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# Saliva testing among teachers during the COVID-19 pandemic: Effects on health concerns, well-being, and precautionary behavior

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ABSTRACT

*Rationale:* At the start of 2021, several SARS-CoV-2 cluster outbreaks in schools threatened in-person education and created a fairly chaotic and frightening environment for school personnel. To keep the schools open while preventing COVID-19 outbreaks, intensive diagnostic testing in teachers and school personnel was strongly recommended but missing at the time.

*Objectives:* A project was launched in Belgian schools to weekly analyze the morning saliva of school personnel using PCR-testing to detect and prevent COVID-19 positive cases. In this quasi-experimental study, we aimed to examine whether the implementation of this saliva testing project impacted school personnel's pandemic-related health concerns, well-being, and adherence to the health-protective measures, contrasting experimental with control schools.

*Methods:* The data were collected during the third wave (Alpha-wave, February–March 2021) of the pandemic. The sample consisted of 435 participants from 34 different schools across Flanders (Belgium) (78.8% female; *M* age = 43.87 years, range = 21–67) of which 82% participated in the weekly saliva tests (i.e., experimental group) and 18% took part in the control group.

*Results:* Results from a series of linear mixed regression models showed that saliva testing buffered against an increase in health concerns among tested school personnel but did not affect participants' general well-being. Slight declines in adherence to the health-protective behaviors were observed, yet this was only the case for participants who felt less supported by their school principal. High degrees of principals' support also fostered the sharpest decreases in school staff's pandemic-related health concerns.

*Conclusions:* When keeping the schools open in unstable pandemic times, weekly saliva testing is a promising strategy to prevent cluster outbreaks while simultaneously safeguarding health concerns among school personnel. School principals appear to play a critical role in the implementation of saliva testing to secure positive effects.

## 1. Introduction

Since January 2020, when the WHO declared COVID-19 to be a global healthcare emergency, countries across the world have witnessed its devasting consequences. In response to this, similar to nearly every other country worldwide (UNESCO, 2021; Viner et al., 2020), Belgian schools temporarily closed in March 2020 as a means to mitigate the spread of the novel coronavirus. Although a debate about the real effect of school closures in combating the virus is still ongoing (Walsh et al., 2021), negative consequences on children's health, well-being, and education are undebatable (Bekkering et al., 2021), including learning loss (Engzell et al., 2021), deteriorating physical and mental health (e.g., anxiety, loneliness; Chaabane et al., 2021), and more unreported cases of child abuse (Marmor et al., 2021). As such, keeping the schools open and maximizing in-person learning became one of the main priorities of governments and health policymakers worldwide (WHO, 2021).

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Nonetheless, as several outbreaks in Belgian primary and secondary schools were recorded during the winter of 2020–2021 (Sciensano, 2021a), the decision to (re)open schools despite the unstable pandemic situation had to be accompanied by effective risk mitigation measures (Bonell et al., 2020). At that time, in the absence of a widespread vaccination campaign and rapid antigen tests (i.e., self-tests), creative solutions to reinstall or preserve face-to-face education to meet the psychological and educational needs of students, while guaranteeing physical safety and health, were much needed.

In line with the WHO recommendation of extensive testing to break the transition chain, in March 2021, a three-week project was launched in which the self-collected morning saliva of teachers and school staff was weekly analyzed using PCR-testing to rapidly detect cases to prevent outbreaks of COVID-19 in Belgian secondary schools. In an interdisciplinary collaboration, the current study aimed to investigate the impact of participation in this saliva project on the health concerns, well-being, and precautionary behavior of teachers and school staff in Belgian secondary schools.

### 1.1. Saliva testing: diagnostic opportunities

Rapid diagnosis and isolation of individuals with a positive status of SARS-CoV-2 infection are considered important elements in the prevention of outbreaks in crowded places, such as schools (Sapkota et al., 2020). Yet, to implement an effective testing strategy in schools, some issues and challenges need to be addressed (Asgary et al., 2021). Typically, the diagnosis of COVID-19 is confirmed by the identification of SARS-CoV-2 RNA in biological samples, usually nasopharyngeal swabs, using real-time reverse polymerase chain reaction testing (i.e., PCR-testing; Wiersinga et al., 2020). Although nasopharyngeal swabbing is the standard procedure for collecting specimens (Atieh et al., 2021), it holds several risks, such as patient discomfort (e.g., sneezing, coughing, or bleeding) and potential risks for disease transmission to healthcare personal during sample collection (Bajaj et al., 2020; Sapkota et al., 2020). Moreover, nasopharyngeal swabbing is less suitable for large-scale testing, such as in schools, as it may add more pressure to local public health capacities (Asgary et al., 2021).

Therefore, saliva, another biological fluid in which SARS-CoV-2 can be detected, is a promising alternative for diagnosis of infection and monitoring of COVID-19 in general (Atieh et al., 2021; Bajaj et al., 2020), and testing of children in particular (Azzi et al., 2021). Salivary detection of SARS-CoV-2 presents potential advantages as the collection does not require trained healthcare workers and self-collection can be done at home (Caulley et al., 2021). Recent meta-analyses concluded that saliva testing has adequate sensitivity and specificity to detect the coronavirus (Atieh et al., 2021; Czumbel et al., 2020; Warsi et al., 2021). Saliva testing is expected to be especially useful in settings where a large number of individuals require screening (Sri Santosh et al., 2020). Indeed, previous studies found that saliva testing was an effective and simple tool to detect asymptomatic cases, thus limiting SARS-CoV-2 transmission, in pupils and teachers in primary school (Carmagnola et al., 2021) and university students (Mendoza et al., 2021). As the first in Europe, the current project analyzes the self-collected morning saliva of Belgian secondary school teachers using PCR-testing. Secondary school teachers are considered a vulnerable group because they have to rotate between classrooms several times a day, and therefore hold an increased risk of getting infected and/or spreading the virus to multiple groups.

### 1.2. Potential psychological advantages of saliva testing

The drastic changes in the educational conditions during the pandemic have not only affected the education and well-being of children (Viner et al., 2021), the resilience and adaptability of teachers were repeatedly challenged as well (Santamaría et al., 2021). A recent meta-analysis points out that many teachers suffered from anxiety (17%), stress (30%), and depressive symptoms (19%) during the pandemic (Ozamiz-Etxebarria et al., 2021), which further seemed to fluctuate as a function of the stability and gravity of the pandemic situation (Allen et al., 2020; Lizana et al., 2021; UNESCO, 2020). Concerns among teachers were found to peak again with the reopening of the schools in the presence of ongoing numbers of viral infections (Allen et al., 2020; Wakui et al., 2021).

Research on the sources of mental strain in teachers during the COVID-19 pandemic indicated that fear of infection and fear of transmission to others, meaning concerns for safety and health for themselves, their families, and loved ones, weighed heavily on teachers (Nabe-Nielsen et al., 2020; Weinert et al., 2021). Pandemic-related health concerns are in part because infected children often only have mild symptomatology or are fully asymptomatic (Badal et al., 2021), which increases the likelihood of unintendedly infecting others. To illustrate the health concerns of teachers, Diliberti et al. (2021) showed that health risks associated with COVID-19, both for the teacher personally as well as for their loved ones, were ranked as the second-highest reason for leaving the profession during the pandemic. Interestingly, in the same study, half of the former teachers who voluntarily resigned due to (mainly) COVID-related reasons considered going back if vaccinations or regular rapid testing would become widely implemented.

Therefore, it seems likely that additional safety measures, such as regular large-scale testing of school personnel, may alleviate their health concerns and mental strain, while simultaneously enabling to keep schools open and safe (Sapkota et al., 2020). Indeed, a recent meta-analysis investigating barriers and facilitators for COVID-19 testing concluded that testing is generally perceived as helpful for managing anxiety and fear, and that negative test results are reassuring for participants (Bevan et al., 2021). To illustrate, in prior screening programs in university settings, the most important benefit of weekly testing, as reported by university students and staff, was the reduced fear of accidently infecting family, friends, and others (Blake et al., 2020; Wanat et al., 2021). Similar motives were found for voluntary signing up for an open-access community testing program in Liverpool (University of Liverpool, 2020).

### 1.3. Potential behavioral pitfalls of testing programs

Although, saliva testing may provide a relatively convenient, fast, and accurate diagnosis of the COVID-19 disease (Atieh et al., 2021), potential pitfalls when implementing testing strategies in schools should not be overlooked. One potential risk when receiving a negative test result is that it might create a false sense of security, thereby causing unintended adverse behavioral effects, such as less strict compliance with physical distancing, hand hygiene, and wearing face masks (Asgary et al., 2021; Trogen and Caplan, 2021). This would be unfortunate, as lower compliance with the measures might in this way cancel the benefits of school testing programs as such. Given that no testing method is 100% accurate, thus yielding false-negative results, and a single negative test does not guarantee long-term protection (Jamal et al., 2020), sustained adherence to hygienic measures continues to play a pivotal role in protecting the community and keeping the schools open and safe.

Such potential reduced compliance is in line with the *risk compensation hypothesis* (Hedlund, 2000). This hypothesis states that while adhering to governmental regulations (e.g., the obligation to wear seat belts) and safety features (e.g., airbags) that are designed to reduce injuries, danger, or risks, individuals might compensate for the gained sense of safety by engaging in other risky behavior (e.g., drive faster; Hedlund, 2000). In fact, at the beginning of the COVID-19 pandemic, concerns arose regarding a false feeling of protection associated with face mask policies, unintentionally causing lower adherence to physical distancing and hand hygiene measures (Martin et al., 2020). A similar concern is that the introduction of COVID-19 vaccines would result in more ignorance of the health-protective measures (Trogen and Caplan,

2021). Moreover, a recent review study concluded that, after a negative test result, individuals engaged in more risky behavior or were more inclined to attend social activities (Bevan et al., 2021). On the other hand, in our daily lives, not every safety law is overshadowed by compensating behavior. Also, the evidence for risk compensation during this pandemic in particular is still rather inconsistent (Liebst et al., 2021).

Therefore, an opposite yet equally likely mechanism to be triggered by regular COVID-19 testing is heightened *infection-related risk perception*, which denotes people's feelings about the risk to themselves or the general population of being infected, as well as the severity of the infection itself (Wise et al., 2020). Based on previous research in the domain of environment and health, higher levels of risk perception during the COVID-19 pandemic are expected to increase behavioral adherence to the health-protective measures (Cori et al., 2020). For instance, when the number of infections, hospitalizations, and death rates was high, people were more inclined to follow the hygienic measures conscientiously, which is likely explained by a heightened level of risk perception (Morbée et al., 2021; Waterschoot et al., unpublished results; Yang et al., 2020). Indeed, risk perception was an important driver for both the acceptance of health-protective measures implemented by the government, more precautionary behavior itself (Siegrist et al., 2021), and vaccination intentions and acceptance (Schmitz et al., 2022).

In sum, regularly engaging in saliva testing may help to preserve or even foster risk perception as it signals that the virus is still circulating, requiring protection for oneself and others. Thus, behavioral adaptation in terms of continued adherence to the sanitary measures may emerge also in the opposite direction as expected by the risk compensation theory, so that, if individuals interpret circumstances as more dangerous, they stay prudent and continue to engage in precautions (Hedlund, 2000).

### 1.4. Role of school principals: creating a supportive climate

In this study, the school principals were appointed as program managers of the saliva project. This involved that they directly received the necessary information about the objectives and desired course of the current saliva project from the program developers and, were responsible for communicating and encouraging this to the target population, meaning the teachers and school staff (Fleuren, 2004). As such, we can expect that school personnel's participation and commitment to the weekly saliva testing, and the extent to which desired outcomes are facilitated or hindered, will be a function of how the school principals manage and communicate the saliva project to its staff (Brug et al., 2017). One prominent factor that may vary across school principals and is expected to meaningfully impact school personnel's behavior and outcomes (Assor et al., 2009), is the extent to which the school principals are perceived successful in fostering a motivating or need-supportive school climate during the three weeks of the saliva testing project.

First, to encourage school personnel's participation, to have their saliva samples taken correctly, and to foster their continued commitment throughout the three weeks of the project, the school staff must be supported in their basic need for autonomy. If approached in an autonomy-supportive way, school staff would be convinced of the usefulness and added value of saliva testing such that they would voluntarily put effort into the project, resulting in higher benefits (Ryan and Deci, 2017; Vansteenkiste et al., 2018). When autonomy-supportive, school principals provide a meaningful rationale for saliva testing in schools, for instance by framing the project within the broader interest of keeping schools open and safe to preserve the well-being and learning progress of children. Autonomy-supportive principals also recognize potential resistance among teachers and respect the choice and rhythm of school personnel to participate in the project (Aelterman et al., 2019). Secondly, successful participation will most likely depend on the extent to which school personnel feels capable of conducting the saliva tests and meeting other requirements of participation. To support the school staff's basic need for competence, sufficient guidance and clarification by the school principals, are expected to build confidence and commitment to participation (Ryan and Deci, 2017; Vansteenkiste et al., 2018). More specifically, participants should get clear and sufficient information about what is expected, and their questions or concerns need to be properly addressed (Aelterman et al., 2019).

### 1.5. Present study

The present intervention study among Belgian school personnel examined the psychological benefits and pitfalls of engaging in large-scale saliva testing in schools. Although the health benefits of this project were deemed high (i.e., avoiding outbreaks), a complementary view on the psychological and behavioral impact of the program was considered critical to deriving more nuanced conclusions regarding its large-scale implementation across Flanders (Belgium). The following three hypotheses were tested. First, we expected that school personnel in the experimental (i.e., tested) group would report lowered health concerns for infection and improved well-being across the three-week period, involving weekly saliva testing, compared to the control group participants. Second, we examined whether the saliva testing would come with potential behavioral pitfalls: saliva testing may lead tested persons to be less adherent to the measures (false sense of security), but also raise risk perception and show continued adherence to the measures in the experimental group. Third, we predicted that school principals' level of need-support during the implementation of the saliva testing would come to amplify presumed benefits while buffering against potential pitfalls. Specifically, school personnel who perceive their principals as need-supportive would report more reduced health concerns, well-being, and – precautionary behavior compared to school personnel who perceives their principals as lower on need support.

## 2. Methods

### 2.1. Procedure

The concept of the project consisted of weekly testing of morning saliva via PCR from teachers and support staff in combination with a broader motivation campaign supported by the Minister of Education. The selection of experimental schools organically grew, as some schools were contacted personally by the department of education, while others volunteered to participate and some recruitment was done in cooperation with the local city authorities (schools in Antwerp). Furthermore, the control group consisted of schools that had spontaneously offered to participate within the course of the project but which, for logistical reasons, were no longer able to join for the actual saliva testing. The launch of this project was constructed so that the different stakeholders in the school would not see it as an extra burden, a sign of distrust, or a sign of lack of appreciation for the efforts they had made for many months.

The saliva project and the data-collection started at the end of February 2021 and ended at the end of March 2022 (see Supplementary Material for more info). At the start of the project, an educational online webinar was organized for all participants by the Minister of Education. During this online seminar, participants were informed of the broader goals of the project, but did not receive information on the study hypotheses. More specifically, the webinar consisted of two parts: 1) the how and why of saliva testing and procedures were explained and supported with short video illustrative video clips; 2) the broader motivational campaign that explained how school management can motivate and engage their staff to create an environment of connection and shared responsibility. Therefore, evidence-based motivational recommendations were presented to stimulate school principals to encourage their staff.

For the experimental group specifically, during the three weeks of

the project, participating school staff was instructed to take a saliva sample once a week in the morning, before brushing teeth, drinking, or eating, following a step-by-step guidance sheet. Afterward, participants were asked to register the unique code of their swabs online and to drop off the saliva sample at their schools before 10 a.m. Saliva swabs were then collected and analyzed using PCR-testing by the nearest lab, and results could be consulted online within 24 h. While participants with a positive result were instructed to adhere to the mandatory isolation rules, with a negative or undetected test results participants were instructed to keep in line with the health-protective measures. When test results were inconclusive, participants had to take another PCR test using preferentially a nasopharyngeal swab. At baseline and the week after the three consecutive weeks of saliva testing, all staff members in both the control and the experimental schools received an email inviting them to filled out online questionnaires on their precautionary behavior, health concerns, well-being, perceived support by the school principal, and perception of the project itself.

### 2.2. Sample

In total, 1056 participants filled out the questionnaire at the start of the saliva project, yet only 435 (41.2%) participated in both the pre- and the post measurement. As depicted in Table 1, the results of a multivariate analysis of variance (MANOVA) comparing the group that participated in the post-measurement ($n = 435$) and the group that did not ($n = 612$) show that those having participated in the post-measurement are older, have more years of job experience and have higher scores for health concerns, risk perception and adherence at baseline. To end up with a complete dataset, only participants who completed both assessments were included in the analyses ($N = 435$), of whom 357 (82%) participated in the saliva tests and 78 participants were in the control group. No participant had prior COVID-19 infection, and all worked at a Belgian school. The mean age of the sample was 43.87 years (range: 21–67) and the work experience of the school staff was 16.35 years on average. Of the total sample of school staff, 76.6% were teachers, 9.4% worked as supportive employees, 8.9% were principals, and 5.3% functioned as administrative or technical staff.

### 2.3. Materials

**Pandemic-related health concerns.** Using two items, participants were asked to report on their own health concerns over the past week ("During the past week in the corona crisis, I was worried about my health") and the health of significant others ("During the past week in the corona crisis, I was concerned about the health of my loved ones"). Both were answered on a five-point Likert scale from 1 ("Not at all agreed") to 5 ("Fully agreed") and correlated highly on both measurement occasions ($r_{pre} = .54$, $r_{post} = .53$, both $p < .001$).

**Risk perception.** Risk perception was measured in both participant groups at baseline and during the post-experimental assessment, using four items. Participants were first asked to indicate their perceived chances of getting infected with the coronavirus (from 1 = "very small" to 5 = "very high") and the perceived severity of potential contamination (from 1 = "not at all serious" to 5 = "very serious") for themselves as well as for the population in general. On both occasions, both items were multiplied and divided by 5, as done in previous COVID-19 research (Morbée et al., 2021). Both subscales of risk perception showed high correlations on both time occasions ($r_{pre} = .47$, $r_{post} = .42$, both $p < .001$).

**Adherence to the COVID-19 measures**. To assess school personnel's self-reported behavioral adherence during the three weeks of the saliva project, participants were asked to what extent they adhered to the four primary behavioral COVID-19 measurements (Morbée et al., 2021) over the past week, namely hand hygiene ("To wash your hands frequently"), physical distance ("To maintain physical distance from others"), wearing a face mask ("To wear a face mask"), and limitations in social contacts ("To limit social contacts to the allowed maximum"). Participants were asked to indicate their agreement on a five-point Likert scale from 1 ("I don't adhere to it at all") to 5 ("I totally adhere to it"). Both measurements showed acceptable internal consistencies ($\alpha_{pre} = .68$, $\alpha_{post} = .73$).

**Well-being**. Well-being over the past week was assessed broadly by creating a composite score, involving indicators of felt anxiety (4 items, e.g., "During the past week I felt tense"), vital energy (2 items, e.g., "During the past week I felt vivid") and life satisfaction (1 item, "During the past week I felt satisfied with my life"). These items were based on validated questionnaires for anxiety (Marteau and Bekker, 1992), vitality (Ryan and Frederick, 1997), and life satisfaction (Pavot and Diener, 1993). For all items, participants were asked to report how many times they had experienced these feelings in the previous week on a 4-point scale: 1 ("Rarely or never, less than one day") to 4 ("Mostly or continuously, five to seven days"). Subscales showed good internal consistencies on both occasions for anxiety ($\alpha_{pre} = .82$, $\alpha_{post} = .87$) and vitality ($r_{pre} = .47$, $r_{post} = .51$, both $p < .001$). After reversing anxiety items, the scale combining all items showed good internal consistencies on both the pre- ($\alpha = 0.87$) and post-experimental assessment ($\alpha = 0.91$).

**School principal** support. Participants' perceived support from the school principal or the project manager with regard to the (non) participation in the saliva project was assessed at the final measurement occasion in the experimental group using five items. These items tapped into general support ("The school principal supports this project"), answering questions ("The school principal/project manager knew how to answer my questions and concerns about this project very well"), giving a good explanation ("The school principal/project manager gave a good explanation on why this project is meaningful"), respecting participation decision ("The school principal/project manager respected my decision to (not) participate in this project") and providing sufficient information ("The school principal/project manager provided the necessary information so that I know what to do"). All questions were answered on a five-point Likert scale, ranging from 1 ("Not at all agreed") to 5 ("Fully agreed"). Cronbach's alpha showed good reliability (5 items, $\alpha_{post} = .83$).

**Table 1**
Results of MANOVA comparing participation complete versus incomplete participation.

| Variables | Incomplete | Complete | *F*-value | *p*-value | | Partial $\eta^2$ |
|---|---|---|---|---|---|---|
| Age | 42.12 | 43.87 | 9.79 | 0 | *** | 0.01 |
| Years of experience | 14.46 | 16.47 | 11.89 | 0 | *** | 0.01 |
| Concerns | 3.46 | 3.58 | 6.57 | 0.01 | ** | 0 |
| Risk perception | 2.13 | 2.24 | 9.33 | 0 | *** | 0.01 |
| Adherence | 4.33 | 4.43 | 14.82 | 0 | *** | 0.01 |
| Well-being | 1.96 | 1.98 | 0.45 | 0.5 | | 0 |
| Wilks Lambda = 0.98, $F(6, 1442) = 4.975$, $p = 0$ | | | | | | |

*Note.* *$p < .05$, **$p < .01$, ***$p < .001$.

## 3. Results

### 3.1. Preliminary analyses

***Randomization.*** Randomization across conditions was successful in terms of the socio-demographic variables age ($t(431) = -0.22$, $p = .83$), work experience ($t(430) = -0.66$, $p = .51$) and biological sex ($\chi^2(1) = 1.335$, $p = .25$). The groups did not differ in terms of COVID-19 exposure. In the baseline measurement, respectively 0% and 0.6% of the control group and the experimental group confirmed a previous school closure. The prevalence of pupils in their school that had to stay home due to a COVID outbreak in the classroom was very similar as well (67.7% in the control group and 67.0% in the experimental group). Also,

the experimental and control conditions did not differ in terms of baseline measurement variables of interest, showing a non-significant MANOVA (Wilks Lambda = 0.996, $F(6, 425) = 0.262$, $p = .95$, see Table 2).

***Sociodemographics.*** No multivariate effect was found for biological sex in terms of the study variables (Wilks Lambda = 0.961, $F(11, 323) = 1.189$, $p = .29$). For the continuous variables age and work experience, Pearson correlation analyses showed that with increasing age participants reported a higher risk perception and higher adherence in the post-experimental assessment (Table 3). Participants with more years of work experience reported higher risk perception and adherence across both measurement occasions, and higher concerns at the post-experimental assessment.

***Correlation Analyses.*** Table 3 shows the Pearson correlations for both the experimental group and the control group, with exception of the values for school support as this construct was only assessed in the experimental group. Within and between time occasions, Pearson correlation analyses showed that levels of health concerns were related to higher risk perception, more adherence, and lower well-being. In line, participants reporting higher levels of risk perception also reported more adherence to the health-protective measures and lower well-being. Well-being is not related to the level of adherence. As an exception, levels of health concerns at pre-measurement were not significantly related to levels of adherence at post-experimental assessment. Also, study variables showed high autocorrelations between both time occasions. Finally, the more participants in the experimental group perceived support from their school principal, the more they adhered to the measures.

### 3.2. Primary analyses

To test our first and second hypotheses, we examined to what extent the group participating in the saliva tests differed from the control group in terms of the study variables (i.e., concerns, risk perception, adherence, well-being) across time. To do so, a series of linear mixed regression models was conducted, a repeated measure procedure involving a regression model that includes both fixed (i.e., intercept, slopes) and random effects (i.e., variances of the intercepts and slopes across individuals; Diggle et al., 2002). Each model included the covariates (i.e., age, sex, and work experience), the main effects for time and group and their interaction (dummy coded with the experimental group as reference level), and subject numbers as random effect. All models were checked for diagnostics (i.e., normality of residuals, heterogeneity), multicollinearity was checked by calculating the Variance Inflation Factors (VIF; indicates multicollinearity when VIF >4), all continuous predictors were centered, and effect sized (by partial eta-squared) were measured for each of the predictors. Although participants were nested within schools, this third-level (i.e., school-level) was not included in the analyses because the proportion of variance due to between-school differences was negligible (0–0.4% for all outcome variables). Consequently, a comparison between two-level models (i.e., measures within persons) versus three-level models (i.e., measures within persons within schools) did not yield a significant difference. More information can be consulted in the supplementary material file.

**Table 2**
Means (Standard Deviations) and univariate analyses with group in prediction of study variables.

| Variables | Group | | *F*-value | *p*-value | Partial $\eta^2$ |
|---|---|---|---|---|---|
| | Experimental | Control | | | |
| **Baseline measure** | | | | | |
| Concerns | 3.59 (0.86) | 3.51 (0.87) | 0.93 | .34 | .00 |
| Risk perception | 2.28 (0.59) | 2.27 (0.73) | 0.00 | .98 | .00 |
| Adherence | 4.47 (0.44) | 4.49 (0.44) | 0.16 | .69 | .00 |
| Well-being | 3.06 (0.62) | 3.08 (0.55) | 0.40 | .53 | .00 |
| **Post-experimental assessment** | | | | | |
| Concerns | 3.48 (0.87) | 3.74 (0.94) | 5.05 | .02 * | .01 |
| Risk perception | 2.59 (0.72) | 2.54 (0.61) | 0.28 | .60 | .00 |
| Adherence | 4.38 (0.53) | 4.50 (0.40) | 4.16 | .04 * | .01 |
| Well-being | 3.01 (0.67) | 2.93 (0.66) | 0.44 | .51 | .00 |
| School support | 4.63 (0.60) | 5.00 (0.54) | 0.40 | .53 | .00 |

*Note.* *$p < .05$, **$p < .01$, ***$p < .001$.

Table 4 presents the output of the models with standardized regression coefficients and effect sizes. A main effect of time was found for health concerns, risk perception, and adherence, but not for well-being. Compared with the baseline assessment, participants reported higher risk perception, fewer health concerns, and less adherence in the post-experimental assessment. A main effect of group was also found for health concerns, indicating that pandemic-related health concerns were lower in the experimental group than in the control group. The effects for concerns were qualified by a significant interaction between time and group. As visualized in Fig. 1, the (standardized) simple regression slopes showed that participants in the control group reported more health concerns in the post-experimental assessment, while those in the experimental group reported fewer health concerns at the end of the project (in this figure, the y-axis was limited only to scores between 3 and 4 of the total 1–5 response scale for the sake of clarity). In addition, a marginally significant interaction effect between time and group was found for adherence, with the (standardized) simple regression slopes indicating participants in the experimental group displayed lowered adherence, while the control group appeared to be more stable (see Fig. 2). Overall, effect sized were small for these effects.

In order to test our third hypothesis, we only used those participating in the saliva tests as we wanted to examine to what extent the need-supportive climate as provided by the school principal qualified differences in study variables across time. Also, 30 participants who reported to be principals themselves were removed from these analyses to avoid bias. On this subsample, a set of linear mixed regression models were performed with all models being checked for diagnostics. Table 5 presents the output of these models, showing the main effects of time on health concerns, and adherence, which has the largest effect sizes. First, the negative association between time and health concerns was found to be qualified by the school principal's need-support such that only those participants perceiving their school principal as being less supportive of their need for autonomy and competence (−1 *SD*) did not display a significant decrease in health concerns across time, as opposed to the sharp decreases in health concerns among the highly supported participants (+1 *SD*; see Fig. 3). Second, the results indicate that those participants perceiving average or low levels of support showed reduced adherence to the health-protective measures from the baseline to the post-experimental assessment (see Fig. 4). When school principal support was perceived high, it functioned as a buffer to the general decreasing levels of adherence, such that the evolution across time was similar to the control group (purple dashed line; here again, the y-axis was limited to scores between 4 and 5 of the total 1–5 response scale for the sake of clarity).

## 4. Discussion

Although keeping the schools open was considered a worldwide priority to counteract a potential learning loss as well as a deterioration in the physical and mental health of students during the COVID-19 crisis (WHO, 2021), for many teachers, returning to face-to-face education in the middle of an ongoing pandemic led to a resurgence of worries and anxiety (Allen et al., 2020; Wakui et al., 2021). Therefore, the current

**Table 3**
Descriptive statistics and Pearson correlations between study variables.

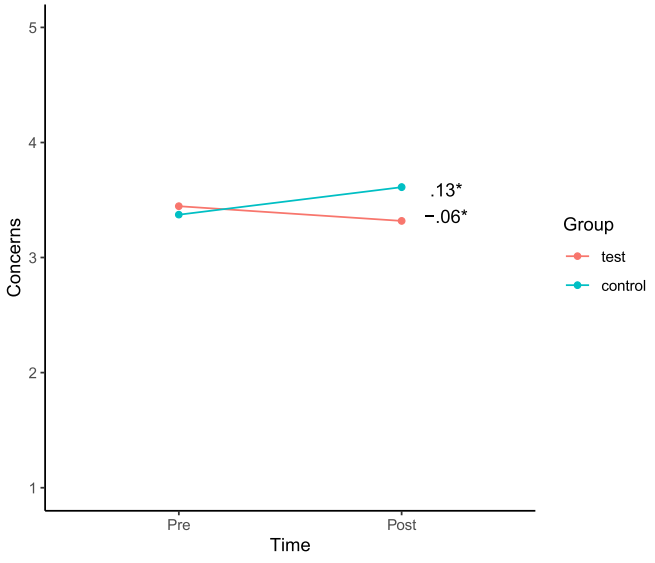
| Variable | 1. | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1. Age | | | | | | | | | | |
| 2. Work experience | .66*** | | | | | | | | | |
| **Pre** | | | | | | | | | | |
| 3. Health concerns | −.05 | .08 | | | | | | | | |
| 4. Risk perception | .09 | .15*** | .42*** | | | | | | | |
| 5. Adherence | .12* | .11* | .14*** | .24*** | | | | | | |
| 6. Well-being | .03 | −.07 | −.42*** | −.22*** | .04 | | | | | |
| **Post** | | | | | | | | | | |
| 7. Concerns | .06 | .15*** | .55*** | .40*** | .19*** | −.36*** | | | | |
| 8. Risk perception | .20*** | .20*** | .38*** | .64*** | .31*** | −.22*** | .43*** | | | |
| 9. Adherence | .15*** | .11* | .10 | .22*** | .61*** | −.02 | .19*** | .27*** | | |
| 10. Well-being | .05 | −.08 | −.35*** | −.21*** | −.08 | .71*** | −.49*** | −.21*** | −.09 | |
| 11. School support[+] | .03 | −.02 | .05 | .06 | .13*** | .11 | −.05 | .08 | .35*** | .09 |

*Note.* *$p < .05$, **$p < .01$, ***$p < .001$; [+]School support was only assessed in the experimental group.

**Table 4**
Output of linear mixed regression models with group and time in prediction of study variables.

| | Concerns | Risk perception | Adherence | Well-being |
|---|---|---|---|---|
| **Fixed effects** | | | | |
| Age | −.12 (.00) * | .07 (.00) | .11 (.01) * | .15 (.01) * |
| Sex [female] | .09 (.01) * | .10 (.01) * | .07 (.00) | −.06 (.00) |
| Work experience | .20 (.01) *** | .13 (.01) * | .04 (.00) | −.17 (.01) ** |
| Time | −.06 (.00) * | .23 (.02) *** | −.09 (.02) *** | −.04 (.00) |
| Group [control] | −.18 (.01) * | .01 (.00) | −.06 (.00) | .07 (.00) |
| Time x Group [control] | .23 (.03) *** | −.03 (.00) | .13 (.01) + | −.09 (.00) |
| **Random Effects** | | | | |
| ICC | .54 | .62 | .59 | .70 |
| Observations | 853 | 858 | 858 | 853 |
| Marginal $R^2$ | .04 | .09 | .03 | .03 |
| Conditional $R^2$ | .56 | .66 | .61 | .71 |

*Note.* +$p < .10$; *$p < .05$, **$p < .01$, ***$p < .001$; $N = 431_{ppnr}$; Coefficients are standardized with (partial eta squared). All VIF's were smaller than 1.03. ICC = Intra-Class Correlation, representing the percentage of between-subject variance.



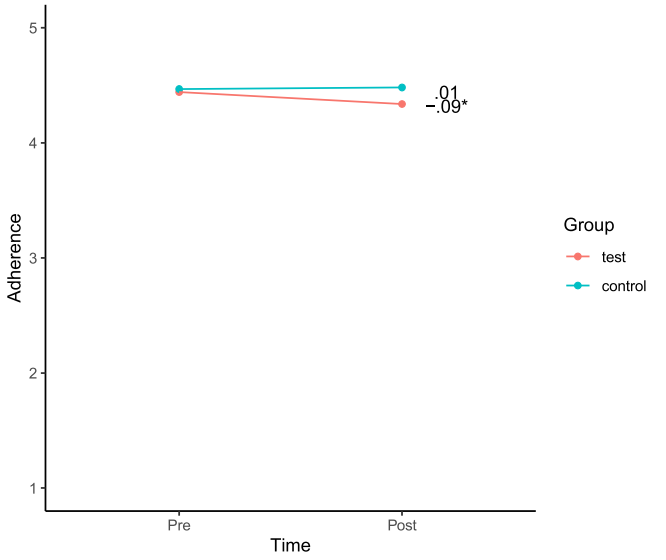

*Note.* * $p$ <.05; simple slope coefficients are standardized.

**Fig. 1.** Visualization of interaction effects between time and group on concerns. *Note.* *$p < .05$; simple slope coefficients are standardized.

quasi-experimental study explored whether weekly saliva tests using PCR to quickly detect coronavirus circulation in schools would alleviate teachers' health concerns, boost their well-being, and impact their precautionary behavior. The role of perceived support by the school principal in facilitating the successful implementation of the saliva project was tested as well. At the pandemic level, the saliva-testing project was promising, given that two "school outbreaks" could be prevented. Moreover, the findings of the current study allow moving beyond an exclusive medical view as the psychological and behavioral benefits and pitfalls of saliva testing were studied.

As many teachers felt unsafe and feared either getting infected themselves or contaminating others (Nabe-Nielsen et al., 2020 Weinert et al., 2021), our first aim was to investigate the role of weekly saliva testing in fostering a sense of security by alleviating teachers' health concerns and stabilizing their general well-being. In line with our expectations, although both groups demonstrated comparably high baseline levels of concerns, participants in the experimental group benefited from decreases in pandemic-related health concerns across time, as opposed to the control group where health concerns sharply intensified throughout the three weeks of the study. These findings are consistent with prior studies, where the reduced "fear of being infected" and "unknowingly infecting others" were identified as the most important assets of participating in a voluntary testing program (Blake et al., 2020; Wanat et al., 2021).

Given the paucity of research exploring other mental health outcomes of COVID-19 testing, in our study, we additionally explored the impact of weekly saliva testing on participants' general well-being. In contrast to our hypothesis, the beneficial effects of saliva testing in terms of reduced pandemic-related health concerns did not entail a further boost in well-being among the tested school staff. Some reasons might help to explain why no effect on well-being was found in this study. First, it may be that, although testing reduces pandemic-related health concerns, the testing itself may unintendedly impose other kinds of mental strain, such as stress whilst waiting for test results (Watson et al., 2022) or financial/emotional burden due to self-isolation should they get a positive test result (Bevan et al., 2021). Second, three consecutive weeks of weekly saliva testing might not be sufficient to capture changes in well-being. Perhaps, as it was stressed that a negative test result did not rule out future containment, receiving a negative test result only led to a momentary feeling of relief, but no real change in well-being. In addition to this, participants realized that the project was of short duration after which they would lose the opportunity for frequent testing. Third, the threatening situation in Belgium and precautionary measures (e.g., limited social contacts) at that time needs to be taken into account as




*Note.* * $p$ <.05; simple slope coefficients are standardized.

**Fig. 2.** Visualization of (marginally significant) interaction effects between time and group on adherence. *Note.* *$p$ < .05; simple slope coefficients are standardized.

**Table 5**
Output of linear mixed regression models with school support and time in prediction of study variables within the experimental group.

| | Concerns | Risk perception | Adherence | Well-being |
|---|---|---|---|---|
| **Fixed effects** | | | | |
| Age | −.01 (.00) | .13 (.01) | .11 (.00) * | −.12 (.01) |
| Sex [female] | .06 (.00) | .04 (.00) | .02 (.00) | .13 (.02) * |
| Experience | .09 (.00) | .07 (.00) | .02 (.00) | .14 (.02) * |
| Time | −.08 (.03) ** | .04 (.03) | −.14 (.10) *** | .04 (.01) |
| School support | .00 (.00) | −.02 (.00) | - .28 (.10) *** | −.02 (.00) |
| Time x School support | −.07 (.01) * | .04 (.00) | .09 (.03) *** | −.01 (.00) |
| **Random Effects** | | | | |
| ICC | 0.55 | 0.61 | 0.61 | 0.69 |
| Observations | 673 | 678 | 678 | 673 |
| Marginal $R^2$ | .04 | .08 | .07 | .05 |
| Conditional $R^2$ | .56 | .64 | .64 | .70 |

*Note.* *$p$ < .05, **$p$ < .01, ***$p$ < .001; $N = 340_{ppnr}$; Coefficients are standardized (with partial eta-squared). All VIF's were smaller than 1.01.

well (Sciensano, 2021b), which may have left little room for improvement in terms of well-being. As such, it might be that in crisis moments during the pandemic, being regularly tested has little impact on well-being. Finally, the observed attrition in the present study may help to explain the non-significant changes in well-being. This would have been the case if participants with initial higher well-being scores discontinued their participation. Yet, such a sampling bias did not occur as no baseline differences were found with regard to well-being between participants who dropped out of the study and those who completed the study.

Next, two opposing hypotheses with regard to the impact of weekly saliva testing on teachers' behavioral adherence to the health-protective measures were tested. In this study, a main effect of time was found for

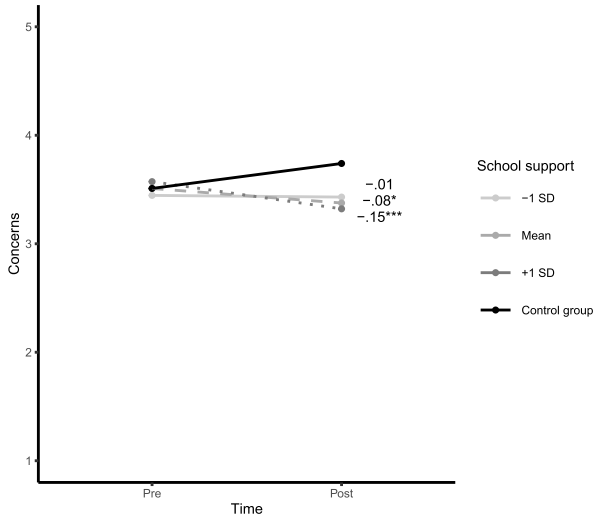



**Fig. 3.** Visualization of interaction effects between time and school support on concerns. *Note.* *$p$ < .05, **$p$ < .01, ***$p$ < .001; simple slope coefficients are standardized.

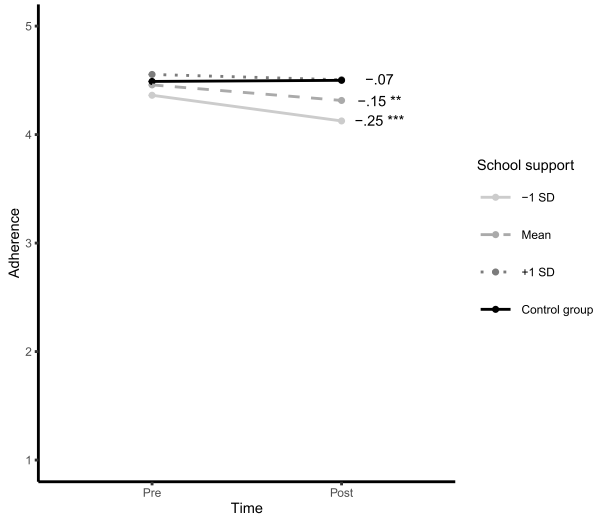



**Fig. 4.** Visualization of interaction effects between time and school support on adherence. *Note.* *$p$ < .05, **$p$ < .01, ***$p$ < .001; simple slope coefficients are standardized.

adherence, indicating general decreases in compliance with the health-protective measures across the three weeks of the testing program. The interaction results between time and group showed a trend in which declines were more pronounced in participants in the experimental group, while adherence in the control group was more stable over time. Thus, at first glance, our study seems to expose a behavioral pitfall of weekly saliva tests in schools, namely reduced engagement in regular hand washing, physical distancing, limiting social contacts, and wearing face masks, a finding that is in line with the risk compensation hypothesis (Hedlund, 2000) and findings from prior COVID-testing programs (Blake et al., 2020; Zhang et al., 2021). However, note that adherence among school staff in the current sample was already remarkably high at baseline and more pronounced compared to the group participants that dropped out throughout the study, which might indicate a ceiling effect. More importantly, even with small decreases across time in the experimental group (4.37), adherence was still above the population mean in Belgium at that time (3.95; www.

motivationbarometer.com, 2021), suggesting that true risk compensation may not have occurred. Still, given the dominance and contagious nature and the rapid circulation of the alpha variant (Sciensano, 2021a) even small drops in adherence in absolute terms could have far-reaching consequences for the further course of the crisis.

Further, follow-up analyses within the experimental group revealed that the decrease in behavioral compliance was only visible among participants who felt less supported by their school principal. On the contrary, when school principals were perceived as more supportive of school personnel's need for autonomy and competence, implying that they provide a meaningful rationale for saliva testing and sufficient guidance and clarification during the enrollment of the project (Aelterman et al., 2019), the adverse effect of testing in terms of reduced behavioral adherence was no longer present. In addition, when school personnel perceived their principal as high in need support, they also reported a sharper decline in health concerns, whereas with lower principal support no improvements in health concerns emerged. These findings are in line with prior research highlighting the importance of a supportive climate in voluntary testing programs (e.g., for HIV; Jamil et al., 2021), the role of supervisor support for health and well-being at work (Hämmig, 2017), and the value of school principal support for the implementation of school-based health programs (Webster et al., 2020). Because a need-supportive climate buffers against a decrease in compliance and comes with greater reductions in health concerns, it can be concluded that a supportive school climate is a crucial condition for a successful implementation of testing programs in schools.

Lastly, it appears that weekly saliva testing itself did not strengthen nor undermine risk perception, as both the experimental and control group simultaneously displayed sharp increases in infection-related risk perception across the course of the saliva project. The lack of significant differences comparing the exponential with the control group may be explained by the pandemic situation at the time, where infection rates, hospitalizations, and the number of people in intensive care in Belgium strongly increased (see supplementary material). Alternatively, the simple participation in the surveys in the control group may in itself have functioned as a signal that the pandemic is still ongoing. Finally, it is worth noting that self-selection may be at work as participants who reported higher risks at baseline were more likely to continue their participation in the study compared to those who dropped out.

### *4.1. Limitations and suggestions for future research*

In this study, three major limitations regarding the generalizability of the results need to be noted. First, the results of the current study should be considered within the context of the pandemic situation at the time the study took place. Given that during the saliva project (from March 1 to March 21) the rate of infections, hospitalizations, and individuals in need of intensive care substantially increased in Belgium (Sciensano, 2021b), the question is whether the effects would also have been observed in less threatening situations. In fact, the week after the saliva testing period, the Belgian government had announced a lockdown 'light' as well as one additional week of school closure (i.e., the so-called "Easter break") to prevent further virus circulation (see Supplementary Material).

Second, participation was completely voluntary, implying that schools and their staff could independently and noncommittally decide to participate in the current saliva testing program. Consequently, already at the outset of the study, the project was highly valued as evidenced by the high scores of participants attributed to the meaningfulness of the project. To illustrate, 95.8% of the sample agreed (45.5%) and totally agreed (50.3%) with the statement that the project is valuable, and 92.8% would (totally) recommend the project to other schools. Given the self-selective nature of the sample, the question can be raised whether the current findings can be readily transferred to other, less motivated populations that undergo mass screening. On the other hand, as the success rate of screening programs using saliva swabs hinges entirely on proper self-collection, rather than a limitation, committed participation could also be considered a prerequisite for the success of the program. Indeed, unmotivated participants may be less conscientious within this process of self-collection. Thus, implementing a saliva screening program must be based on well-considered choices.

A final limitation with regard to the representativeness of the sample is the fact that only 41.2% of the total sample completed the post measurement. As elaborated on in the description of the sample, those having participated in the post-measurement are older, have more years of experience and have higher scores for concerns, risk perception and adherence at baseline.

Next, some limitations with regard to the study design need to be taken into account as well. First, the study design cannot be considered as a true experiment because the selection of schools and the distribution of schools to one of the study conditions could not happen at random. Nevertheless, the control and experimental group did not differ in terms of socio-demographic variables and did not show any significant differences in the baseline measurements of our study variables, thus can be considered comparable. In line with this, there was a large imbalance between the control and the experimental group in terms of the number of participants. This could be worrying regarding biased estimates in the analyses. However, the smallest group still had a sufficient sample size and the use of mixed- effects has been shown to be well suited to unbalanced designs (e.g., Hesselmann, 2018).

Moreover, ideally, the study design would include mixed-methods as well. Future studies could add more qualitative measures, for example, teachers could be asked to testify about what they find helpful in the support of their principals, as this information would be valuable for a more profound understanding of the concept of social support, which could, in turn, be translated into more concrete advice and guidelines for policymakers.

Lastly, the study design is rather limited in terms of the test (weekly) and duration (3 weeks) and did not include a follow-up survey. Due to the large geographical separation of schools (drop-off points for the saliva samples) and the laboratories for PCR-testing making the logistics of the project challenging, it was considered impossible to increase the frequency of testing. Additionally, the participant burden needed to be taken into account, as schools' staff was already under a lot of pressure at that time of the pandemic. Nevertheless, we are convinced that the current study design was strong enough to capture real psychological and behavioral changes, as the testing- and vaccination strategies were much more limited at that time (e.g., rapid antigen tests or self-test were not available at that time). Future research could experiment with more frequent testing (e.g., twice a week) and preferably over a longer period of time to replicate the current findings.

## 5. Conclusions

Across many countries worldwide, keeping the schools open and safe became one of the main priorities of different governments. This noble objective proved difficult to maintain in the light of increased virus circulating in schools, as was the case in the winter of 2020–2021 (Sciensano, 2021a). The present quasi-experimental study indicates that weekly PCR tests on self-collected saliva of school staff is a promising intervention for preventing large cluster outbreaks. In addition, weekly saliva tests helped to simultaneously establish a sense of safety among school personnel by alleviating health concerns. Importantly, the benefits of such a large-scale saliva testing program did not emerge by definition as adequate support by school staff was found to be a prerequisite for its success. Specifically, only to the extent tested school personnel perceived the school principal as sufficiently supportive of their basic needs for autonomy and competence, school personnel reported a decrease in health-related concerns while not being vulnerable to reduced adherence to the health-protective measures. Investing in large-scale testing programs may be helpful to combat future pandemics or crises given that these programs are implemented in a motivating

way.

## CRediT author statement

**Marlies Van de Casteele**: Investigation, Writing – Original Draft –, Program Administration. **Waterschoot Joachim**: Investigation, Methodology, Software, Formal analysis, Writing – Review & Editing. **Anthierens Sibyl**: Writing – Review & Editing. **DeSmet Ann**: Writing – Review & Editing. **Galand Benoit**: Writing – Review & Editing. **Goossens Herman**: Conceptualization, Resources, Writing – Review & Editing. **Morbée Sofie**: Investigation, Writing – Review & Editing. **Vansteenkiste Maarten**: Conceptualization, Methodology, Writing – Review & Editing, Supervision.

## Data availability

The data that has been used is confidential.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.socscimed.2022.115295.

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