

Experiences with opt-in, at-home screening for SARS-CoV-2 at a primary school in Germany: an implementation study

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ABSTRACT

Background Over the course of the pandemic, many countries have repeatedly closed schools and shifted schoolchildren to remote learning. However, evidence for negative mental and physiological health consequences of such measures for schoolchildren is increasing, highlighting the need for evidence-based recommendations on how to safely reopen schools. This study aims to assess implementation experiences, acceptability and feasibility of opt-in, at-home SARS-CoV-2 screening using rapid diagnostic tests (RDTs) to facilitate safe face-to-face teaching during a pandemic.

Methods We present data from a prospective study implementing an RDT-based screening programme at a primary school in southwest Germany. In addition to quantitative data collected to assess screening diagnostic yield (number of participants, tests handed out to participants, positive RDT results reported), we conducted qualitative in-depth interviews with participating pupils, parents and school stakeholders to elicit implementation experiences and screening perceptions.

Results The screening intervention was highly accepted and appreciated among participants; no screening-associated positive RDT was reported over the duration of the study. Self-testing at home before coming to school was feasible, but more positive consequences of screening participation (eg, easing of mask mandates) besides a personal feeling of safety would have been appreciated across respondent groups. Participants preferred home-based RDTs over some other measures, particularly mask mandates. Despite the RDTs being licensed as self-tests in Germany, additional training can help avoid mistakes, and ensuring intervention ownership and improving pre-implementation communication can facilitate buy-in.

Conclusions Antigen-RDT-based SARS-CoV-2 screening programmes relying on self-testing at home are a feasible and acceptable supplement to the public health toolbox to facilitate a safe return to face-to-face teaching at schools.

Trial registration number DRKS00024845.

INTRODUCTION

To curb infection rates in the context of the COVID-19 pandemic, many countries suspended routine, face-to-face teaching in primary and secondary schools, and—where

What is known about the subject?

- Efforts to reduce COVID-19-associated school disruption are currently being debated globally to reduce the impact of extended school closures on children's well-being.
- Rapid diagnostic tests (RDTs) for SARS-CoV-2 are reliable and can be performed as self-tests at home.
- Although countries have already introduced RDT-based screening programmes to facilitate safe face-to-face teaching, little is known about screening acceptance and experiences.

What this study adds?

- Pupils, parents and school staff perceive home-based RDT screening as feasible and less disrupting than other protective measures (eg, mask mandates).
- Implementers should communicate early and clearly, and provide a support system for training, troubleshooting, and in case of positive results.
- Concerns remain regarding the fidelity of home-based test performance in cases where pupils or parents are hesitant, even when testing is compulsory.

possible—schoolchildren were shifted to remote learning.^{1 2} However, as studies outlined the negative effects of school closures on children's education and health,^{3 4} and as evidence mounted regarding children's reduced risk of severe disease progression,^{5 6} schools began reopening. Amid reopening, debates ensued regarding the nature and content of infection prevention measures. One such measure entailed routine testing via either antigen-based rapid diagnostic tests (RDTs) or pooled PCR testing for SARS-CoV-2.

The proposal to implement large-scale screening efforts at schools was criticised both from an epidemiological perspective

(regarding imperfect test performance, especially of RDTs), and from a pragmatic perspective (viewing tests as an unnecessary burden for schoolchildren and their parents).⁷⁻⁹ On the other hand, a study from Great Britain suggested that SARS-CoV-2 protective measures in schools were broadly accepted among schoolchildren and parents, and expansion of routine SARS-CoV-2 testing would be welcomed.¹⁰ To the best of our knowledge, there is no evidence available on the perceptions of and experiences with the implementation of testing for entrance screening in school settings, and the effects on compliance with other safety measures (eg, masks).

An in-depth investigation of school-based testing implementation can facilitate evidence-based recommendations for best practices of entrance screening in schools, not only in the context of this pandemic but also for future public health crises. This study responds to calls in the literature to better understand opportunities and challenges for COVID-19 mitigation or prevention strategies in schools.¹¹⁻¹³ We provide insights regarding how RDTs for home-based screening of primary schoolchildren can be implemented, and whether such screening approaches can be a feasible and accepted addendum to the pandemic response toolbox in Germany.

METHODS

We conducted a prospective implementation study to assess experiences with and perceptions of introducing in-home RDT-based screening at a primary school in a periurban area of southwestern Germany. Throughout the early pandemic, schools in the region were routinely fully or partly closed, only offering basic face-to-face supervision to children whose parents work in fields classified as essential. Since the beginning of 2021, an increasing number of academics, policymakers, school representatives and parents argued for schools to be reopened with comprehensive screening approaches complementing other hygiene measures.^{14 15}

Responding to calls from policymakers for pilot projects testing the feasibility and acceptability of such screening efforts, our study-based screening was initiated in March 2021. Statewide compulsory screening was introduced for schools in April 2021, informed by findings from pilot projects testing different approaches, including our own study. **Figure 1** presents a timeline of study-related processes and the general context.

Intervention design

Several schools in the region expressed interest to participate in pilot projects for SARS-CoV-2 screening. We selected one school suited to fill key gaps in the discourse, particularly with regard to setting (periurban) and age of schoolchildren (primary school). The design of the screening intervention was developed in partnership with school stakeholders (**figure 2**). For each week of screening, pupils and staff members who voluntarily decided to participate in the study received three antigen-based RDTs to be performed independently at home on Mondays, Wednesdays and Fridays. The test used was the STANDARD Q COVID-19 Ag Tests (SD Biosensor, Gyeonggi-do, Korea), an independently validated and WHO-approved SARS-CoV-2 RDT.^{16 17}

We trained members of the school staff and parents who volunteered on how to perform the test, and then trained others in a snowball system. We additionally provided participants with a step-by-step guide on how to perform the test (online supplemental file 1), and we set up telephone and email hotlines that could be contacted in case of screening-related questions. Additionally, the local health authority and local doctors were informed about the study.

After 4 weeks of screening, compulsory testing was introduced for all schools in the German state of Baden-Württemberg.¹⁸ The design of this statewide screening was very similar to the study intervention, with the main difference being only two tests per week and parents having to confirm the test result to the school in writing.

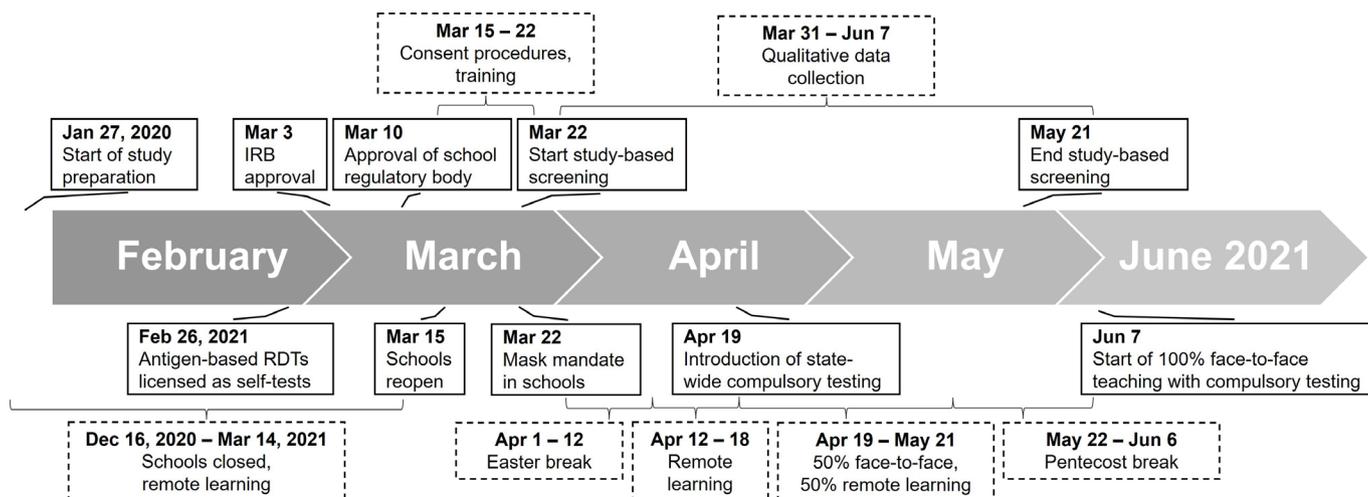


Figure 1 Study processes and the general context. RDTs, rapid diagnostic tests. IRB, institutional review board

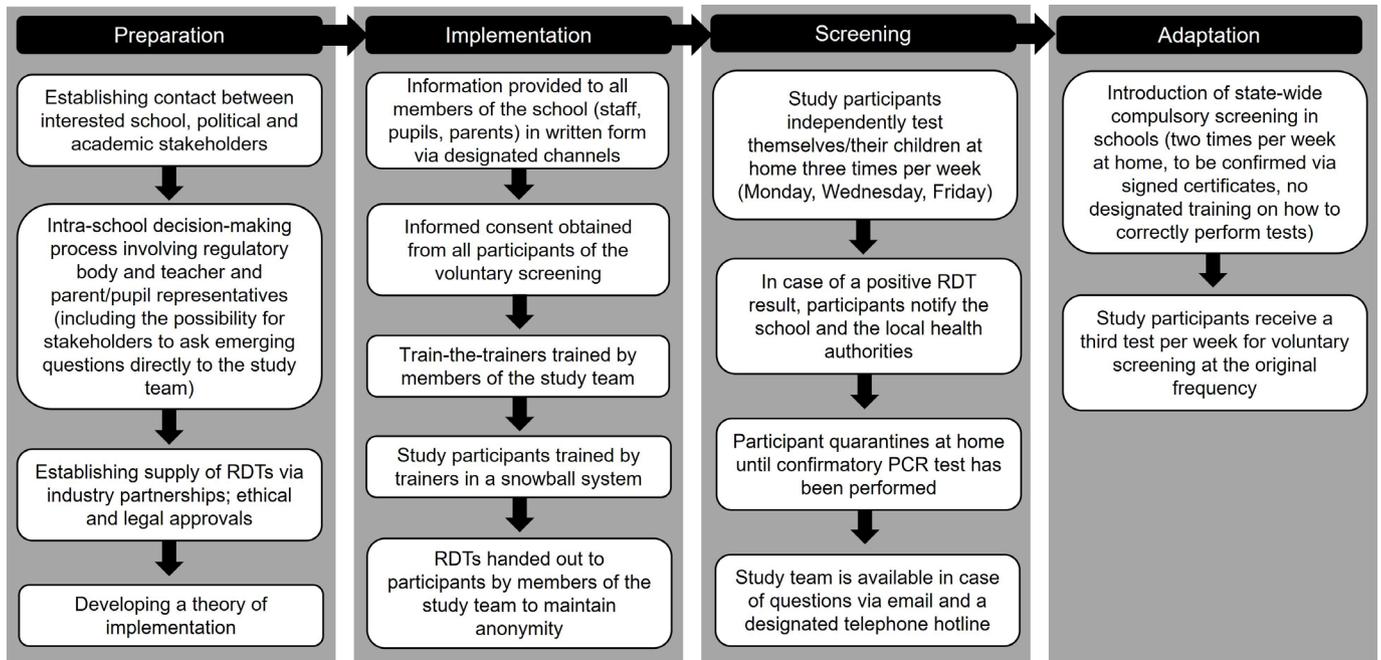


Figure 2 Implementation and theory of intervention of the RDT-based screening. RDT, rapid diagnostic test.

No training was offered in the context of the statewide screening. Upon onset of the compulsory screening, all study participants were supplied with one test per week to supplement the two RDTs provided by the state to maintain the original screening frequency.

Data collection and analysis

Quantitative (number of participants, number of tests handed out, and number of tests reported to be positive) and qualitative (in-depth interviews with children, parents and school stakeholders) data were collected over the entire duration of the study; data collection and

analysis procedures are outlined in figure 3. All participants provided written informed consent separately for their participation in the screening and, if applicable, when they participated in the qualitative interview. We followed consolidated criteria for reporting qualitative research (COREQ) guidelines¹⁹ to report our findings (see online supplemental file 2).

The semistructured interview guides, including questions and further probes (see online supplemental file 3), were developed based on the literature and the study team’s previous experience conducting qualitative

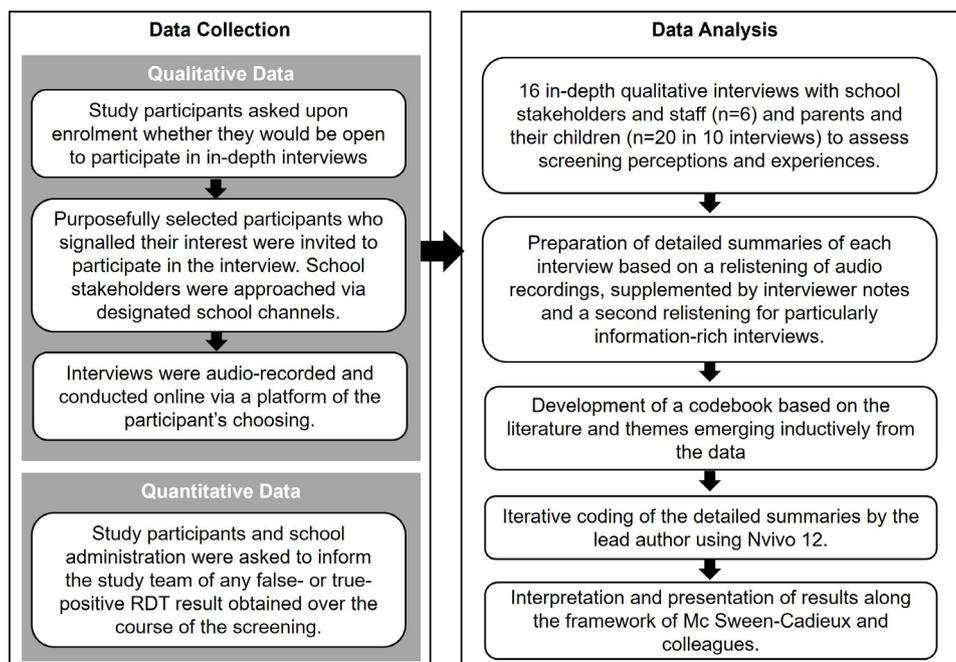


Figure 3 Data collection and analysis. RDT, rapid diagnostic test.



interviews on SARS-CoV-2 RDTs in Germany.²⁰ For the qualitative interviews, we chose among 60 parents of 65 pupils who had signalled an openness to participate in an interview, contacting 25 of them via email (and purposefully including them based on residence in larger or smaller villages, and being parents to children from grades 1–4). Half of these emails received a response and we ultimately interviewed 10 parents (stopping early due to data saturation). Reasons for not participating among those who responded to our email invitation but declined or postponed an interview (n=3) included scheduling difficulties and the high workload of managing home-schooling for pupils while working from home oneself. Parents agreeing to be interviewed were asked whether their child would also be open to being interviewed, with 10 children from 9 parents agreeing to participate. School staff and stakeholders were contacted through designated school channels.

Interviews were scheduled via email and conducted in German on a video call platform of the participant's choosing. Prior to each interview, the interviewer described the content and purpose of the interview, and participants were invited to ask any questions. Parents and pupils were interviewed together, with the pupil sometimes not being present for the entire duration of the interview. In some cases, respondents' smaller children were in the same room during the interview. To the best of the interviewer's knowledge, no other individuals were present.

The lead author (JW), who has graduate level education and several years of experience in conducting qualitative research, conducted all interviews. He acknowledges that working in his country of origin, in close proximity to where he lives, could result in biases, especially in light of being affected by similar COVID-19-associated restrictions and policies as respondents. The interviews on average lasted 45 min (range 24–74 min) and concluded once saturation was reached (for interviews with parents and pupils) or all respondents expressing interest to participate were interviewed (for school stakeholders and staff). JW and MS prepared detailed summaries of each interview, key sections were transcribed verbatim and translated into English.

Qualitative data were analysed drawing on thematic analysis,²¹ combining inductive (themes emerging from the data) and deductive (concepts derived from the literature) approaches (figure 3). JW iteratively applied the resulting codebook to the entire set of interview summaries, discussing emerging similarities and differences across respondent groups with SAM and CMD.

Patient and public involvement

Members of the school administrative staff and parents of pupils initiated contact with the study staff to express interest for developing a pilot project to assess the feasibility and acceptability of RDT-based screening at schools. Staff and parents were actively involved in the conceptualisation and implementation of the study. To maintain

anonymity, school staff were not involved in participant recruitment or data collection. One coauthor (NT) is a parent to two school pupils, was responsible for initiating the study, and also participated in an interview as a key informant.

RESULTS

Study participants

A majority of school staff decided to participate in the voluntary screening (n=21 out of 34, 62%), as well as a majority of pupils and their parents (n=109 out of 186; 59%). After the introduction of the statewide compulsory screening, n=15 (14%) participating pupils did not collect their additional third weekly study-based RDT, indicating that they were screening the state-mandated two times per week. Interviews were conducted with 6 school stakeholders and staff, 10 pupils and 10 parents (9 mothers and 1 father). The study lasted 9 weeks (22 March–21 May 2021). During this time, SARS-CoV-2 incidence in the region initially increased from 106.7 infections per 100 000 inhabitants per week (22 March) to 154.1 (27 April) before it fell to 54.3 by the end of the study-based screening (21 May).²²

Over the course of the study, no study-related positive RDT result (neither false positive nor true positive) was communicated to the school or the study team. After the onset of statewide compulsory testing in schools, while the study-based screening was still in place, the school was notified of one case of SARS-CoV-2 in a pupil whose parents had self-reported a negative RDT 1 day prior. No further cases were reported.

Implementation experiences, home-based testing

To highlight implementation processes and experiences, we group themes inductively emerging from the data along the framework of Mc Sween-Cadieux and colleagues (table 1)²³ which combines the Consolidated Framework for Implementation Research²⁴ and the Ecological Framework.²⁵ The framework investigates factors influencing intervention implementation across six domains: intervention, individuals, support system, inner setting, outer setting and the implementation process.

Intervention

School stakeholders highlighted their key motivations for exploring RDT-based screening as minimising risks of secondary infections and school closures, as well as a hope that screening may lead to other positive consequences (eg, repeal of mask mandates). Some participants voiced concerns regarding screening because it placed an unnecessary burden on children, especially in light of increasing communication at the time that children were not a driver of the pandemic and the perception that children's physical and mental health was already strained enough by the pandemic. Consequently, a majority of stakeholders appreciated the newest generation of RDTs because they relied on anterior-nasal swabs, which were

Table 1 Implementation experiences across domains

Domains	Themes	Key quotes
Intervention: home-based RDTs to screen primary school pupils	Framing of the intervention by school stakeholders as an option to minimise risks for staff and families, and to avoid school closures	'It was this balancing act between pedagogy, psychological needs of the children, and health protection. The risk assessment, what happens when we carry it into the school and get a wave of infections here.' (school stakeholder 1)
	Usability and reliability of the RDTs and associated concerns pre-implementation	'A key experience why I wasn't against it was the practicability of this test. If this test would have meant offering children this other test [using nasopharyngeal swabs] on a regular basis, then I would have blocked it.' (school stakeholder 1)
	Concerns regarding additional burden for children , but less burdensome as compared with other measures (eg, mask mandates) or potential consequences	'That's the concern that this brings in unnecessary unrest, in addition to the unrest that is already there in any case. Now there are even tests being done that potentially are positive.' (school stakeholder 2)
	Feasibility of home-based testing as compared with on-site screening, but risk of alternative use	'Otherwise you probably would have to do that somewhere in the school, that I think is difficult to implement. How do you do that with so many children, [...] I don't know how to imagine that.' (mother 2)
	Hopes for positive consequences of screening implementation	'That also was a question of the parents: If we participate in this study, do we still have to wear these stupid masks?' (school stakeholder 1)
	Framing as a research study important but also resulting in concerns regarding ulterior motives	'It's not about testing the tests. It's about figuring out: can we manage to create a good scenario to test ourself in our everyday lives? And does it really help to control the spread?' (school stakeholder 1)
Individuals: pupils, parents and school staff using the tests	Motivations for participation included an increased sense of safety and wanting to contribute to COVID-19 research	'We basically immediately decided to participate. Because if we don't do research on this virus, you can't analyze it. The more information you get about it, the better, and for us it wasn't a big sacrifice to participate. [...] And a higher sense of security of course is nice, too.' (mother 4)
	Appreciation for tests and intervention: overall good testing experiences across respondent groups	'In general, I found it great that this was done. I talked with colleagues who also have children in primary schools that don't have tests. They were immediately jealous.' (mother 5)
	Gradual integration of testing into daily routines: from 'annoyed' and 'scared' to 'like brushing teeth'	'In the beginning I always was a bit scared, but my mother said that it's not that bad. Then I was really happy when the test was negative. [Now] I'm not afraid anymore. When I knew what was coming it wasn't bad at all anymore.' (female pupil 10)
	No increased risk taking as a result , feeling of safety as the main consequence	'I still don't party or meet a lot of people [...] But in fact, this morning I tested myself. That is a good feeling, I'm happy then. You don't expect anything but a negative result, but you're just happy: This safety I have for today.' (school stakeholder 3)
	Surprise and incomprehension regarding concerns and criticism of those not participating	'I didn't at all expect that anyone could have a problem with this testing and the study. I had thought: Everyone must see how reasonable this idea is, how little invasive that is for the outcome that means we have security for our children and for the village here.' (mother 1)
	Support system: trainers, study staff and external resources	Telephone hotline and other contacts offered by the study team were appreciated (but not used by participants)
Train-the-trainer system for building self-testing capacity as feasible but lacking supervision		'Something I would have wished for to be different was how information was passed on. In our class it wasn't really clear how you can get trained. The trainers in the end just said that whoever had questions could reach out.' (mother 5)
External support (eg, local doctors) not used in light of lack of cases		'There were many options to reach out to in case of difficulties. Great.' (mother 2)
Inner setting: periurban primary school in the context of the COVID-19 pandemic	RDT-based screening as the newest development after more than 1 year of pandemic state of emergency	'It was an exceptionally difficult year. We had imagined it to be completely different, for the small children who still have to get used to the school routines, have to learn the rules, the continuity you usually have in the school.' (father 8)
	Screening not a dominant topic in intraschool interactions	'Almost noone cares about that. Also not everyone participates. Sometimes someone says something like: Do you also participate in the study? Or whether the test is pleasant or not. But the study does not play a big role in the school.' (male pupil 1)
	General perception of high screening acceptance within the school but debates outlining overarching disagreements regarding the pandemic	'We simply always have this dilemma: It's about the children! [...] We also have colleagues who see more the psychological needs of the children [...] We also have colleagues who are more focused on the protection of health. [...] This general thing that develops in the entire society does not completely pass over our staff.' (school stakeholder 1)

Continued

Table 1 Continued

Domains	Themes	Key quotes
Outer setting: legal, ethical and public discourses	Overarching dissatisfaction with policy decisions; screening in light of a year of constant and often rapid changes	'For a very long time I saw our workplace protection disregarded by the state government. Secondary schools received masks. Yes of course, they introduced the mask mandate earlier [...] and in our case they just assumed that small children are not infectious.' (school stakeholder 1)
	Shift to compulsory screening appreciated by most but concerns surfaced regarding potential shortcomings	'I don't think that [that compulsory screening in the current form has a lot of benefits] because those who voluntarily participated in the study are the ones who want to actively help and see the danger. And those who didn't participate probably have a different attitude.' (father 8)
Implementation process: introducing RDTs	Implementation ownership: initiated by and relying on local stakeholders	'[The school headmaster] also really stood up for this. That was also some educational work that was being done.' (school stakeholder 4)
	Implementation process as acceptable and successful; short time for decision-making and training as the new normal	'You can't improve it because it already was good. I liked it that there were additional tests for trying it out [or] when one goes wrong. It was well communicated from the beginning. You were well informed via the information sheet. The pick-up of the tests was organized well, too. I liked the tests and the study, I don't have particular recommendations.' (mother 9)
	Better communication might reduce barriers for participation	'Something I actually would have found helpful, from my perspective, would have been an online office hours to inform people about the tests [at the outset of the program when parents were deciding whether to engage] where you say: you have questions, and I am here to answer them.' (school stakeholder 4)

RDT, rapid diagnostic test.

viewed as less burdensome for those performing the tests in general and children in particular.

A major point of debate entailed whether to conduct screening at home or on-site. School stakeholders and staff predominantly highlighted organisational and infrastructural barriers to school-based screening, including the strain on already limited teaching time, concerns regarding the psychological consequences of a pupil testing positive in school (including potential stigmatisation by peers), and questions regarding teacher accountability. While participants generally acknowledged these concerns, several parents also discussed concerns that not everyone would conscientiously perform the tests at home. This was voiced when testing became compulsory, especially addressing families who initially had decided against study participation.

Individuals

An increased sense of safety was reported as the key motivation for, and consequence of testing across respondent groups for participation in the study and testing in general. Participants also reported a desire to contribute to COVID-19 research, thereby increasing the chance for a timely return to 'a more normal school routine' (mother 3). The screening itself was generally appreciated, and a majority of participants described how initial reservations or 'fear' (female pupil 3) regarding the tests were alleviated after the first few times, and the screening quickly was integrated into the morning routine 'like brushing teeth' (mother 10). Children themselves described RDTs as being much less disrupting or burdensome compared with other measures encountered over the course of the pandemic, in particular compared with mask mandates in schools.

Several participants voiced incomprehension or 'disappointment' (school stakeholder 6) regarding the

number of families deciding against participation, or recounted frustration when interacting with screening hesitant parents or staff members. Several expressed disappointment regarding the limited consequences of participating in the screening and expected motivation and buy-in of others to increase once testing was seen as having consequences beyond a personal sense of security.

Support system

Participants appreciated offers made by the study team, including telephone and email hotlines, although neither was used during the course of the study. No participant reported interacting with complementary local resources (eg, local health authority or local doctors). The experience of quick notification and confirmatory testing in light of one positive result outside the study was seen as affirming that the support system in place would work.

Most participants appreciated the implemented train-the-trainer system and reported their interactions during the training as reassuring and empowering for when they performed the first RDT with their children, particularly when mistakes emerged during training (eg, moving the test kit around, placing it on an uneven surface, wrong usage of buffer fluid). In a few instances, however, the snowball training system did not work as envisioned, with information only being relayed verbally. Nevertheless, participants saw themselves as being better prepared and able to assist others when statewide compulsory screening was implemented without prior training.

Inner setting

In light of prior experiences like school closures, quarantines, and challenges associated with remote learning, the intervention was perceived as less disruptive compared with other measures and associated with the hope for

some continuity 'at least until the summer break' (school stakeholder 5).

Both children and teachers reported the study-based screening to be only a side topic, if at all, in their interactions at school, although participating teachers recounted how sometimes children talked about their experiences or the reasons why their parents were against testing in class. In general, participants perceived screenings (both as part of the study and following the introduction of compulsory screening) as being highly accepted.

Outer setting

Participants stated that their support of the study-based screening represented an attempt to increase their own safety, which they felt had been neglected by elected authorities. The subsequent introduction of compulsory screening therefore was appreciated by most participants, although concerns were voiced that a stricter control of testing fidelity than currently in place might be required, as not everyone was eager to comply.

Implementation process

The study was advocated by school stakeholders and also relied on those stakeholders for successful implementation. This resulted in high level of stakeholder ownership, which was seen as particularly relevant for study buy-in across respondent groups. The broad buy-in was particularly important given a context marked by a highly emotionalised debate around COVID-19 control measures in schools.

Respondents generally appreciated the chosen implementation process. Although the information sheets, particularly the information sheet for children, and the communication by school stakeholders were appreciated, respondents expected study participation to further increase with additional events and opportunities for potential respondents to ask questions directly of the study team prior to making a decision about participation (this opportunity was only offered to the parents' association and staff, though not all parents).

DISCUSSION

This study outlined experiences implementing home-based RDTs for universal screening in a primary school setting. The screening was highly accepted and viewed as feasible among interviewed participants. Negative consequences (eg, more risk-taking behaviour) were not observed. However, concerns surfaced regarding the broad utility of screening when many individuals within a social setting may decline participation or not perform tests as advised. Interviewed participants expected screening acceptance and motivation to increase if the test was perceived to have consequences beyond a heightened sense of personal security. No case of SARS-CoV-2 was detected via the screening in the context of this study, and no clusters of infections indicated undetected cases.

Our findings regarding the screening's feasibility mirror outcomes of projects that implemented self-sampling for SARS-CoV-2 testing in school settings.^{26 27} However, this evidence stems from secondary schools²⁷ or from oral self-sampling.²⁶ The high acceptance of screening expressed by our participants mirrors qualitative evidence regarding the acceptance of broader COVID-19 prevention measures in schools in the UK.¹⁰ We expand on this evidence by highlighting the acceptability and feasibility of home-based nasal sampling among primary school pupils.

The topic of large-scale RDT-based screening efforts in schools is emotionally highly charged in Germany, including lawsuits and homeschooling by parents who are fundamentally against SARS-CoV-2 testing for their children.⁸ Our findings highlight that an emotionally charged intervention can be generally acceptable to a target population if stakeholder buy-in and ownership is achieved through repeated explanations and demonstrations of the intervention.

Our study demonstrates that testing was perceived as less burdensome to participants, including pupils, than more established measures, such as facial masks. Considering the exceptional burden faced by schoolchildren and parents in the pandemic,²⁸ and in light of increasing evidence regarding the impact of school closures on health and education^{29 30} and that children are at lower risk of severe disease progression,^{5 6} our results provide evidence that RDT-based screening is an acceptable and feasible way to facilitate in-person teaching. To the best of our knowledge, no positive cases (neither true positive nor false positive) emerged in the course of our study; we acknowledge however that a positive case may shift experiences with and perceptions of the intervention. We thus encourage further implementation research that captures a true positive case (which could increase acceptability due to successfully avoiding potential transmission) or a false positive case (which could decrease acceptability due to concerns about test reliability).

Beyond COVID-19, one other public health measure relying on self-testing in school settings in high-income countries entails screening for head lice. A study in primary schools in Australia aimed to assess the reliability of home-based screening for head lice, and only found a sensitivity of parental reports of 16%.³¹ This suggests challenges when shifting testing from schools into the private realms, particularly in cases where a positive test result could be perceived as stigmatising or as having consequences for short-term school access. While this concern was also voiced by participating parents and educators in our study, the participation of over 50% of staff and parents probably reflects important distinctions between routine lice screening and self-testing amid a viral pandemic.

This study provides timely and in-depth qualitative data, producing insights into the real-life discourse amid rapidly changing regulations. The study site is representative for schools in periurban settings; research to date

on health interventions at schools has predominantly focused on the urban context. However, our study also has limitations. First, only parents and pupils who had decided to voluntarily participate in the overarching screening programme could be recruited for interviews; critical voices therefore might be under-represented in the data on parents and their children. Additionally, we designed the screening approach in this study as a realistic scenario for large-scale rollout, which included PCR-based confirmatory testing only in cases where a positive RDT result was reported. To minimise screening-associated burden and to bolster participation, the research team together with school stakeholders also decided against asking participants to systematically report negative test results or the emergence of COVID-19-associated symptoms. No cluster of cases emerged in the study setting, suggesting that the screening did not systematically miss infections, but the biased collection of test result data inhibits broad statements regarding screening accuracy. Finally, as RDTs for SARS-CoV-2 have been introduced in Germany on a large scale in recent months, generalisability of our results to other countries where RDTs were less present in the public discourse might be limited.

RDT-based screening is an acceptable and easily scalable intervention to decrease risk of transmissions at schools and facilitate face-to-face teaching amid a pandemic. Policymakers should ensure comprehensive capacity building for testing, fit-for-purpose training materials for all age levels, and train-the-trainer programmes to enable scale up of universal screening. Furthermore, consistent communication on regulations and readily available support networks (hotlines via phone or email) can reduce burden for school staff and families.

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Data availability statement Considering the high public interest in research on COVID-19, qualitative data of participants who have indicated their agreement to this as part of the informed consent procedure can be shared with other researchers. However, to preserve the anonymity of respondents and considering the personal nature of qualitative data, requests will be considered on a case-by-case basis. Please contact the corresponding author.

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Wie wird der Antigen-Schnelltest durchgeführt?

Lesen Sie sich die Gebrauchsanweisung genau durch, bevor Sie den Antigen-Schnelltest durchführen. Der Test sollte unbedingt bei **Zimmertemperatur** durchgeführt werden, d.h. alle Teile des Tests sollten seit mindestens 30 Minuten bei Zimmertemperatur gelagert werden, bevor Sie den Test starten. Wenn der Test zu kalt ist, kann er falsche Ergebnisse liefern!

1. Was brauche ich für den Test?

Inhalt des Test-Sets

1. Testkassette (hier verpackt und ausgepackt dargestellt)



2. Nasentupfer



4. Probenflüssigkeit



5. Verschlusskappe



5. Kontrollkugeln
(verpackt zusammen mit der Testkassette, nicht für den Test benötigt. Orangene Kugeln müssen sichtbar sein).



Zusätzlich brauche ich: Taschentuch, Uhr oder Timer, verschließbare Mülltüte

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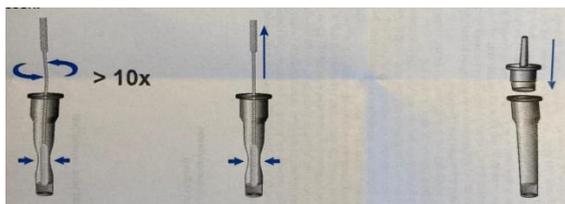
2. Nasenabstrich

1. **Schnäuzen** Sie bzw. Ihr Kind einmal in das bereit gelegte Taschentuch.
2. Öffnen Sie die Verpackung mit dem Nasentupfer und nehmen Sie ihn aus der Verpackung. Achten Sie dabei bitte darauf, **NICHT** den weichen Tupferkopf zu berühren!
3. Legen Sie den Kopf leicht nach hinten.
4. Führen Sie den Nasentupfer mit der **weichen Seite etwa 2 cm** tief in ein Nasenloch ein, bis ein ganz leichter Widerstand zu spüren ist. Es könnte etwas kitzeln, sollte aber nicht wehtun.
5. **Drehen** Sie den Tupfer mindestens **4-mal in der Nase für insgesamt 15 Sekunden**.
6. Ziehen Sie den Tupfer wieder heraus.
7. **Wiederholen** Sie den Vorgang mit **demselben** Tupfer im **anderen Nasenloch** (mindestens 4-mal drehen für insgesamt 15 Sekunden).



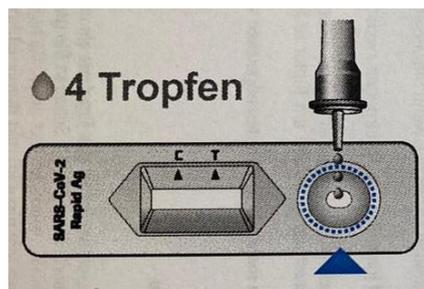
3. Weiterverarbeitung des Tupfers

1. Öffnen Sie das Röhrchen mit der Probenflüssigkeit (behalten Sie den Tupfer dabei in der Hand, legen Sie ihn **nicht** auf dem Tisch ab. Alternativ öffnen Sie das Röhrchen mit der Probenflüssigkeit von dem Nasenabstrich und stellen sie es geöffnet bereit (Beispielsweise mit einer Wäscheklammer oder in einem Duplo-Stein).
2. Stecken Sie den Tupfer in das geöffnete Röhrchen.
3. Drücken Sie mit Daumen und Zeigefinger das Röhrchen unten fest zusammen und drehen Sie den Tupfer mindestens 10-mal (für insgesamt mindestens 10 Sekunden).
4. Halten Sie die untere Hälfte des Röhrchens zusammengedrückt und ziehen Sie während das Röhrchen zusammengedrückt ist den Tupfer aus dem Röhrchen, um möglichst viel Flüssigkeit aus dem Tupfer zu pressen. Entsorgen Sie den gebrauchten Abstrichtupfer in der bereitgelegten Mülltüte.
5. Drücken Sie die Verschlusskappe auf das Extraktionsröhrchen.



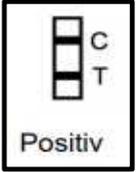
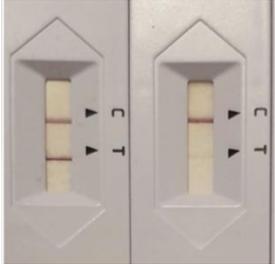
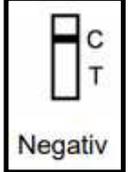
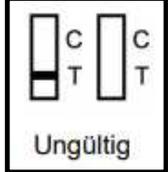
4. Testdurchführung

1. Öffnen Sie den Beutel und entnehmen Sie die Testkassette. Überprüfen Sie, dass mindestens ein orangenes Kügelchen sichtbar ist.
2. Drehen Sie das Röhrchen um und geben Sie 4 Tropfen der Flüssigkeit in die **runde** Probenvertiefung, indem Sie das Röhrchen leicht zusammendrücken.
3. Lassen Sie die Testkassette auf einer ebenen Fläche liegen. Lesen Sie das Testergebnis nach **15-30 Minuten** ab.
4. **Achtung:** Ein nach mehr als 30 Minuten abgelesenes Testergebnis kann falsch sein!



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5. TestauswertungLesen Sie das Testergebnis nach **15-30 Minuten** ab.

 <p>Positiv</p> <p>Zwei (2) Farblinien, eine bei C und eine bei T. Jede noch so blasse Farblinie bei T zählt!</p> <p>→ der Test ist positiv</p> <p>Begeben Sie sich in Selbstisolation und lassen das Ergebnis per PCR bestätigen</p> <p>Beispiele: beide positiv</p> 	 <p>Negativ</p> <p>Nur eine (1) Linie, bei C. Es erscheint nur eine Farblinie bei C und keine Farblinie bei T.</p> <p>→ der Test ist negativ</p> <p>Beachten sie weiter alle geltenden Hygiene- und Abstandsregeln</p> <p>Beispiel: negativ</p> 	 <p>Ungültig</p> <p>Keine Farblinie bei C: (unabhängig davon, ob bei T eine Farblinie erscheint oder nicht)</p> <p>→ Ungültiges Ergebnis. In diesem Falle wiederholen Sie den Test mit einer neuen Testpackung.</p>
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Wichtig: Ein **negatives** Ergebnis allein schließt eine Infektion mit SARS-CoV-2 **nicht aus!** Beachten Sie weiterhin die geltenden Abstands- und Hygieneregeln, besonders bei Umgang mit Personen die durch Krankheit oder Alter ein erhöhtes Krankheitsrisiko haben. Sollten Sie Symptome einer SARS-CoV-2-Infektion aufweisen, sollten Sie einen Arzt bzw. eine Ärztin kontaktieren.

COREQ (CONsolidated criteria for REporting Qualitative research) Checklist

A checklist of items that should be included in reports of qualitative research. You must report the page number in your manuscript where you consider each of the items listed in this checklist. If you have not included this information, either revise your manuscript accordingly before submitting or note N/A.

Topic	Item No.	Guide Questions/Description	Reported on Page No.
Domain 1: Research team and reflexivity			
<i>Personal characteristics</i>			8
Interviewer/facilitator	1	Which author/s conducted the interview or focus group?	Title page
Credentials	2	What were the researcher's credentials? E.g. PhD, MD	Title page
Occupation	3	What was their occupation at the time of the study?	Title page, 8
Gender	4	Was the researcher male or female?	8
Experience and training	5	What experience or training did the researcher have?	
<i>Relationship with participants</i>			7-9, Figure 2
Relationship established	6	Was a relationship established prior to study commencement?	
Participant knowledge of the interviewer	7	What did the participants know about the researcher? e.g. personal goals, reasons for doing the research	8
Interviewer characteristics	8	What characteristics were reported about the interviewer/facilitator? e.g. Bias, assumptions, reasons and interests in the research topic	8
Domain 2: Study design			
<i>Theoretical framework</i>			
Methodological orientation and Theory	9	What methodological orientation was stated to underpin the study? e.g. grounded theory, discourse analysis, ethnography, phenomenology, content analysis	6, 8
<i>Participant selection</i>			
Sampling	10	How were participants selected? e.g. purposive, convenience, consecutive, snowball	Figure 3, 7-8
Method of approach	11	How were participants approached? e.g. face-to-face, telephone, mail, email	Figure 3, 7-8
Sample size	12	How many participants were in the study?	
Non-participation	13	How many people refused to participate or dropped out? Reasons?	Figure 3, 7-9
<i>Setting</i>			8
Setting of data collection	14	Where was the data collected? e.g. home, clinic, workplace	
Presence of non-participants	15	Was anyone else present besides the participants and researchers?	Figure 3, 8
Description of sample	16	What are the important characteristics of the sample? e.g. demographic data, date	8
<i>Data collection</i>			Figure 2, Figure 3
Interview guide	17	Were questions, prompts, guides provided by the authors? Was it pilot tested?	
Repeat interviews	18	Were repeat interviews carried out? If yes, how many?	7-8, suppl 3
Audio/visual recording	19	Did the research use audio or visual recording to collect the data?	
Field notes	20	Were field notes made during and/or after the interview or focus group?	N/A (Figure 3)
Duration	21	What was the duration of the interviews or focus group?	Figure 3
Data saturation	22	Was data saturation discussed?	Figure 3
Transcripts returned	23	Were transcripts returned to participants for comment and/or	8
			8
			N/A

Topic	Item No.	Guide Questions/Description	Reported on Page No.
		correction?	
Domain 3: analysis and findings			Figure 3, 8
<i>Data analysis</i>			
Number of data coders	24	How many data coders coded the data?	Figure 3, 8
Description of the coding tree	25	Did authors provide a description of the coding tree?	Figure 3, 8
Derivation of themes	26	Were themes identified in advance or derived from the data?	Figure 3, 8-9
Software	27	What software, if applicable, was used to manage the data?	
Participant checking	28	Did participants provide feedback on the findings?	
<i>Reporting</i>			Table 1, 11-15
Quotations presented	29	Were participant quotations presented to illustrate the themes/findings? Was each quotation identified? e.g. participant number	Table 1, 11-15
Data and findings consistent	30	Was there consistency between the data presented and the findings?	Table 1, 11-15
Clarity of major themes	31	Were major themes clearly presented in the findings?	Table 1, 11-15
Clarity of minor themes	32	Is there a description of diverse cases or discussion of minor themes?	

Developed from: Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. *International Journal for Quality in Health Care*. 2007. Volume 19, Number 6: pp. 349 – 357

Once you have completed this checklist, please save a copy and upload it as part of your submission. DO NOT include this checklist as part of the main manuscript document. It must be uploaded as a separate file.

Supplemental file 3: Interview guides

Experiences with opt-in, at-home screening for SARS-CoV-2 at a primary school in Germany: an implementation study

Supplemental file 3: Semi-structured interview guides

Study tools for parents and their children (version 1.0, 22.02.2021)

[Children will not be interviewed individually but only together with their parents]

Interview mit Eltern und ihren Kindern

Präambel: Guten Tag, ich bin Jonas Wachinger, wissenschaftlicher Mitarbeiter am Heidelberger Institut für Global Health und der Abteilung Infektiologie, Sektion Tropenmedizin, am Universitätsklinikum Heidelberg. Wie Sie ja bereits wissen führen wir an der Brunnenschule ein Pilotprojekt durch zum Potential von Antigen-basierten COVID-19 Schnelltests. Die Ergebnisse dieser Studie sollen dazu verwendet werden, klare Empfehlungen zur Verwendung von COVID-19 Schnelltests im Schulkontext zu entwickeln. Dafür möchten ich heute gerne ein Interview mit Ihnen (und eventuell Ihrem Kind) durchführen.

Alle Informationen, die Sie mit mir teilen, sind vertraulich und werden nur im Rahmen dieser Studie in pseudonymisierter Form ausgewertet. Ein Rückschluss von den Daten auf Sie als Person wird nicht möglich sein. Es gibt keine richtigen oder falschen Antworten, ich bin an Ihrer persönlichen Meinung und Ihren Erfahrungen interessiert. Dieses Interview wird etwa eine Stunde dauern.

(Das Formular für die informierte Einwilligung wird vorgelesen und von dem/der Teilnehmer:in unterschrieben. Im Anschluss wird das Aufnahmegerät eingeschaltet).

Teil 1: Vorgegangene COVID-19 Testerfahrungen

1. Was waren Ihre bisherigen Erfahrungen mit COVID-19 und den damit verbundenen Schulschließungen?
 - a. Wie hat COVID-19 konkret den Unterricht an der Brunnenschule bisher beeinflusst?
2. Wurden Sie oder eine ihnen nahestehende Person bereits zu einem früheren Zeitpunkt auf COVID-19 getestet? Was waren die Erfahrungen damit?

Supplemental file 3: Interview guides

3. Was ist Ihre Meinung zu der Art und Weise, wie im Moment in Deutschland auf COVID-19 getestet wird?
 - a. Haben Sie schon von sogenannten Antigen-Schnelltests gehört? Wenn ja, was?
 - b. Was halten Sie von den Überlegungen, an Schulen in Deutschland zusätzlich zu den bestehenden Hygienemaßnahmen auch ein Screeningverfahren auf COVID-19 einzuführen?

Teil 2: Erfahrungen mit Screening

1. Sie haben sich freiwillige dazu entschieden, an dem im Rahmen dieser Studie durchgeführten Screeningprojekt teilzunehmen. Was waren dafür die zentralen Gründe?
2. Haben Sie bereits mit Ihrem/n Kind/ern den im Rahmen des Projektes an der Brunenschule verteilten Schnelltest auf COVID-durchgeführt?
 - a. Wenn ja, wann/wie oft? Wenn nein, warum nicht?
3. Können Sie einmal die übliche Testsituation beschreiben?
 - a. Wann führen Sie die Tests durch? Wie entscheiden Sie sich für diesen Zeitpunkt?
 - b. Welche Vorbereitungen treffen Sie?
 - c. Welche Schritte führen Sie bei der Testung durch?
 - d. Was machen Sie, nachdem das Ergebnis angezeigt wird?
4. Was sind Ihre Erfahrungen mit den Tests?
 - a. [Falls das Kind mit an den Interviews teilnimmt: Wie findest Du/Sie den Test?]
 - b. Gibt es Dinge, die besonders praktisch sind/besonders (un)angenehm?
5. Wie einfach/schwer ist die Durchführung der Tests?
 - a. Wie wurden Sie in der Durchführung der Tests unterwiesen?
 - b. War dieses Training ausreichend? Was würden Sie daran verbessern?
6. Hatten Sie schon einmal ein positives Testergebnis?
 - a. Haben Sie schon von positiven Ergebnissen gehört?
 - b. Was waren/wären die nächsten Schritte bei einem positiven Ergebnis?
7. Bei Studien wie dieser kommt es öfters vor, dass die Tests nicht ausschließlich für den eigentlichen Studienzweck, also hier die Testung der Kinder vor der Schule, verwendet werden. Welche Umstände könnten im Rahmen dieser

Supplemental file 3: Interview guides

Studie Ihrer Meinung nach dazu führen, dass die Tests anders, oder mit anderen Leuten, verwendet werden?

Teil 3: Einfluss des Screenings auf den (Schul-)Alltag

8. Wie hat sich durch das Screening Ihr Alltag verändert?
 - a. Haben negative Testergebnisse einen Einfluss auf Ihr Verhalten?
9. Welche Veränderungen berichtet Ihr Kind aus dem Schulalltag?
 - a. [Falls das Kind mit an den Interviews teilnimmt: Ist es jetzt anders an der Schule, seit es die Tests gibt? Redet Ihr in der Klasse über die Tests?]

Teil 4: Verbesserung und Ausweitung des Verfahrens

10. Gibt es bestimmte Dinge, die Sie an dem momentanen Vorgehen ändern oder verbessern würden?
 - a. Was macht dieses Screening besonders einfach/angemessen?
 - b. Was ist schwierig, wo sind Sie auf Schwierigkeiten gestoßen?
11. Glauben Sie, dass ein derartiges Screening auch auf andere Schulen/auf einen größeren Maßstab ausgeweitet werden könnte?
 - a. Was ist dabei besonders zu beachten?

Teil 5: Abschluss

12. Gibt es etwas, über das wir bisher noch nicht gesprochen haben? Etwas, das Sie gerne noch hinzufügen möchten?
13. Haben Sie Anmerkungen?

Herzlichen Dank für Ihre Zeit!

Supplemental file 3: Interview guides

Study tools for school staff and stakeholders (version 1.0, 22.02.2021)

Interview mit schulischen Entscheidungsträgern

Präambel: Guten Tag, ich bin Jonas Wachinger, wissenschaftlicher Mitarbeiter am Heidelberger Institut für Global Health und der Abteilung Infektiologie, Sektion Tropenmedizin, am Universitätsklinikum Heidelberg. Wie Sie ja bereits planen wir an der Brunnenschule ein Pilotprojekt zum Potential von Antigen-basierten COVID-19 Schnelltests. Die Ergebnisse dieser Studie sollen dazu verwendet werden, klare Empfehlungen zur Verwendung von COVID-19 Schnelltests im Schulkontext zu entwickeln. Um das Screening-Konzept möglichst genau an die Gegebenheiten an der Brunnenschule anpassen zu können möchte ich heute gerne ein Interview mit Ihnen durchführen.

Alle Informationen, die Sie mit mir teilen, sind vertraulich und werden nur im Rahmen dieser Studie in pseudonymisierter Form ausgewertet. Ein Rückschluss von den Daten auf Sie als Person wird nicht möglich sein. Es gibt keine richtigen oder falschen Antworten, ich bin an Ihrer persönlichen Meinung und Ihren Erfahrungen interessiert. Dieses Interview wird maximal eine Stunde dauern.

(Das Formular für die informierte Einwilligung wird vorgelesen und von dem/der Teilnehmer:in unterschrieben. Im Anschluss wird das Aufnahmegerät eingeschaltet).

Teil 1: Bisherige Erfahrungen mit COVID-19 an der Brunnenschule

1. Welche Erfahrungen haben Sie mit COVID-19 hier an der Brunnenschule gemacht?
2. Wie hat COVID-19 in den Zeiten, in denen an der Brunnenschule in den letzten 12 Monaten Präsenzunterricht stattgefunden hat, den Unterricht geprägt?

Teil 2: Empfehlungen zur Implementierung

3. Wie ja bereits beschrieben ist unser momentaner Ansatz, jedem Kind und jedem Mitarbeitenden der Brunnenschule pro Woche drei Schnelltests zur Verfügung zu stellen. Die Kinder führen die Schnelltests zu Hause zusammen mit Ihren Eltern durch. Sollte das Testergebnis positiv sein, sollen die Familien die Schule informieren und die Kinder zu Hause behalten. Außerdem soll das Gesundheitsamt informiert werden, um die folgenden Schritte zu besprechen.
 - a. Was halten Sie von diesem Ansatz?
 - b. Halten Sie diesen Ansatz für realistisch?

Supplemental file 3: Interview guides

- c. Was wäre noch wichtig, zu beachten?
 - d. Was könnten zentrale Hürden sein?
 - e. Wie könnten wir dieses Konzept weiter verbessern/an die Situation an der Brunnenschule anpassen?
 - f. Was wären zentrale Personen, mit denen wir noch im Vorfeld sprechen könnten/sollten?
4. Welche Rolle können derartige Teststrategien Ihrer Meinung nach Deutschlandweit spielen?
 - a. Ist eine Skalierung solcher Teststrategien realistisch?
 - b. Welche Rahmenbedingungen müssten dafür gegeben sein?

Teil 3: Abschluss

1. Gibt es etwas, über das wir bisher noch nicht gesprochen haben? Etwas, das Sie gerne noch hinzufügen möchten?
2. Haben Sie Anmerkungen?

Herzlichen Dank für Ihre Zeit!

Supplemental file 3: Interview guides

Interview mit Mitarbeitenden der Schule

Präambel: Guten Tag, ich bin Jonas Wachinger, wissenschaftlicher Mitarbeiter am Heidelberger Institut für Global Health und der Abteilung Infektiologie, Sektion Tropenmedizin, am Universitätsklinikum Heidelberg. Wie Sie ja bereits wissen führen wir an der Brunnenschule ein Pilotprojekt durch zum Potential von Antigen-basierten COVID-19 Schnelltests. Die Ergebnisse dieser Studie sollen dazu verwendet werden, klare Empfehlungen zur Verwendung von COVID-19 Schnelltests im Schulkontext zu entwickeln. Dafür möchte ich heute gerne ein Interview mit Ihnen durchführen.

Alle Informationen, die Sie mit mir teilen, sind vertraulich und werden nur im Rahmen dieser Studie in pseudonymisierter Form ausgewertet. Ein Rückschluss von den Daten auf Sie als Person wird nicht möglich sein. Es gibt keine richtigen oder falschen Antworten, ich bin an Ihrer persönlichen Meinung und Ihren Erfahrungen interessiert. Dieses Interview wird etwa eine Stunde dauern.

(Das Formular für die informierte Einwilligung wird vorgelesen und von dem/der Teilnehmer:in unterschrieben. Im Anschluss wird das Aufnahmegerät eingeschaltet).

Teil 1: Vorangegangene COVID-19 Testerfahrungen

1. Was waren Ihre bisherigen Erfahrungen mit COVID-19 und den damit verbundenen Schulschließungen?
 - a. Wie hat COVID-19 konkret den Unterricht an der Brunnenschule bisher beeinflusst?
2. Wurden Sie oder eine ihnen nahestehende Person bereits zu einem früheren Zeitpunkt auf COVID-19 getestet? Was waren die Erfahrungen damit?
3. Was ist Ihre Meinung zu der Art und Weise, wie im Moment in Deutschland auf COVID-19 getestet wird?
 - a. Haben Sie schon von sogenannten Antigen-Schnelltests gehört? Wenn ja, was?
 - b. Was halten Sie von den Überlegungen, an Schulen in Deutschland zusätzlich zu den bestehenden Hygienemaßnahmen auch ein Screeningverfahren auf COVID-19 einzuführen?

Teil 2: Erfahrungen mit Screening

Supplemental file 3: Interview guides

4. Sie haben sich freiwillige dazu entschieden, an dem im Rahmen dieser Studie durchgeführten Screeningprojekt teilzunehmen. Was waren dafür die zentralen Gründe?
5. Haben Sie bereits einen der im Rahmen des Projektes an der Brunnenschule verteilten Schnelltests auf COVID-19 durchgeführt?
 - a. Wenn ja, wann/wie oft? Wenn nein, warum nicht?
6. Können Sie einmal die übliche Testsituation beschreiben?
 - a. Wann führen Sie die Tests durch? Wie entscheiden Sie sich für diesen Zeitpunkt?
 - b. Welche Vorbereitungen treffen Sie?
 - c. Welche Schritte führen Sie bei der Testung durch?
 - d. Was machen Sie, nachdem das Ergebnis angezeigt wird?
7. Was sind Ihre Erfahrungen mit den Tests?
 - a. Gibt es Dinge, die besonders praktisch sind/besonders (un)angenehm?
8. Wie einfach/schwer ist die Durchführung der Tests?
 - a. Wie wurden Sie in der Durchführung der Tests unterwiesen?
 - b. War dieses Training ausreichend? Was würden Sie daran verbessern?
9. Hatten Sie schon einmal ein positives Testergebnis?
 - a. Haben Sie schon von positiven Ergebnissen gehört?
 - b. Was waren/wären die nächsten Schritte bei einem positiven Ergebnis?
10. Bei Studien wie dieser kommt es öfters vor, dass die Tests nicht ausschließlich für den eigentlichen Studienzweck verwendet werden. Welche Umstände könnten im Rahmen dieser Studie Ihrer Meinung nach dazu führen, dass die Tests anders, oder mit anderen Leuten, verwendet werden?
 - a. Haben Sie schon von entsprechenden Ereignissen gehört?

Teil 3: Einfluss des Screenings auf den (Schul-)Alltag

11. Welchen Einfluss hat das Screening (und negative Testergebnisse) auf Ihr Verhalten und Ihren Alltag?
12. Wie hat sich durch das Screening Ihr Alltag an der Schule verändert?
 - a. Gibt es Veränderungen darin, wie Sie mit den Kindern interagieren/arbeiten?
 - b. Wie reagieren die Kinder auf die Tests?

Supplemental file 3: Interview guides

13. Gab es in einer Ihrer Klassen bereits den Fall, dass ein Kind wegen eines positiven COVID-Testes nicht zum Unterricht gekommen ist?
- Falls ja, könnten Sie diese Situation kurz beschreiben?
 - Wie haben Sie darauf reagiert? Wie haben die Kinder reagiert?

Teil 4: Verbesserung und Ausweitung des Verfahrens

14. Gibt es bestimmte Dinge, die Sie an dem momentanen Vorgehen ändern oder verbessern würden?
- Was macht dieses Screening besonders einfach/angemessen?
 - Was ist schwierig, wo sind Sie auf Schwierigkeiten gestoßen?
15. Glauben Sie, dass ein derartiges Screening auch auf andere Schulen/auf einen größeren Maßstab ausgeweitet werden könnte?
- Was ist dabei besonders zu beachten?

Teil 5: Abschluss

16. Gibt es etwas, über das wir bisher noch nicht gesprochen haben? Etwas, das Sie gerne noch hinzufügen möchten?
17. Haben Sie Anmerkungen?

Herzlichen Dank für Ihre Zeit!