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ORIGINAL ARTICLE

Primary schools' readiness for SARS-CoV-2 preventive measures in Maputo City, Mozambique: a cross-sectional study

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Background: To reduce the spread and transmission of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), schools implemented a series of non-pharmacological interventions such as handwashing stations and cleaning protocols. A baseline assessment of the available interventions and readiness scores for SARS-CoV-2 prevention was conducted in primary schools in Maputo City, Mozambique.

Methods: A cross-sectional study was conducted between August and October 2023. Data were collected using a semi-structured questionnaire that assessed the availability of preventive measures. Readiness scores were calculated, based on the relative frequency of available preventive measures against SARS-CoV-2, recommended by the government. Schools with readiness scores of 100% were considered ready.

Results: Of the enrolled schools, 60.6% (66/109) were from the public sector. The median readiness score for preventive measures against SARS-CoV-2 implemented in schools was 70%. Water was the most frequent available measure, with 98.2% (107/109). Ash/soap for handwashing (47.7% [52/109]) and functioning thermometers (31.2% [34/109]) were the least available measures. Private schools showed significantly higher readiness scores compared with public schools ($p<0.001$).

Conclusions: Private compared with public schools had higher readiness scores for preventive measures against SARS-CoV-2 in Maputo City, Mozambique. These findings suggest a need for targeted interventions to improve readiness in public schools.

Keywords: Maputo City, Mozambique, primary schools, readiness, SARS-CoV-2.

Introduction

The emergence of the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in Wuhan City, Hubei Province, China, at the end of 2019, quickly escalated into a public health emergency of international concern in January 2020 and was declared a pandemic in March 2020.[1,2] SARS-CoV-2 infection can progress to coronavirus disease 2019 (COVID-19), characterized by symptoms such as fever, myalgia, dyspnoea, diarrhoea and cough.[3]

Full school closures were implemented as a non-pharmacological intervention to control the virus's spread.[4,5] Later, partial or full opening of schools was recommended after application of preventive measures to limit the spread of SARS-CoV-2,[6] as children, although they were susceptible to infection, when infected they were less likely to progress to disease,[7] thus, being asymptomatic, they could silently contribute to the emergence of moderate and severe COVID-19 cases in other population groups.[8]

Mozambique, a low-income country situated in the sub-Saharan African region, initiated a full closure of schools following the detection of the first COVID-19 case in March 2020,[5] lasting until March 2021[9] and then again in July 2021 in the main capital cities of the country, where an increased number of cases were recorded, including Maputo City.[10] A month later, in August 2021, in-class teaching was resumed for all schools that had implemented the government recommended measures to mitigate the spread of SARS-CoV-2.[11] Non-pharmacological interventions set at schools in Mozambique included availability of handwashing stations, ventilated classrooms, safe disposal of biological waste and the continued promotion of individual safety measures such as handwashing, cough etiquette and proper use of face masks.[12] Some of the preceding measures are also of interest for water, sanitation and hygiene (WASH) interventions, such as water availability, which can help reduce the burden of WASH-related diseases in school-age children.[13,14] However, the level of their implementation—readiness score—is yet to be determined, which can be used to identify schools with an increased potential risk of having an outbreak. The readiness score can also be used to determine the effectiveness of the implemented interventions in controlling outbreaks at schools. We conducted a baseline assessment of the availability and readiness scores for measures against SARS-CoV-2 in primary schools in Maputo City, which indicates the level of implementation of non-pharmacological interventions and its associated factors.

Methods

A cross-sectional study was conducted in Maputo City primary schools between August and October 2023. We estimated a minimum sample size of 126; assumptions used were a 50% chance of readiness score, a 95% confidence interval (CI), a 5% error margin and a population of 185 schools. Simple random sampling in R version 4.1.0 (R Foundation for Statistical Computing, Vienna, Austria) was used to select the schools, without replacement.

The school's legal representatives were interviewed and data were recorded in a paper-based semi-structured form. All collected data were double-entered and compared in Epi Info version 3.4.5 (Centers for Disease Control, Atlanta, GA, USA). Inconsistencies were resolved using the paper-based form. Independent variables included municipal area, whether the school was private or public, total number of classrooms in the school, total number of classrooms in use for teaching in the school, maximum number of students allowed per classroom, type of water commonly used by the school, waste segregation practices, waste disposal methods and prior reports of COVID-19 cases at school and in which group (students, teachers or supporting staff).

Preventive measures against SARS-CoV-2 collected at schools included the availability of water, stations or buckets for handwashing, ash or soap for handwashing, cleaned bathrooms, cleaned classrooms, available trash bins in the school yard, ventilation in classrooms (i.e. open windows and doors), visible signs encouraging preventive measures against SARS-CoV-2 (handwashing, mask use and cough etiquette) and the presence of functioning thermometers. All preventive measures were reported by interviewees, a school representative and were verified by the interviewer before completing the paper-based form.

The dependent variable, readiness score was standardized from 0% to 100%, based on the relative frequency of available preventive measures against SARS-CoV-2 at the school recommended by the government. The readiness score for each school resulted from equal-weighted items. Schools that had implemented all recommended preventive measures, this is, had a readiness score of 100%, were deemed ready.

Data analysis was performed using R version 4.4.0 (R Foundation for Statistical Computing). For qualitative variables, we summarized the results as both relative and absolute frequencies. Quantitative variables were summarized using median, first (Q1) and third (Q3) quartiles (IQR) and ranges to provide a comprehensive overview of the data distribution.

Cross-tabulations between qualitative variables and readiness scores were made. Of the surveyed schools, the percentage of schools classified as ready was estimated by the Wilson method to obtain 95% CIs. To compare median readiness scores for two (e.g. private or public schools) or more independent groups (e.g. municipal districts), the Mann–Whitney–Wilcoxon rank sum test and Kruskal–Wallis test were used, respectively.

If differences were found in medians using the Kruskal–Wallis test, the Dunn's test for multiple comparisons with Bonferroni correction was performed. Spearman's correlation coefficient was used for quantitative or ordinal variables. P-values $<5\%$ were considered statistically significant.

Results

Sample characteristics

Of the 185 primary schools in Maputo City, 126 were randomly selected, of which 109 schools were enrolled (86.5%). Of the 17 non-included schools in this analysis, 4 were geographically inaccessible, 5 were not located, 2 were closed, 5 changed from a primary to secondary teaching level and 1 school was excluded because it did not provide responses to all the readiness questions described in the methods.

Of the enrolled schools, 60.6% (66) were from the public sector. The maximum number of school-age children allowed per classroom ranged from 8 to 83, with a median of 44 (IQR 25–50) (Table 1).

At least one COVID-19 case in each school was reported in 45.9% (50/109) of the schools. COVID-19 cases in school-age children were reported in 22.0% (24/109) of the enrolled schools, while COVID-19 cases in teachers were reported in 39.4% (43/109) of the enrolled schools (Table 1).

Availability of preventive measures against SARS-CoV-2 and readiness score

Water was the most frequently available measure, reported by legal representatives of the schools, with 98.2% (107/109), followed by cleaned classrooms with 94.5% (103/109). The least common available measures were ash or soap for handwashing (47.7% [52/109]) and functioning thermometers (31.2% [34/109]) (Table 2). According to legal representatives, more than half of the included schools had non-operational thermometers (55.0% [60/109]) (Supplementary Table S1).

Table 1. Maputo City primary schools' characteristics

Characteristics	Values
Municipal district, % (n)	
KaMavota	22.0 (24)
KaMaxakeni	11.0 (12)
KaMpfumu	22.0 (24)
KaMubukwana	26.6 (29)
KaTembe	8.3 (9)
Nlhamankulu	10.1 (11)
Type of school, % (n)	
Private	39.4 (43)
Public	60.6 (66)
Number of classrooms in the school, median (IQR), minimum–maximum	10 (7–15), 3–33
Number of classrooms in use at school, median (IQR), minimum–maximum	10 (7–15), 2–30
Maximum number of school-age children allowed for classroom, median (IQR), minimum–maximum	44 (25–50), 8–83
Water source commonly used at school, % (n)	
Hole with electric pump	22.0 (24)
None	1.8 (2)
Others	3.7 (4)
Public piped water	72.5 (79)
Segregated trash, % (n)	
No	76.1 (83)
Yes	23.9 (26)
How is trash disposed?, % (n)	
Open burning	39.5 (43)
Other	6.4 (7)
Remove outside school	54.1 (59)
Any COVID-19 case at school?, % (n)	45.9 (50)
Any COVID-19 case in school-aged children?, % (n)	22.0 (24)
Any COVID-19 case in teachers?, % (n)	39.4 (43)
Any COVID-19 case in support staff?, % (n)	18.3 (20)

Table 2. Availability of preventive measures against SARS-CoV-2 and readiness score in Maputo City primary schools

Characteristics	Values
Available water, % (n)	98.2 (107)
Cleaned classrooms, % (n)	94.5 (103)
Trash bins at schools, % (n)	92.7 (101)
Ventilated classrooms, % (n)	89.0 (97)
Stations or buckets for handwashing, % (n)	88.1 (96)
Cleaned bathrooms, % (n)	75.2 (82)
Trash bins at classrooms, % (n)	58.7 (64)
Visible signs encouraging preventive measurements against SARS-CoV-2, % (n)	56.0 (61)
Ash or soap for washing hands, % (n)	47.7 (52)
Functional thermometer, % (n)	31.2 (34)
School's readiness, median (IQR), minimum–maximum	70 (60–90) 30–100

The readiness score for preventive measures against SARS-CoV-2 implemented in schools ranged from 30% to 100%, with a median of 70% (IQR 60–90) (Table 2). Of the surveyed schools, 13.8% (15/109) were classified as ready (95% CI 8.5 to 21.5).

Factors associated with readiness score

Readiness scores were higher in private schools than in public schools (median 90% versus 60%; $p<0.001$). Schools that segregated trash had a median readiness score of 80%, whereas schools that did not segregate trash had a median of 70% ($p=0.045$) (Table 3).

Schools that removed the trash outside the school had a median of 80%, while those practicing open burning or other methods had a median of 60% ($p<0.001$) (Table 3). Post hoc comparison indicated that the school's readiness score difference for how trash was disposed, was between the schools that removed the trash outside and the schools that practiced open burning ($p<0.001$).

Schools where non-COVID-19 cases were reported among teachers exhibited a higher readiness score compared with schools with documented cases among teachers (with median

Table 3. Factors associated with readiness scores for measures against SARS-CoV-2 in Maputo City primary schools

Characteristics	Values[a]	p-Value
Municipal district		NS[b]
KaMavota	70 (60–83)	
KaMaxakeni	75 (70–83)	
KaMpfumu	80 (70–90)	
KaMubukwana	70 (60–90)	
KaTembe	80 (60–90)	
Nlhamankulu	70 (55–75)	
Type of school		<0.001[c]
Private	90 (70–100)	
Public	60 (60–70)	
Water source commonly used at school		NS[b]
Hole with electric pump	80 (68–100)	
None	50 (45–55)	
Others	90 (78–93)	
Public piped water	70 (60–80)	
Segregated trash		0.045[c]
No	70 (60–85)	
Yes	80 (63–90)	
How is trash disposed?		<0.001[b]
Open burning	60 (60–70)	
Other	60 (55–75)	
Remove outside school	80 (70–90)	
Any COVID-19 case at school?		NS[c]
No	70 (60–90)	
Yes	70 (60–90)	
Any COVID-19 case in school-age children?		NS[c]
No	70 (60–90)	
Yes	70 (60–83)	
Any COVID-19 case in teachers?		0.018[c]
No	70 (70–90)	
Yes	60 (55–90)	
Any COVID-19 case in support staff?		NS[c]
No	70 (60–90)	
Yes	80 (60–90)	
Number of classrooms in the school	−0.258[d]	0.007[e]
Number of classrooms in use at school	−0.202[d]	0.035[e]
Maximum number of school-age children allowed for classroom	−0.516[d]	<0.001[e]

NS: not significant.
[a]School's readiness: median (IQR).
[b]Kruskal–Wallis test.
[c]Mann–Whitney–Wilcoxon rank sum test.
[d]Spearman's correlation coefficient.
[e]Spearman's correlation test.

readiness scores of 70% and 60%, respectively). Additionally, the readiness scores showed a negative association with the tota number of classrooms in the school (p=0.007), total number of classrooms in use at the school (p=0.035) and the maximum number of students permitted per classroom (p<0.001) (Table 3).

Discussion

The assessment of preventive measures against SARS-CoV-2 adhered to the guidelines set forth by Mozambique's government.[12] Our findings indicate that the majority of schools demonstrated a readiness level >50%. This contrasts with a study conducted in Ethiopia before the reopening of schools, which revealed that 50.2% of schools scored below half of the total items being evaluated, with none fully implementing all recommended preventive measures.[15] The differences between our study and the Ethiopian study may be attributed to the timing, as more resources might have been allocated to schools over time. Additionally, our study was conducted after four waves of the pandemic had been reported in the country,[16] with multiple variants of concern detected, which likely prompted improvements in preventive measures to curb the virus's spread within school settings.

The frequency of schools fully implementing all recommended measures in our study was lower compared with Bangladesh and India, where a higher proportion of schools managed to implement all recommended preventive measures.[17,18] These disparities can be partially attributed to the varying economic capacities of countries to ensure a consistent availability of SARS-CoV-2 preventive measures. This suggests that middle-income countries like India and Bangladesh might be more capable of implementing and maintaining preventive measures consistently compared with low-income countries like Mozambique.

In our findings, the least implemented measures in schools were the availability of soap or ash for handwashing and the presence of functional thermometers, both found in less than half of the schools. Similar results were reported in a study in Ethiopia, indicating limited availability of soap for handwashing in primary schools.[19] In Bangladesh, a study revealed that nearly half of the schools did not have thermometers to measure students temperatures.[18] These findings highlight the implications associated with handwashing without soap or ash, which may reduce the effectiveness in removing germs and respiratory viruses such as SARS-CoV-2, reducing the ability to interrupt spread of the virus.[20]

Readiness levels were observed to be higher in private schools compared with public schools, likely due to the continuous financial burden required to comply with health protocols for SARS-CoV-2 prevention. Reopening reports from African countries have indicated that financial constraints are a significant challenge for implementing these measures, particularly in public schools that rely on government funding.[21] Future research should explore the longitudinal impact of these measures on COVID-19 transmission in school settings.

Our analysis revealed that most schools did not practice waste segregation, increasing the risk of exposure to potentially infectious waste among school staff and raising the likelihood of outbreaks. A World Health Organization report highlights that the use of protective kits such as masks and gloves, driven by

COVID-19, has led to the production of a significant amount of trash, and recommends increased awareness on the need to manage waste safely for the health of individuals and for the preservation of the environment.[22]

Methods of trash disposal were associated with readiness scores for SARS-CoV-2 preventive measures in schools. Schools that disposed of trash outside their premises exhibited higher readiness scores compared with those practicing open burning within school grounds. This difference might be linked to greater awareness of sanitary and environmental practices, which could extend to the adoption of preventive measures against SARS-CoV-2. Government authorities recommend trash disposal in sanitary landfills, ensuring that trash is not dumped or burned in the open air, nor in locations that pose a risk to human health or the environment.[23] Open burning increases the environmental hazard as well the potential adverse health outcomes in schools infrastructures, students, staff and the surrounding communities.[24]

In our study, a higher number of positive COVID-19 cases were reported among teachers compared with students. This difference may result from access to SARS-CoV-2 testing determined by reported symptoms.[25] The low reporting of positive COVID-19 cases in students may be due to the lower notification of symptomatic cases in children compared with adults;[26] also, students may have been advised not to report illness to the school due to fear of stigma and in order to not miss classes, as they would be quarantined at home.

Schools that did not report cases of COVID-19 among teachers had higher readiness scores compared with schools that reported COVID-19 cases among teachers. We hypothesize that higher readiness scores for preventive measures against SARS-CoV-2 were influenced by the establishment of a robust culture promoting safe practices at schools, such as handwashing and ventilated and uncrowded classrooms.

In Mozambique, a low-income country, the student:teacher ratio in primary education is defined by government authorities as 61 students per teacher; however, in the study area, Maputo City, the observed ratio in 2023 was 46.8.[27] Our study observed a negative correlation between the readiness score and the number of classrooms in the school, the number of classrooms in use and the maximum number of students allowed in each classroom. Reducing the number of classrooms, limiting classroom use and restricting the number of students per classroom may alleviate pressure on school resources, facilitating the consistent implementation of hygiene measures and creating a more controlled environment for effective prevention.

Water was the most frequently available measure, followed by clean classrooms. This may be attributed to the efforts of authorities to expand the water supply as part of school preparations for the resumption of in-person classes in the context of COVID-19, aiming to enable the implementation of rigorous hygiene protocols such as regular cleaning of surfaces, common areas and handwashing.

The findings of this study should be considered in the context of some limitations. The minimum sample size for Maputo City was not achieved, which limits the generalizability of our findings to the whole city; however, we have included >50% of the available schools of the area of study. Furthermore, the evaluation method used in our study to determine the readiness score may not allow equitable comparison with studies from other regions. Also, the study was conducted after the country had passed through four waves. These limitations should be considered when interpreting the results.

Schools, where children interact closely, are prime locations for the transmission of respiratory and gastrointestinal illnesses.[28,29] Practices like frequent handwashing and utilizing hand sanitizers can substantially decrease the proliferation of respiratory and gastrointestinal pathogens. Furthermore, enhanced classroom air circulation can lower the concentration of airborne pathogens, helping to prevent the spread of diseases.[30]

Likewise, isolating individuals with symptoms and implementing contact tracing protocols, which were crucial during the COVID-19 pandemic,[31] are equally important for managing outbreaks of other contagious illnesses. By consistently implementing a combination of these non-pharmaceutical interventions, schools can continue to operate safely while safeguarding the health of students and staff from various infectious threats, reducing absenteeism and preventing larger outbreaks in the broader community.

In conclusion our study showed variability on the level of preventive measures against SARS-CoV-2 in primary schools in Maputo City, where private schools had higher scores compared with the public ones. The least frequent measures were the availability of a functional thermometer and ash/soap for handwashing. The number of classrooms and maximum number of students allowed per classroom were negatively correlated with the readiness score. Such findings should be considered by the health and education policymakers to control and prevent further disease outbreaks in school settings.

Supplementary data

Supplementary data are available at *International Health* online.

Authors' contributions: AFLB and RP drafted the first version of the manuscript and cleaned and analysed the data. AFLB, AC, AG, ND and OI designed the protocol and acquired the funding. RP, FC, EU, LA, FI and EM collected data. AFLB, RP and LG interpreted the data. All authors reviewed and approved the final manuscript.

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Competing interests: None declared.

Ethical approval: This study was approved by the Mozambique National Health Bioethics Committee (IRB00002657; reference number 71/CNBS/22). Written or verbal consent was waived as the study included

infrastructure data and de-identified aggregated data on COVID-19 cases at the evaluated schools. Administrative authorization was given by the minister of health and by the education authority.

Data availability: Data used for this analysis can be requested from the Instituto Nacional de Saúde, Mozambique, through the corresponding author. Researchers interested in secondary analysis must submit a research proposal for consideration by the study investigators as well as by the Directorate for Research in Health and Well-Being. Upon approval, the requestor must sign a data use agreement.

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