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The impact of Non-Pharmaceutical Interventions on anxiety disorders during the COVID-19 pandemic in Sub-Saharan Africa

Evidence from a cross-sectional study in four countries in 2021

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List of Acronyms

CI : confidence interval

DAG : Directed Acyclic Graph

GAD : Generalized Anxiety Disorder

GAD-7 : 7-item Generalized Anxiety Disorder

NPIs : Non-Pharmaceutical Interventions

OR : odds ratio

OxCGRT : Oxford Covid-19 Government Response Tracker

RERI : Relative Excess Risk due to Interaction

SI : Stringency Index

Abstract

Title: The impact of Non-Pharmaceutical Interventions on anxiety disorders during the COVID-19 pandemic in Sub-Saharan Africa: evidence from a cross-sectional study in four countries in 2021

Context: Non-Pharmaceutical Interventions (NPIs) have been implemented worldwide to limit the spread of the COVID-19 pandemic. Though effective in reducing disease incidence, concerns have been raised about their unintended mental health impacts. Sub-Saharan African (SSA) countries, with already fragile health systems, may have faced a disproportionate mental health burden; yet, evidence from the region remains scarce.

Objectives: This study aimed to investigate the association between anxiety and NPI stringency, as well as the effects of specific COVID-19 policies. A secondary objective was to explore interactions to identify population groups most vulnerable to the mental health impacts of school and public transport closures.

Methods: We used data from the Life with Corona Africa survey – a cross-sectional phone survey conducted in 2021 in Uganda, Tanzania, Sierra Leone, and Mozambique – along with policy data from the Oxford COVID-19 Government Response Tracker. Generalized Anxiety Disorder (GAD) was assessed using the GAD-7 questionnaire. Multivariable logistic regression models were applied.

Results: Results from 24,000 participants showed that higher policy stringency was associated with increased odds of screening positive for GAD (OR = 1.15, 95% CI: 1.11–1.20). School closures (OR = 1.70, 95% CI: 1.54–1.87) and public transport closures (OR = 2.15, 95% CI: 1.83–2.54) had the strongest associations with GAD. Interaction analyses revealed that women, adults over 25, and individuals from the highest socioeconomic (SES) group were more affected by school closures, while men, adults under 25 or over 55, and those from the highest SES group were more impacted by transport closures.

Conclusion: Our findings highlight the mental health impact of pandemic-related policies in SSA and underscore the need to consider mental health implications when designing public health responses. Further research in SSA is essential to inform equitable and effective policy in future health crises.

Keywords: COVID-19, anxiety, Non-Pharmaceutical Interventions, Sub-Saharan Africa

I. Introduction

The first case of COVID-19 in Sub-Saharan Africa was detected in Nigeria on 27 February 2020 (1). A few weeks later, on 11 March 2020, the World Health Organization (WHO) declared that the global spread of the virus could be characterized as a pandemic (2). Subsequently, the first case of COVID-19 was detected in Tanzania on 16 March 2020 (3), in Uganda on 21 March 2020 (3), in Mozambique on 22 March 2020 (3) and in Sierra Leone on 31 March 2020 (4).

To limit the transmission of the virus and its impact on human lives, governments implemented a variety of measures: home confinement, geographic containment, restriction or prohibition of gatherings, closure of establishments (5). These Non-Pharmaceutical Interventions (NPIs) have shown to be effective in controlling the COVID-19 pandemic, as reduction in the virus incidence has been observed after the implementation of lockdowns (6), school closing (7,8), workplace closing (7,8), cancel of public events (8) and restrictions on gathering size (8). However, these NPIs have also had negative effects on the population such as increased unemployment (6), reduced access to health facilities (9) or reduced access to social support structures (10).

In parallel, a mental health crisis has been observed (11). Between 2019 and 2020, an estimated 76 million additional cases of anxiety disorders were attributable to the COVID-19 pandemic (12). According to the Global Burden of Disease Study 2021, the disability-adjusted life years (DALYs) associated with anxiety disorders increased by 16.7% (13). The impact of the pandemic on mental health resulted from uncertainty about job loss and economic hardship (9,10,14,15), social isolation (9), reduction in physical activity (9), disruption in health services (9,10,16,17) and medication supply chains (9), or more direct effects of the disease such as information on death rates (10), on the number of cases (12,18) and fear of contracting the virus (9,14,15,19). While the deterioration of mental health has been observed worldwide, some authors suggest that countries hit hardest by the pandemic had the greatest increase in prevalence of depressive and anxiety disorders (12). Sub-Saharan African countries were already facing challenges in their healthcare systems before the pandemic, with scarce workforce capacity (20,21) and shortage on mental healthcare staff (10), underfunding (20) and low access to universal health coverage with high out-of-pocket expenditures (20,21). As a result of these pre-existing difficulties, very few African countries have sufficient diagnostic capacities to install an effective surveillance system (22) and resources went lacking from the start of the pandemic. For example, Sierra Leone only had 13 ventilators in the country in April 2020 for a population of almost 8 million people (23). In addition, even if age-average is lower

in Sub-Saharan Africa than in high-income countries, they suffer from a high prevalence of comorbidities increasing the risk for complications from the COVID-19 (21). Therefore, it is possible that the impact of the pandemic on mental health has been particularly important for inhabitants of Sub-Saharan Africa. Indeed, while the prevalence of Generalized Anxiety Disorder (GAD) was lowest in low-income countries before the COVID-19 crisis (24), during the pandemic, it became higher in Africa than in populations from other geographical regions (25). The prevalence of anxiety disorders is estimated to have increased by 21.5% in Sub-Saharan Africa between 2019 and 2020 (12).

The extent to which NPIs have also participated to this mental health crisis, in addition to the pandemic itself, still needs further investigation. In high-income countries, mixed findings are reported in the scientific literature: several studies found an association between the stringency of NPIs and the prevalence of anxiety or depressive symptoms, but with a small effect size (18,26), when a systematic review found no conclusive evidence that lockdowns increased anxiety and depressive symptoms (6). Another study found a decrease in anxiety symptoms in England during the lockdown (27). Notably, most studies have focused on high-income countries. Very few studies have evaluated the impact of NPIs on mental health in African countries and none have evaluated the impact of different types of NPIs on mental health in these countries. However, it is likely that heightened stringency of NPIs produce outcomes that differ by country (18).

Among African countries, the governments of Uganda, Tanzania, Sierra Leone and Mozambique took very different approaches with regard to NPIs. Uganda implemented one of the strictest and longest lockdowns in the world. Introduced on 30 March 2020, it included the closure of borders, non-essential businesses, schools and universities, restrictions on the use of private vehicles and a night-time curfew (19). The restrictions were gradually eased between September 2020 and May 2021, before another lockdown was introduced. Tight restrictions continued until the end of January 2022 (28). In contrast, neighbouring Tanzania took a different public health approach. During the first year of the pandemic, the government denied the presence of COVID-19 cases in the country (28). It quickly stopped collecting data on the pandemic and promoted prayer and traditional medicine rather than NPIs to prevent and cure the infection (29). When the presidency changed hands in March 2021, the new president acknowledged the existence of the pandemic in the country and began promoting preventive measures (28) and vaccination (30). Nevertheless, Tanzania never imposed a lockdown (29). Sierra Leone introduced two three-day lockdowns, in April and May 2020. Between these full lockdowns, inter-district travel restrictions and a night curfew were maintained (19). Restrictions were gradually lifted from May 2020 (28). Mozambique introduced restrictions such as the closure of schools and institutions, restrictions on public gatherings and restrictions

on international travel. A lockdown was imposed in May 2020, with strict restrictions only being gradually lifted from October 2020 onwards (28). During 2021 only relatively mild COVID-19 restrictions were maintained in both Sierra Leone and Mozambique (28). Overall, the differences in policy measures between these four countries make them an interesting combination for analysing and understanding the impact of NPIs aimed at controlling the COVID-19 pandemic in Sub-Saharan Africa.

To fill in the research gap on how NPIs may have impacted anxiety disorders in Sub-Saharan African countries, we conducted a study in 2021 in Uganda, Tanzania, Sierra Leone and Mozambique, with two main aims: first, to explore the association between anxiety and overall stringency of the COVID-19-related policies; and second to explore the association between anxiety and different type of COVID-19 policies. Our secondary analysis aims to identify the population groups which were the most impacted by two policies (school closing and closure of public transport), with regards to anxiety.

The student conducted this study autonomously, under the supervision of Prof. Anke Hoeffler. The student defined the research question, conducted a literature review in line with the objectives, performed the statistical analysis and ensured the presentation of the results and the writing of the thesis. For this work, she used data previously collected by a team lead by Prof. Tilman Brück and Prof. Anke Hoeffler. Several articles have already been published based on this data (28,31–33), and more are in progress. During the internship, the student also contributed to data collection for another research project: BW Schützt!, an interventional study on mental health among refugees in Germany (34,35).

II. Methods

1. Data

a. The Life with Corona Africa survey

The Life with Corona Africa survey was a phone-based cross-sectional survey conducted in 2021 across four African countries: Uganda, Sierra Leone, Mozambique, and Tanzania. It collected data on socio-demographic characteristics, housing, asset ownership, food insecurity, personal exposure to the COVID-19 and mental health (32,36). Interviews were conducted by trained professionals using computer-assisted telephone interviewing (33). 12 rounds of interviews were conducted, corresponding to one round per month in 2021.

Participants were eligible if they were adults, i.e., 18 years old and above. In the four countries, participants were randomly selected from pre-existing databases, which were generated through random digit dialling (RDD) or face-to-face interviews (32). In Mozambique, data were collected by the survey company Intercampus from a large database of around 600,000 mobile phone contacts. In Tanzania, Sierra Leone and Uganda, data were collected by the non-governmental organization (NGO) BRAC International. Participants in these countries were selected from the Independent Evaluation and Research Cell (IERC) database (37), which includes more than 10,000 individuals per country, drawn from previous surveys and/or from a list of the beneficiaries of the NGO (32). Using these databases, stratified random sampling was applied to ensure representativeness of the study population, with stratification based on age, gender and residence location (urban or rural). However, given the substantial sample size of the study, the databases did not contain a sufficient number of respondents to preserve balanced representation (e.g., a significant proportion of the BRAC projects focus on women) (32). Therefore, post-stratification weights were applied to adjust for imbalances and ensure representativeness of the study population with respect to age, gender and residence location (31).

Anxiety symptoms were measured with the 7-item Generalized Anxiety Disorder scale (GAD-7), a validated tool for the screening of Generalised Anxiety Disorder (GAD) according to the DSM-5 (38). A positive screening for GAD was defined as a score of 8 and above on the GAD-7 questionnaire. This cutoff value has shown to provide the best balance between sensitivity and specificity in identifying Generalized Anxiety Disorder (GAD) (39,40), allowing for a sensitivity of 0.83 and a specificity of 0.84 (39).

Official case counts of COVID-19 reported by national authorities were considered unreliable due to limited testing capacity, inconsistent surveillance systems and the resulting risk of underreporting. To address these limitations, we used a self-assessed COVID-19 exposure variable, derived from participants' responses to four questions: “Have you ever had, or do you

believe that you have ever had, the coronavirus?", "In the last 14 days, do you think you have met (seen) anyone who you think had the coronavirus when you met them?", "Do you personally know someone who has died from the coronavirus in your area?", "Do you think your area has a high incidence of coronavirus?". A score variable was then created corresponding to the number of "yes" answers given to these four questions. For comparison, Appendix 1 displays graphs showing the evolution of the official number of COVID-19 cases and the perceived COVID-19 exposure variable over time in 2021 for each country.

Socio-economic status (SES) was calculated based on asset ownership and housing characteristics. Participants were asked whether they owned various assets (e.g. radio, television, sofa, car, livestock) and about certain housing characteristics (number of rooms, access to electricity and to piped water). To combine this information into a proxy of SES, we performed a Principal Component Analysis (PCA), including 12 categorical variables and 1 discrete numerical variable (number of rooms in the house). We then extracted the coordinates of the first dimension of the PCA and we included them in our dataset as a continuous variable. In this proxy variable, higher values indicate higher SES. PCA has been widely used to construct SES indices (41). Although PCA is theoretically only suited for continuous variables, and Multiple Correspondence Analysis (MCA) is the preferred method when dealing with categorical variables, studies have shown that PCA and MCA have a high agreement when constructing SES indices (42). Additionally, PCA have the advantage of performing when given both continuous and categorical data, allowing for a more comprehensive index, which is not feasible with MCA (42). The continuous SES-proxy variable was then categorized in 3 groups, as suggested by Howe et al (42): the lowest 40% were classified as the lowest SES group, the highest 20% as the highest SES group, and the remaining as the intermediate SES group.

b. The Oxford COVID-19 Government Response Tracker

To measure the intensity of the COVID-19 control measures, we used publicly available data from the Oxford COVID-19 Government Response Tracker (OxCGRT) (43). OxCGRT collected information from publicly available sources on national policies implemented by governments to control the spread of the virus and used this information to create a stringency index. This index is based on nine policy indicators: school closing, workplace closing, cancellation of public events, restrictions on gatherings size, closure of public transport, stay-at-home requirements, restrictions on internal movement, restrictions on international travel and public information campaigns. Each indicator has an ordinal score to measure the stringency of the measure. The average of the nine indicators is calculated to obtain the stringency index (SI). This index was reported daily from the 1st January 2020 to the 31st December 2022 (43). For easier interpretation, we rescaled the SI from 0-100 to 0-10.

Each of the nine policy indicators was measured on a different scale, ranging from 0 to 2 or 3, depending on the indicator. As the intervals between categories did not necessarily occur at equal intervals and because we wanted to capture the effect of any applied measure on mental health, we converted the OxCGRT indicator variables into binary variables using an 'any effort' scenario (44): any non-zero value was coded as 1 and all zeros were coded as 0.

2. Statistical analysis

a. Regression model

A positive screening for Generalized Anxiety Disorder was considered as a binary variable, we therefore applied a multivariable logistic regression model to evaluate the association between the stringency of NPIs and screening positive for GAD (Model 1). A GAD-7 score ≥ 8 was not a rare event. Nonetheless, we maintained the use of a logistic regression for matter of better comparison to the literature on the subject. Another multivariable logistic regression model was performed with the different OxCGRT policy indicators, all included in a single model to account for the effect of each measure on mental health, controlling for confounding by other co-existing policies (Model 2). We excluded the measures “restriction on international travel”, “workplace closure” and “public information campaign” from the analysis because they showed very low variation during the observation period. The assumption of log-linearity for continuous independent variables was assessed prior to model fitting.

To account for the clustering of the data in time and space, we used a fixed-effect for country and month of interview, using dummy variables. This approach enabled all cluster-level variation to be held constant, individuals being compared within the same cluster (45).

A Directed Acyclic Graph (DAG) was drawn based on the existing literature to identify the covariates to include in the model (Appendix 2). Covariates were included if they were considered confounders, i.e. if they were associated both with the exposure and the outcome. After selecting the covariates to be included, the list was validated by drawing an additional DAG using the method described by Shrier and Platt (46), to ensure that no backdoor paths were left open.

The secondary analysis consisted of an interaction analysis to explore which population groups were most vulnerable to anxiety when NPIs were implemented. The analysis focused on the two policies most strongly associated with Generalized Anxiety Disorder, by including product terms in the multivariable logistic regression model for these two policies (Models 3-5). Additive interaction was then assessed by calculating the Relative Excess Risk due to Interaction (RERI). Results were presented following the recommendations of Knol and VanderWeele (47,48).

b. Missing values

The variable “perceived COVID-19 exposure” had 14.7% missing values. To address this, we calculated the mean perceived COVID-19 exposure by district of residence and imputed missing values using the mean of the participant’s district.

For all other variables, missingness was minimal (less than 1%). Participants with missing values on these variables were therefore excluded from the analysis.

3. Ethical considerations

Informed oral consent was obtained from all participants before the interview, by reading out the consent statement at the start of the interview. This statement contained information about the purpose of the interview, the confidentiality of their personal information, and their right to refuse to answer any question or withdraw from the interview at any time.

The study was approved by the UNU-WIDER ethical commission.

4. Other considerations

Artificial intelligence ChatGPT was used to correct English grammar and improve the style of the written text.

III. Results

1. Descriptive analysis

a. Study population

A total of 24,000 participants were interviewed during the study period, of which 6,000 from each of the four countries, corresponding to 500 participants per country per month. The response rate was around 50%, the main reasons for non-response were inactive phone contacts and non-response to phone calls.

Weighted characteristics of the participants are presented in Table 1. Most of the participants were aged between 25 and 45 years old, with a mean age of 36.6 years old. 51% were women and 91% of the households had at least one member under 18 years old. Participants lived mostly in rural areas (68%). After applying weights, 53% of the study population was in the lowest SES group, 32% was in the intermediate group and 14% was in the highest SES group. Perceived COVID-19 exposure was low, with a mean of 0.31 out of 4.

Generalized anxiety disorder (GAD), assessed by a GAD-7 score of 8 or above, was present among 26% of the participants. It was more frequent among participants from 25 to 55 years old (ranging from 26% to 28%, versus 21% for individuals between 18 and 25 years and 19% for individuals over 55). Screening positive for GAD was also more frequent among women (28% versus 23% for men) and in households with children. Additionally, GAD was notably more frequent in Mozambique (41%) than in other countries (Uganda 20%, Tanzania 19% and Sierra Leone 22%). Fluctuations were also observed by month, ranging from a minimum of 17% of GAD in February to a maximum of 35% in April 2021.

Table 1. Description of the study population (weighted estimates)

	Overall	GAD-7 score ≥ 8	
Characteristic	**N = 24,000**[1]	**No** N = 17,855[1]	**Yes** N = 6,145[1]
GAD-7 score ≥ 8	6,145 (26%)		
Age			
18-24	4,050 (17%)	3,181 (79%)	869 (21%)
25-34	10,230 (43%)	7,497 (73%)	2,733 (27%)
35-44	5,586 (23%)	4,027 (72%)	1,559 (28%)
45-54	2,726 (11%)	2,011 (74%)	714 (26%)
> 55	1,409 (5.9%)	1,139 (81%)	270 (19%)
Gender			
Men	11,700 (49%)	9,010 (77%)	2,690 (23%)
Women	12,300 (51%)	8,845 (72%)	3,455 (28%)
Household composition			
Only adults	1,919 (8.0%)	1,605 (84%)	315 (16%)
Children, no elderly	15,530 (65%)	11,458 (74%)	4,072 (26%)
Elderly, no children	351 (1.5%)	273 (78%)	79 (22%)
Elderly and children	6,199 (26%)	4,520 (73%)	1,679 (27%)
Residence location			
Rural	16,440 (68%)	12,095 (74%)	4,345 (26%)
Urban	7,560 (32%)	5,760 (76%)	1,800 (24%)
SES status			
Lowest	12,820 (53%)	9,436 (74%)	3,384 (26%)
Intermediate	7,741 (32%)	5,980 (77%)	1,762 (23%)
Highest	3,439 (14%)	2,439 (71%)	1,000 (29%)
Perceived Covid-19 exposure	0.31 (0.68)	0.29 (0.65)	0.39 (0.76)
Country			
Uganda	6,000 (25%)	4,788 (80%)	1,212 (20%)
Tanzania	6,000 (25%)	4,834 (81%)	1,166 (19%)
Sierra Leone	6,000 (25%)	4,667 (78%)	1,333 (22%)
Mozambique	6,000 (25%)	3,566 (59%)	2,434 (41%)
Month of interview			
January	897 (3.7%)	694 (77%)	203 (23%)

	Overall	GAD-7 score ≥ 8	
Characteristic	**N = 24,000**[1]	**No** N = 17,855[1]	**Yes** N = 6,145[1]
February	2,881 (12%)	2,377 (83%)	504 (17%)
March	2,669 (11%)	2,121 (79%)	548 (21%)
April	878 (3.7%)	575 (65%)	303 (35%)
May	2,060 (8.6%)	1,464 (71%)	597 (29%)
June	2,520 (11%)	1,851 (73%)	669 (27%)
July	1,899 (7.9%)	1,412 (74%)	488 (26%)
August	1,903 (7.9%)	1,434 (75%)	469 (25%)
September	1,547 (6.4%)	1,175 (76%)	372 (24%)
October	1,959 (8.2%)	1,294 (66%)	665 (34%)
November	2,146 (8.9%)	1,519 (71%)	626 (29%)
December	2,638 (11%)	1,936 (73%)	702 (27%)

[1]n (%); Mean (SD)

b. Non-Pharmaceutical Interventions (NPIs)

Figure 1 represents the evolution of the Stringency Index (SI) and of the proportion of participants screening positive for GAD, by country and by month in 2021. As described in the Introduction, SI fluctuated over time as different measures were implemented in the countries to respond to the evolution of the epidemic. Graphically, we can observe that generally the proportion of participants screening positive for GAD fluctuates in response to changes in SI values. However, some discrepancies between the two curves can be observed. Indeed, in Uganda, for instance, the proportion of participants with GAD decreases from August on, whereas the SI remains relatively stable. In Tanzania, the proportion of GAD increases from February to June, when the SI only begins increasing in April. In Mozambique, the proportion of GAD decreases from April to July whereas the SI remains stable from April to June before increasing from June to July.

Figure 1. Monthly SI and proportion of GAD, by country

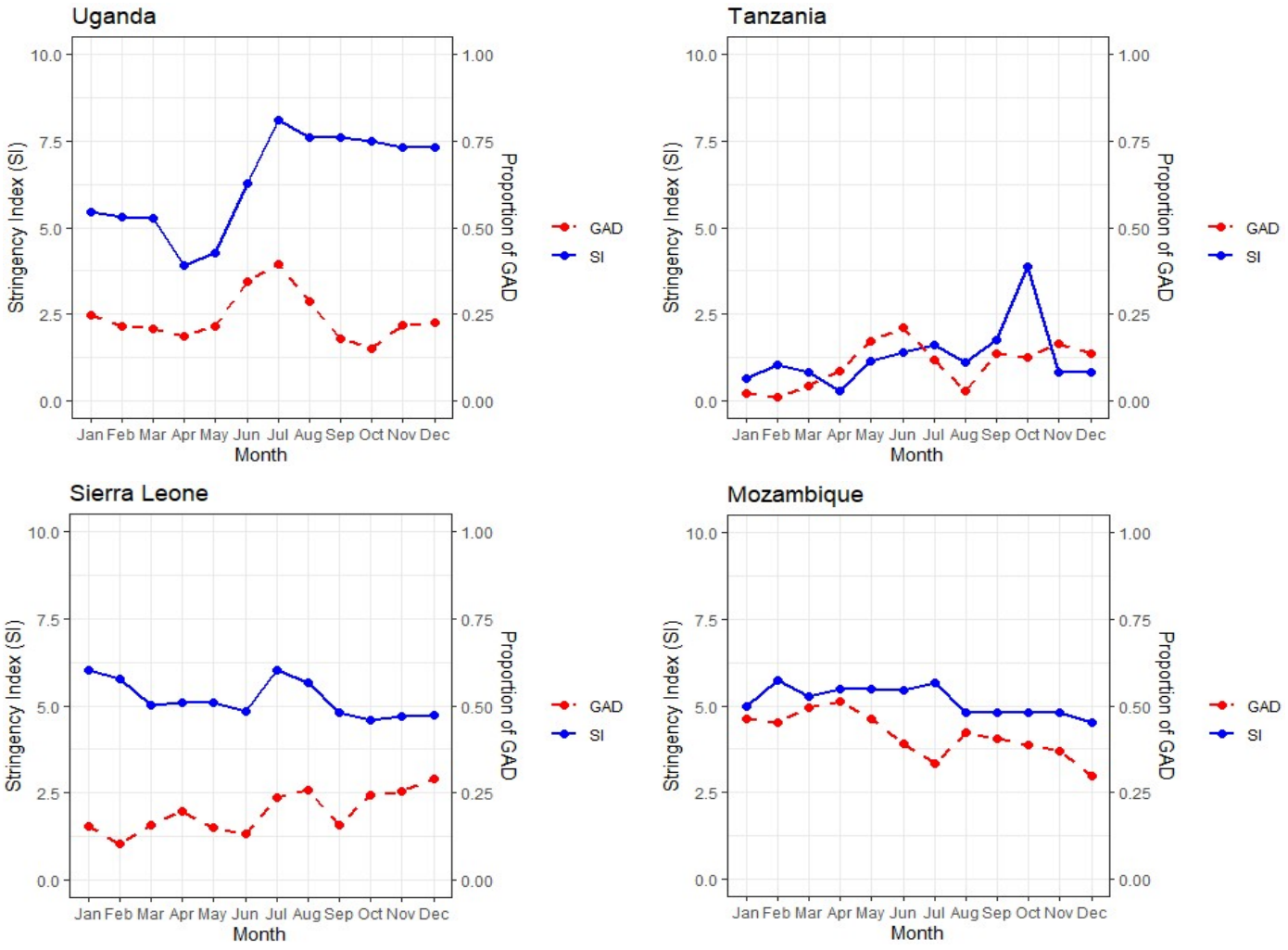


Table 2 represents the proportion of occurrence and co-occurrence of the different policies of interest during the study period. The two most frequent policies were “Cancel public events” and “Close of public transport”, present in 74% and 71% of the days in 2021, respectively. Therefore, the most frequent co-occurrence of policies was “Cancel public events” and “Close of public transport”, present simultaneously in 69% of the days in 2021.

Table 2. Proportion days during the survey period with occurrence and co-occurrence of policies

Policy	School closing	Cancel public events	Restrictions on gathering size	Close public transport	Stay at home requirements	Restrictions on internal movement
School closing	0.66	0.59	0.53	0.57	0.49	0.17
Cancel public events	0.59	0.74	0.65	0.69	0.61	0.17
Restrictions on gathering size	0.53	0.65	0.67	0.61	0.62	0.17
Close public transport	0.57	0.69	0.61	0.71	0.59	0.20
Stay at home requirements	0.49	0.61	0.62	0.59	0.64	0.20
Restrictions on internal movement	0.17	0.17	0.17	0.20	0.20	0.20

2. Statistical analysis

a. Primary analysis

Model 1 explored the association between the rescaled SI and a positive screening for Generalized Anxiety Disorder, controlling for perceived COVID-19 exposure (Table 3). An increase of 1 point in the rescaled SI (equivalent to a 10-point increase in the original index) was associated with increased odds of screening positive for GAD (OR = 1.15, 95% CI = 1.11–1.20). In the same model, perceived COVID-19 exposure was significantly associated with higher odds of GAD (OR = 1.16, 95% CI = 1.10–1.21), indicating that individuals who reported greater exposure to COVID-19 were more likely to screen positive for GAD.

Table 3. Association between the stringency index and generalized anxiety disorder (Model 1)

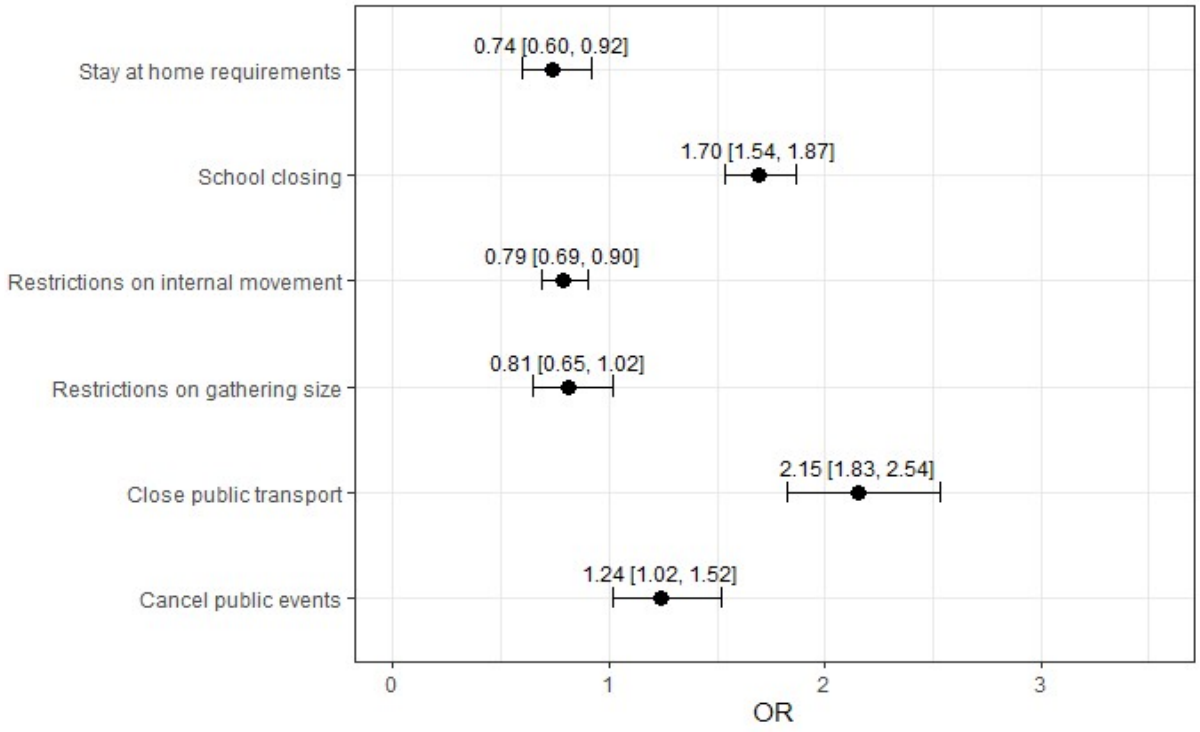
Characteristic	OR	95% CI	p-value
Stringency Index (SI)	1.15	1.11, 1.20	<0.001
Perceived COVID-19 exposure	1.16	1.10, 1.21	<0.001

Abbreviations: CI = Confidence Interval, OR = Odds Ratio

Weighted multivariable logistic regression controlling for perceived COVID-19 exposure and including a country-fixed effect and a month-fixed effect

Model 2 explored the independent association of different policies with Generalized Anxiety Disorder (Figure 2). Policies associated with an increase in the likelihood of screening positive for GAD were school closing (OR = 1.70, 95% CI = 1.54–1.87), close of public transport (OR = 2.15, 95% CI = 1.83–2.54) and cancellation of public events (OR = 1.24, 95% CI = 1.02–1.52). Policies associated with a decrease in the likelihood of screening positive for GAD were stay-at-home requirements (OR = 0.74, 95% CI = 0.60–0.92) and restrictions on internal movement (OR = 0.79, 95% CI = 0.69–0.90). Restrictions on gathering size was not statistically associated with GAD.

Figure 2. Association between different policies and generalized anxiety disorder (Model 2)



Weighted multivariable logistic regression model including the six policies, controlling for perceived COVID-19 exposure, and including a country-fixed effect and month-fixed effect

b. Secondary analysis

We then performed interaction analyses to explore the presence of effect modification for the policies “school closing” and “close of public transport”, in order to identify the population most vulnerable toward these policies, with regard to Generalized Anxiety Disorder.

Model 3 explored how gender modified the association between the two policies “school closing” and “close of public transport” and Generalized Anxiety Disorder (Table 4). Among individuals not exposed to either policy, women had significantly higher odds of screening positive for GAD compared to men (OR = 2.51, 95% CI = 2.17–2.90).

Both women and men exhibited higher odds of screening positive for GAD when exposed to school closures or public transport closures, compared to their respective unexposed counterparts. However, for both policies, multiplicative interaction was statistically significant and negative, as indicated by product terms less than 1, men being the reference group (e.g., OR = 0.79 for school closing, 95% CI = 0.68–0.91, p = 0.002). This suggests that the relative increase in odds associated with exposure was significantly smaller in women than in men (OR for school closing among men = 2.03, 95% CI = 1.79–2.31 ; OR for school closing among women = 1.61, 95% CI = 1.43–1.80 ; OR for transport closing among men = 3.36, 95% CI = 2.76–4.10 ; OR for transport closing among women = 1.84, 95% CI = 1.54–2.19).

When compared to men not exposed to school closing, the joint effect of being a woman and being exposed to school closure was associated with a higher odds of screening positive for GAD (OR = 4.03, 95% CI = 3.38–4.80). This joint effect is greater than that observed for men exposed to school closure (OR = 2.03, 95% CI = 1.79–2.31). This difference reflects, in part, the higher baseline odds of GAD among women (OR = 2.51, 95% CI = 2.17–2.90), even though the relative increase in odds associated with school closure was smaller for women than for men.

On the additive scale, a significant super-additive interaction was observed for school closing (RERI = 0.49, 95% CI = 0.03–0.94). This indicates that the combined absolute risk associated with being a woman and being exposed to school closure was greater than the sum of their individual effects. In other words, despite a smaller relative effect in women, the absolute increase in risk attributable to school closures was greater in women than would be expected based on the effects of gender and policy exposure alone. No significant additive interaction was found for the policy "close of public transport".

Table 4. Modification of the effect of policies on generalized anxiety disorder by gender (Model 3)

Policy	Gender	Joint effect Policy exposure (OR and 95% CI)		Stratified analysis - within gender strata (OR and 95% CI)	Product term (OR and 95% CI)	RERI
		No	Yes			
School closing	Men	Ref	2.03 [1.79, 2.31]	2.03 [1.79, 2.31]		
	Women	2.51 [2.17, 2.90]	4.03 [3.38, 4.8]	1.61 [1.43, 1.80]	0.79 [0.68, 0.91] p=0.002	0.49 [0.03, 0.94]
Close of public transport	Men	Ref	3.36 [2.76, 4.1]	3.36 [2.76, 4.10]		
	Women	2.51 [2.17, 2.90]	4.62 [3.75, 5.69]	1.84 [1.54, 2.19]	0.55 [0.46, 0.65] p=<0.001	-0.26 [-0.8, 0.29]

Abbreviations: CI = Confidence Interval, OR = Odds Ratio, RERI = Relative Excess Risk due to Interaction

Weighted multivariable logistic regression including a country-fixed effect and a month-fixed effect, and controlling for perceived COVID-19 exposure and other co-existing policies

Model 4 examined whether age modified the association between the policies “school closing” and “close of public transport” and Generalized Anxiety Disorder (Table 5). Among individuals not exposed to these policies, participants aged 25–54 had higher odds of screening positive for GAD (OR = 1.70, 95% CI = 1.37–2.11), while individuals aged >55 had lower odds (OR = 0.55, 95% CI = 0.36–0.83), when compared to those aged 18–24.

For school closing, exposure did not significantly increase the odds of screening positive for GAD among participants aged 18–24 (OR = 1.19, 95% CI = 0.98–1.43). However, for age groups 25–54 and >55, the product terms were significant, indicating positive multiplicative interaction, suggesting that participants aged 25 and above were more likely to screen positive for GAD when exposed to school closing than individuals aged between 18 and 24 (OR for 25-54 = 1.81, 95% CI = 1.64–2.01 ; OR for > 55 = 2.31, 95% CI = 1.63–3.28). Furthermore, the additive interaction for individuals aged >55 was significant (RERI = 1.21, 95% CI = 0.23–2.19), suggesting a super-additive effect. Therefore, individuals over 55 experienced a disproportionately higher absolute risk (additive interaction) along with higher odds (multiplicative interaction) of Generalized Anxiety Disorder when exposed to school closures compared to the younger reference group.

Exposure to the policy “close of public transport” significantly increased the odds of screening positive for GAD among participants aged 18–24 (OR = 3.27, 95% CI = 2.52–4.25). Among individuals aged 25–54, both multiplicative and additive interactions were significant, with the product term indicating a weaker relative effect of the policy in this age group compared to 18–24 (OR = 1.86, 95% CI = 1.57–2.20). The RERI indicated a sub-additive interaction (RERI =

−3.40, 95% CI = −4.63 to −2.17), suggesting that exposure induced a lower increase in absolute risk of Generalized Anxiety Disorder than the combined effect of age and policy exposure. No significant interaction – on either the multiplicative or additive scale – was observed for individuals aged above 55.

Table 5. Modification of the effect of policies on generalized anxiety disorder by age (Model 4)

Policy	Age group	Joint effect Policy exposure (OR and 95% CI)		Stratified analysis - within age strata (OR and 95% CI)	Product term (OR and 95% CI)	RERI
		No	Yes			
School closing	18–24	Ref	1.19 [0.98, 1.43]	1.19 [0.98, 1.43]		
	25–54	1.70 [1.37, 2.11]	3.08 [2.44, 3.88]	1.81 [1.64, 2.01]	1.53 [1.26, 1.85] p=<0.001	-0.36 [-1.06, 0.34]
	> 55	0.55 [0.36, 0.83]	1.27 [0.83, 1.94]	2.31 [1.63, 3.28]	1.95 [1.32, 2.86] p=<0.001	1.21 [0.23, 2.19]
Close of public transport	18–24	Ref	3.27 [2.52, 4.25]	3.27 [2.52, 4.25]		
	25–54	1.70 [1.37, 2.11]	3.15 [2.45, 4.07]	1.86 [1.57, 2.20]	0.57 [0.45, 0.72] p=<0.001	-3.40 [-4.63 -2.17]
	> 55	0.55 [0.36, 0.83]	2.60 [1.73, 3.90]	4.74 [3.16, 7.10]	1.45 [0.93, 2.24] p=0.098	-1.37 [-2.77, 0.02]

Abbreviations: CI = Confidence Interval, OR = Odds Ratio, RERI = Relative Excess Risk due to Interaction

Weighted multivariable logistic regression including a country-fixed effect and a month-fixed effect, and controlling for perceived COVID-19 exposure and other co-existing policies

Model 5 examined whether socioeconomic status (SES) modified the association between the policies “school closing” and “close of public transport” and Generalized Anxiety Disorder (Table 6). Among individuals not exposed to these policies, participants from the lowest SES group had significantly higher odds of screening positive for GAD compared to those from the highest SES group (OR = 5.14, 95% CI = 3.99–6.63).

For school closures, exposure was associated with increased odds of screening positive for GAD among individuals from the highest SES group (OR = 2.17, 95% CI = 1.82–2.59). Statistically significant multiplicative and additive interactions were observed for both the intermediate and lowest SES groups. Specifically, the product terms indicated negative multiplicative interaction (intermediate SES group: OR = 0.71, 95% CI = 0.58–0.87; lowest SES group: OR = 0.74, 95% CI = 0.60–0.91), and the RERI indicated sub-additive effects (intermediate SES group: RERI = -1.74, 95% CI = -2.42 to -1.06; lowest SES group: RERI = -5.57, 95% CI = -7.12 to -4.03). These findings suggest that the impact of exposure to school

closures on GAD was lower – both on the relative and absolute scales – among individuals from the intermediate and lowest SES groups compared to those from the highest SES group.

For the closure of public transport, exposure was also associated with increased odds of screening positive for GAD among participants from the highest SES group (OR = 2.67, 95% CI = 2.07–3.44). Significant multiplicative and additive interactions were found for the lowest SES group (product term: OR = 0.41, 95% CI = 0.31–0.53; RERI = -6.41, 95% CI = -8.28 to -4.53), indicating a reduced impact of exposure to this policy among individuals from the lowest SES group in comparison to individuals from the highest SES group. For the intermediate SES group, additive interaction was significant (RERI = -1.81, 95% CI = -3.00 to -0.62), although no significant multiplicative interaction was observed.

Notably, the OR for the joint effects of being from the lowest SES group and being exposed to either policy was higher than those observed for the highest SES group. However, interaction analyses revealed that individuals from the lowest SES group experienced a smaller increase in anxiety disorders in response to policy exposure – both on the multiplicative and additive scales. These results reflect the elevated baseline likelihood of screening positive for GAD among participants from the lowest SES group when compared to those in the highest SES group.

Table 6. Modification of the effect of policies on generalized anxiety disorder by socioeconomic status (Model 5)

Policy	SES group	Joint effect Policy exposure (OR and 95% CI)		Stratified analysis - within strata of SES (OR and 95% CI)	Product term (OR and 95% CI)	RERI
		No	Yes			
School closing	SES - highest	Ref	2.17 [1.82, 2.59]	2.17 [1.82, 2.59]		
	SES - intermediate	1.28 [0.98, 1.67]	1.98 [1.49, 2.63]	1.54 [1.34, 1.78]	0.71 [0.58, 0.87] p=0.001	-1.74 [-2.42, -1.06]
	SES - lowest	5.14 [3.99, 6.63]	8.27 [6.30, 10.85]	1.61 [1.41, 1.83]	0.74 [0.60, 0.91] p=0.004	-5.57 [-7.12, -4.03]
Close of public transport	SES - highest	Ref	2.67 [2.07, 3.44]	2.67 [2.07, 3.44]		
	SES - intermediate	1.28 [0.98, 1.67]	3.91 [2.98, 5.11]	3.04 [2.48, 3.74]	1.14 [0.86, 1.51] p=0.352	-1.81 [-3.00, -0.62]
	SES - lowest	5.14 [3.99, 6.63]	5.56 [4.22, 7.33]	1.08 [0.88, 1.33]	0.41 [0.31, 0.53] p<0.001	-6.41 [-8.28, -4.53]

Abbreviations: CI = Confidence Interval, OR = Odds Ratio, RERI = Relative Excess Risk due to Interaction

Weighted multivariable logistic regression including a country-fixed effect and a month-fixed effect, and controlling for perceived COVID-19 exposure and other co-existing policies

c. Sensitivity analysis

The primary analysis yielded the following main results: a higher stringency index was associated with increased odds of screening positive for Generalized Anxiety Disorder. In particular, exposure to school closing and the closure of public transportation was associated with higher odds of a positive GAD screening.

To assess the robustness of these findings, we conducted several sensitivity analyses, all of which were consistent with the main results presented above. First, to account for the fact that a GAD-7 score ≥ 8 was not a rare outcome in our sample, we conducted modified Poisson regression with robust standard errors (Appendix 3). Second, given that participants from Mozambique had a notably higher prevalence of GAD (42%) compared to the other countries and that the survey was performed by a different organisation, we performed an analysis excluding Mozambican participants (Appendix 4). Third, to account for a risk of multicollinearity due to the co-occurrence of the different policies, we performed one regression for each of the policies individually, instead of one regression accounting for all policies at the same time (Appendix 5). Fourth, instead of a cutoff score of 8 and above on the GAD-7 questionnaire, we used a cutoff value of 9 and above, which was reported to have similar performance scores (sensitivity = 0.80, specificity = 0.82) (39) (Appendix 6). Fifth, we addressed missing data in the variable “perceived COVID-19 exposure” by applying Multiple Imputation by Chained Equations (MICE) as an alternative imputation method (Appendix 7). Additionally, we performed an analysis excluding participants with missing data. Finally, we performed a regression including socio-demographic variables likely to be associated with anxiety disorders, as done in other studies (18,49) – variables were included following the disjunctive cause criterion described by VanderWeele (50) (Appendix 8).

Finally, a sensitivity analysis was performed on the interaction analysis focusing on socioeconomic status. The SES-index was recalculated using Multiple Correspondence Analysis (MCA). Results from the interaction analysis using the revised SES index were consistent with the initial analysis for the policy “close of public transport”. However, for “school closing”, in contrast to the initial analysis, neither multiplicative nor additive interaction was observed (Appendix 9).

IV. Discussion

1. Key results

In our descriptive analysis, we found that 26% of participants screened positive for Generalized Anxiety Disorder (GAD). This result is within the range reported in a meta-analysis of 23 studies, which found a pooled prevalence rate for anxiety of 37% overall and 30% specifically in Sub-Saharan Africa (25).

A GAD-7 score of 8 and above was notably more frequent among the Mozambican population than in the other three countries. Several factors may help explain this difference. In 2021, Mozambique was the poorest among the four countries (GDP per capita of USD 509.9 in 2021, compared to USD 1159.9 for Tanzania, USD 882.8 for Uganda and USD 885.2 for Sierra Leone) (51). The country was also experiencing an ongoing conflict in the northern province of Cabo Delgado, which began in 2017 and intensified during 2020 and 2021, leading to numerous deaths and displacements (52,53). In addition, Mozambique faced significant food insecurity, affecting approximately half of the population in 2021 (31,54). Therefore, Mozambicans may have been exposed to multiple stressors prior to the COVID-19 pandemic, which could have contributed to a higher baseline prevalence of anxiety or increased susceptibility to the mental health impacts of the pandemic due to pre-existing vulnerabilities.

Our primary analysis revealed a significant increase in the odds of screening positive for GAD when individuals were exposed to more stringent COVID-19 related policies (OR = 1.15, 95% CI = 1.11–1.20). This finding aligns with existing research from high-income countries. For example, a study examining countries that are members, candidates, or partners of the OECD found that a 10-point increase in the SI was associated with higher odds of presenting anxiety symptoms (OR = 1.014, 95% CI = 1.008-1.019) (26). In Canada, a survey performed in 2021 showed that individuals exposed to a SI of 80 or above had 39% higher odds of reporting that the COVID-19 pandemic affected their overall well-being, compared to those exposed to a SI between 50 and 60 (OR = 1.39, 95% CI = 1.02–1.89) (49). Similarly, a study on 15 high-income countries found that a higher SI was associated with increased psychological distress and decreased life satisfaction (18). Exploring Google Trends data, a study showed an increase in the online search for terms such as “boredom”, “loneliness”, “worry” and “sadness” during the lockdowns in European countries and the United-States (55). Furthermore, a large international study covering countries in Europe, North and South America, Africa, Asia, and Oceania found that higher SI scores was associated with greater reports of negative emotions (56). In contrast, some studies have reported different findings. For example, a meta-analysis focusing on European countries and the United-States found no association between lockdowns and anxiety symptoms (6). Additionally, a study in the United-

Kingdom observed a decline in anxiety symptoms over the 20 weeks following the introduction of the lockdown, with the sharpest decrease being observed during the strictest lockdown period (27).

Our primary analysis also revealed that the two policies most strongly associated with increased odds of screening positive for GAD were the closure of public transport (OR = 2.15, 95% CI = 1.83–2.54) and school closures (OR = 1.70, 95% CI = 1.54–1.87). The literature on school closures presents mixed findings. A study conducted in the United-States found that school closures were associated with an increase in the number of daily visits to mental health facilities (mean difference of 8.8 for 100,000 individuals) (57). In contrast, other studies reported no statistically significant association between school closing and anxiety levels (58), psychological distress (18) or mental well-being (59). On the other hand, a Canadian study found that exposure to school closures was associated with decreased odds of reporting that the COVID-19 pandemic negatively affected overall well-being (OR = 0.84, 95% CI = 0.71–0.99) and mental health (OR = 0.70, 95% CI = 0.59–0.83) (49). Similarly, the effects of public transport closures on anxiety remain inconsistent across studies. A meta-analysis covering 26 countries (including Nigeria, the only African country in the sample) found that closure of public transport was the only policy significantly associated with increased anxiety levels (58). However, other studies found no association between public transport closures and mental well-being in European countries (59), and one study focusing on high-income countries even reported a decrease in psychological distress associated with such closures (18).

As described above, the majority of the studies report an association between the stringency of NPIs and anxiety symptoms. However, the impact of specific types of policies varies across studies. Notably, important methodological differences between studies may partially account for these differences. For instance, studies focused on different time periods: first semester of 2020 (27,55,56,58), second semester of 2020 (26,57), and the full 2020-2021 period (18,49). One could hypothesize that the mental health impact of NPIs was greater in the early phase of the pandemic – when uncertainty was high and the situation was out of the ordinary – compared to later phases, as individuals gradually adapted to ongoing social distancing measures. On the other hand, long-lasting NPIs leading to economic precarity could then impose a burden on mental health as coping strategies are drained. In addition, most of this research has focused on high-income countries. However, it is likely that the mental health impact of NPIs varied depending on pre-pandemic factors such as access to health services, a country's political and economic stability, food security, employment rates, social support structures, and the presence of ongoing conflicts. For example, while the impact of economic disruption on mortality remains unclear in high-income settings, evidence suggests that it leads to increased mortality rates in low- and middle-income countries (60). Finally, studies employed

a range of different instruments to assess anxiety and psychological distress, including the GAD-7 (6,27,58), the Kessler Psychological Distress scale K-10 (26), the Brief Symptom Inventory (6) and the WHO-5 Well-Being Index (59).

In our secondary analysis, we explored interactions between school closing or closure of public transport and gender, age and SES groups.

First, we found that, at baseline, women were more likely to screen positive for GAD, a result consistent with findings from other studies (12,18,27,61). We found negative multiplicative interaction but positive additive interaction for women exposed to school closure. These results highlight the importance of exploring interaction on both scales. Notably, additive interaction is more relevant for public health applications (48), as it better reflects the impact in terms of the number of cases. Other studies in high-income countries have also reported a greater impact of school closing on women's well-being than on men's (26,59). As school closed, women increased their time spent on housework and childcare, more than men (17,62,63). In Tanzania, some women even reported feeling overwhelmed by the task of homeschooling their children (15). In parallel, women – who are generally more affected by job loss during periods of economic instability (17) – were more likely to have lost their job during the pandemic (15,16,63). This is especially true in developing countries, where the majority of women work in the informal sector (16). This double burden for women of reduced paid work and increased unpaid labour (15,16) may contribute to long-lasting gender inequalities, via reduced participation of women in the labour market, even after the pandemic (62). On the other hand, a study in England found a faster improvement of anxiety levels among women than among men during the lockdown, suggesting a possible higher resilience or greater adaptation capacity of women in this context (27).

Second, we found that, at baseline and compared to adults aged 18-24, adults aged 25-54 were more likely to screen positive for GAD, whereas adults over 55 were less likely to screen positive. These findings are consistent with other studies showing that older adults are less likely to experience anxiety symptoms or psychological distress at baseline (12,27,61,64). Older adults have reported lower feelings of social isolation and lower negative relationship quality than younger adults (65). One possible explanation is that older adults benefit from the strength of experience, allowing them to draw on past coping strategies during stressful events or previous crises (65,66). Additionally, we found that school closing had a greater impact on anxiety symptoms among individuals aged 25 and above than among the younger reference group. One hypothesis is that adults over 25 are more likely to have school-aged children than younger adults. Supporting this, a study conducted in the United States found that school closures had a stronger impact on individuals aged 31-40, who showed a higher number of

daily visits to mental health facilities during this period (57). In addition, we found that adults aged 25-54 were relatively less impacted by the closure of public transport in terms of anxiety symptoms, compared to younger adults. One possible explanation may be related to employment status: in our study population, individuals aged 25-54 were more often self-employed (53%) or farmers (17%) than younger adults (42% and 13%, respectively). These individuals may have been less reliant on public transport for their work commute.

Third, we found that, at baseline, individuals from the lowest SES group were more likely to screen positive for GAD than individuals from the highest SES group. This results is consistent with findings from other studies (12,18,27,61,67). Interestingly, we also observed that individuals from the lowest SES group had a lower likelihood of screening positive for GAD when exposed to the closure of public transport, compared to those from the highest SES group. One possible explanation is that individuals in the highest SES group in our study population lived in urban areas more often than those in the lowest SES group (77% versus 54%). They may subsequently be more dependent on public transportation. Additionally, some authors have suggested that wealthier individuals may have been more negatively affected by the COVID-19 pandemic and related restrictions, as they are more dependent on salaried income (68) and less accustomed to anticipating reductions in resource availability (67).

2. Strengths and limitations

This study has several limitations.

First, the study population was not initially representative of the general population in terms of age, gender and residence location. Although post-stratification weights were applied to enhance representativeness, unmeasured differences may remain. As a result, the extent to which these findings can be generalised beyond the study sample remains uncertain.

Second, response rate was around 50%, with the main reason for nonparticipation being nonresponse to the calls. This is likely to introduce a selection bias, differential by the outcome, as individuals who do not own a mobile phone are more likely to belong to a lower SES group, which is a risk factor for anxiety (61). In the years 2019 to 2022, the share of the population which owned a mobile phone was 61% in Mozambique, 76% in Sierra Leone, 75% in Tanzania and 77% in Uganda (69). Therefore, it is possible that our sample population be less anxious than the general population. On the other hand, most worried individuals might be more willing to respond to a survey, providing a bias in the other direction. Anyhow, given the country-level measure of the exposure, it is unlikely that a selection bias differential by exposure be present.

Since we are estimating odds ratios, a selection bias differential only by the outcome should not bias the calculated estimates.

Third, the GAD-7 questionnaire is a screening tool, rather than a diagnosis tool, and it is based on self-declaration of symptoms, which could introduce a risk of social desirability bias. However, studies show that the GAD-7 score has acceptable sensitivity and specificity for identifying GAD compared to the established gold standard clinical diagnosis (39). Nevertheless, misclassification due to imperfect performances of the GAD-7 questionnaire is unlikely to be differential by exposure, as the exposure is assessed at a country level and was collected through other studies. Therefore, the risk of non-differential information bias might only bias the estimate towards the Null, underestimating or masking existing associations.

Fourth, the combined use of country-level exposure variables and individual-level outcome variables raises the risk of ecological fallacy. Although country fixed effects were included to control for unobserved national-level heterogeneity, the use of aggregated exposure data may not fully reflect individual-level variation in actual stringency. Indeed, the stringency index does not capture the extent of compliance with NPIs within countries, nor regional differences in adherence. Moreover, given the rapid and concurrent introduction of multiple NPIs during the COVID-19 pandemic, isolating their individual effects is challenging. Our decision to code indicator policies as binary variables under the ‘any effort’ scenario may also introduce misclassification bias. For example, individuals may be coded as exposed to a policy even if it was only recommended, not enforced. However, this misclassification is unlikely to be differential with respect to the outcome, meaning any resulting bias would likely be towards the Null, potentially underestimating or masking existing associations.

Finally, as a cross-sectional study, our analysis is particularly vulnerable to bias from unobserved confounding and cannot establish temporality. The findings should therefore be interpreted with caution, as correlations between policy environments and mental health outcomes, not as evidence of causal effects at the individual level. Future research employing longitudinal data and incorporating both individual-level exposures and outcomes could further strengthen the findings of the present study.

To our knowledge, this study is the first to explore the association between different type of NPIs and anxiety disorders with a focus on Sub-Saharan African countries. Despite the limitations discussed above, the large sample size and the inclusion of participants from four different African countries – with significantly different approaches to NPIs – provide valuable insights into how policy environments may be associated with mental health outcomes in these settings.

In addition, the use of the GAD-7 score, a validated and standardized tool, enhances the comparability and replicability of the results. The consistency of our primary findings across multiple sensitivity analyses reinforces the robustness of our results. While the generalisability of the results is uncertain, and causal inferences cannot be drawn due to the study's design, the research offers a valuable initial insight into cross-country patterns in contexts where longitudinal data are scarce.

V. Perspectives and conclusion

Various mechanisms have been explored to explain how NPIs may impact mental health and it is likely that the association is multifactorial, involving several pathways. First, lockdowns have had a significant impact on households' economic well-being. They have been associated with increased unemployment (6) and reduced income levels (68,70,71). In low- and middle-income countries, households have coped with declining income by reducing expenditures on non-food essentials (such as clothing, healthcare and education) (28,70), reducing food expenditures (68), spending savings (28,68,70) or increasing work in the farm (68). In Uganda, an increased likelihood of missing meals was observed during the first lockdown (68), and in Sierra Leone, 78% of households reported moderate to severe food insecurity in 2021 (32). Second, self-reported physical distancing has been identified as a mediator in the association between NPIs and psychological distress (18,55). Reduced social interaction can weaken the social support which plays a crucial role during stressful times. Third, reduced mobility has also been found to mediate the link between NPIs and psychological distress or negative emotions (18,55). Indeed, spending less time outdoors may contribute to poorer mental health. Additionally, forced cohabitation during lockdowns may increase household conflict and associated violence. For example, increases in gender-based violence were observed in South Africa (72), domestic violence was reported to rise in Ghana (72) and more frequent intimate partner violence against women was documented in Uganda (68). Finally, other factors discussed in the literature include reduced leisure time due to NPIs (59) and perceptions of how governments managed the pandemic (18).

Further research is needed to better understand the impact of NPIs on anxiety disorders, the mechanisms involved, and the most affected population groups, in order to inform policy decisions during future public health crises. Special attention should be given to low- and middle-income countries, where 80% of the global population lives (21) and which often face pre-existing vulnerabilities related to economic well-being and access to healthcare. Efforts should also be made to collect individual-level longitudinal data on mental health and exposure to NPIs in these settings, to better support future evidence-based responses.

In summary, studying participants living in Uganda, Tanzania, Sierra Leone and Mozambique in 2021, we found increased likelihood of screening positive for Generalized Anxiety Disorder among those exposed to more stringent COVID-19 policies, particularly when exposed to the closing of school and of public transportation. We observed that women, individuals over 25, and those from the highest SES group were more affected by school closures with regards to GAD. In contrast, men, individuals under 25 or over 55, and individuals from the highest SES group were more affected by the closure of public transportation. This

study provides important groundwork for future research to further investigate these dynamics and guide future balanced public health responses.

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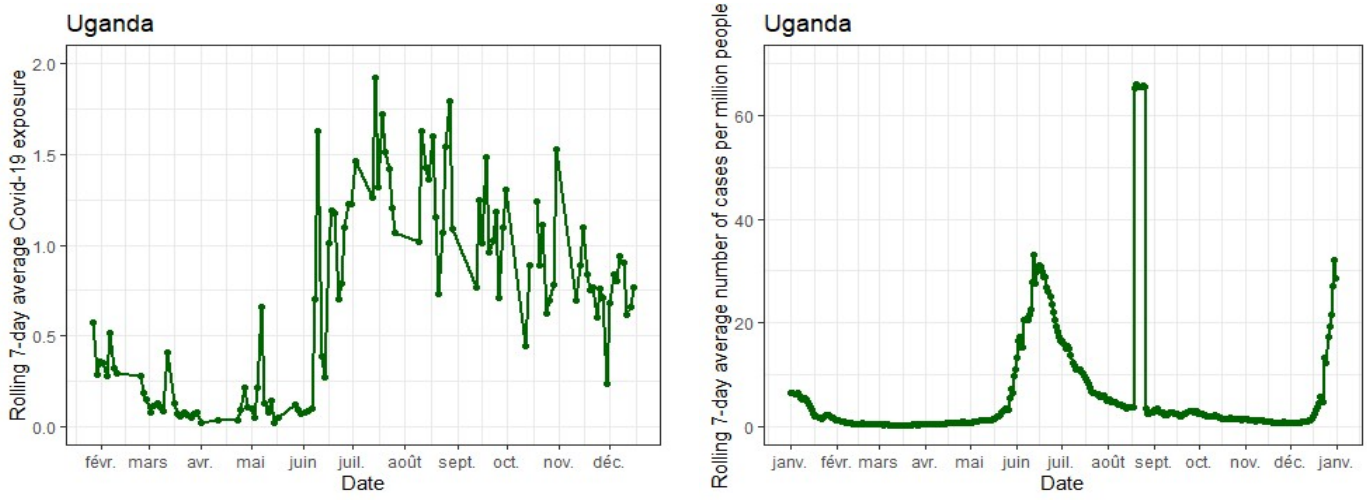
Appendices

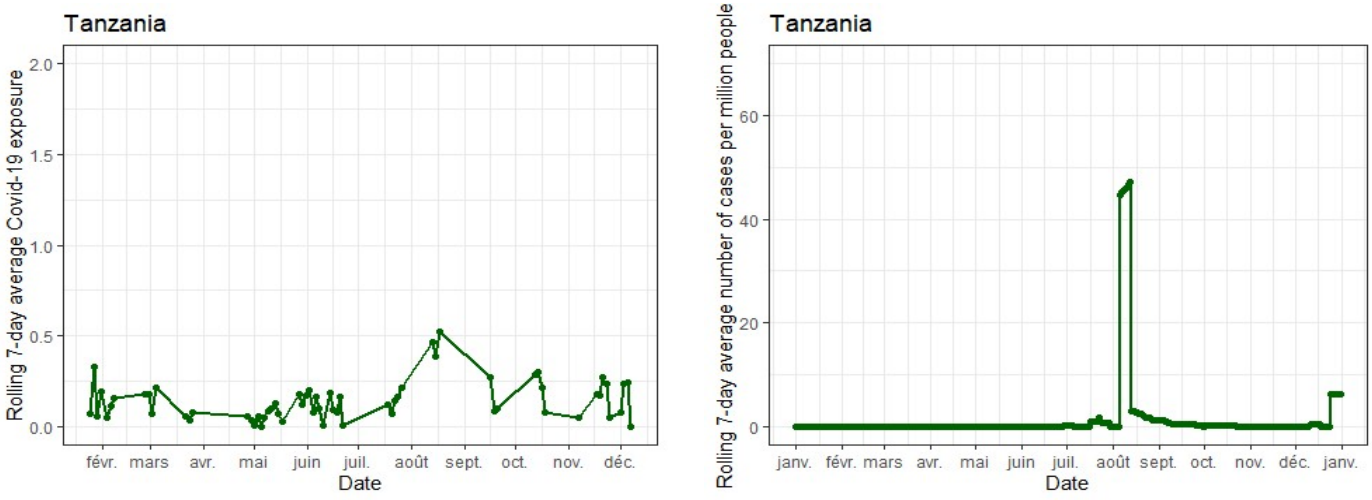
List of Appendices

Appendix 1 – evolution of perceived Covid-19 exposure and official number of cases in 2021, by country

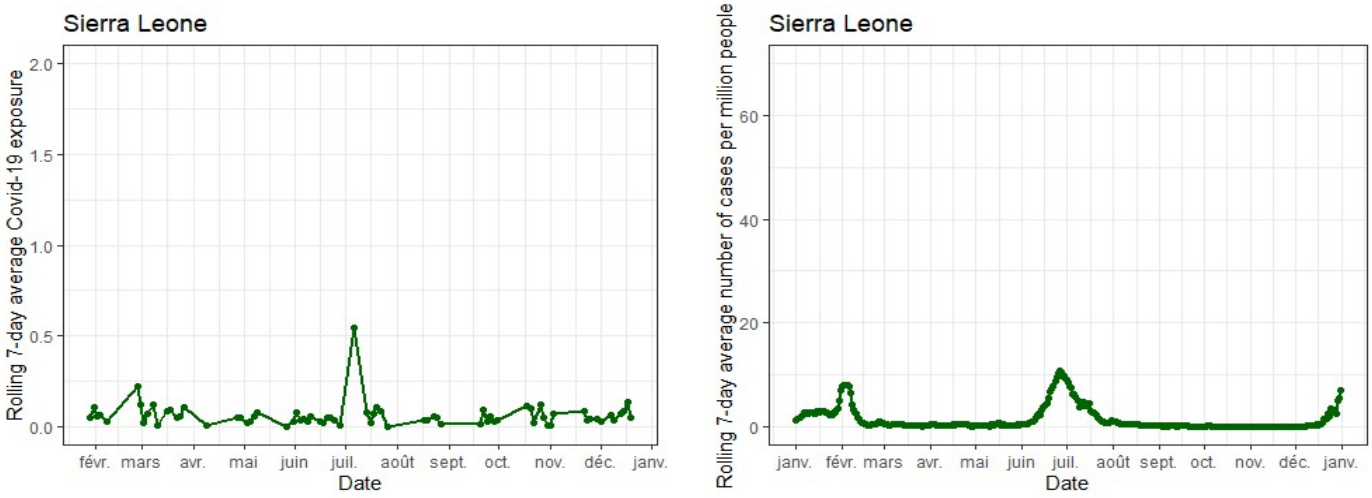
Supplemental Figure 1A. Uganda 2021 – evolution of perceived Covid-19 exposure and official number of cases



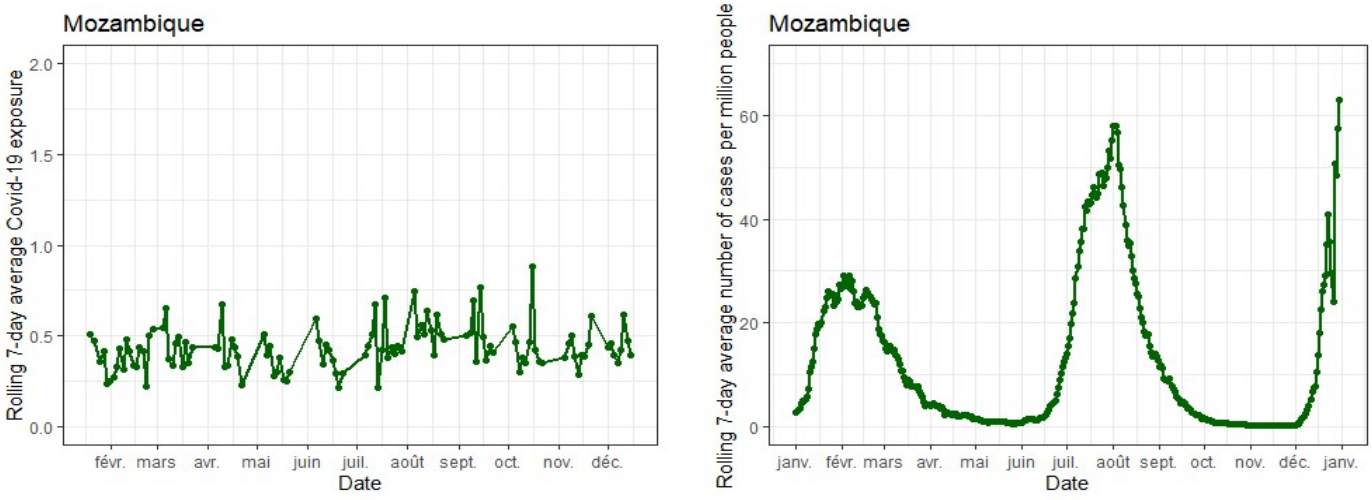
Supplemental Figure 1B. Tanzania 2021 – evolution of perceived Covid-19 exposure and official number of cases



Supplemental Figure 1C. Sierra Leone 2021 – evolution of perceived Covid-19 exposure and official number of cases

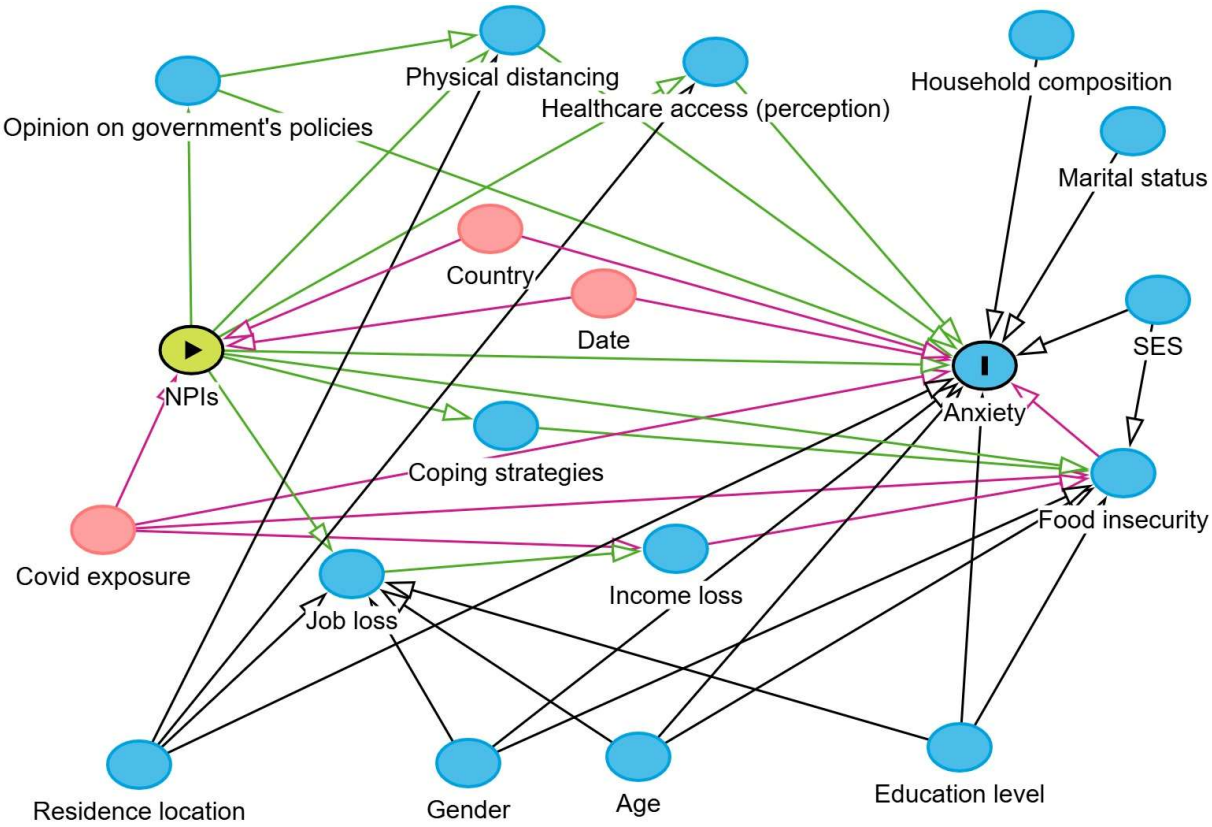


Supplemental Figure 1D. Mozambique 2021 – evolution of perceived Covid-19 exposure and official number of cases

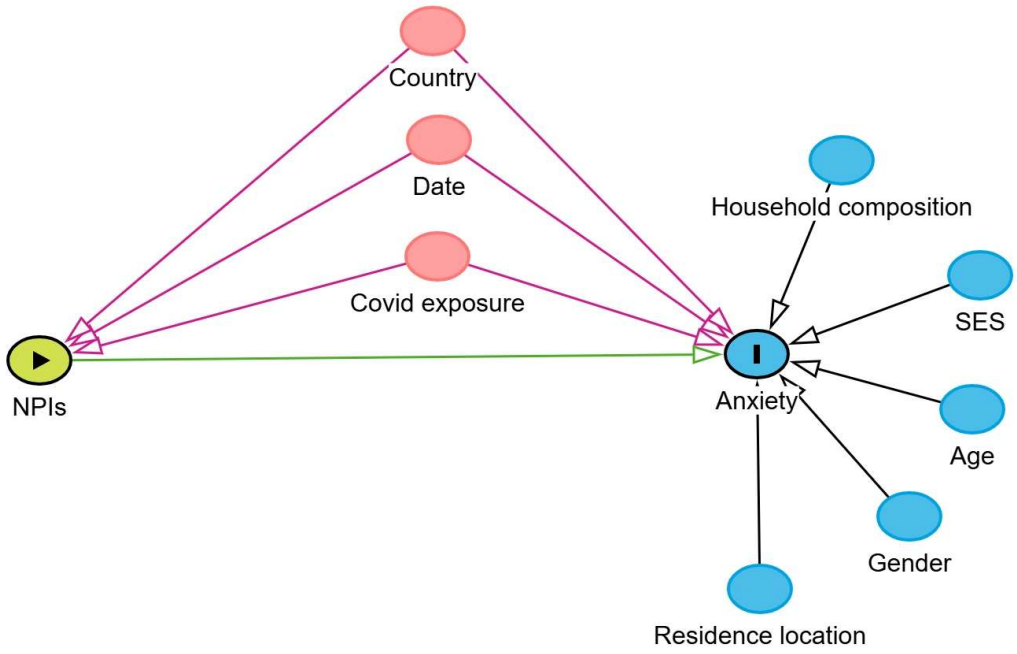


Appendix 2 – Directed Acyclic Graphs (DAGs)

Supplemental Figure 2A. Complete DAG



Supplemental Figure 2B. Simplified DAG – including only variables presented in the analysis



Appendix 3 – sensitivity analysis – modified Poisson regression with robust error

In this sensitivity analysis, Model 1 and 2 were performed using a Poisson regression with robust error to account for the fact that a GAD-7 score ≥ 8 was not a rare outcome. Results were consistent with the main conclusion of the primary analysis: higher SI was associated with increased odds of screening positive for GAD, exposure to the closing of schools and of public transportation was associated with higher odds of a positive GAD screening.

Supplemental Table 1A. Association between the stringency index and Generalized Anxiety Disorder

Characteristic	PR	95% CI	p-value
Stringency Index (SI)	1.11	1.05, 1.18	<0.001
Perceived Covid-19 exposure	1.11	1.06, 1.16	<0.001

Abbreviations: CI = Confidence Interval, RR = Risk Ratio

Weighted multivariable modified Poisson regression including a country-fixed effect and a month-fixed effect

Supplemental Table 1B. Association between different policies and Generalized Anxiety Disorder

Characteristic	PR	95% CI	p-value
School closing	1.42	1.25, 1.61	<0.001
Cancel public events	1.19	0.93, 1.51	0.167
Restrictions on gathering size	0.88	0.69, 1.12	0.286
Close public transport	1.65	1.39, 1.96	<0.001
Stay at home requirements	0.76	0.59, 0.97	0.028
Restrictions on internal movement	0.87	0.75, 1.01	0.063

Abbreviations: CI = Confidence Interval, RR = Risk Ratio

Weighted multivariable modified Poisson regression including a country-fixed effect and a month-fixed effect, and controlling for perceived Covid-19 exposure

Appendix 4 – sensitivity analysis – excluding Mozambican participants

In this sensitivity analysis, Model 1 and 2 were performed excluding participants from Mozambique. Results were consistent with the main conclusion of the primary analysis: higher SI was associated with increased odds of screening positive for GAD, exposure to the closing of schools and of public transportation was associated with higher odds of a positive GAD screening.

Supplemental Table 2A. Association between the stringency index and Generalized Anxiety Disorder

Characteristic	OR	95% CI	p-value
Stringency Index (SI)	1.08	1.03, 1.13	0.002
Perceived Covid-19 exposure	1.11	1.05, 1.18	<0.001

Abbreviations: CI = Confidence Interval, OR = Odds Ratio

Weighted multivariable logistic regression including a country-fixed effect and a month-fixed effect

Supplemental Table 2B. Association between different policies and Generalized Anxiety Disorder

Characteristic	OR	95% CI	p-value
School closing	1.88	1.58, 2.24	<0.001
Cancel public events	0.67	0.48, 0.95	0.025
Restrictions on gathering size	1.42	0.89, 2.27	0.145
Close public transport	5.67	3.70, 8.70	<0.001
Stay at home requirements	0.42	0.25, 0.71	<0.001
Restrictions on internal movement	0.63	0.53, 0.75	<0.001

Abbreviations: CI = Confidence Interval, OR = Odds Ratio

Weighted multivariable logistic regression including a country-fixed effect and a month-fixed effect, and controlling for perceived Covid-19 exposure

Appendix 5 – sensitivity analysis – one regression per policy

In this sensitivity analysis, one regression was performed for each of the six policies of interest, instead of one regression accounting for all policies at the same time. Results were consistent with the main conclusion of the primary analysis: exposure to the closing of school and of public transportation was associated with higher odds of screening positive for GAD.

Supplemental Table 3A. Association between school closing and Generalized Anxiety Disorder

Characteristic	OR	95% CI	p-value
School closing	1.75	1.61, 1.91	<0.001
Perceived Covid-19 exposure	1.17	1.12, 1.23	<0.001

Abbreviations: CI = Confidence Interval, OR = Odds Ratio

Weighted multivariable logistic regression including a country-fixed effect and a month-fixed effect

Supplemental Table 3B. Association between cancellation of public events Generalized Anxiety Disorder

Characteristic	OR	95% CI	p-value
Cancel public events	1.74	1.51, 2.00	<0.001
Perceived Covid-19 exposure	1.18	1.12, 1.23	<0.001

Abbreviations: CI = Confidence Interval, OR = Odds Ratio

Weighted multivariable logistic regression including a country-fixed effect and a month-fixed effect

Supplemental Table 3C. Association between restrictions on gathering size and Generalized Anxiety Disorder

Characteristic	OR	95% CI	p-value
Restrictions on gathering size	0.82	0.74, 0.92	<0.001
Perceived Covid-19 exposure	1.20	1.15, 1.26	<0.001

Abbreviations: CI = Confidence Interval, OR = Odds Ratio

Weighted multivariable logistic regression including a country-fixed effect and a month-fixed effect

Supplemental Table 3D. Association between closure of public transport and Generalized Anxiety Disorder

Characteristic	OR	95% CI	p-value
Close public transport	1.95	1.71, 2.22	<0.001
Perceived Covid-19 exposure	1.18	1.13, 1.23	<0.001

Abbreviations: CI = Confidence Interval, OR = Odds Ratio

Weighted multivariable logistic regression including a country-fixed effect and a month-fixed effect

Supplemental Table 3E. Association between stay-at-home requirements and Generalized Anxiety Disorder

Characteristic	OR	95% CI	p-value
Stay at home requirements	0.67	0.60, 0.75	<0.001
Perceived Covid-19 exposure	1.20	1.15, 1.26	<0.001

Abbreviations: CI = Confidence Interval, OR = Odds Ratio

Weighted multivariable logistic regression including a country-fixed effect and a month-fixed effect

Supplemental Table 3F. Association between restrictions on internal movement and Generalized Anxiety Disorder

Characteristic	OR	95% CI	p-value
Restrictions on internal movement	0.95	0.86, 1.06	0.376
Perceived Covid-19 exposure	1.20	1.15, 1.26	<0.001

Abbreviations: CI = Confidence Interval, OR = Odds Ratio

Weighted multivariable logistic regression including a country-fixed effect and a month-fixed effect

Appendix 6 – sensitivity analysis – cutoff value of 9 at the GAD-7 questionnaire

In this sensitivity analysis, Model 1 and 2 were performed by defining a positive screening for GAD as a value of 9 and above on the GAD-7 questionnaire. Results were consistent with the main conclusion of the primary analysis: higher SI was associated with increased odds of screening positive for GAD, exposure to the closing of schools and of public transportation was associated with higher odds of a positive GAD screening.

Supplemental Table 4A. Association between the stringency index and Generalized Anxiety Disorder

Characteristic	OR	95% CI	p-value
Stringency Index (SI)	1.10	1.05, 1.15	<0.001
Perceived Covid-19 exposure	1.15	1.10, 1.21	<0.001

Abbreviations: CI = Confidence Interval, OR = Odds Ratio

Weighted multivariable logistic regression including a country-fixed effect and a month-fixed effect

Supplemental Table 4B. Association between different policies Generalized Anxiety Disorder

Characteristic	OR	95% CI	p-value
School closing	1.70	1.53, 1.88	<0.001
Cancel public events	1.02	0.82, 1.28	0.831
Restrictions on gathering size	0.76	0.59, 0.97	0.029
Close public transport	2.22	1.86, 2.65	<0.001
Stay at home requirements	0.92	0.73, 1.16	0.494
Restrictions on internal movement	0.71	0.61, 0.82	<0.001

Abbreviations: CI = Confidence Interval, OR = Odds Ratio

Weighted multivariable logistic regression including a country-fixed effect and a month-fixed effect, and controlling for perceived Covid-19 exposure

Appendix 7 – sensitivity analysis – MICE imputation of the variable perceived Covid-19 exposure

In this sensitivity analysis, Model 1 and 2 were performed, after imputation of the variable "perceived COVID-19 exposure" was done using MICE (Multiple Imputation by Chained Equations). Results were consistent with the main conclusion of the primary analysis: higher SI was associated with increased odds of screening positive for GAD, exposure to the closing of schools and of public transportation was associated with higher odds of a positive GAD screening.

Supplemental Table 5A. Association between the stringency index and Generalized Anxiety Disorder

Characteristic	OR	95% CI	p-value
Stringency Index (SI)	1.17	1.12, 1.21	<0.001
Perceived Covid-19 exposure	1.08	1.04, 1.12	<0.001

Abbreviations: CI = Confidence Interval, OR = Odds Ratio

Weighted multivariable logistic regression including a country-fixed effect and a month-fixed effect

Supplemental Table 5B. Association between different policies and Generalized Anxiety Disorder

Characteristic	OR	95% CI	p-value
School closing	1.70	1.55, 1.88	<0.001
Cancel public events	1.24	1.01, 1.51	0.038
Restrictions on gathering size	0.84	0.67, 1.05	0.121
Close public transport	2.15	1.83, 2.53	<0.001
Stay at home requirements	0.72	0.58, 0.89	0.003
Restrictions on internal movement	0.81	0.71, 0.92	0.002

Abbreviations: CI = Confidence Interval, OR = Odds Ratio

Weighted multivariable logistic regression including a country-fixed effect and a month-fixed effect, and controlling for perceived Covid-19 exposure

Appendix 8 - sensitivity analysis – covariate selection following the disjunctive cause criterion

In this sensitivity analysis, Model 1 and 2 were performed, including covariates selected following the modified disjunctive cause criterion described by VanderWeele (50): any pre-exposure covariate that is a cause of the exposure, or the outcome, or both were included. Additionally, variables were excluded if they were considered mediators or instrumental variables (i.e. a variable that is only a cause for the exposure but has no relation with the outcome). Any variable that was considered a proxy to another variable, which was a common cause for the exposure and the outcome was also included.

Based on the literature, perceived COVID-19 exposure was included as it was considered to be a cause both of the exposure and of the outcome (i.e. a confounder). Gender, age, SES, residence location, household composition, marital status and years of education were included as they had been identified as risk factors for anxiety disorders in previous studies. In the binary analysis, all variables were statistically associated with both the exposure and the outcome, though including them in the model modified the beta coefficient by less than 10%.

Results were consistent with the main conclusion of the primary analysis: higher SI was associated with increased odds of screening positive for GAD, exposure to the closing of schools and of public transportation was associated with higher odds of a positive GAD screening.

Individuals aged 25 to 55 had higher odds of screening positive for GAD compared to those aged 18 to 24. Higher odds of screening positive for GAD were also observed among women, individuals from the lowest SES group, and those living in households with children and/or elderly members. In contrast, being married and having more years of education were protective factors against GAD.

Supplemental Table 6A. Association between the stringency index and Generalized Anxiety Disorder

Characteristic	OR	95% CI	p-value
Stringency Index (SI)	1.19	1.14, 1.24	<0.001
Perceived Covid-19 exposure	1.22	1.16, 1.28	<0.001
Age group			
18-24	—	—	
25-35	1.51	1.37, 1.66	<0.001
35-44	1.67	1.50, 1.87	<0.001
45-54	1.70	1.49, 1.93	<0.001
55-100	1.09	0.92, 1.29	0.3
Gender			
Men	—	—	
Women	1.22	1.15, 1.30	<0.001
Residence location			
Rural	—	—	
Urban	1.01	0.94, 1.08	0.9
Years of education	0.96	0.95, 0.97	<0.001
SES group			
Highest	—	—	
Intermediate	1.07	0.97, 1.18	0.2
Lowest	2.04	1.83, 2.29	<0.001
Household composition			
Only adults	—	—	
Children, no elderly	1.95	1.71, 2.24	<0.001
Elderly, no children	1.70	1.25, 2.28	<0.001
Elderly and children	2.34	2.02, 2.71	<0.001
Marital status			
No	—	—	
Yes	0.82	0.77, 0.89	<0.001

Abbreviations: CI = Confidence Interval, OR = Odds Ratio

Weighted multivariable logistic regression including a country-fixed effect and a month-fixed effect

Supplemental Table 6B. Association between different policies and Generalized Anxiety Disorder

Characteristic	OR	95% CI	p-value
School closing	1.74	1.57, 1.91	<0.001
Cancel public events	1.18	0.96, 1.44	0.12
Restrictions on gathering size	0.94	0.74, 1.18	0.6
Close public transport	2.24	1.90, 2.65	<0.001
Stay at home requirements	0.75	0.60, 0.94	0.011
Restrictions on internal movement	0.78	0.68, 0.90	<0.001
Covid-19 exposure	1.24	1.19, 1.30	<0.001

Abbreviations: CI = Confidence Interval, OR = Odds Ratio

Weighted multivariable logistic regression including a country-fixed effect and a month-fixed effect, and controlling for perceived Covid-19 exposure, gender, age, SES, residence location, household composition, marital status and years of education

Appendix 9 – sensitivity analysis – Socioeconomic index calculated by Multiple Correspondence Analysis (MCA)

In this sensitivity analysis, we performed the interaction analysis using a different method to construct the SES index. We performed a Multiple Correspondence Analysis (MCA), including only categorical variables, and therefore excluding the variable reflecting the number of rooms in the participant's accommodation. Agreement in SES classification between the original and modified indices was 85% for the lowest SES class and 70% for the intermediate and highest SES classes (Table 7A). Results were consistent with the initial analysis for the policy "close of public transport". However, for "school closing", in contrast to the initial analysis, neither multiplicative nor additive interaction was observed

Table 7A. Agreement in SES classification between PCA and MCA

	MCA		
PCA	Lowest	Intermediate	Highest
Lowest	85.08	14.91	0.01
Intermediate	14.62	70.29	15.08
Highest	0.23	30.29	69.48

Table 7. Modification of the effect of policies on Generalized Anxiety Disorder by SES

Policy	SES group	Joint effect Policy exposure (OR and 95% CI)		Stratified analysis - within strata of SES (OR and 95% CI)	Product term (OR and 95% CI)	RERI
		No	Yes			
School closing	SES - highest	Ref	1.93 [1.61, 2.31]	1.93 [1.61, 2.31]		
	SES - intermediate	1.40 [1.09, 1.79]	2.34 [1.80, 3.05]	1.68 [1.46, 1.92]	0.87 [0.71, 1.06] p=0.173	-1.46 [-2.14, -0.78]
	SES - lowest	4.60 [3.64, 5.81]	7.46 [5.79, 9.62]	1.62 [1.42, 1.86]	0.84 [0.68, 1.04] p=0.107	-4.69 [-6.00, -3.39]
Close of public transport	SES - highest	Ref	2.98 [2.32, 3.83]	2.98 [2.32, 3.83]		
	SES - intermediate	1.40 [1.09, 1.79]	3.46 [2.67, 4.49]	2.48 [2.04, 3.02]	0.83 [0.64, 1.09] p=0.175	-2.55 [-3.72, -1.37]
	SES - lowest	4.60 [3.64, 5.81]	5.71 [4.36, 7.47]	1.24 [1.01, 1.53]	0.42 [0.32, 0.54] p<0.001	-6.16 [-7.85, -4.48]

Abbreviations: CI = Confidence Interval, OR = Odds Ratio, RERI = Relative Excess Risk due to Interaction

Weighted multivariable logistic regression including a country-fixed effect and a month-fixed effect, and controlling for perceived COVID-19 exposure and other co-existing policies

Résumé – version française

Titre : L'impact des interventions non pharmaceutiques sur les troubles anxieux pendant l'épidémie de COVID-19 en Afrique subsaharienne : résultats d'une enquête transversale dans quatre pays en 2021

Contexte : Pour freiner la propagation de l'épidémie de COVID-19, des interventions non pharmaceutiques (INP) ont été déployées à l'échelle mondiale, permettant une réduction de l'incidence du virus. Cependant, leurs effets sur la santé mentale suscitent des inquiétudes, notamment en Afrique subsaharienne (ASS), où l'impact psychologique pourrait avoir été particulièrement marqué du fait de systèmes de santé déjà fragiles avant la pandémie.

Objectifs : Cette étude visait à analyser le lien entre l'anxiété et la sévérité des INP, ainsi que l'effet de certaines politiques spécifiques. L'objectif secondaire était d'identifier les groupes les plus vulnérables aux fermetures d'écoles et de transports publics.

Méthodes : Nous avons utilisé les données de l'enquête téléphonique transversale *Life with Corona Africa*, menée en 2021 en Ouganda, Tanzanie, Sierra Leone et Mozambique, couplées aux données sur les politiques du *Oxford COVID-19 Government Response Tracker*. Le trouble anxieux généralisé (TAG) a été dépisté par le questionnaire GAD-7. Des régressions logistiques multivariées ont été effectuées.

Résultats : Sur 24 000 participants, une sévérité accrue des politiques était associée à une probabilité plus importante de TAG (OR = 1,15 ; IC 95 % : 1,11–1,20). Les fermetures d'écoles (OR = 1,70, IC 95 % : 1,54–1,87) et des transports publics (OR = 2,15, IC 95 % : 1,83–2,54) étaient les politiques les plus fortement associées au TAG. Les femmes, les plus de 25 ans et les personnes à haut statut socio-économique (SSE) étaient davantage affectées par les fermetures d'écoles ; les hommes, les moins de 25 ou plus de 55 ans, et ceux à haut SSE étaient davantage affectées par les fermetures des transports.

Conclusion : Nos résultats soulignent l'impact des politiques de lutte contre la pandémie sur la santé mentale en Afrique subsaharienne, et la nécessité d'en tenir compte dans la conception des réponses de santé publique. Davantage de recherches sont nécessaires dans cette région pour orienter des politiques équitables et efficaces lors de futures crises sanitaires.

Mots-clés : COVID-19, anxiété, interventions non pharmaceutiques, Afrique subsaharienne