for example, the threshold for positivity PCR varies from country to country. In Belgium, at the time of the study in 2021, a PCR with C_t results over 30 was still considered positive, compared to 28 in Germany or in France.

Our data showed that children are not an important vector in the transmission of SARS-CoV-2. It is therefore important to learn from this pandemic that children need to be protected in future epidemics. School is a very important place for children, a place where they can develop, flourish, socialize, and even access certain services, such as nutrition and school health.

3.3 Questionnaires

The questionnaires were in paper format to increase participation in the study. However, some questions required only a single response. Electronic questionnaires would have avoided this problem, but this would have led to inequalities and a lower response rate.

The questionnaires were initially designed to be analyzed for transmission associated with positive results obtained during the study by the PCR test. As there were no transmission results, we analyzed the responses to the questionnaires according to the results of the rapid detection test. These results did not lead to an emergence of factors between positive and negative results, suggesting that other factors play a role in the presence of antibodies.

4. Well-being of children and school staff

During the COVID-19 crisis, the restrictive measures implemented to reduce virus transmission—such as lockdowns, school closures, and reduced social contact—profoundly disrupted daily life. These disruptions may have influenced individuals' emotional and social equilibrium. In this study, well-being is approached from two complementary angles: anxiety symptoms in children, and both anxiety and depressive symptoms among school staff. It is important to emphasize that the well-being indicators analyzed here are not necessarily a direct consequence of the pandemic itself. Multiple contextual or individual factors—such as pre-existing vulnerabilities, personal circumstances, or structural conditions—may also play a role in shaping well-being.

4.1 Anxiety among children and staff

Everyone can experience a deterioration in well-being, which is too often minimized in comparison with other physical conditions or illnesses, even though well-being is also important because a loss in well-being can have catastrophic consequences and even be lethal. Well-being status should be assessed when treating any illness.

Most people are resilient, but those exposed to adverse circumstances, such as inequality, poverty, and violence, are at a greater risk of a deterioration in well-being. Risks can occur at any stage of life, but those occurring during sensitive periods, particularly early childhood, are likely to be especially damaging. Bad experiences and their accumulation can lead to a deterioration in well-being and possible complications later in life, including mental health disorders. Protective factors are also acquired throughout life, building resilience, confidence, and self-control [78]. The social and emotional aptitudes acquired early in life are important for coping with life and with the various complications encountered. Balanced well-being helps people to participate in community life and make connections with others. Every single person needs others for emancipation [79].

A deterioration in well-being may have several causes, linked or not, at different points in life, but exposures in early childhood persist over time. Adversity can become biologically embedded, enhancing the likelihood of long-term change; this underlines the importance of being aware of contextual factors [80].

Mental disorders are one of the top 10 leading causes of health loss worldwide, with anxiety and depression disorders being the most common across all age groups and places [81].

In 2019, WHO estimated that 301 million people experienced anxiety and 280 million experienced depression disorders worldwide [28]. In 2020, a study among 204 countries and territories showed 298 million people experienced anxiety and 193 million experienced depression disorders. After adjusting for the COVID-19 pandemic, 374 million people experienced anxiety disorders, and 246 million experienced depression disorders. Between the 2 years, there was an increase of 26% and 28% respectively. The increase was greater among women than men and there was also a greater change in prevalence among younger age groups, which can indicate the impact of social restrictions and school closures [82].

The Institute For Health Metrics And Evaluation has estimated that 15% of the total number of years lived with disability worldwide were caused by mental disorders in 2019. 28% more people suffered from anxiety and depressive disorders as a result of the COVID-19 pandemic in 2020 than in 2019 [81].

The COVID-19 pandemic reinforced social inequalities and affected the well-being of a large number of people, whether or not they had pre-existing conditions [28].

Many causes linked to the COVID-19 pandemic can explain the increase in anxiety. The loss of a loved one caused by COVID-19, the loss of a job, social isolation, fear of the future, the economic crisis, the climate crisis, tensions within family violence, the infodemic, etc.

In addition to the COVID-19 pandemic, other causes can explain the increase in anxiety and depression among adults and children. In 2023, many causes of anxiety appeared in the world, such as, for example, the war in Ukraine, which led to an increase in the energy crisis.

Mental health is mainly a priority for adults. Although care in psychiatric hospitals is not always adapted to the needs of the patient, depression is fairly rare in children under 10, while anxiety can begin at a very young age. Psychiatric problems in children are not treated in hospital psychiatric departments (under the age of 18), but children are often placed in pediatric departments and overload the departments. In the end, care is not adapted to these children.

During the pandemic in the year 2021, children with similar symptoms or symptoms of COVID-19 had to stay at home and were placed in quarantine as a precaution. Of course, parents also had to change their habits to be present in such cases. While teleworking was becoming a habit for many companies during this health crisis, it was not always easy to take care of a child, even more so when he or she was sick when the parents were teleworking. Intra-family tensions were frequent, and finally, the deterioration in well-being became a vicious circle. The child had to stay at home,

as did the parents, feeling isolated from peers and activities, developing irritable behavior, the parents becoming impatient, and creating a climate of unease for both parents and the child. This climate of unease could be further reinforced by insecurities linked to the pandemic, financial difficulties in the household, uncertainty about the future, etc. This could lead to domestic violence or an escalation of domestic violence pre-existing before distancing measures against the COVID-19 pandemic. Children are sensitive to the environment and the people around them. The environment is an important factor in a developing child. A meta-analysis reported an increase in domestic violence during the pandemic. If a child suffers from domestic violence at home, school is the only place for most of them to access mental health and support services, as well as proper nutrition [83].

Apart from access to school, having access to a green (park, forest, etc.) or a blue (beach, lake, river, etc.) space contributes to greater well-being [84–88]. This was not the case during the COVID-19 pandemic when restrictions on movements and sometimes total isolation were imposed to protect the population from transmission of the virus.

In May 2020, an online study was conducted to analyze the psycho-social well-being of 44,000 children and adolescents in the Flemish region during the COVID-19 pandemic. The study found that 77% of children and 64% of teenagers were bored more often since the start of the pandemic crisis. They felt lonelier, more tired, and more stressed. Due to the confinement measures, there was more violence, with one child in two reporting more quarrels at home and one child or teenager in 10 reporting physical or verbal abuse [89].

In order to analyze the well-being of adults and children, we used standard validated scales. One of the scales used in this study was the Hospital Anxiety and Depression scale to analyze the well-being of adults. Those adults who obtained a score of or over 11 on 21, are defined as having a depression state as suggested by authors who developed HAD. This tool is used to detect anxiety and depressive disorders. In case

of a high score, specialist advice is required to diagnose a possible pathological condition [47]. In many studies, HAD is used to analyze anxiety and depression in different types of populations. Its ease of use, self-completion, and rapid application have made it widely used in a variety of studies.

We checked the validity of the standard validated scale questionnaires used during this study. In 2021, Cronbach's α was 0.86 for the responses of anxiety, and 0.72 for the responses for social desirability. Another validity was made by the inverse correlation (r=-0.18) between anxiety and social desirability scores. For the staff, Cronbach's α was 0.78 for the responses of anxiety, and 0.77 for the responses of depression.
Values in 2023 were closed: Cronbach's α was 0.84 for the responses of anxiety, and 0.77 for the responses of social desirability. Another validity was made by the inverse correlation (r=-0.31) between anxiety and social desirability scores. For the staff, Cronbach's α was 0.78 for the responses of anxiety, and 0.71 for the responses of depression.

A study conducted in Canada verified the validity of the RCMAS questionnaire in French on French-Canadian children aged 8 to 13. The study concluded that the RCMAS tool can be used as a screening instrument for the early detection of anxiety in children in schools, and for research purposes [90].

Our results showed that social desirability was higher among younger children and in schools with a lower socioeconomic status. We represented anxiety as a function of social desirability according to sex, age, and socioeconomic status of the school during and after the COVID-19 pandemic crisis (Figures 12a and 13a, see Annex 18 & Annex 19, p.212-213). We observed that the majority of children who showed high social desirability and, therefore, an underestimated anxiety report were younger children from schools with a low socioeconomic status.

Anxiety was higher in children who were not involved in fixed activities (57%) compared to children who were (50%). One argument is that the children who are involved in activities outside of school are children from high SES. Among children not involved in organized fixed activities, less than half (45%, 35/77) came from a school with a high SES. Among those who had activities, 91% (135/149) came from a school with a high SES. From our data, it's true that children from high SES were usually more involved in organized activities. However, SES is a calculation based on data from all children's families, we cannot emphasize on each individual background. Some children can have a disadvantaged background in a school with a high SES.

Anxiety was higher in children attending a school with a low SES (61%) compared to children attending a school with a high SES (50%). In 2021, during our study, the lockdown period prevented teachers from going on school excursions with their children, and so, schools with a high SES had no more planned activities at that time than those with a lower SES. Therefore, the higher anxiety is attributed to the family or the environment of the child.

The anxiety in children was still high, even higher in 2023 (63%) compared to 2021 (53%). The children in 2023 were not automatically the same as in 2021. Some children only participated in 2021, others in 2023, and a few participated in both periods (n=27).

In drawings, 67% (68/102) were girls, the mean age was 9.75 ± 1.62, and 53% of the children (54/102) were in 3rd grade. Isolation was reported in some drawings, with 38% (39/102), and 54% in 6th grade (21/39).

In 2023, from the 11 schools initially participating in 2021, only 9 accepted again. In 2021, children from a school with a low SES participated with 25% (57/231). The 2 schools that refused to participate has a low SES. So, in 2023, low SES school children participated with 18% (50/276). Analysis of drawings in relation to the SES

of the school could not have been done, because one school participated in 50% of the total number of participants, and the SES was high.

A long COVID might play a role

Although the deterioration in well-being is not directly linked to COVID-19, long COVID can also lead to a deterioration in well-being.

Long COVID has been defined by the 2024 National Academies of Sciences, Engineering, and Medicine (NASEM) as "*an infection-associated chronic condition that occurs after SARS-CoV-2 infection and is present for at least 3 months as a continuous, relapsing, or progressive disease state that affects one or more organ systems*" [91].

The complexity is that a person can be affected by Long COVID even if he or she wasn't diagnosed with COVID-19, symptoms can appear at different times after the infection of COVID-19 and affect people for varying periods [92]. Requiring a test to prove past SARS-CoV-2 infection is pointless, because it excludes false-negative patients, and almost everyone today has had at least one SRAS-CoV-2 infection [91].

It can affect different parts of the body, such as the brain, the lungs, and the heart. The symptoms can vary, such as cough, trouble breathing, fever, trouble sleeping, mood changes, brain fog, etc. Over 200 different symptoms have been noted to date [93]. It affects people for weeks, months, or longer after getting COVID-19. People experiencing Long COVID have difficulties in carrying out daily activities due to the symptoms. Approximately one million are unemployed at one time or another due to Long COVID [92].

Long COVID occurs in children when a child continues to show one or more new symptoms of COVID-19 for at least 4 weeks after contracting the infection. There are more than 60 symptoms in children and one of them is mood changes. There is no cure for the Long COVID, but some symptoms can be treated with specific

medicine. To help the body and the mind and prevent the situation from getting worse, the child should rest [94].

It is therefore difficult to determine the real impact of the COVID-19 pandemic on the deterioration of well-being. However, the impact of the pandemic on the various factors influencing well-being, such as economic situation, family situation, health, etc. is real and needs to be addressed. There is an urgent need to address measures and provide the necessary help to children who are experiencing suffering, and who are becoming adolescents. A deterioration in well-being can have catastrophic consequences during adolescence and adulthood, such as depression, psychosis, and suicide. Suicide is the fourth leading cause of death among young people between 15 and 29 [95].

4.2 Barriers to well-being Access

Beyond the deterioration in well-being due to the pandemic and its consequences, as well as other factors involved, whether individuals or otherwise, there are also other issues already present before the COVID-19 pandemic that can alter well-being.

4.3 Financing preventive health care in Belgium

One of the pre-existing issues prior to the pandemic was the lack of funding for preventive health care.

In 2021, 11.0% of the Belgian Gross Domestic Product (GDP) was related to health, compared to 12.3% in France, 12.9% in Germany, 11.3% in the Netherlands, and 12.4% in the UK. In 2021, 3.1% of the expenditures on health were used for prevention, compared to 5.5% in France, 6.4% in Germany, 8.7% in the Netherlands, and 12.5% in the UK [96]. This reflects the low investment in prevention in Belgium compared to other countries. Appropriate, effective prevention and easier access to information would have considerable benefits both for the consequences of a deterioration in well-being and for the health budget. Treatment and care for mental health can be very long and very costly. Then, preventing a deterioration in well-

being is vital and could help to avoid many of the consequences for individuals and society in general. Investing in the prevention of mental health should be a priority.

Precarity

One of the biggest challenges to improving the well-being of the population is precarity.

In 2023, the Belgian population is estimated at 11 697 557 people [97]. In 2022, persons at risk of poverty or social exclusion were estimated at 22% for European Union, and at 19% for Belgium (2 144 000 Belgian) [98]. The Belgian population lives in a household whose overall income is under the poverty threshold which is 1366 € per month for a single person, and 2868€ for two people with two children, which is 13%. They are considered as a group at risk of income poverty. Belgians suffering from severe material and social deprivation, and unable to afford several basic goods and services represent 6% of the population [99]. In 2022, 1% of households with schoolchildren had no internet access at home [100]. In 2020, 5% of the Belgian household budget was allocated to health [101].

Information access

Another problem is the access to information about available mental health services. Some resources to help people struggling with their well-being are proposed by the government. However, there is little information circulating about these resources. Not everyone has access to the internet or electronic devices to search for appropriate information. Even when electronic devices are available, it is not easy to find the right information on the internet. Adults have difficulty meeting their own needs when it comes to their own well-being, so helping a child seems even more difficult. Pediatricians and general practitioners can provide a list of people who can help children feel better, but it is often necessary to see several to find the right person.

Lack of healthcare professionals and decline in quality of care

Another problem, already present before the pandemic and worsening with it, is the shortage of healthcare professionals. Work conditions are difficult, and the salary is not encouraging. Hospitals are increasingly concerned with ensuring a profit (sometimes only to survive) rather than providing care itself. Care is often limited to the treatment of visible signs and symptoms, to the detriment of the underlying cause of a disease.

In addition to the lack of healthcare professionals, there are inequalities in the geographical distribution of mental health treatment institutions between regions of Belgium and even between provinces. Mental health care provision is more balanced in the Flemish region. Mental health care is mainly available around Charleroi, Namur, and in Brabant Wallon; otherwise, it is very limited in the Wallonia region [102].

4.4 Services available

Even if there is a lack of resources, personnel, and institutions available to help the population, and more specifically children, with their mental health needs, certain services have been specifically set up to complement the so-called hospital institutions. This list of services is not exhaustive; there are probably other services concerned with well-being.

Centre Psycho-Médico-Social

School is an important place for the children, after the family environment. In FWB in Belgium, the Centre Psycho-Médico-Social (CPMS) is a first-line team working in collaboration with the school. The team includes psychologists, social assistants, and nurses. They offer tri-disciplinary follow-up by organizing class councils, meetings with parents, and interviews with children, principals, and teachers [103,104].

During the COVID-19 pandemic in January 2022, the government reinforced the CPMS teams to limit the impact of the pandemic in schools. Their missions were to support the well-being of students, develop or guarantee a safe and positive school climate, and prevent school dropouts [105].

These measures were extended but ended on 30th November 2022 [106].

Mobile team

The CPMS team is the reference for violence and school dropouts. Besides these teams, other organizational structures can help the child with these issues. One of these organizations is called the mobile team, which can act to improve the relationship between the child, his or her parents, and the scholar system. Their actions are for example animations to prevent violence, meeting with the protagonists, animations on self-esteem, animations on classroom environment, and more [107].

In 2015, a new mental health policy for children and adolescents introduced mobile teams to reinforce the existing help and care system in each province. The mobile team works in pairs with a psychologist, an educator, or a social assistant. They try to intervene within 48 hours; they act quickly, but they do not replace appropriate care [108–110].

This measure was initially created to detect mental or psychiatric disorders at an early stage and to integrate care into a more global approach. It was also introduced to relieve congestion in healthcare institutions, but the institutions are still overwhelmed by the demand [110,111].

Academic support services

Academic support services are organizations based on a voluntary initiative by children under the age of 18. These children can access these services if they are excluded and unable to re-enroll, or enrolled and in a situation of absenteeism, or dropping out or in a crisis with the school, or non-enrolled and not home-schooled

or enrolled but not attending school. Their mission is to create a comforting environment, with social, educational, and pedagogical support [112].

SOS Children teams

SOS Children teams are other organizations set up in 1979 by FWB. Today there are 14 centers. A team includes at least one medical doctor, one psychologist, one social assistant, one jurist, one administrative secretary, and one coordinator. This team guarantees medical, psychiatric, psychological, social, and legal approaches in every situation they have to manage.

Their mission is to ensure individual protection. They deal with self-initiated abuse situations. Upon intervention requested by any person, institution, or service, or upon a request of the advisor of the youth assistance. They can also provide preventive assistance to future parents whose environment or behavior creates a risk of abuse for the unborn child. They also deal with therapeutic care for minors who have committed sexual offenses. They organize discussion groups for victims of childhood sexual abuse or discussion groups for parents of abused children.

They usually operate in 3 phases: (1) of a request, (2) evaluation and diagnosis, and (3) therapeutic project.

(1) They analyze the request;

(2) They investigate in order to make a diagnosis. The team meets the various parties involved. They have direct contact with the child, parents, or persons in charge but also gather opinions of schools, general physicians, CPMS centers, hospitals, CPAS, to obtain an overall view of the problem and get as close as possible to reality.

(3) They propose therapeutic care that they can provide themselves partially or totally. They can also refer care to other services that can provide more specific help, such as the judicial authorities, Service d'Aide à la Jeunesse (SAJ), CPMS, mental

health centers, hospitals, etc. In some cases, the person reporting the abuse may be involved in the therapeutic project, because he or she has established a special relationship with the child and the family.

The help is not limited to the protection of the child. They try to create rooms making talk possible between the child and the family. They identify the function of violence and integrate it into biological, psychological, and social dimensions. They work towards a functional family reorganization to avoid the repetition of abuse.

Targeting the well-being of the child, the team provides support for the child's family environment by helping the child himself or herself. However, if this support is detrimental to the child, they don't provide it and only the child is considered. The team respects professional confidentiality and will only disclose information if it is not harmful to the child.

In many family situations, the abuse reported is a part of the problems encountered by family members. Other difficulties are often encountered, at the social level, or the school level. It is therefore useful for different partners to work together and take part in the care provided to the child. As a result, the teams work in collaboration with people from other sectors [113].

Centers for youth

On March 30, 2015, the Belgian government set up 11 centers of Mental health for children and adolescents. They offer integrated and complete care for children and adolescents between 0 and 23 years of age with psychiatric problems. Each center works in close collaboration with all healthcare providers [108].

Youth Assistance Service and Youth Protection Service

There is also in Belgium an organization called Youth Assistance Service whose role is to help young people. They develop a prevention policy to help the young population and their families, by referring them to first-line services, developing

general prevention initiatives in response to problems commonly encountered in the field, and relaying problems commonly encountered to other services.

The youth assistance service and the youth protection service can provide help to young persons and their families in difficulties or danger. They reorient and provide support to young persons in trouble and their families [114].

Technical Advisory Group

In February 2021, a Technical Advisory Group (TAG) was established to provide guidelines for actions to take in response to Member States of the WHO European Region and other organizations interested in the mental health impacts of the COVID-19 pandemic.

They proposed some recommendations for the general population, vulnerable groups, mental health services, and the health and social care workforce. They recommended that the member states take some specific actions. For example, member states should promote and provide access to information, and access to help people with stress and loneliness. For people directly touched by COVID-19, they should promote and give access to mental health and psychosocial support [115].

Online consultations and free front-line psychological care

During the COVID-19 pandemic, the general population was respecting distance measures or confined at home for several periods, which complicated the consultations with professional health care. The Belgian Institut National d'Assurance Maladie-Invalidité (INAMI) proposed that healthcare professionals practice using online consultations to facilitate follow-up [116]. In addition, the INAMI has proposed reimbursing short-term front-line psychological care to reduce the psychological impact of COVID-19 and its consequences regardless of age, for all persons with anxiety, depression, social, and behavioral troubles [117]. In this continuum, since the 1st of July 2022, they reimburse care for long COVID-19 symptoms, which includes the care of psychologists [118]. At the end of October

2022, the government proposed a collaboration between CPMS and the first-line psychologists supported by the government [105].

Well-being and electronic devices

The use of electronic devices has become ubiquitous over the years, and even more with the COVID-19 pandemic. There is an increase in applications on electronic devices aiming at helping people with their mental health and well-being [119]. However, these methods have to be used with caution. There is still insufficient protection of personal data when using medical applications via mobile phone [120]. Technologies haven't been proven to improve well-being effectively at present [121].

Another important point is the lack of equity in access to and use of these technologies. In 2023, basic digital skills were estimated at 59% in Belgium (for a population aged between 16-75) [122]. 5% of Belgian (aged between 16-75) do not use internet devices [100].

The Table 7 below summarizes the various services available for children and mental health in Belgium.

Name of the service available	Date starting	Age	Specificities
Centre Psycho-Médico-Social	1-04-1960	From nursing to secondary schools 2.5 to 18 years old	In collaboration with schools: offer tri-disciplinary follow-up by organizing class councils, meetings with parents, and interviews with children, principals, and teachers
Mobile team	12-05-2004	From nursing to secondary schools 2.5 to 18 years old	Reference for violence and school dropouts
Academic support services	?	Under the age of 18 years old	Children excluded and not eligible for re-enrolment; enrolled and in situation of absenteeism, dropping out or crisis at school; not enrolled and not home-schooled or enrolled but not attending school
SOS children teams	1979	Under the age of 18 years old	Listen to a person directly or indirectly involved in a situation of abuse; Multidisciplinary assessment and assistance; awareness-raising and training
Centers for youth	30-03-2015	From 0 to 23 years old	Offer integrated and complete care with psychiatric problems
Youth Assistance Service & Youth Protection Service	4-03-1991	Under the age of 18 years old	Develop a prevention policy: refer to first-line services; develop general prevention initiatives in response to problems commonly encountered in the field; relay problems commonly encountered to other services
Technical Advisory Group	1-02-2021	General population	Provide guidelines for actions to take in response to Member States of the WHO European Region and other organizations interested in the mental health impacts of the COVID-19 pandemic
Online consultations & free front-line psychological care	2020 01-07-2022 21-10-2022	General population	INAMI proposed to healthcare professionals to practice using online consultations in order to facilitate follow-up; proposed reimbursing short-term front-line psychological care 01-07-2022 reimburses care for long COVID-19 symptoms At the end of October 2022, the government proposed a collaboration between CPMS and the first-line psychologists
Wellbeing and electronic devices	?	General population	Applications on electronic devices aiming at helping people with their mental health and well-being

Table 7: Some support services for children available in Belgium

4.5 Public Health Implications and Future Directions

Besides all the services available at that time and those created to help the population regarding their well-being, some other initiatives were taken, and other initiatives need to be taken to help the population.

Numerous initiatives have been taken by child pediatric psychiatrists and the Belgian parliament to limit the deterioration in children's well-being during the health crisis [123]. Some hackathons were organized to find solutions to the crisis and its consequences. In 2020, a platform named "JOY" (www.joy-platform.be) was created by the Belgian Pediatric COVID-19 Task Force, the National Commission for Children's Rights, and other associations to help, inform, advise, and connect children, adolescents, healthcare professionals, parents, and teachers, in order to address the negative impacts of the COVID-19 pandemic [124].

Even if the government has become aware of the impact of the pandemic, as well as the consequences that may have resulted from it, the deterioration in children's well-being is still present. It is therefore urgent to take the necessary measures to limit long-term complications.

Investing in preventive health care, increasing the number of healthcare personnel, and improving access to information on the various health services are measures that can be taken to improve well-being.

Another aspect to consider is the impact of measures taken during the pandemic on children. Indeed, the measures taken during the pandemic aimed at the general population without considering the specificities of children, especially those from disadvantaged backgrounds. Although everyone had to make sacrifices, children paid the highest price. Furthermore, the government measures taken at that time were not explained in a suitable way for children [125]. In future epidemics, this aspect should be taken into consideration, and a communication approach should be

adopted that is easily adapted to the general population, but also to the most disadvantaged groups, such as children.

It seems important to measure well-being at several points in childhood, as well-being is not a fixed state. In order to achieve this, the use of well-being during childhood and scholarship seems an appropriate initiative.
After discussions with the principal of one school, who was genuinely concerned about children's well-being, we realized that there are no age-appropriate questionnaires in primary schools with suitable questions relating to well-being. The biggest problem with the available questionnaires is that the questions do not reflect children's well-being and limit the range of possible answers. As the school is an important place for the children, it will be accurate to develop specific questionnaires to monitor the children's well-being. It will be a path in understanding the evolution of the children's well-being inside the school field, but also to contribute to a better follow-up of the actual situation of each child. This could be a way of improving the actions and support to be provided to each child so that they can be relayed to the appropriate health care services.

Children are one of the most vulnerable groups when it comes to well-being, and their well-being is deteriorating rapidly. There is an urgent need to address strategies to limit the consequences of the COVID-19 pandemic, or any other causes, on children. If left untreated, children's pain and suffering can lead to complications such as depression, suicide attempts, or even death later in life. In many ways, our infancy and childhood environment can shape the rest of our lives. Most adult mental disorders emerge during childhood or adolescence.

5 Feedback

A feedback was done after the end of the study in 2021. Initially, the results for each participant were planned to be reported according to their anonymous identification number specifically created for this study. Because of the low participation rate in

some classes, and because of data protection, we were unable to use this option. Instead, we created a global report for each school with their specific results as feedback as well as to protect individual data.

The final database for the data collected in 2021 was completed on February 10th, 2022. The final database for the data collected in 2023 was finalized on June 1st, 2023.

Chapter 7 : Limitations and strengths of our studies

This study has several limitations that must be taken into account when interpreting the results.

While participation in 2021 was higher than initially expected, participation rates varied widely across schools. Refusals to participate could be attributed to multiple factors, including the infodemic surrounding COVID-19. The excessive and often contradictory flow of information during the pandemic created confusion and fear among the population, especially among parents unfamiliar with health-related discourse. This general anxiety likely contributed to hesitancy toward participation.

Recruitment was further complicated by public health measures, which limited face-to-face interactions. Although several materials were made available—including paper consent forms, flyers, and explanatory videos—access to information remained unequal. Families from disadvantaged backgrounds may not have had access to the electronic equipment or stable internet connection needed to view the videos. In addition, the complexity and length of the consent forms may have increased confusion, particularly among parents with limited health literacy or limited proficiency in French, even if translated documents were provided.

The use of rapid antibody tests presented operational challenges. Readings were conducted on-site at schools and required timely interpretation, which proved demanding, particularly in schools with high participation. Despite adherence to the recommended 15-minute waiting period, we observed a 10% discrepancy between initial and second readings, with 78% of those corresponding to conversions from negative (IgG–) to positive (IgG+) results.

Phylogenetic analysis was limited by the small number of analyzable samples and technical constraints. Only a partial genome was obtained for a subset of samples,

preventing any definitive conclusions regarding intra-school transmission or circulation of the same strain within a class.

This study took place during a low-incidence period of COVID-19 cases in Belgium, and therefore, of low circulation of the virus. In January 2021, at the beginning of our study, the incidence rate for the last 14 days, in Belgium, was 205 for 100,000 inhabitants, with a positivity rate of 6.7%. In May 2021, at the end of our study period, the incidence was 355 for 100,000 inhabitants, with a positivity rate of 6.3%. In May 2021, the immunization rate for all individuals of more than 18 years of age was 12.4%, and, for the population of more than 65 years old, this was 27.7%. The dynamics of COVID-19 transmission changed quickly after the end of this study, with the appearance of the Delta variant inducing a wave from late July 2021 until early December 2021, followed by the Omicron wave [126]. As a consequence, due to the higher transmissibility of those variants, the incidence of COVID-19 in Belgium also increased significantly [91]. During the wave of Fall 2020, the COVID-19 incidence in the school population was considerably lower than in the general population [63,126]. This figure has changed during the wave of Fall 2021 with a recorded incidence in children aged 0–9 years old 5.3 times higher than during the same period 1 year before [126].

The well-being assessment in 2021 relied on a booklet completed by children aged 6–7, many of whom required assistance from parents or siblings to complete it. This external help may have introduced response bias or influenced children's answers. However, additional logistic regression analyses did not reveal any significant difference in the results, particularly for anxiety and social desirability (see Figures 10a and 11a, Annexes 15 and 16, p.209-210). To address this issue, the 2023 data collection involved direct questioning by research team members.

Social desirability was measured only for children, not for staff, representing a potential bias in self-reported data. Additionally, well-being was assessed only in

2021 (during the pandemic) and in 2023 (post-crisis), with no baseline data available prior to the pandemic, which limits longitudinal interpretation.

Among school staff, quality of life was assessed based on current perceptions and projected quality of life five years into the future. We did not collect retrospective perceptions of pre-pandemic quality of life (e.g., in 2019), which would have allowed for more robust comparisons across time.

Children's drawings were used only in the 2023 data collection. The absence of similar data in 2021 precluded a direct comparison across the different phases of the pandemic, which would have been valuable in interpreting changes in perceived well-being.

Finally, although population-based studies are inherently complex to conduct, they remain critical for understanding public health dynamics. This study is, to our knowledge, the only one in Belgium to have simultaneously explored SARS-CoV-2 transmission and children's well-being during the pandemic, while accounting for the socioeconomic status of schools. It is also the only study to have used the three-drawing method to capture children's perception of school before, during, and after the COVID-19 crisis.

These limitations should be considered when interpreting the results. However, they do not diminish the relevance of the insights gained; rather, they highlight the need for practical, inclusive strategies to strengthen future epidemic preparedness.

Chapter 8: Recommendations and Conclusion

Before concluding, it is important to turn these findings into action. The following recommendations provide a framework for improving epidemic preparedness and ensuring that the needs of children are no longer overlooked.

1. Recommendations

We are not exempt from a new pandemic, and it is therefore essential to draw lessons from the current one.

One of the most urgent recommendations is to keep schools open as long as possible, depending on the characteristics of the epidemic. Even when schools remain open, children will inevitably be affected by the broader consequences of the crisis and preventive measures. However, the negative impact will be far less severe than if schools were to close completely. While protecting the population remains a top priority, future epidemic responses should include targeted strategies that consider the specific needs of different population groups, especially children, to limit long-term consequences. Alternative preventive approaches must also be explored to help maintain social contact and psychosocial stability throughout a health crisis.

The issue of accessible information emerged as a major challenge during the COVID-19 pandemic. Children often struggled to understand adult discourse, particularly when it involved technical or scientific vocabulary. Similarly, individuals from disadvantaged backgrounds frequently lacked access to the resources needed to understand health information correctly. Public health communication should therefore be adapted in terms of language, format, and delivery channel to ensure inclusivity and clarity.

Mental well-being is not a fixed state— it evolves. Promoting well-being requires collaboration between mental health specialists and the development of more reliable, age-appropriate tools that can be monitored over time. Creating

questionnaires that include indicators of social desirability and that are sensitive to children's evolving emotional states could help detect early warning signs and guide appropriate interventions. These tools could be implemented through the PSE, which already conducts regular health visits throughout a child's school career.

However, the PSE teams were understaffed and overwhelmed during the COVID-19 pandemic. Additional resources are therefore essential—not only to enable the implementation of such monitoring tools but also to ensure timely identification and support for children in psychological distress.

Another critical recommendation is to increase the national health budget dedicated to prevention and health promotion. Investing in preventive well-being measures—especially in schools—can significantly reduce the long-term burden of the deterioration in well-being and the associated treatment costs. Early intervention is more efficient, more equitable, and ultimately more sustainable.

Improving access to information about available well-being services is equally necessary. Many families and even healthcare professionals are unfamiliar with the existing care network. Mapping and promoting these networks more effectively, especially through professionals who work with children, would help to improve access to care and ensure children are referred to the right services more quickly.

This pandemic also emphasized the need to prepare the population—not only for managing infection, but for preventing and mitigating deterioration in well-being. Promoting mental health awareness through education and school programs can contribute to a more caring environment, reduce stigma, and encourage early help-seeking [127]. These actions would support long-term resilience at both individual and societal levels.

Finally, increasing participation in future population studies will require rethinking ethical procedures. Current protocols are often not adapted to general populations, particularly those with limited health literacy. Simplifying study materials with clear, accessible language and favoring face-to-face communication over digital-only approaches would help build trust and ensure that more families understand and

engage with research. Providing translated materials, offering visual explanations, and creating space for questions are all concrete strategies that could improve inclusion. Prioritizing clarity in communication and minimizing technological barriers is key to preventing confusion and countering misinformation in future crises.

2. Conclusion

The COVID-19 pandemic was not only a global health emergency—it was a mirror reflecting the deep inequalities embedded in our societies.
While adults debated testing strategies and lockdown policies, children quietly bore the weight of the crisis—isolated, anxious, and largely unheard.

This research provides a comprehensive view of the impact of the COVID-19 pandemic on primary school communities in Belgium. Our data do not allow us to demonstrate that children were the principal transmitters during the COVID-19 pandemic, even during active pandemic phases, and that transmission within schools remained minimal under real-world conditions.

However, the pandemic's social and psychological toll was significant, particularly among the most vulnerable. Children from lower SES schools and staff members reported high levels of anxiety, with long-lasting effects visible even after lockdowns were lifted. These findings highlight the disproportionate burden borne by disadvantaged populations—not only in terms of exposure, but also in access to information, and participation in health initiatives.

Participation in the study itself reflected this inequality: lower SES was a major barrier to involvement, amplified by digital exclusion, linguistic limitations, and overly complex ethical procedures. These challenges call for a rethinking of how health research engages with vulnerable communities, particularly in crisis contexts.

Information strategies should be more oriented towards low socioeconomic populations to control the disease.

Protecting children's well-being must be central to future epidemic responses. Schools are more than educational spaces—they are essential health and social anchors, especially for the most vulnerable. Closing schools is not a neutral act: it amplifies pre-existing inequalities, isolates children from vital support systems, and leaves long-lasting scars on their emotional development.

The pandemic did not invent these disparities—it exposed and widened them. Children paid the highest price for a crisis they did not cause, and many are still living with its psychological and social consequences. If we fail to act now, we risk normalizing suffering and missing a historic opportunity to rethink how we support young people's health—during crises and beyond.

This study offers not only data, but a call to responsibility. Investing in prevention, simplifying research access, and protecting school environments must become permanent pillars of public health policy.

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Annex

- Annex 1: Protocol 2020/16NOV/552
- Annex 2: Favorable decision by the ethics committee for the protocol 2020/16NOV/552
- Annex 3: Protocol 2022/06DEC/469
- Annex 4: Favorable decision by the ethics committee for the protocol 2022/06DEC/469
- Annex 5: Contributions to the study
- Annex 6: Symptoms reported by children during the COVID-19 pandemic crisis
- Annex 7: Contacts outside the school reported by children during the COVID-19 pandemic crisis
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- Annex 9: Children's feelings reported during the COVID-19 pandemic crisis
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- Annex 12: Symptoms reported by staff during the COVID-19 pandemic crisis
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- Annex 15: Association between anxiety without the children of 6 and 7 years and characteristics using logistic regression

Annex 1: Protocol 2020/16NOV/552

SARS-CoV-2 transmission in Belgian primary schools of the Federation Wallonie - Bruxelles. An epidemiological pilot study.

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Les PSE des écoles impliquées,

La direction et les instituteurs des écoles impliquées

1.0 Synopsis

Title	**SARS-CoV-2 transmission in Belgian primary schools of the Federation Wallonie - Bruxelles. An epidemiological pilot study.**
Study design	Interventional prospective SARS-CoV-2 infection study.
Study duration	Autumn – winter 2020-2021
General objective	Description and quantification of transmission dynamics of SARS-CoV-2 in primary schools.
Specific objectives	To assess the role of children attending primary school in the spread of SARS-CoV2 during the 2020-2021 pandemic • To assess transmission from asymptomatic infected children to other children attending the same school • To assess transmission from asymptomatic infected children to adults (parents and teachers) • To assess transmission from asymptomatic infected adult within the school environment to a child • To assess if a laboratory confirmed case in a classroom has been infected outside the school
Study hypothesis	The investigators hypothesize that children are less likely to become infected in the school environment, compared to the household or outside the school setting. Primary schools do not play a major role in SARS-CoV-2 spreading. They hypothesize that incidence level in schools is mainly a consequence of community transmission ie. the incidence level in households and that the secondary attack rate in schools remains at least 5 times lower than the transmission level in households.
Outcomes	• Infection of a child with SARS-CoV-2 secondary to a classmate • Infection of an adult with SARS-CoV-2 secondary to a child • Infection of a child with SARS-CoV-2 secondary to an adult within the school • Infection of a child with SARS-CoV -2 secondary to a household contact or outside the school
Exploratory outcome	Phylogenetic analysis of the SARS-CoV-2 in positive salivary tests by a Whole Genome Sequencing (WGS) test. The aim of this exploratory outcome is to determine potential linkages between cases.

Study participants/numbers of participating schools	All Belgian primary schools of the Federation Wallonie – Bruxelles that have organized a full resumption of school activities with the control measures recommended by the government, are eligible for the study. **Inclusion criteria** All children and school attenders from selected schools will be invited to participate. **Exclusion criteria** Refusal to provide written informed consent before enrolment **Sampling procedure** Each participating primary school will be considered as a cluster. Eight schools will be chosen by purposive sampling on three criteria: either high (≥ 2 classes per grade) or low size of the school, a school within an area with either a high or a low incidence of SARS-CoV-2 during April 2020, the first wave of covid-19 in Belgium, and a school with either a high or a low socioeconomic level (Belgian 20-point-scale ISE index >14 or <6). As direct partners in the project, physicians in charge of health promotion in schools (PSE teams) will select schools.
Study description	**Inclusion visit** All participants (children and adults school attenders) will be tested at the inclusion day with - A salivary SARS-CoV2 test - A rapid serological test by finger prick (AVIOQ®) to determine the seroprevalence of SARS-CoV-2 All participants (children and adults school attenders) will be invited to fill a questionnaire on an electronic format when possible or with a paperback part if not, depending on parents' convenience. **Follow-up visits** During six consecutive weeks, all participants will be tested once a week with a salivary test. During six consecutive weeks, all participants will be invited to complete a follow-up questionnaire to assess any symptom compatible with a SARS-CoV-2 infection or a contact with a confirmed SARS-CoV-2 case or a travelling return from a risk area.
Endpoints	- Time varying number and proportion of children infected with SARS-CoV-2 secondary to an infected classmate (transmission rate inside school but from a child to a child). - Time varying number and proportion of adult school-attenders infected with SARS-CoV-2 secondary to an asymptomatic infected child (transmission rate inside school but from a child to an adult); - Time varying number and proportion of children infected with SARS-CoV-2 secondary to an infected adult school attender (transmission rate inside school but from an adult to a child);

	- Time varying number and proportion of children infected with SARS-CoV -2 secondary to a household contact or outside the school (transmission rate from outside school).
Statistical analyses plan	**Sample size determination** As a pilot study, no formal sample size calculation was performed. The expected number of children is 2400, the expected number of adult school attenders is 200, and the expected number of classes is 72. Initial incidence and then secondary attack rates will be calculated and compared between gender, across age, and between the three kinds of schools using Poisson or Binomial negative regression if overdispersion. Analyses will be weighted to correct for cluster effect of classes (ICC=0.09).

2.0 Background and Rationale

To date, children represent a minority of confirmed cases of COVID-19 worldwide, and it is clear that they are less severely ill when infected (critical illness is very rare: ~1% and death remains extremely rare) than their adult counterparts. In Belgium, the last Sciensano report on children and Covid-19 reveals that children only represent 3% of all infections and 1.7% of all hospitalizations (1). Their role in transmission especially the role of asymptomatic children remains however an unresolved question. Children were, at first, suspected to be a motor of the COVID-19 pandemic, in parallel to influenza infection where school attendance plays an important role in amplifying epidemics. However, more and more data highlight huge differences between the two infections. The role of an individual in the transmission is multifactorial and influenced, among other things, by susceptibility to acquire infection, viral load, symptoms, contact patterns in the community, and social behaviour.

Even with the certainty that children can get infected, available data on probability of viral acquisition state that children have about half the risk of acquiring the virus compared to adults (2). These data are supported by information from contact tracing among households and have been reviewed in four different studies (3-6). Seroprevalence studies show also that children, especially less than 10-year old individuals, have lower rate of past infection (7-10).

However, it is unclear if asymptomatic children with positive PCR on saliva are contagious for their peers in primary school settings and if so, what this secondary attack rate is in this school setting. When quantifying viral load, studies have been conflicting and as well limited in their study design, however viral load does not seem to be majorly influenced by age, and viable viral particles have been retrieved from children's upper respiratory tract specimens (11). These laboratory results must be confronted to clinical observation in order to appreciate their significance. Data on that respect are scarce and what is available emerged from contact tracing in households where children tend to be less identified as index cases. But as they are often asymptomatic or mildly symptomatic, they could be underrepresented as index-cases. In school settings, available data are conflicting but highlight that other factors such as age, or, protective measures such as hand hygiene and social distancing have an impact. In France, transmission is described to have taken place in a secondary school, while in a primary school, transmission likely occurred within households and child transmission mainly reflected the

community presence of infections (12). When studies have been undertaken in settings where more strict protective measures were taken, evidence of transmission within school is limited. Some studies identify no secondary cases (13-15). UK surveillance identifies transmission driven solely by adults (16).

Some argue that, as previously said, these data were collected during lockdown and schools' closure or during careful re-opening and do not reflect the true transmission dynamics. A second often used comment is that only secondary cases linked to symptomatic confirmed cases are taken into account and the role of asymptomatic individuals, mainly children, is underestimated and not measured.

On the other hand, one cannot forget the importance of education and school attendance either, as the WHO pointed out recently. The unanswered question on transmission by children can affect political decisions, economical aspects, wellbeing of children and their families as well as their right for education (17).

It seems, for all these reasons, of importance to assess the transmission dynamics within the school's environment that resume to a full activity according to governmental measures, and, to analyse and sequentially address the impact of asymptomatic individuals.

3.0 Objectives and outcomes

The general objective of our study is to describe the transmission dynamics of SARS-CoV-2 in primary schools in Fédération Wallonie-Bruxelles.

3.1 Specific objectives

Specific objectives of the study are to assess the role of children attending primary schools in the spread of SARS-CoV-2 during the 2020-2021 pandemic

- To assess the child-to-child transmission within primary schools
- To assess the child-to-adult transmission within primary schools
- To assess the adult-to-child transmission within primary schools
- To assess the incidence of asymptomatic children who got infected through contact with an index case outside of the school environment

The investigators hypothesize that children are mostly infected outside school and that primary schools do not play a major role in SARS-CoV-2 spreading. They hypothesize proportional hazards between schools and surrounding areas; an incidence in schools at least 5 times lower than incidence outside the school area and it increases with increasing community transmission rates. Sciensano reports show that the ratio between cases in 10-19 years and cases in 0-9 years remains below 5; as an example, between September 16th and 30th, 2020, it was 4008/731 = 5.5 despite the same time at school.

3.2 Outcomes

- Infection of a child with SARS-CoV -2 secondary to a classmate
- Infection of an adult school-attender with SARS-CoV-2 secondary to an infected child
- Infection of a child with SARS-CoV-2 secondary to an adult school attender
- Infection of a child with SARS-CoV-2 secondary to a contact outside the school, including the household

3.3 Exploratory outcomes

Exploratory outcomes will be performed pending sufficient or additional resources.

These are anticipated to include assessment of phylogenetic analysis of SARS-CoV-2 in positive salivary tests by a Whole Genome Sequencing (WGS) test. The aim of this exploratory outcome is to determine transmission linkages between cases and reveal transmission patterns inside households and at school, supporting epidemiological investigation.

We will perform WGS tests only on positive rt-PCR salivary tests with a high viral load defined with a Ct lower than 30 (limit of the technique to perform the analysis). Exploratory phylogenetic analysis may involve collaboration with other specialized laboratories and research groups in Belgium and/or abroad. This would involve transfer of coded samples, traceable only by means of a subject identifier.

3.4 Endpoints

- Time varying number and proportion of children infected with SARS-CoV-2 secondary to an asymptomatic infected classmate (transmission rate inside school with the child being the infector).

- Time varying number and proportion of adult school-attenders infected with SARS-CoV-2 secondary to an asymptomatic infected child (transmission rate inside school but from a child to an adult);
- Time varying number and proportion of children infected with SARS-CoV-2 secondary to an infected adult school-attender (transmission rate inside school but from an adult to a child);
- Time varying number and proportion of children infected with SARS-CoV-2 secondary to a household contact or outside the school (transmission rate from in the community).

4.0 Methodology

4.1 Study design

This study is an interventional prospective SARS-CoV-2 infection study.

4.2 Study Period

The study will be conducted during the autumn-winter season 2020-2021 and we expect to start on 15th November 2020.

4.3 Selection of participating schools

All Belgian primary schools of the Federation Wallonie – Bruxelles that have organized a resumption of school activities with the social control measures recommended by the government, are eligible for the study. All children and school attenders attending included schools will be eligible to participate.

Each participating school will be considered as a statistical cluster because children within a school share more correlation together than with children from other schools (children are not an independent and identically distributed (i.i.d.) sample) and an intraclass coefficient (ICC) of 9% will be used in analysis.

We will enrol schools according to the following three criteria:

- School size: small school versus a large one

- Incidence of Sars-CoV-2 infection during the first wave of the pandemic in April 2020
    - Regions/cities with a low incidence (from 1.5 to 4.9 per thousand inhabitants on May 6th, 2020)
    - Regions/cities with a high incidence (from 5.0 to 7.5 per thousand inhabitants on May 6th, 2020)
- Socio-economic level of the school: low socio-economic level versus high level, based on ISE that is an official Belgian 20-point-scale index for all schools of the Federation Wallonie-Bruxelles (FWB).

Crossing those three criteria leads to eight categories of schools and one school of each category will be sampled

- Small school - very low incidence city - low socio-economic level
- Small school - very low incidence city - high socio-economic level
- Small school - very high incidence city - low socio-economic level
- Small school - very high incidence city - high socio-economic level
- Large school - very low incidence city - low socio-economic level
- Large school - very low incidence city - high socio-economic level
- Large school - very high incidence city - low socio-economic level
- Large school - very high incidence city - high socio-economic level

According to the definition of the FWB, investigators consider a small school a school with less than 300 children enrolled in the school and a large one a school with more than 300 children.

To determine regions with the highest and lowest incidence of SARS-CoV-2 infection during the first pandemic wave in Belgium investigators will refer to the epidemiological reports of Sciensano: https://covid-19.sciensano.be/fr/covid-19-situation-epidemiologique

Written agreement to proceed has been provided by the Ministry of Education and all concerned "Réseaux d'enseignements" in Fédération Wallonie-Bruxelles. Each school of the FWB is followed by a health promotion team (PSE: promotion de la santé à l'école). Physicians from these teams will propose a purposive sample of schools to enter into the study. A

principal investigator, subinvestigator or a PSE team member will contact the school's director and the organizing committee. In case of refusal, another school of the same category will be invited to participate. The participation of schools will be voluntary.

4.4 Study population

All children registered and attending selected primary schools of the Fédération Wallonie - Bruxelles and all adult's school attenders working in the same selected schools will be the study participants.

4.4.1 Inclusion criteria

- All children registered and attended the selected primary schools of the Fédération Wallonie - Bruxelles and adult's school attenders working in the same selected schools.
- Signed informed assent form by child and informed consent form by theirs parents (or legal guardian) and by adult's school attenders before enrolment

4.4.2 Exclusion criteria

Refusal or absence to provide written informed consent before enrolment

4.4.3 Definitions

4.4.3.1 Asymptomatic versus symptomatic cases

- A positive case: a participant who has a positive PCR salivary test for SARS-CoV-2 detected by systematic weekly screening
- Asymptomatic case: a participant who has a positive salivary test for SARS-CoV-2 during the study period and who did not declare any symptoms compatible with COVID-19
- Symptomatic case: a participant who has a positive salivary test with symptoms compatible with COVID-19 during the study period

4.4.3.2 High versus low risk contact

Definitions of high or low risk contact in the present study are the same as the national definition edited by Sciensano (version 1 october 2020)

https://covid-19.sciensano.be/sites/default/files/Covid19/COVID-19_procedure_contact_FR.pdf

- High risk contact is defined as
  - a person who had face to face contact for at least 15 minutes within a distance of 1.5 meter, without wearing mask or
  - a person with a physical contact
  - a contact with secretions or body fluid
  - who has travelled with a COVID-19 patient for at least 15 minutes, in any vehicle, seated two seats apart

with the index case within the 48 hours before the onset of symptoms, or in the last, 48 hours before the positive test, in case of asymptomatic participants

- Low risk contact is
  - a person who had face to face contact for at least 15 minutes within a distance of 1.5 meter, and wearing the mask correctly
  - a person who had face to face contact for less than 15 minutes within a distance of 1.5 meter (face to face) or
  - a person in the same room for at least 15 minutes with a distance more than 1.5 meter

with the index case within the 48 hours before the onset of symptoms, or in the last, 48 hours before the positive test, in case of asymptomatic participants

School attenders in primary school are wearing a mask when the social distancing cannot be maintained.

5.0 Conduct of the study

Parents and children attending selected schools will be informed of the exact nature of the study with a written version of participant information transmitted by the school director. Parents and children will be invited to participate in a virtual zoom (professional version with secured password) meeting. During this meeting the study objectives, procedures and implications will be explained to the teachers, parents and children. Where/When feasible a

video adapted to each school will be posted on the virtual school platform to be able to reach the maximum of parents and children. Written informed consent will then be obtained from the participants and/or their legal guardian.

Once a week and for six consecutive weeks, all participants of the school will be invited to provide a self-sampled salivary specimen, in the schools and under supervision of medical students on contract.

Currently, procedures only identify symptomatic cases. Interferences with current guidelines will impact results of this study as symptomatic cases and asymptomatic participants with a high-risk contact would be excluded from schools. Indeed, systematic saliva samples will not

Results of the salivary PCR SARS-CoV2 will not be communicated to participants during the study period. Salivary samples of the study will not be analysed routinely but will be treated in batch according to the laboratory capacity of the national platform BIS. The estimated time between sample collection and the availability of the result will be more than a week. Clinical relevance and societal repercussions of the communication to a participant of a positive result so long afterward will be irrelevant. Indeed, it is currently recognized by most experts that contagiousness lasts 7 days after the onset of symptoms. In a study from Taiwan of 100 COVID-19 cases and 2761 close-contacts, secondary attack rates was significantly higher among contacts whose exposure to the index case started within 5 days of symptom onset compared with those exposed later (no secondary cases among the 852 contacts exposed to index case after day 6 of symptom onset) (18).

It is important to stress that participation to the present study does not exclude participants to follow the national recommendations as detailed in Sciensano procedures, namely a test performing in case of compatible symptoms of SARS-CoV-2 infection or a quarantine in case of a high-risk contact. Investigators will also insist to students and school attenders on the importance of non-pharmaceutical interventions, including physical distancing and mask to prevent SARS-CoV-2 transmission as recommended by Sciensano.

Protocols (ONE as in the Ministry of Education's circular) will be applied as per the standard procedures. The decision to close a classroom will be taken by the PSE and if needed after concertation with the hygiene control inspector of COCOM or AVIQ.

To investigate a possible link between the absence from school of a participant and SARS-CoV-2 infection, the PSE team member will interview this participant later. This interview will continue until 2 weeks after the end of the study to complete data collection.

Any salivary PCR SARS-CoV2 test that comes back positive (with a maximum Ct of 30) will be analysed by a Whole Genome Sequencing (WGS) of the SARS-CoV2 virus (exploratory outcome). Phylogenetic analysis of the virus is expected to determine transmission linkages between cases and to map transmission patterns inside households and at school.

5.1 Inclusion day

All participants, children and adults school attenders, will be tested at the inclusion day with

- a salivary SARS-CoV2 PCR test collected in the school, under investigators supervision
- a rapid serological test by finger prick (AVIOQ®) to determine the seroprevalence of SARS-CoV-2
- All participants (children and adult school attenders) will be invited to complete an electronic questionnaire when possible and a paperback questionnaire otherwise.

  The questionnaire will address the following information (see attached file) partially inspired of the questionnaire used in the prevalence study *"Prevalence and incidence of antibodies against SARS-COV-2 in children measured for one year in Belgium: a sero-epidemiological prospective cohort study"* (study coordinator: Els Duysburgh, Sciensano).

  - Socio-demographic data: gender, birth date, home postal code, a contact email address, a contact mobile number, country of birth of child and parents
  - Housing information: number of people in the household, number of siblings, number of sleeping rooms, distance between school and home
  - Exposition information: pre- and after-school daycare attending, extracurricular activities, parent's profession, transportation means between home and school

The salivary SARS-CoV2 sample will be performed at school by the participant him or herself under the supervision of the subinvestigators (80 medical students on contract) for minor

participants. An explanatory film on the method of self-performing the saliva sample will be provided to participants. The children and the teachers will use a garling method to produce saliva. The full procedure is explained in the explanatory film. The participant will wear an adapted mask while gargling. A full explanation of the used gargling sampling technic is also well detailed in the attached paper (19)

The procedure will be performed in a well-ventilated space one participant at a time. The medical student who will collect the sample will wear adapted personal protective equipment (PPE) in order to reduce the risk of transmission to as good as 0. The PPE will include FFP2 mask, gloves, glasses and a protective gown.

After collection, salivary samples will be transported to one of the three participating laboratories (UCLouvain - ULiège - ULB) by the medical student.

Teachers of each class will be invited to complete a questionnaire once with the following questions

- Number of children in the classroom
- Size of the classroom
- Ventilation system and heating system of the classroom (CO2 sensor if any)
- Sanitary protocols of the school: eg hand washing recommendations
- Play-time space: indoor or outdoor
- Lunch space: in the classroom, school cafeteria, etc
- Organisation of pre- and after-school daycare attending: separation according to levels or mix of all classes. Number of children attending.

5.2 Follow-up visit

All participants, children attending selected schools and adults school attenders, will be asked to provide a weekly salivary specimen for six consecutive weeks.

All participants, children attending selected schools and adult school attenders, will have to complete a follow-up questionnaire, once a week for six consecutive weeks (See attached file) providing information about

- any compatible symptom with a SARS-CoV-2 infection
- a high-risk contact with a confirmed SARS-CoV-2 case

- social contacts (number of contacts during the last 7 days outside the school environment and outside the household, including travelling abroad)

6.0 Microbiological analyses

6.1 Salivary test

In an epidemiological study with repeated tests, a simple and non-invasive method to test participants is mandatory. The salivary sample collection is simple, painless and can be performed by the participant himself (under supervision for younger participants). A salivary collection device is developed by the University of Liège (Belgium) and currently used by university students of ULiège.

For this study a saline mouth rinse/gargle sample will be used to collect the saliva from participants. This self-collected sampling was tested on 50 participants, aged 4 to 71 years and showed a sensitivity of 98% to detect SARS-CoV-2 by PCR compared with nasopharyngeal swab (19).

6.2. Real-time SARS-CoV-2 PCR

Saliva will be extracted using the MagMAX Viral/pathogen Nucleic Acid Isolation kit on a KingFisher automated platform (ThermoFisher). An unrelated MS-2 phage RNA sequence is added to each specimen to demonstrate the process efficiency. Purified RNA will then be retro-transcribed and amplified on a QuantStudio5 real-time PCR platform with the TaqPath™ COVID-19 RT-PCR kit (Thermo Fisher), which targets ORF1ab, N and S coding sequences using three different sets of primers and probes.

In case of a positive salivary PCR test for SARS-CoV-2 with a maximum Ct of 30, a whole-genome sequencing of the virus will be done at the medical microbiology facility (MBLG) of the UCLouvain (Brussels)

RNA is extracted from the specimen using the QIAamp viral RNA mini kit (QIAGEN). Fifty ng of purified RNA are then retro-transcribed using the Maxima H minus double-stranded cDNA synthesis kit (Thermo Scientific) following the manufacturer recommendations. A DNA NGS-library is then created using the Nextera DNA Flex for enrichment library kit (Illumina). Briefly, 50 to 1000 ng of cDNA are restricted in small fragments in order to create a DNA library of

approximately 300 nucleotides long using bead-linked transposomes (eBLT) (Illumina). That tagmentation process is followed by a DNA clean-up and an amplification using unique-dual primers (IDT for Illumina UDI set of primers) recognizing the sequence added to each DNA strand during the tagmentation phase and adding a specific sequence to all strands of each sample. Amplified libraries are purified and dosed in spectrophotometry. Libraries are then pooled equimolarly and hybridized with a capture probe panel targeting SARS-CoV-2 as well as 40 other common respiratory viruses (Respiratory Virus Panel v2, Illumina). The enriched pooled library is finally amplified and purified. After a spectrophotometric dosage, the final library is diluted to 100 picomolar and charged on either an iSeq100 or NextSeq550 Mid-output cartridge allowing respectively 8 million or 260 million paired-end reads, in a 2 x 150 bp format. Each sample needs a minimum of 1 million reads to ensure a good coverage of the SARS-CoV-2 genome.

Raw sequences in a fastq format are processed through two different bioinformatic pipelines. First, the Dragen RNA pathogen analysis suite available through the BaseSpace Illumina on-line platform allows the generation of a consensus sequence and gives a percentage of each viral species detected in the library. Second, the Integrated Database Network System (IDNS) coupled to the advanced sequencing platform NGS pipeline from Smartgene allows the generation of SARS-CoV-2 consensus sequences and sequence comparisons in order to define sequence mutations in nucleotide or amino acid format. Phylogenetic analysis is available with a set of reference or personal sequences. Association of metadata to each sample allows selective analysis and group comparisons.

Whole-genome sequences will be shared on the GISAID open-source international platform. Clade determination and comparison to published SARS-CoV-2 sequences in a phylogenetic tree format is available through the NextClade web site.

6.3. SARS-CoV-2 serology

For Baseline seroprevalence data we will use a lateral flow test antibody IgG/IgM assay (colloidal gold) (Avioq) (Avioq, Bio-Tech, Shandong, China) CE-labelled. Sensitivity for Both IgM and IgG was 68.8% (IC 95% 60.3-76%) and the specificity was 95.8% (IC 95%88.5-98.6%) (20).

7.0 Statistical analyses plan

7.1 Sample size and statistical analysis

As a pilot study, no formal sample size determination was performed. The expected number of children is 2400 (4 times 200 plus 4 times 400), the expected number of adult school attenders is 200, and the expected number of classes is 72. With an incidence around 0.5-1%, the expected number of cases is 120-240. Initial incidence and then secondary attack rates (as transmission estimator) will be calculated and compared between gender, across age, and between the three kinds of schools using Poisson or Binomial negative regression if overdispersion. Characteristics of classes will be compared between schools using ANOVA with F-tests for continuous variable and chi-square or Fisher exact tests for discrete variables. Any significant difference will be considered for correlation with incidence rates (per classes) and attack rates within the Poisson or Binomial negative regression. A cluster effect (Rho = 1.09 or ICC=0.09) will be assessed for weighting data analysis. Estimates will be presented with their 95% Confidence interval. Differences will be presented as absolute and relative differences.

8.0 Risks - Benefits to participating to the study

The results of the salivary tests will be communicated at the end of the study period to the participants. There is no direct benefit for participants, and we are hoping they will gain a great awareness of better understanding this urgent public health issue for young children. The indirect effects to keep primary schools open even in case of red code are all the benefits for children to attend school and the positive impact on society such as facilitating parents' working especially in case of lockdown when teleworking is extremely challenging for parents looking after young children. Depending on results, this study could provide reassuring data concerning teachers' work conditions.

All Children of participating schools will receive once a week a healthy snack to thank them for participation to the study.

9.0 Ethics

9.1 Declaration of Helsinki and ICH Guidelines for Good Clinical Practice (GCP)

Study investigators will ensure that this study is conducted according to the principles of the latest revision of the Declaration of Helsinki and in full conformity with the ICH Good Clinical Practice (GCP) and local regulatory requirements.

9.2 Informed consent

Written, informed consent must be obtained from all participants (inform assent for children) and their parents (or legal guardians) for children before a participant can be included in the present study.

9.3 Ethics committee and regulatory agency review

The protocol proposed Inform consent form (ICF), and all other study documents, will be submitted to the local ethics committee "Commission d'Ethique hospitalo -facultaire des Cliniques universitaires St-Luc - UCLouvain" in Brussels for approval. The Principal Investigator will submit and, where necessary, obtain approval from the EC for all subsequent substantial amendments to the protocol and ICF.

9.4 Subject confidentiality

This study will be carried out in accordance with the law (July 30, 2018) on the use and processing of sensitive data, the law of patient's right (August 22, 2002) and the general European regulation on the protection of personal data (May 25, 2018). Identity and participation of patients to the survey will remain strictly confidential.

The manager of confidential data will be Pr. Annie Robert.

All data will be coded: a unique study number containing no personally identifiable information (PII) will identified each subject, and, will be use in the questionnaire, database and sampling. A separate confidential file containing PII will be stored in a secured (locked) location in accordance with data protection requirements. Only the study investigators, the EC and regulatory authorities will have access to the records.

No participant name will be mentioned on samples. A sequential identification number will be automatically allocated to each participant enrolled in the study. This number will identify the participant and will be composed of 12 digits:

- a two-digits number allocated to the school he/she is attending and the replacement if the first school stop for any reason
- a two-digits number allocated to the class, with a first digit for the grade, or 9 for adults outside the class) and a second digit numbering classes within each grade
- a two-digits serial number within the class he/she is in, and above 50 for teachers in charge of the class
- a two-digits sequential number corresponding to adults linked to the child
- a two digits control number (such as modulo 89 of the 8 first digits)
- a two-digits number corresponding to the calendar week of data collection

This unique and automatically checked IDs will allow parents or guardians to enter on a website with a unique password they will receive with ID, in order to fill data for their child. Each child will receive a paperback diary for daily activities and all these books will be collected at the end of the study. Information in the paperback notebooks will be entered after the study in case of no internet access for parents or French problems.

The date of birth of the participant will be mentioned on the sample along with his/her ID number.

The online questionnaires will only be accessible with a login and a password respecting the standards of complexity related to passwords. The data collected will be anonymised. Only the investigators of the study will be aware of the link between the different questions and the participants. The server is hosted by a computing infrastructure at UCLouvain, which is configured to update automatically. The physical location of the server is in the IT manager's office. Access to the said office is limited and secure. Backups of data encoded on the server will be encrypted on an external drive. No remote access will be allowed to the server.

10.0 Samples storage and biobank

Saliva samples, sera and remains of these collected samples will be stored after consent in biobanks.

The biological materials will be stored in the biobank of each participating lab where samples will be analysed. Documentation and location of each collected material and its remain after analysis will be performed at the site of the biobank. The manager of the UCLouvain biobank is Prof. Etienne Marbaix who is responsible for it.

As mentioned, saliva samples will be used to perform a rt-PCR for SARS-CoV-2. Any positive sample will be analysed for viral phylogenetic purposes. All samples will be stored at -80°C, according to the procedure for viral particles preservation. All samples and remains will be held in the biobank for 15 years.

All patients or their parents/tutor will be informed on the sample use and storage. They will also be informed on the strict confidentiality of any patient data and will be assured that all samples will be anonymized.

11.0 Financial and Insurance

This study will be financially supported by research funds of FWB.

The involved parties will be insured, in accordance with the Belgian law 2004022376 *"Loi relative aux expérimentations sur la personne humaine du 7 mai 2004 et mises à jour au 16-11-2018,"* against financial loss resulting from personal injury and/or other damages, which may arise as a consequence of this study.

12.0 Intellectual property

The intellectual property of the present study belongs to UCLouvain.

UCLouvain IREC UCLouvain LIÈGE université ULB

13.0 References

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16. Ismail SA, Saliba V, Lopez Bernal JA, Ramsay ME, Ladhani SN. SARS-CoV-2 infection and transmission in educational settings: cross-sectional analysis of clusters and outbreaks in England. medRxiv. 2020 (Preprint).
17. Faust SN, Munro APS. It's Time to Put Children and Young People First During the Global COVID-19 Pandemic. JAMA Pediatr. 2020.
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19. Goldfarb D, Tilley P, Al-Rawahi G. Self-collected Saline Gargle Samples as an Alternative to Healthcare Worker Collected Nasopharyngeal Swabs for COVID-19 Diagnosis in Outpatients. medRxiv. 2020 (Preprint)
20. Montesinos I, Gruson D, Kabamba B. Evaluation of two automated and three rapid lateral flow immunoassays for the detection of anti-SARS-CoV-2 antibodies. Journal of clinical Virology. 2020

14.0 Annexes

14.1 Inclusion questionnaires

14.1.1 For children

14.1.2 For school attenders

14.2 Follow-up questionnaires

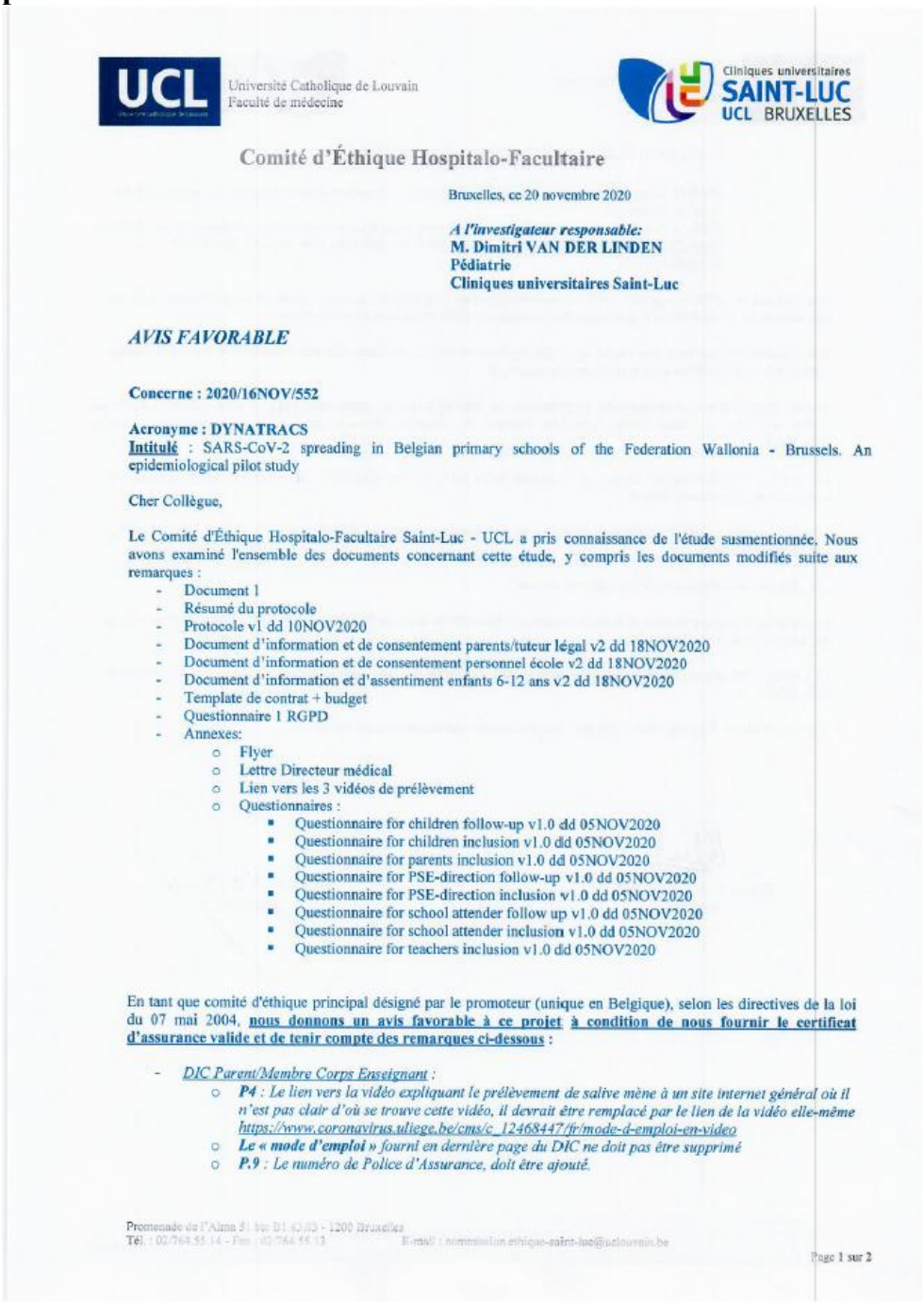
14.2.1 For children

14.2.2 For school attenders

14.3 Inclusion questionnaire for parents

14.3 Inclusion questionnaire for teachers

Annex 2: Favorable decision by the ethics committee for the protocol 2020/16NOV/552



UCL Université Catholique de Louvain
Faculté de médecine

Cliniques universitaires SAINT-LUC UCL BRUXELLES

Comité d'Éthique Hospitalo-Facultaire

Bruxelles, ce 20 novembre 2020

A l'investigateur responsable:
M. Dimitri VAN DER LINDEN
Pédiatrie
Cliniques universitaires Saint-Luc

AVIS FAVORABLE

Concerne : 2020/16NOV/552

Acronyme : DYNATRACS
Intitulé : SARS-CoV-2 spreading in Belgian primary schools of the Federation Wallonia - Brussels. An epidemiological pilot study

Cher Collègue,

Le Comité d'Éthique Hospitalo-Facultaire Saint-Luc - UCL a pris connaissance de l'étude susmentionnée. Nous avons examiné l'ensemble des documents concernant cette étude, y compris les documents modifiés suite aux remarques :

- Document 1
- Résumé du protocole
- Protocole v1 dd 10NOV2020
- Document d'information et de consentement parents/tuteur légal v2 dd 18NOV2020
- Document d'information et de consentement personnel école v2 dd 18NOV2020
- Document d'information et d'assentiment enfants 6-12 ans v2 dd 18NOV2020
- Template de contrat + budget
- Questionnaire 1 RGPD
- Annexes:
  - Flyer
  - Lettre Directeur médical
  - Lien vers les 3 vidéos de prélèvement
  - Questionnaires :
    - Questionnaire for children follow-up v1.0 dd 05NOV2020
    - Questionnaire for children inclusion v1.0 dd 05NOV2020
    - Questionnaire for parents inclusion v1.0 dd 05NOV2020
    - Questionnaire for PSE-direction follow-up v1.0 dd 05NOV2020
    - Questionnaire for PSE-direction inclusion v1.0 dd 05NOV2020
    - Questionnaire for school attender follow up v1.0 dd 05NOV2020
    - Questionnaire for school attender inclusion v1.0 dd 05NOV2020
    - Questionnaire for teachers inclusion v1.0 dd 05NOV2020

En tant que comité d'éthique principal désigné par le promoteur (unique en Belgique), selon les directives de la loi du 07 mai 2004, **nous donnons un avis favorable à ce projet à condition de nous fournir le certificat d'assurance valide et de tenir compte des remarques ci-dessous** :

- *DIC Parent/Membre Corps Enseignant :*
  - ***P4** : Le lien vers la vidéo expliquant le prélèvement de salive mène à un site internet général où il n'est pas clair d'où se trouve cette vidéo, il devrait être remplacé par le lien de la vidéo elle-même https://www.coronavirus.uliege.be/cms/c_12468447/fr/mode-d-emploi-en-video*
  - ***Le « mode d'emploi »** fourni en dernière page du DIC ne doit pas être supprimé*
  - ***P.9** : Le numéro de Police d'Assurance, doit être ajouté.*

Promenade de l'Alma 51 bte D1.42.03 - 1200 Bruxelles
Tél. : 02/764.55.14 - Fax : 02/764.55.13 E-mail : commission.ethique-saint-luc@uclouvain.be

Page 1 sur 2

UCL Université Catholique de Louvain
Faculté de médecine

Cliniques universitaires SAINT-LUC UCL BRUXELLES

Comité d'Éthique Hospitalo-Facultaire

- ***P.10-11** : Page de signature : La police de caractère est anormalement grande. A adapter selon le reste du document.*
- ***P.11 :** « - Je consens ... Je donne également mon accord au transfert et au traitement de ces données dans d'autres pays que la Belgique. » Ceci est mentionné nulle part ailleurs. Est-ce bien d'application ?*

Nous rappelons à l'investigateur qu'il est personnellement responsable de cette étude et au promoteur qu'il est responsable de la conformité linguistique des formulaires d'information et de consentement.

Aucun participant ne peut être admis dans une expérimentation ou un essai clinique avant que le comité d'éthique (IRB/IEC) n'ait donné un avis écrit favorable au projet.

Aucune modification ni changement au protocole ne peut être mis en route sans l'approbation préalable écrite du comité d'éthique à l'amendement approprié excepté les situations prévues dans les bonnes pratiques cliniques (BPC/GCP).

Le comité d'éthique principal déclare qu'il procède selon les directives ICH/GCP, les lois et règlements applicables, et ses propres procédures écrites.

Le comité d'éthique principal déclare qu'aucun de ses membres ayant une affiliation avec l'étude ou le sponsor n'a voté pour cette étude.

Une liste des membres actuels est jointe en annexe.

Le comité d'éthique principal sera continuellement informé de tous les SUSAR et déviations liés à ce protocole et qui se sont produits en Belgique.

Le comité d'éthique sera également informé du statut de l'étude sur base continue (comme requis par les directives ICG-GCP 4.10.1).

Nous vous prions d'agréer, cher Collègue, l'expression de nos sentiments les meilleurs.

Pharm. P. de PIERPONT
Membre

Prof. J.-M. MALOTEAUX
Président

Promenade de l'Alma 51 bte B1.43.03 - 1200 Bruxelles
Tél. : 02/764.55.14 - Fax : 02/764.55.13 E-mail : commission.ethique-saint-luc@uclouvain.be

Annex 3: Protocol 2022/06DEC/469

Résumé et protocole du mémoire

1. Renseignements généraux

1.1 Coordonnées de l'étudiante

Thienpont Alexandra, étudiante en 2ème année de master en sciences de la Santé Publique à l'Université Catholique de Louvain.

E-mail : alexandra.thienpont@student.uclouvain.be

GSM : 0472/09.60.88

1.2 Titre du protocole

« Le bien-être des enfants dans les écoles primaires de la Fédération Wallonie – Bruxelles après la pandémie de la COVID-19. »

1.3 Sponsor

Institut de Recherche Expérimentale et Clinique, EPID, UCLouvain

1.4 Promoteur du mémoire et investigateur responsable

Pr. Annie Robert. Institut de Recherche Expérimentale et Clinique, Responsable du pôle de recherche Epidémiologie et biostatistique (EPID) – UCLouvain : annie.robert@uclouvain.be

1.5 Co-promotrice du mémoire

Mme Kelly Cremer. Infirmière, Master en santé publique, Doctorante à l'Institut de Recherche Expérimentale et Clinique, EPID - UCLouvain (supervision Pr. Annie Robert): kelly.cremer@uclouvain.be

1.6 Chercheurs associés

Dr. Julie Frère. Pédiatre-infectiologue au CHU Liège, Pediatric Task force member.
Dr. Olga Chatzis. Pédiatre-infectiologue aux Cliniques universitaires Saint-Luc, Institut de Recherche Expérimentale et Clinique, PEDI, UCLouvain, Pediatric Task force member.
Dr Florence Renard. Médecin scolaire et de santé publique, Conseillère Médicale Promotion de la Santé à l'école (PSE).
Pr Dimitri Van der Linden. Institut de Recherche Expérimentale et Clinique, PEDI – UCLouvain, Pediatric Task Force spokesperson.
Dr Mathilde de Keukeleire. Chercheur qualifié, Institut de Recherche Expérimentale et Clinique, EPID-UCLouvain.

2. Rationnel de l'étude

Nous avons mené une étude nommée DYNAtracs, dans 11 écoles primaires de la Fédération Wallonie-Bruxelles du 14 janvier au 18 mai 2021. Les 11 écoles primaires ont été sélectionnées sur les extrêmes de 3 critères : l'incidence faible/élevée dans la commune (incidence < ou ≥5,0/1000 personnes durant la 1ère vague en mai 2020), une petite/grande école (< ou ≥230 élèves) et un indice socio-économique (ISE) faible/élevé de l'école (ISE ≤7 ou ≥13).
Nous avons enrôlé 932 enfants (932/2488=38%) et 242 membres du personnel (242/444=55%). Dans chaque école, nous sommes allés à 6 reprises. Lors de la visite d'inclusion, chaque participant a réalisé un test sérologique. Chaque participant a été invité à réaliser un test salivaire PCR et à répondre à un questionnaire lors de chaque visite.
21% des enfants et 25% des membres du personnel présentaient une sérologie IgG+.(1) Les résultats PCR ont montrés un faible taux de positifs parmi les participants : 3% chez les enfants et 2% chez les membres du personnel.(2)
Les données de bien-être des enfants et des membres du personnel recueillies durant la pandémie de la COVID-19 sont en cours d'analyse et de rédaction.

2.1 Question de recherche et définition des variables

La pandémie de la COVID-19 a-t-elle impacté le bien-être des enfants dans les écoles primaires de la Fédération Wallonie – Bruxelles, selon la perception du bien-être ou de l'anxiété des enfants et du personnel qui les encadrent ?

Bien-être :
Selon la définition de l'OMS : « *La santé est un état de complet bien-être physique, mental et social, et ne consiste pas seulement en une absence de maladie ou d'infirmité.* » (3)
La santé mentale est: « *Un état de bien-être dans lequel un individu prend conscience de ses propres capacités, peut faire face aux stress normaux de la vie, peut travailler de manière productive et est capable d'apporter une contribution à sa communauté.* »(3)

Le bien-être se définit comme un :« *État agréable résultant de la satisfaction des besoins du corps et du calme de l'esprit* ».(4)

Le bien-être dans cette étude sera évalué par l'échelle « *The Revised Children's Manifest Anxiety Scale* » (RCMAS)(5,6) et l'échelle « *Hospital Anxiety and Depression Scale* » (HAD).(7,8)

COVID-19 : Maladie causée par le virus SARS-CoV-2.

SARS-CoV-2 : Severe Acute Respiratory Syndrome Coronavirus 2.

Enfants dans les écoles primaires : Enfants de la 1ère à la 6ème primaire.

Membres du personnel: Adultes travaillant dans les écoles.

Anxiété : « *Inquiétude pénible, tension nerveuse, causée par l'incertitude, l'attente ; angoisse* »(9)

2.2 Description de la population choisie

1) Les enfants de la 1ère à la 6ème primaire, fréquentant les 11 écoles primaires sélectionnées lors de la première étude en 2021 de la Fédération Wallonie-Bruxelles.
2) Les adultes travaillant dans les 11 écoles primaires sélectionnées lors de la première étude de 2021 de la Fédération Wallonie-Bruxelles.

2.3 Références bibliographiques et résultats ou données obtenus antérieurement ayant un lien avec l'expérimentation et servant de base pour celle-ci.

- Frère, J.; Chatzis, O.; Cremer, K.; Merckx, J.; De Keukeleire, M.; Renard, F.; Ribesse, N.; Minner, F.; Ruelle, J.; Kabamba, B.; Rodriguez-Villalobos, H.; Bearzatto, B.; Delforge, M.-L.; Henin, C.; Bureau, F.; Gillet, L.; Robert, A.; Van der Linden, D. SARS-CoV-2 Transmission in Belgian French-Speaking Primary Schools: An Epidemiological Pilot Study. *Viruses* 2022, *14*, 2199. https://doi.org/10.3390/v14102199 SARS-CoV-2 transmission in Belgian primary schools of the Federation Wallonie - Bruxelles. An epidemiological pilot study (2);

- Kelly Cremer, Julie Frère, Olga Chatzis et al. SARS-CoV-2 antibody seroprevalence in children and workers from Belgian French-speaking primary schools, 13 July 2022, PREPRINT (Version 1) available at Research Square [https://doi.org/10.21203/rs.3.rs-1781857/v1](1)

- Protocole de l'étude DYNAtracs « SARS-CoV-2 Transmission in Belgian Primary Schools of the Federation Wallonia - Brussels: An Epidemiological Pilot Study (DYNAtracs) » publié le 16/09/2021 (numéro d'identification NCT05046470);

- Protocole de l'étude DYNAtracs « Study of COVID-19 transmission in Belgian French-speaking primary schools of the Federation Wallonia – Brussels in Belgium» publié le 20/04/2022 (numéro d'identification ISRCTN16837012).

3. Objectifs de l'essai

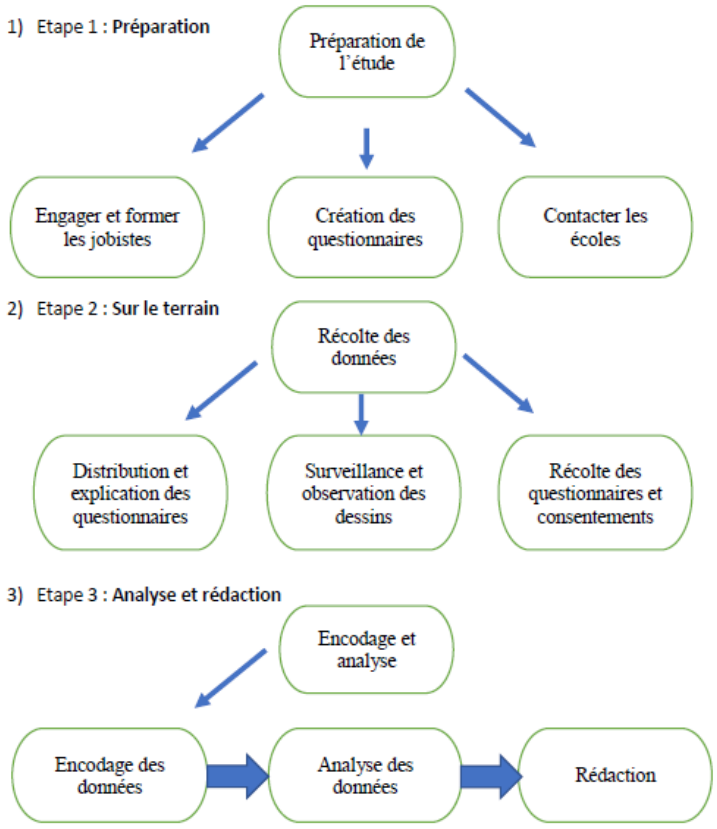
L'objectif de l'étude initiale portait sur la dynamique de la transmission du virus SARS-CoV-2 dans des écoles primaires de la Fédération Wallonie-Bruxelles.

L'objectif de cette présente étude est de documenter le bien-être des enfants et des travailleurs suite à la pandémie de la COVID 19 dans les écoles primaires de de la Fédération Wallonie-Bruxelles.
Le but de cette étude est de proposer des actions concrètes de santé publique pour aider à la prise en charge et développer des outils pour limiter les dégâts à plus long terme de la pandémie de la COVID-19.

4. Conception de l'essai et méthodologie appliquée

4.1 Description du type d'expérimentation à réaliser + schéma de la conception, de la marche à suivre et des étapes de l'étude

Nous allons mener une étude transversale d'observation.
Nous avons développé des questionnaires et un formulaire de consentement ci-annexés. Nous allons engager des jobistes et les former vis-à-vis des questionnaires. Nous allons contacter les écoles dans lesquelles nous souhaitons nous rendre. Nous leur déposerons le protocole et le formulaire de consentement avant le début de l'étude.
Au sein des 11 écoles, il y a approximativement 2488 enfants et 444 membres du personnel.
Ensuite, nous irons un jour dans chaque école pour la récolte des données. Les questionnaires seront donnés à chaque participant ayant rendu un formulaire de consentement signé. Chaque participant sera invité à répondre au questionnaire de manière anonyme et les données seront récoltées sous formes de panel.
Chaque enfant de 3ème et de 6ème année (n=830) sera invité à réaliser 3 dessins relatifs à l'expression de son ressenti vis-à-vis de la pandémie de la COVID-19. Afin de réaliser cette tâche dans les meilleures conditions, 2 personnes encadreront chaque enfant.
Nous souhaitons commencer la récolte des données dans les écoles en février 2023. L'encodage et l'analyse des données seront terminés en mars 2023.


1) Etape 1 : Préparation
Préparation de l'étude
Engager et former les jobistes
Création des questionnaires
Contacter les écoles
2) Etape 2 : Sur le terrain
Récolte des données
Distribution et explication des questionnaires
Surveillance et observation des dessins
Récolte des questionnaires et consentements
3) Etape 3 : Analyse et rédaction
Encodage et analyse
Encodage des données
Analyse des données
Rédaction

6

4.2 Critères de sélection des sujets à inclure dans l'étude (tous les sujets choisis au hasard, tous les sujets évaluables, etc.)

Tous les enfants des 11 écoles sélectionnées de la Fédération Wallonie – Bruxelles et les adultes travaillant dans ces écoles sont éligibles à cette étude si chaque participant a rendu le formulaire de consentement signé.

4.3 Énoncé précis des principales données à évaluer durant l'expérimentation

Nous évaluerons le bien-être, l'anxiété des enfants et des membres du personnel des écoles de la Fédération Wallonie-Bruxelles précédemment choisies.

4.4 Durée prévue de la participation des sujets

Notre équipe se rendra un jour dans chaque école. La durée de participation des sujets ne dépasse pas une journée.

4.5 Méthodes d'analyse des données

Nous utilisons deux échelles nous permettant d'évaluer l'anxiété :

- The Revised Children's Manifest Anxiety Scale (RCMAS)(5,6).
- Hospital Anxiety and Depression Scale (HAD)(7,8).

L'analyse des proportions sera réalisée par des tests de khi carré.
Les associations de ces proportions avec les caractéristiques de l'enfant ou de l'adulte seront analysées par régression logistique.

4.6 Description des «règles d'arrêt» ou des «critères de poursuite» concernant la participation des sujets en partie ou en totalité

Il s'agit d'une étude transversale d'observation, il n'y a pas de critère d'abandon ou de règles d'arrêt.

5. Public cible

5.1 Nombre de sujets prévu

Il y aura approximativement 2488 élèves dans 125 classes et 444 travailleurs dans les 11 écoles de la Fédération Wallonie-Bruxelles.

5.2 Critères d'inclusion des sujets

Tous les élèves et les membres du personnel des 11 écoles primaires sélectionnées de la Fédération Wallonie – Bruxelles ayant rendu un formulaire de consentement éclairé signé.

5.3 Critères d'exclusion des sujets

Refus ou absence de formulaire de consentement signé avant l'inclusion.

6. Confidentialité des données

L'identité de l'enfant ou du membre du personnel et sa participation à cette étude demeureront strictement confidentielles. Il ne sera pas identifié(e) par son nom ni d'aucune autre manière reconnaissable dans aucun des dossiers, résultats ou publications en rapport avec l'étude. La protection des données personnelles est assurée par la loi belge du 30 juillet 2018 relative à la protection des personnes physiques à l'égard des traitements de données à

caractère personnel. Les données seront traitées conformément au Règlement Général sur la Protection des Données (RGPD du 25 mai 2018) et à la loi belge du 22 août 2002 relative aux droits des participants à une étude de santé. L'UCLouvain sera responsable du traitement de ses données. La participation à l'étude signifie que l'infirmière investigatrice recueille des données et que le promoteur de l'étude les utilise dans un objectif de recherche et dans le cadre de publications scientifiques et de santé publique destinées à la collectivité.
L'infirmière investigatrice a un devoir de confidentialité vis-à-vis des données collectées. Ceci veut dire qu'elle s'engage non seulement à ne jamais divulguer le nom de l'enfant ou le nom du membre du personnel dans le cadre d'une publication ou d'une conférence mais aussi qu'elle codera (que l'identité de l'enfant ou du membre du personnel sera remplacée par un code d'identification dans l'étude composé de 12 chiffres) les données avant de les transmettre au gestionnaire de la base des données collectées (Pr Annie Robert).
Les données personnelles transmises ne contiendront pas d'association d'éléments qui permettraient d'identifier l'enfant ou le membre du personnel.
Pour le gestionnaire des données de recherche désigné par le promoteur (Prof Annie Robert), les données transmises ne permettent pas d'identifier l'enfant ou le membre du personnel. Ce dernier est responsable de la collecte des données recueillies par tous les investigateurs participant à la recherche, de leur traitement et de leur protection en conformité avec les impératifs de la loi belge relative à la protection de la vie privée.
Le promoteur s'engage à utiliser les données collectées uniquement dans le cadre de l'étude à laquelle l'enfant ou le membre du personnel participe. Toute utilisation des données de l'enfant ou du membre du personnel en dehors du contexte décrit dans le présent document ne pourrait être menée qu'après approbation du comité d'éthique.

7. Comité d'éthique

L'expérimentation est soumise à l'approbation du « Comité d'Ethique Hospitalo-Facultaire Saint- Luc – UCLouvain ».

8. Assurance

8.1 Indiquer les coordonnées de l'assureur
MS AMLIN INSURANCE SE,
Bd. du Roi Albert II n° 37,
1030 Bruxelles
www.msamlin.be
Tel : 02/894.70.00

8.2 Copie du certificat d'assurance couvrant la responsabilité même sans faute (art . 29 loi du 7 mai 2004 sur l'expérimentation humaine).

MS amlin

ATTESTATION D'ASSURANCE

POLICE LXX111372

MS AMLIN INSURANCE SE, établie à 1030 Bruxelles, Bd. du Roi Albert II n° 37, atteste par la présente que les garanties du présent contrat sont acquises à

Université Catholique de Louvain
Place de l'Université 1
1348 Louvain-La-Neuve

Responsabilité assurée

La responsabilité civile légale même sans faute du fait de l'organisation d'expérimentations sur la personne humaine.

Expérimentation assurée

- Titre de l'étude : Le bien-être des enfants dans les écoles primaires de la FDW après la pandémie de la COVID - 19.
- Promoteur : Alexandra Thienpont
- Nombre de participants en Belgique : 3000
- Monocentrique : ☑
- Multi-centrique : ☐

Liste des différents sites :

- Durée : 02/01/2023 pour 4 semaines sur une fenêtre de temps de 6 mois

☐Classe 1.A
Etudes de cohortes (type prospectif ou rétrospectif) : simple observation clinique (volontaires sains). Observation clinique de patients capables de donner leur consentement. Questionnaire à compléter par des patients. Etudes sur échantillon : urines, salives, secrétions diverses, sauf lorsque l'obtention de l'échantillon fait partie de l'expérimentation et nécessite des actes autres que le simple prélèvement externe. Expérimentation avec prise de sang par veine périphérique lorsque cette prise de sang aurait de toute façon dû être effectuée.

☑Classe 1.B
Observation clinique de personnes incapables de donner leur consentement. Examen clinique simple sans aucune manoeuvre thérapeutique. Investigation non invasive permise : échographie, électroencéphalogramme, électrocardiogramme, radiographie standard ou CT-Scanner sans contraste. Test à l'effort sous-maximal sans plus sur des volontaires ou des patients en l'absence de risques connus ischémie coronaire au cours d'un test.

MS Amlin Insurance SE | Boulevard Roi Albert II 37, 1030 Bruxelles | Tel +32 (0)2 894 70 00 | www.msamlin.com
Assureur agréé par la Banque Nationale de Belgique (BNB) sous le numéro 3092
RPM Bruxelles – TVA BE0644 921 425 - Banque : IBAN BE77 2100 0008 6342 - BIC GEBABEBB

9

Montant assuré

2.500.000 € par sinistre et par expérimentation, pour tous dommages corporels, matériels et immatériels consécutifs confondus.

L'assurance est conforme à la loi belge du 7 mai 2004 relative aux expérimentations sur la personne humaine.

Fait à Louvain-la-Neuve 25 novembre 2022

Pour la compagnie,

Olivier Brisaer
Underwriting Liability

MS Amlin Insurance SE | Boulevard Roi Albert II 37, 1030 Bruxelles | Tel +32 (0)2 894 70 00 | www.msamlin.com
Assureur agréé par la Banque Nationale de Belgique (BNB) sous le numéro 3092
RPM Bruxelles – TVA BE0644 921 425 - Banque : IBAN BE77 2100 0008 6342 - BIC GEBABEBB

9. Références

1. Cremer K, Frère J, Chatzis O, De Mendonca R, Minner F, Kabamba B, et al. SARS-CoV-2 antibody seroprevalence in children and workers from Belgian French-speaking primary schools [Internet]. In Review; 2022 juill [cité 8 nov 2022]. Disponible sur: https://www.researchsquare.com/article/rs-1781857/v1

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10. Suppléments

A) Questionnaire bien-être enfant
B) Questionnaire enfant avec dessin
C) Questionnaire membre du personnel
D) Information et formulaire de consentement des enfants
E) Consentement éclairé des parents
F) Consentement pour les membres du personnel
G) Budget de l'étude

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Annex 4: Favorable decision by the ethics committee for the protocol 2022/06DEC/469

UCLouvain

Université Catholique de Louvain
Faculté de médecine

Cliniques universitaires SAINT-LUC UCL BRUXELLES

Comité d'Éthique Hospitalo-Facultaire

Bruxelles, ce 30 janvier 2023

A l'investigateur responsable:
Mme Annie ROBERT
EPID
Clos Chapelle-aux-champs 30/B1.30.13
1200 Woluwe-Saint-Lambert

Cc : A l'étudiante:
alexandra.thienpont@student.uclouvain.be

Cc : kelly.cremer@uclouvain.be

AVIS FAVORABLE DEFINITIF

Concerne : 2022/06DEC/469

N° Protocole : MASTER
Acronyme : n/a
Intitulé : Le bien-être des enfants dans les écoles primaires de la Fédération Wallonie ? Bruxelles après la pandémie de la COVID-19.

Cher Collègue,

Le Comité d'Éthique Hospitalo-Facultaire Saint-Luc - UCL a pris connaissance de l'étude susmentionnée. Nous avons examiné l'ensemble des documents concernant cette étude, y compris les documents modifiés suite aux remarques :

- Formulaire de Soumission, reçu le 11/01/2023
- Protocole, version 2, du 9 janvier 2023
- Résumé, version 2, du 9 janvier 2023
- Document d'information et de consentement – Parents/Tuteurs Légaux - Version 2 du 9 janvier 2023
- Document d'information et de consentement – Personnel des Ecoles - Version 2 du 9 janvier 2023
- Document d'information et d'assentiment de l'enfant (1ère-6ème primaire) - Version 2 du 9 janvier 2023
- Questionnaires, reçus le 11/01/2023
- Certificat d'assurance Amlin daté du 25 novembre 2022
- CVs datés et signés du PI + co-PI, reçus le 11/01/2023
- Estimation budget DYNAtracs, reçu le 06/12/2022
- Réponses aux remarques du CEHF, daté du 9 janvier 2023
- Questionnaire 1 GDPR reçu le 30.01.2023

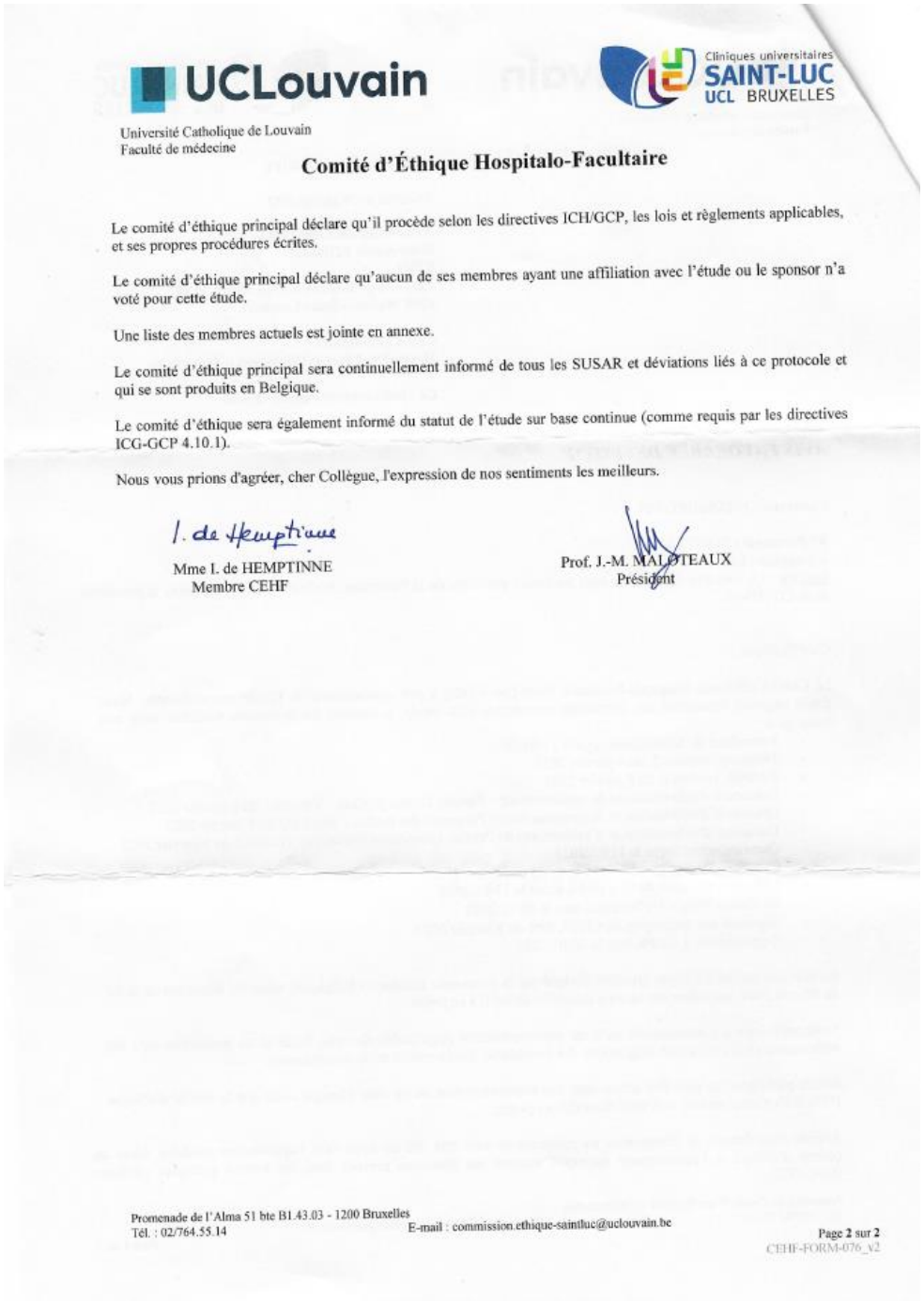
En tant que comité d'éthique principal désigné par le promoteur (unique en Belgique), selon les directives de la loi du 07 mai 2004, nous donnons un avis favorable définitif à ce projet.

Nous rappelons à l'investigateur qu'il est personnellement responsable de cette étude et au promoteur qu'il est responsable de la conformité linguistique des formulaires d'information et de consentement.

Aucun participant ne peut être admis dans une expérimentation ou un essai clinique avant que le comité d'éthique (IRB/IEC) n'ait donné un avis écrit favorable au projet.

Aucune modification ni changement au protocole ne peut être mis en route sans l'approbation préalable écrite du comité d'éthique à l'amendement approprié excepté les situations prévues dans les bonnes pratiques cliniques (BPC/GCP).

Promenade de l'Alma 51 bte B1.43.03 - 1200 Bruxelles
Tél. : 02/764.55.14 E-mail : commission.ethique-saintluc@uclouvain.be



UCLouvain

Université Catholique de Louvain
Faculté de médecine

Cliniques universitaires SAINT-LUC UCL BRUXELLES

Comité d'Éthique Hospitalo-Facultaire

Le comité d'éthique principal déclare qu'il procède selon les directives ICH/GCP, les lois et règlements applicables, et ses propres procédures écrites.

Le comité d'éthique principal déclare qu'aucun de ses membres ayant une affiliation avec l'étude ou le sponsor n'a voté pour cette étude.

Une liste des membres actuels est jointe en annexe.

Le comité d'éthique principal sera continuellement informé de tous les SUSAR et déviations liés à ce protocole et qui se sont produits en Belgique.

Le comité d'éthique sera également informé du statut de l'étude sur base continue (comme requis par les directives ICG-GCP 4.10.1).

Nous vous prions d'agréer, cher Collègue, l'expression de nos sentiments les meilleurs.

I. de Hemptinne

Mme I. de HEMPTINNE
Membre CEHF

Prof. J.-M. MALOTEAUX
Président

Promenade de l'Alma 51 bte B1.43.03 - 1200 Bruxelles
Tél. : 02/764.55.14
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Annex 5: Contributions to the study

In 2021

AR, DVL, OC, JF, MDK, BK, and FR, participated in the design, and protocol of the study.

KC contacted the PSE team and schools to obtain their agreement to take part in the study. KC organized the distribution of information documents (flyers, protocol, consent forms) to participating schools. KC collected signed consent forms and received anonymized lists of participants. KC planned the various visits with the help of each principal of the different schools. KC has created a follow-up booklet for each child. KC collected, analyzed, and interpreted data, drafted, and edited the final manuscripts, tables, and figures. KC hired and trained the working students' team for the study, providing information on the organization of the study, the questionnaires, and the notebook on paper format.

MDK collected, contributed to the analysis and interpretation of the data, and supported and edited the final manuscript.

JF, OC, and DVL helped collect data and supported manuscript writing. JF, OC, and DVL organized an information videoconference with participating schools. JF has created videos to explain the various tests (PCR and rapid detection test). JF, OC, and DVL trained medical students for the testing procedures.

AR designed and supervised the project for the first study supported data analyses and interpretation, and edited final manuscripts.

In 2023

AR, KC participated in the design, and protocol of the study.

KC created questionnaires, drawings questionnaires, and scales to analyze drawings. KC hired a working students' team KC collected, analyzed, and interpreted data, drafted, and edited the final manuscripts, tables, and figures for the study.

AR designed and supervised the project for the study supported data analyses, and interpretation, and edited final manuscripts.

Annex 6: Symptoms reported by children during the COVID-19 pandemic crisis

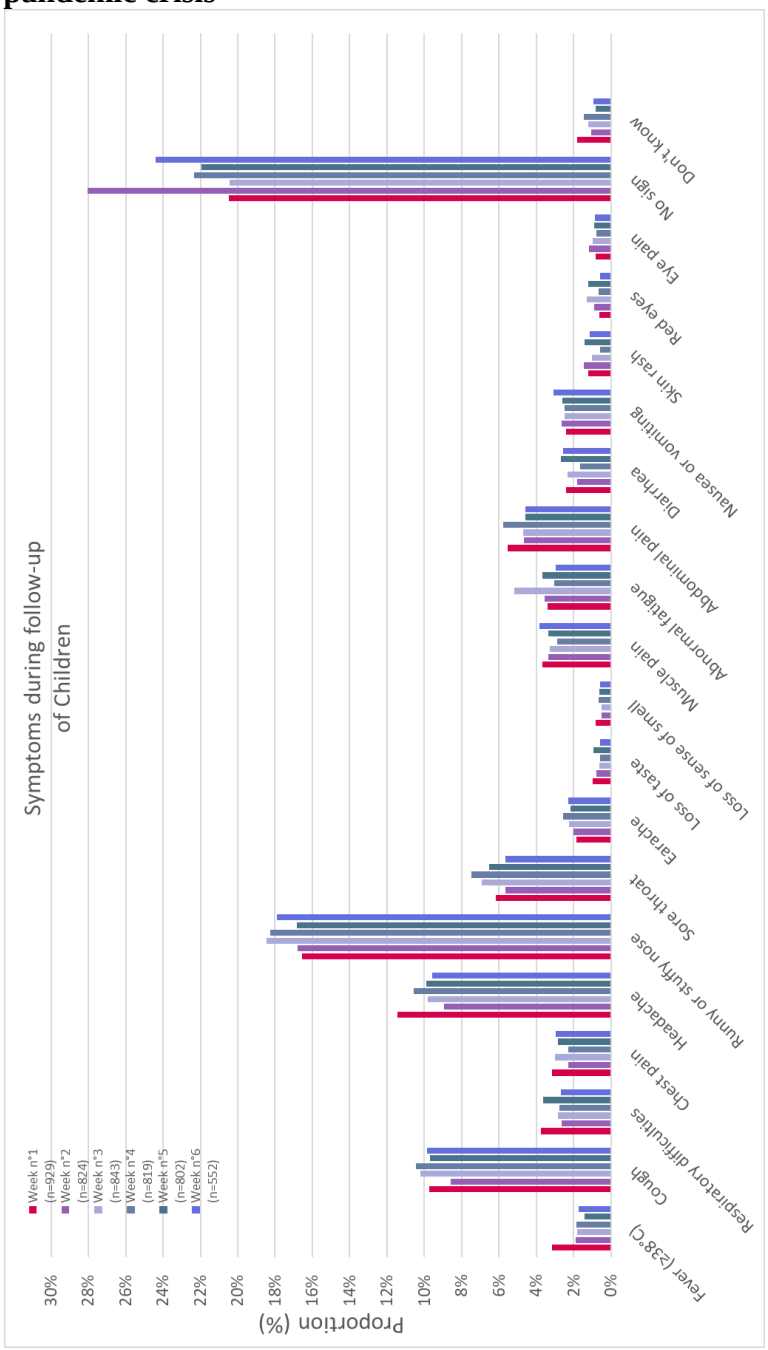


Figure 1a: Symptoms reported by children during the COVID-19 pandemic crisis

Annex 7: Contacts outside the school reported by children during the COVID-19 pandemic crisis

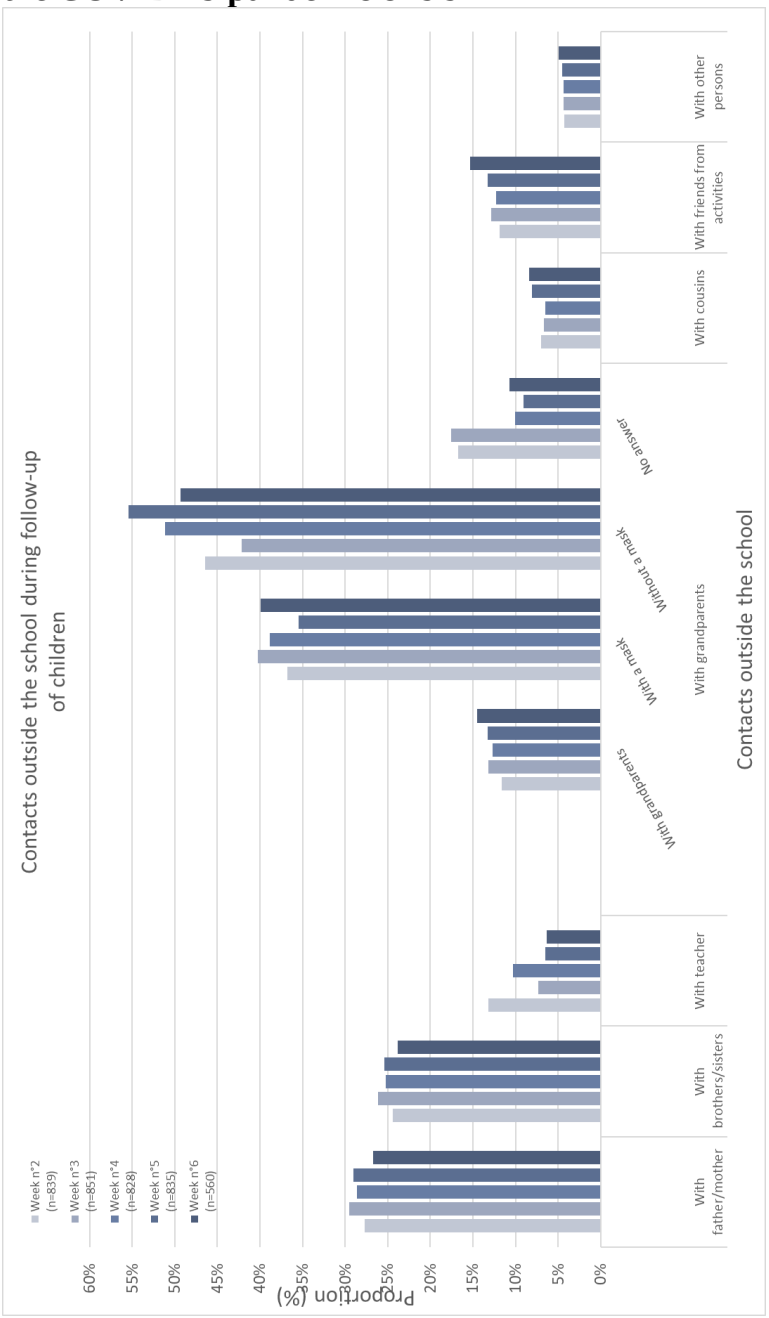


Figure 2a: Contacts outside the school reported by children during the COVID-19 pandemic crisis

Annex 8: Visit a place outside the school reported by children during the COVID-19 pandemic crisis

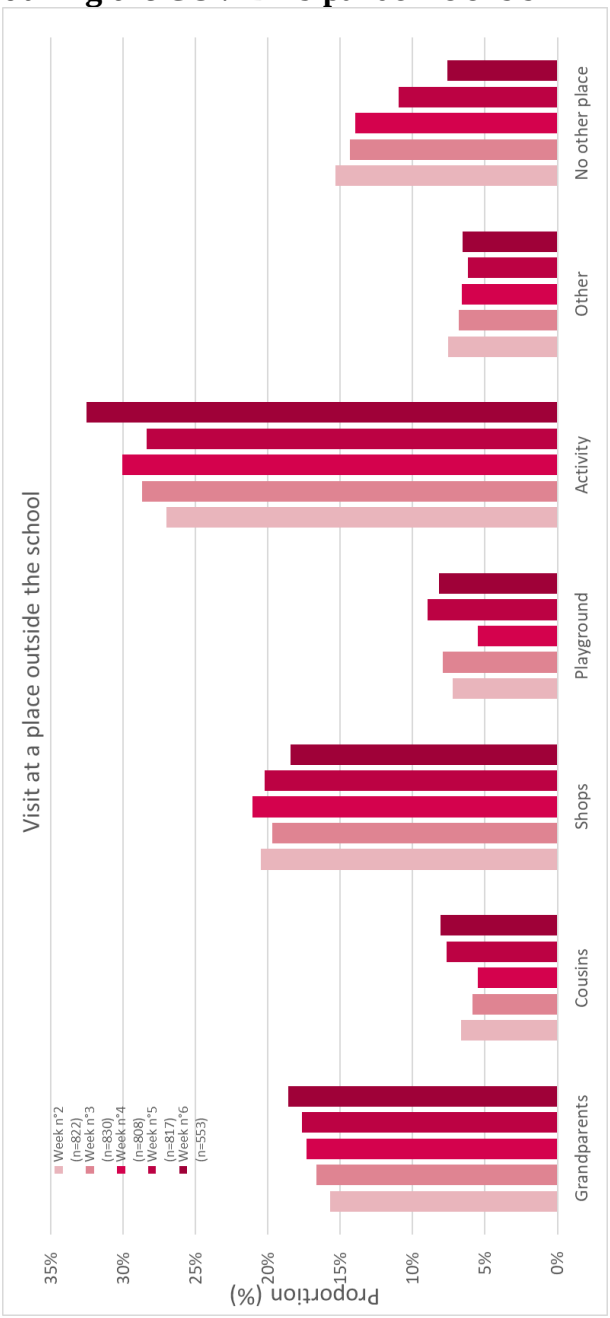


Figure 3a: Visit a place outside the school reported by children during the COVID-19 pandemic crisis

Annex 9: Children's feelings reported during the COVID-19 pandemic crisis

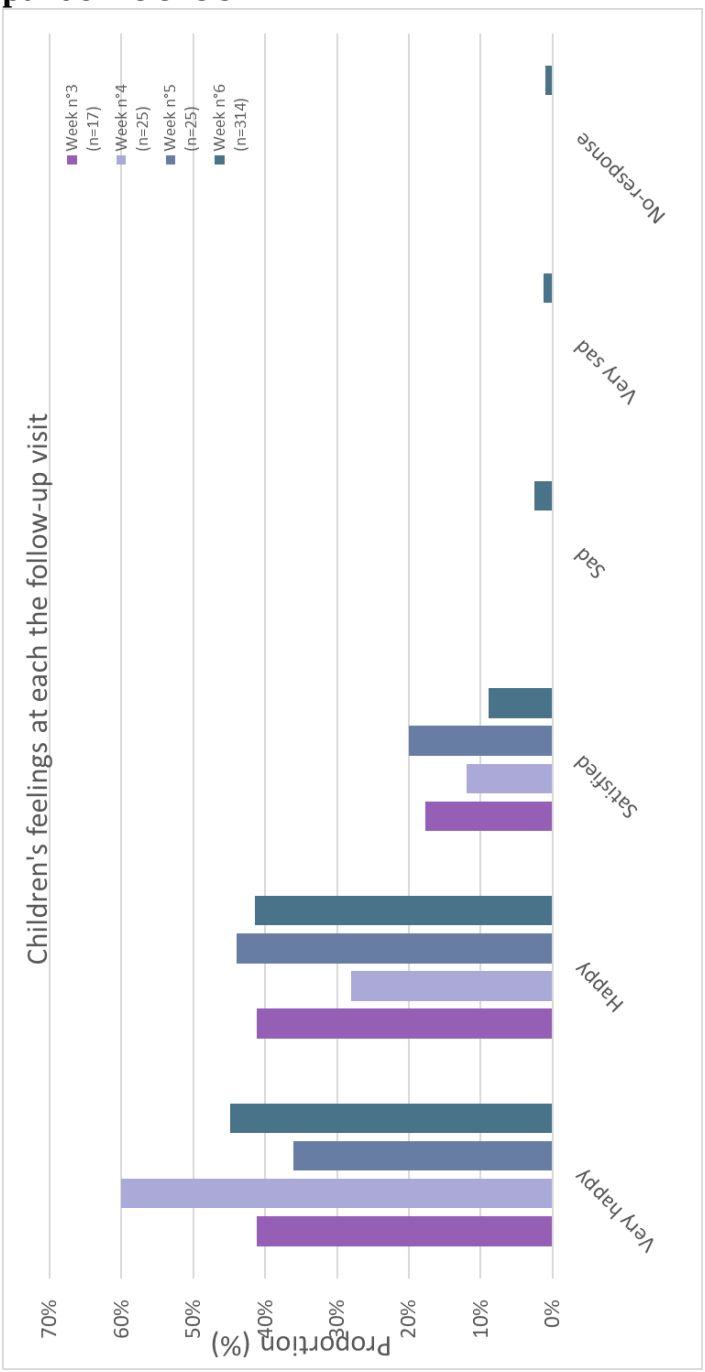


Figure 4a: Children's feelings reported during the COVID-19 pandemic crisis

Annex 10: Contacts outside the school reported by children during the COVID-19 pandemic crisis

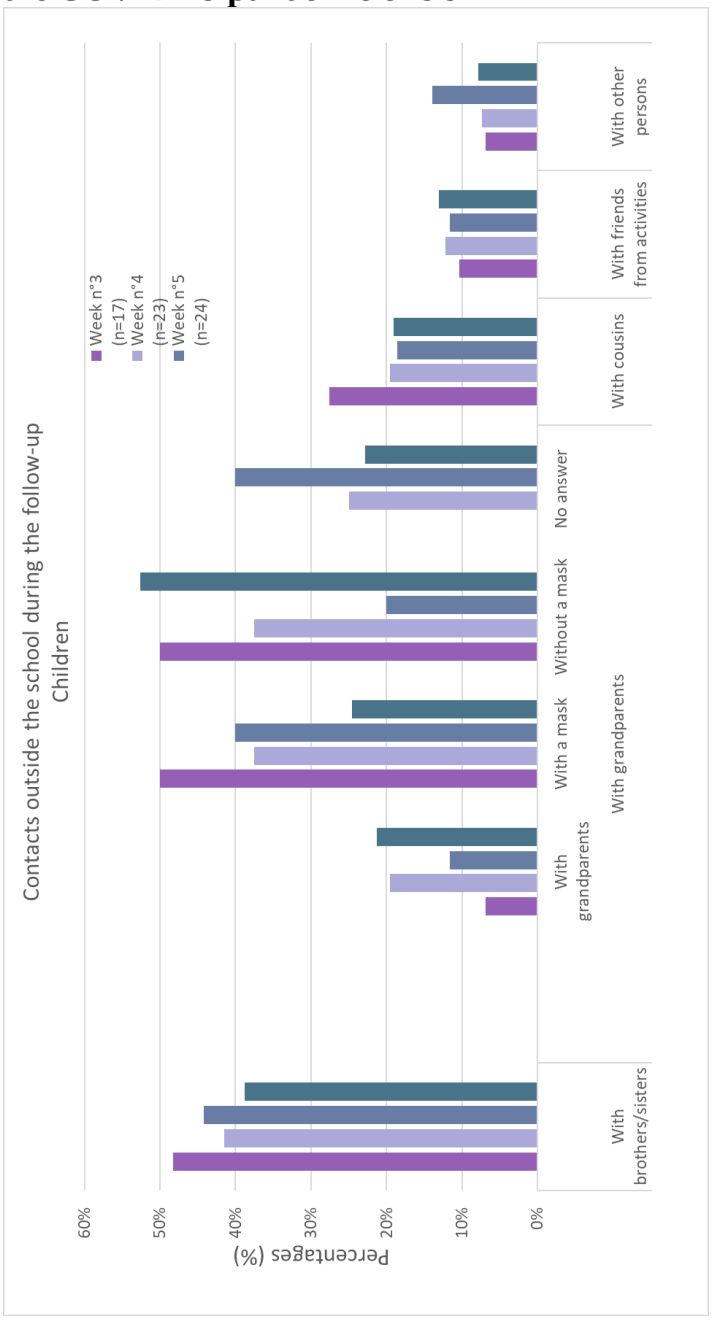


Figure 5a: Contacts outside the school reported by children during the COVID-19 pandemic crisis

Annex 11: Visit a place outside the school reported by children during the COVID-19 pandemic crisis

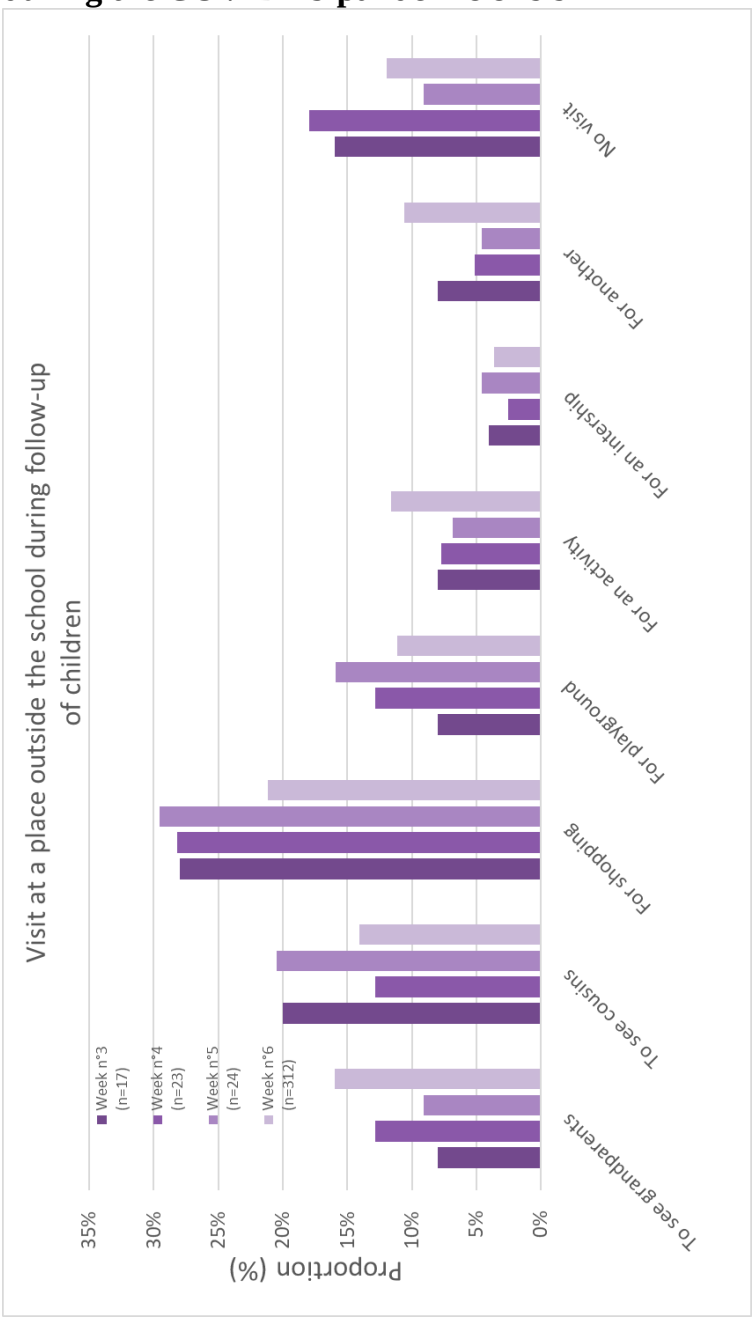


Figure 6a: Visit a place outside the school reported by children during the COVID-19 pandemic crisis

Annex 12: Symptoms reported by staff during the COVID-19 pandemic crisis

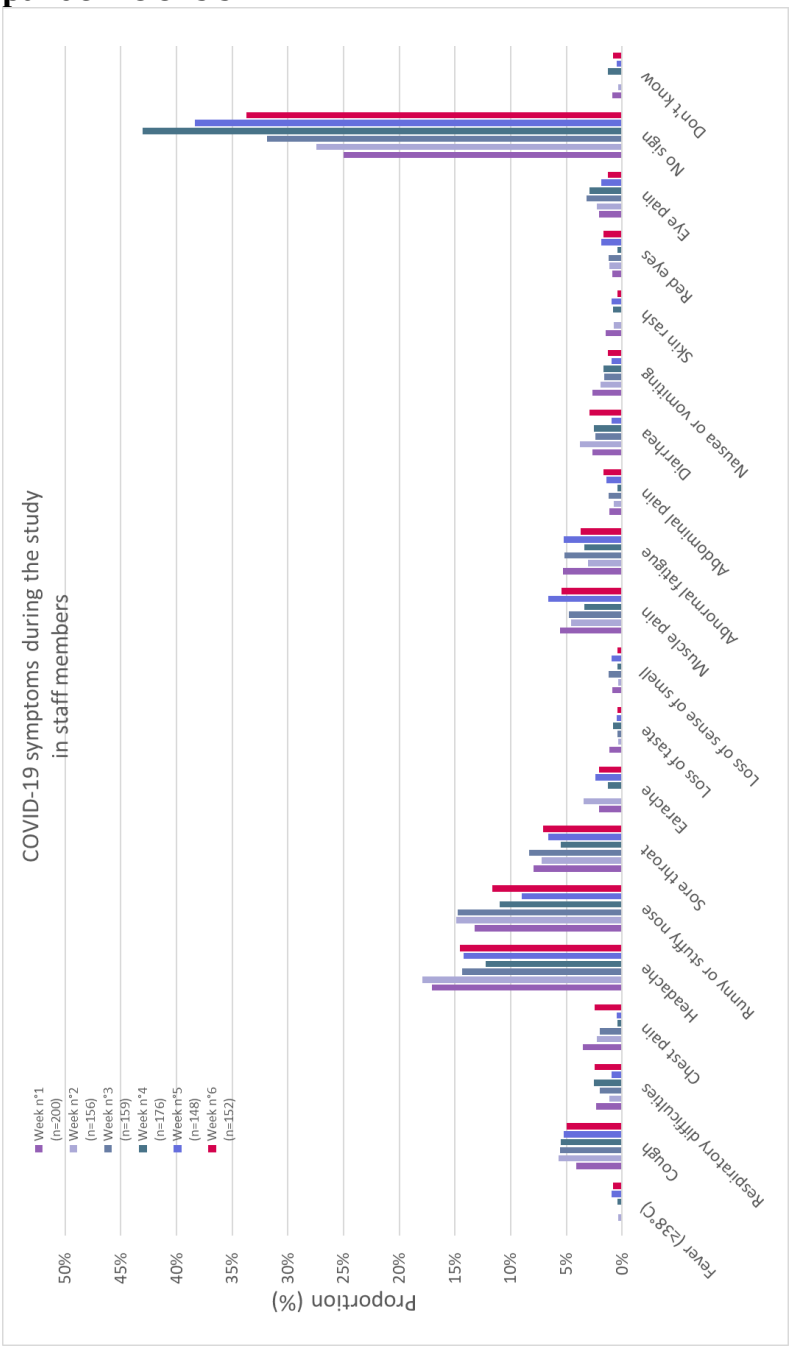


Figure 7a: Symptoms reported by staff during the COVID-19 pandemic crisis

Annex 13: Contacts outside the school reported by staff during the COVID-19 pandemic crisis

Figure 8a: Contacts outside the school reported by staff during the COVID-19 pandemic crisis

Annex 14: Visit a place outside the school reported by staff during the COVID-19 pandemic crisis

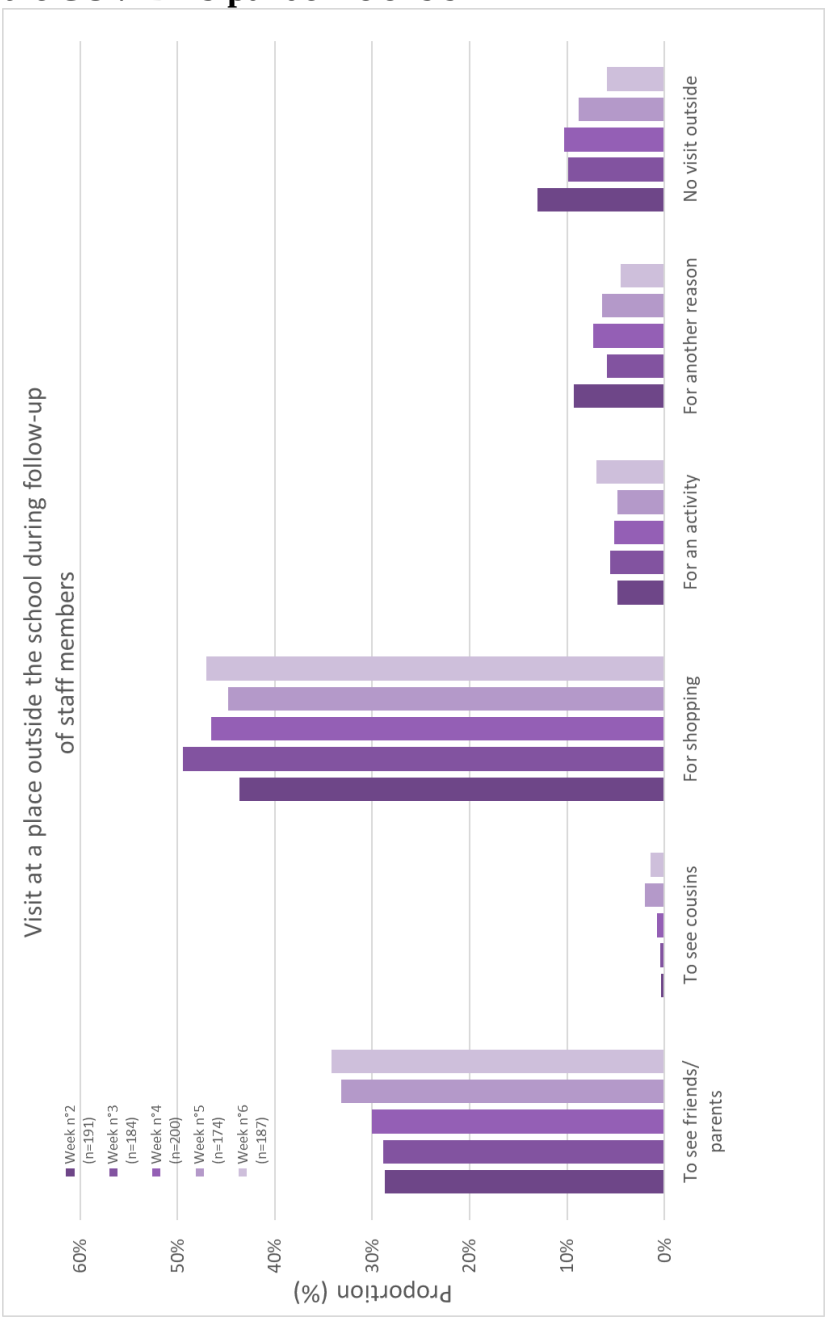
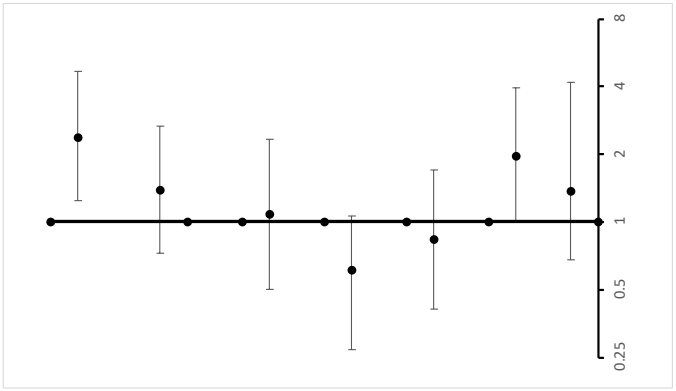


Figure 9a: Visit a place outside the school reported by staff during the COVID-19 pandemic crisis

Annex 15: Association between anxiety without the children of 6 and 7 years and characteristics using logistic regression

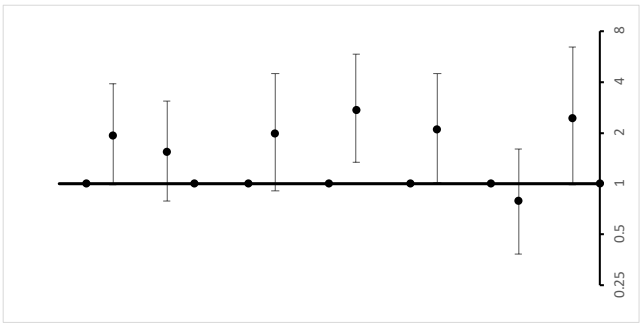


	n	RCMAS anxiety≥ 10	OR	(95%CI)	Adj OR	(95%CI)
Child						
Sex of the child						
Boys	77	44.2%	1		1	
Girls	106	56.6%	1.65	(0.92 ; 2.99)	2.38	(1.24 ; 4.67)
Age of the child (years)						
8-9	79	54.4%	1.19	(0.65 ; 2.19)	1.39	(0.73 ; 2.66)
10-12	92	50.0%	1		1	
Organized fixed activity						
Yes	118	48.3%	1		1	
No	60	56.7%	1.40	(0.75 ; 2.63)	1.08	(0.50 ; 2.33)
Outdoors/street activity						
Yes	67	59.7%	1		1	
No	102	52.0%	0.61	(0.33 ; 1.12)	0.54	(0.27 ; 1.06)
School inclusion criteria						
Local incidence						
Low	123	50.4%	1		1	
High	60	53.3%	1.12	(0.61 ; 2.09)	0.84	(0.41 ; 1.71)
Size of the school						
Small	79	43.0%	1		1	
Large	104	57.7%	1.80	(1.00 ; 3.28)	1.97	(1.00 ; 3.97)
Socioeconomic status						
Low (≤ 7)	41	61.0%	1.65	(0.82 ; 3.41)	1.66	(0.68 ; 4.16)
High (≥ 13)	142	48.6%	1		1	

n: number; Adj OR: adjusted odds ratio in multiple logistic regression; CI: confidence interval;
† 12 missing values; †† 5 missing values; ‡ 4 missing values

Figure 10a: Association between anxiety without the children of 6 and 7 years and characteristics using logistic regression

Annex 16: Association between social desirability without the children of 6 and 7 years and characteristics using logistic regression



	n	RCMAS SD≥5	OR	(95%CI)	Adj OR	(95%CI)
Child						
Sex of the child						
Boys	77	39.0%	1		1	
Girls	106	52.8%	1.75	(0.97 ; 3.20)	1.94	(0.98 ; 3.92)
Age of the child (years) †						
8-9	79	50.6%	1.33	(0.73 ; 2.45)	1.55	(0.79 ; 3.08)
10-12	92	43.5%	1		1	
Organized fixed activities ††						
Yes	118	41.5%	1		1	
No	60	58.3%	1.97	(1.05 ; 3.73)	2.00	(0.90 ; 4.51)
Outdoors/street activities ‡						
Yes	67	32.8%	1		1	
No	102	60.8%	2.54	(1.36 ; 4.83)	2.75	(1.34 ; 5.84)
School inclusion criteria						
Local incidence						
Low	123	40.7%	1		1	
High	60	60.0%	2.19	(1.17 ; 4.15)	2.11	(1.01 ; 4.48)
Size of the school						
Small	79	46.8%	1		1	
Large	104	47.1%	1.01	(0.56 ; 1.82)	0.79	(0.38 ; 1.61)
Socioeconomic status						
Low (≤7)	41	65.9%	2.71	(1.33 ; 5.74)	2.45	(0.98 ; 6.42)
High (≥13)	142	41.5%	1		1	

n: number; Adj OR: adjusted odds ratio in multiple logistic regression; CI: confidence interval;
† 12 missing values; †† 5 missing values; ‡ 4 missing values

Figure 11a: Association between social desirability without the children of 6 and 7 years and characteristics using logistic regression

Annex 17: Participation in staff in 2023

School	Children		Staff	
	Participants	Number of children	Participants	Number of school staff
	n(%)	N	n(%)	N
La Hulpe (PC: 1310)	29 (16.6)	175	5 (13.9)	36
Herve (PC: 4650)	51 (29.3)	174	8 (25.0)	32
Beauraing (PC: 5570)	28 (9.4)	297	6 (17.1)	35
Angleur (PC: 4031)	124 (50.4)	246	8 (22.9)	35
Châtelineau 1 (PC: 6200)	4 (1.9)	210	0 (0.0)	40
Châtelineau 2 (PC: 6200)	10 (4.0)	247	0 (0.0)	50
Berchem-Sainte-Agathe (PC: 1082)	11 (2.8)	393	1 (1.9)	52
Jette (PC: 1090)	23 (9.3)	246	4 (11.8)	34
Koekelberg (PC: 1081)	2 (0.8)	259	1 (3.1)	32

n=participants; N=total number

Table 1a: Participation in staff after the COVID-19 pandemic crisis (in 2023)

Annex 18: Anxiety and social desirability according to sex, age, and socioeconomic status of the children during the COVID-19 pandemic crisis

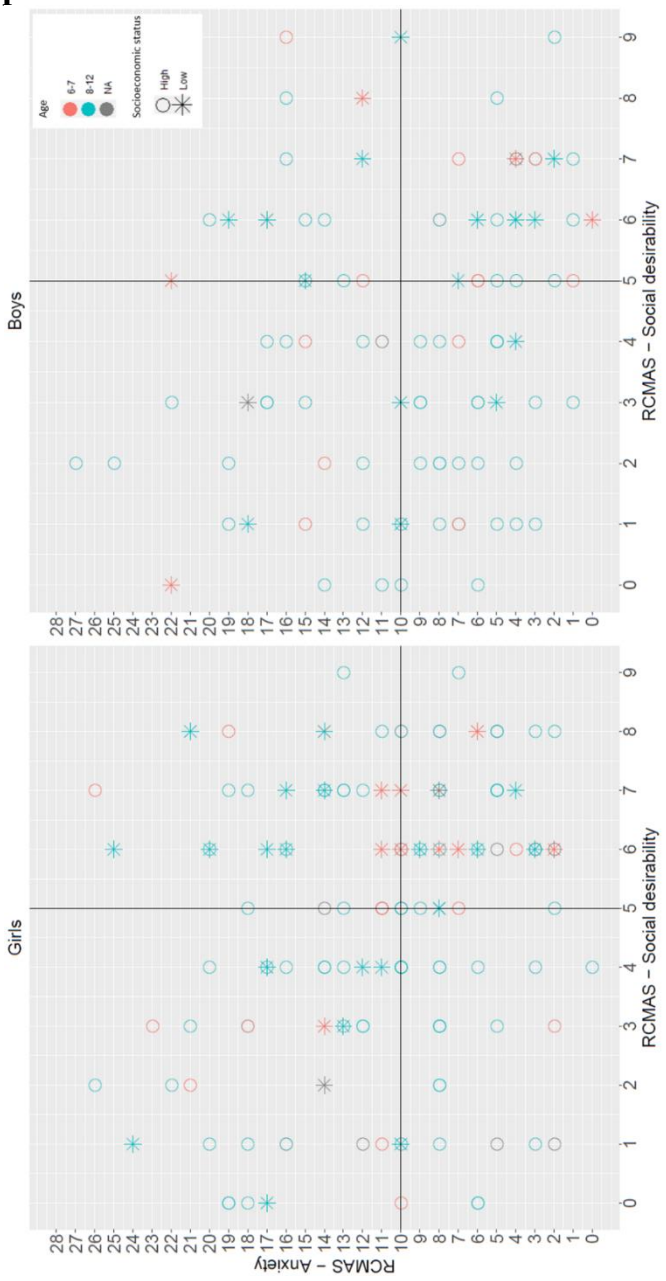


Figure 12a: Anxiety and social desirability according to sex, age, and socioeconomic status of the children during the COVID-19 pandemic crisis

Annex 19: Anxiety and social desirability according to sex, age, and socioeconomic status of the children after the COVID-19 pandemic crisis

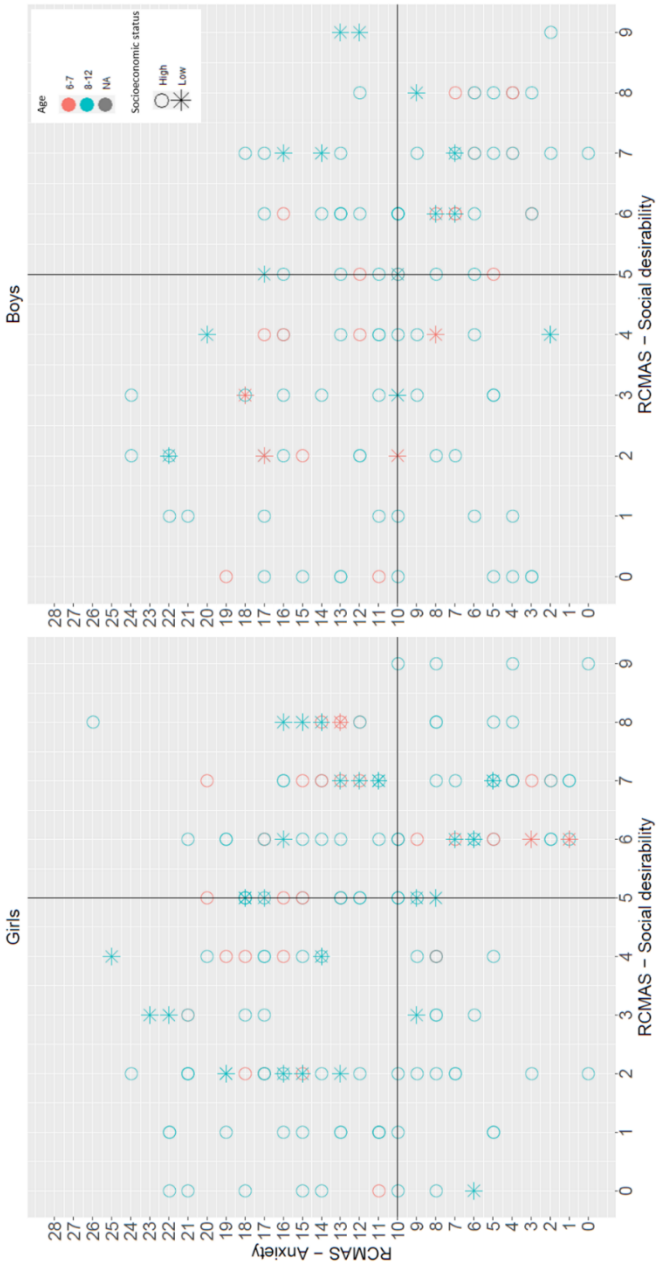


Figure 13a: Anxiety and social desirability according to sex, age, and socioeconomic status of the children after the COVID-19 pandemic crisis