Levels of handwashing and vaccine uptake in Kenya, Uganda, and Tanzania to prevent and control COVID-19: a systematic review and meta-analysis

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Abstract

Introduction: Coronavirus Disease 2019 (COVID-19) presents a massive challenge in Africa due to overwhelmed and underresourced health systems, as well as the existing burden of communicable and non-communicable diseases. Self-inoculation may occur when an individual touches their mucous membrane following direct contact between their hands and severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2)-contaminated surfaces. Therefore, handwashing can be used along with COVID-19 vaccines to reduce the spread of SARS-CoV-2 and the burden of COVID-19. We were interested in investigating the levels of handwashing and vaccine uptake to control and prevent COVID-19 in Kenya, Uganda and Tanzania using a systematic review and meta-analysis.

Methods: We searched PubMed, African Index Medicus and African Journals Online for studies published since inception to 31st January 2023. We included all studies that assessed: the levels of COVID-19 vaccine acceptance and hesitance as indicators of vaccine uptake; and studies on the levels of handwashing to prevent and control COVID-19 in Kenya, Uganda and Tanzania. Study findings were synthesized by meta-analysis to get the pooled effect measure. Three studies were synthesized qualitatively due to high level of heterogeneity in effect measure precluding a quantitative meta-analysis.

Results: Our search identified 128 articles of which 17 studies with 18,305 participants and 622 vaccination sites were reviewed with 14 of them being meta-analyzed. This systematic review and meta-analysis reports high levels of COVID-19 vaccine acceptance and handwashing in Kenya, Uganda and Tanzania at 67% (95% CI: 55, 78) and 88% (95% CI: 73, 97), respectively. Vaccine hesitance among the participants was low at 31% (95% CI: 15, 49).

Conclusions: Despite their importance in the control and prevention of COVID-19, some countries do not implement handwashing and vaccination effectively. There is a need for public health strategies to raise awareness about the importance of handwashing and the uptake of the COVID-19 vaccine.

Registration: PROSPERO ID CRD42023394698; registered on 6th January 2023.

BACKGROUND

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the causal agent of Coronavirus Disease 2019 (COVID-19), is transmitted via respiratory droplets (1). Self-inoculation may occur when one touches their mucous membranes of the nose, mouth, or eyes after direct contact with contaminated surfaces (2). Further, SARS-CoV-2 can be transmitted indirectly when contaminated hands spread the virus to other surfaces (2). As of 16th March 2023, the World Health Organization (WHO) had reported over 760 million verified cases of COVID-19 including more than six million deaths (3). Coronavirus Disease 2019 (COVID-19) presents a massive challenge in Africa due to overwhelmed and underresourced health systems, as well as the existing burden of communicable and non-communicable diseases (4).
Implementing public health and social measures such as handwashing and vaccination against COVID-19 can slow down the spread of SARS-CoV-2 (5). More than 13 billion vaccine doses have been administered globally to control and prevent COVID-19 (3). Clinical trials along with observational studies have reported numerous COVID-19 vaccines to be harmless and efficacious in averting severe illness and risk of death (6–8). Similarly, studies show that handwashing reduces chances of self-contamination and subsequent nasal inoculation; while vaccination prevents SARS-CoV-2 infection and severe health outcomes linked to COVID-19 (9,10). A study reported that handwashing decreased the spread of respiratory viruses by 45–55% (11,12). In addition, Saunders-Hastings et al. reported that hand hygiene decreased the spread of H1N1 influenza in humans by 38% (13). Evaluation of adult participants showed that handwashing was effectual in decreasing the spread of influenza virus (14).

Handwashing and vaccine uptake as well as social distancing have been used as key ways of reducing transmission of SARS-CoV-2 (15). Understanding hand hygiene and vaccine uptake behaviour in Kenya, Uganda and Tanzania may be important in formulating public health programs to contain COVID-19 in the three countries. However, few studies have investigated the link between handwashing and vaccine uptake strategies to control and prevent COVID-19 in East Africa. Our objective was to conduct a systematic review and meta-analysis of levels of handwashing and COVID-19 vaccine uptake in Kenya, Uganda and Tanzania to prevent and control COVID-19. The outcomes of interest included vaccine hesitance and vaccine acceptance as indicators of levels of vaccine uptake, and levels of handwashing.

**METHODS**

**Study design**

We conducted this study according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) and the Centre for Reviews and Dissemination (CRD) guidelines (16,17). The systematic review and meta-analysis was registered under registration number CRD42023394698 on the International Prospective Register of Systematic Reviews (PROSPERO) database.

**Eligibility criteria**

Inclusion criteria: (1) studies on the levels of COVID-19 vaccine acceptance as an indicator of vaccine uptake in Kenya, Uganda and Tanzania; (2) studies on the levels of COVID-19 vaccine hesitance as an indicator of vaccine uptake in Kenya, Uganda and Tanzania; (3) studies on the levels of handwashing to prevent and control COVID-19 in Kenya, Uganda and Tanzania; (4) studies published in any language were considered for inclusion.

Exclusion criteria: (1) literature reviews, conference abstracts, and case series; (2) preprints; (3) articles with unclear measures of vaccine uptake; (4) studies conducted in countries other than Kenya, Uganda and Tanzania; (4) studies on COVID-19 vaccine side effects; (5) studies without the relevant exposure or treatment were excluded.

**Literature search**
We conducted a systematic literature search in PubMed, African Index Medicus and African Journals Online to select plausibly eligible articles published since database inception to 31st January 2023. Moreover, we manually screened citations of eligible articles to identify additional studies. We formulated a search strategy based on the PECOS framework by combining the terms handwashing, vaccine, COVID-19, prevention, policy, Kenya, Uganda, and Tanzania. The search approach used in the PubMed database was modified to suit other databases. The detailed approach of literature search is available in supplementary file 1.

**Study selection**

We used the Mendeley reference manager to manage the articles identified during the search. Identical studies were initially excluded using Mendeley after which irrelevant articles were removed by screening the titles and abstracts for relevance. We then reviewed full texts of the potentially relevant studies to determine eligibility for inclusion. The eligible studies were selected by two independent reviewers and discordant outcomes were resolved through discussion.

**Data extraction**

Two independent researchers extracted data from the eligible articles using a predefined and standardized excel sheet. Variables that were extracted from these studies included: (1) the name of the first author(s); (2) the title of the study; (3) the year of publication; (4) study objective(s); (5) the publishing journal; (6) the study design; (7) the sample size; (8) participants’ characteristics including age; (9) the inclusion and exclusion criteria; (10) indicators of hand washing levels; (11) indicators of vaccine uptake levels; (12) main finding and other findings.

**Quality assessment**

We evaluated the risk of bias in the eligible articles based on the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist. The checklist consists of 22 essential recommendations considered key for good reporting of non-experimental research. These recommendations focus on aspects such as the article's title and abstract, the background, materials and methods, the findings and discussion sections, among others.

**Statistical analysis**

We conducted meta-analyses of single proportions to calculate the overall proportion using the metaprop function of the Meta package in R (version 4.1.2). Heterogeneity between studies was assessed using I² statistics, with an I² of more than 75% indicating substantial heterogeneity. We used a funnel plot to check for publication bias and the Eggers test for assessing funnel plot asymmetry. Heterogeneous studies were synthesized through a narrative summary based on the specific outcome indicator.

**RESULTS**

4.1 Study selection
Our literature search yielded 124 articles and an additional four papers from potentially eligible articles (Figure 1). We excluded 6 duplicates and 90 studies that were irrelevant after screening titles and abstracts. We excluded 15 papers after a full-text review of the remaining articles, including one preprint and 14 others without the outcome of interest. A total of 17 studies with 18,305 participants and 622 vaccination sites were included in the systematic review. Only 14 of the 17 studies were meta-analyzed. Some studies could not be meta-analyzed because they reported heterogeneous effect estimates, including vaccination rates and odds ratios of getting the COVID-19 vaccine.

Basic characteristics of eligible studies

We included observational studies published between 2021 and 2023 in this systematic review and meta-analysis. The eligible studies included 15 cross-sectional studies, one mixed-method study and one longitudinal study. Seven of these studies were conducted in Kenya, with Uganda and Tanzania having eight and two studies, respectively. The sample sizes varied across studies ranging from 33 to 4,136 participants. Only three of four studies that reported handwashing levels in Kenya, Uganda and Tanzania had handwashing as the primary outcome.

Quality evaluation

According to the STROBE checklist, 15 of 17 studies met the recommendations for conducting observational studies (supplementary file 2). This finding indicates high overall methodological quality and low risk of bias of these studies.

Levels of handwashing in Kenya, Uganda and Tanzania

The participants of the studies that reported handwashing levels as a way of preventing and controlling COVID-19 were adults with a mean (SD) ages ranging from 34.8(11.2) years to 38.2(14.8) years. These studies reported that approximately 80.4–97% of the respondents practiced handwashing and 28.6% of facilities enforced obligatory use of hand hygiene (supplementary file 3). Further meta-analysis of three of those studies (N = 1,646) showed that the pooled estimate proportion was 0.88 (95% CI: 0.73, 0.97) (Fig. 2).

Levels of vaccine acceptance in Kenya and Uganda

On the other hand, 10 studies reported on levels of vaccine acceptance in Kenya and Uganda with Tanzania lacking a study with this outcome. Six of the 10 studies were conducted among Ugandan respondents. All the studies were conducted among participants 15 years old and above. The vaccine acceptance rate ranged between 37.3% and 84.5% across studies. Supplementary file 4 shows the characteristics of the studies that focused on vaccine acceptance to prevent and control COVID-19 in Kenya and Uganda. Meta-analysis of eight of those studies (N = 10,384) reported that the pooled estimate proportion for vaccine acceptance in Kenya and Uganda was 0.67 (95% CI: 0.55, 0.78) (Fig. 3).
Levels of vaccine hesitance in Kenya, Uganda and Tanzania

Six observational studies reported the levels of COVID-19 vaccine hesitance among the study participants in Kenya, Uganda and Tanzania. These studies were conducted among adult respondents above 18 years of age. Three of the studies reported vaccine hesitance as a secondary outcome indicating vaccine uptake levels in the three countries. The COVID-19 vaccine hesitance levels across studies were between 6% and 65.5% among the study participants. The characteristics of studies of vaccine hesitance in Kenya, Uganda and Tanzania are depicted in supplementary file 5. A meta-analysis of the six studies (N = 7,032) reported that the pooled estimate proportion was 0.31 (95% CI: 0.15, 0.49) in Kenya, Uganda and Tanzania (Fig. 4).

Publication bias

A funnel plot was evaluated for all three outcomes and the results are shown on supplementary file 6, figures S1 – S3. The two sides of each funnel plot were symmetrical, and no significant publication bias was found in this study.

DISCUSSION

To date, there are scarce data on the levels of handwashing and COVID-19 vaccine uptake in East Africa. Information regarding these interventions to contain the spread of SARS-CoV-2 is helpful in developing public health strategies of managing COVID-19. This study involved conducting a systematic review and meta-analysis of handwashing and vaccine uptake levels among Kenyan, Ugandan, and Tanzanian study participants.

In the current study, a total of 17 articles were systematically reviewed after which 14 were included in the final analysis conducted according to the outcome measure. Overall, the included studies had high methodological quality and the pooled handwashing levels in Kenya, Uganda and Tanzania were 88% (95% CI: 73, 97). The level of vaccine uptake in the three countries was fairly high as indicated by vaccine acceptance and vaccine hesitance at 67% (95% CI: 55, 78) and 31% (95% CI: 15, 49), respectively.

Handwashing was associated with reduced levels of COVID-19 suggesting that this strategy could be effective in the control and prevention of COVID-19. These findings are concordant with those reported by Beale et al. showing that handwashing (6–10 times per day) predicted a decreased susceptibility to coronavirus infection (14).

Despite clinical trials reporting most COVID-19 vaccines to be harmless and efficacious, the findings of this study suggest that there are considerable levels of vaccine hesitance in Kenya, Uganda and Tanzania. These findings are concordant with those of Afolabi and Ilesanmi, and Mutombo et al. which reported considerable vaccine hesitancy in Africa in addition to low COVID-19 vaccine coverage in the continent (18,19).
To the best of our knowledge, this is the first systematic review and meta-analysis exploring levels of handwashing and vaccine uptake in the prevention and control of COVID-19 in Kenya, Uganda and Tanzania. Moreover, our study is comprehensive as it includes a large number of relevant articles published to date. Our systematic review and meta-analysis has a few limitations: we may have missed some studies since some African journals are not indexed in PubMed. Lastly, only observational studies, which tend to provide weaker evidence compared to randomized clinical trials, were included in the meta-analysis section and some studies could not be meta-analyzed.

Conclusions
Evidence of the levels of handwashing and vaccine uptake in Kenya, Uganda and Tanzania is limited and inconsistent. This finding warrants further investigation to determine the levels of handwashing and vaccine uptake to control and prevent COVID-19.

Abbreviations
COVID-19: Coronavirus disease-19; SARS-CoV-2: Severe acute respiratory syndrome coronavirus-2; WHO: World Health Organization; CI: Confidence interval; SD: standard deviation; PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses; CRD: Centre for Reviews and Dissemination guidelines; PROSPERO: International Prospective Register of Systematic Reviews; STROBE: Strengthening the Reporting of Observational Studies in Epidemiology checklist; PECO: population, exposure, comparator, and outcome

Declarations
Ethics approval and consent to participate: Not applicable

Consent for publication: Not applicable because this study did not collect primary data.

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

Supplementary information: Supplementary information is provided in supplementary files 1 – 6.

Competing interests: The authors declare that they have no competing interests.

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Authors’ contributions: JMM: conceptualization, data curation, formal analysis, investigation, methodology, validation, visualization, writing – original draft preparation, writing – review & editing, project administration, supervision; RM: data curation, methodology, writing – review & editing; HM: data
Acknowledgements: Not applicable

References


Figures
Figure 1

PRISMA chart depicting study selection process.

<table>
<thead>
<tr>
<th>Authors</th>
<th>Country</th>
<th>Events</th>
<th>Total</th>
<th>Weight</th>
<th>Proportion [95% CI]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mboowa et al., 2021</td>
<td>Uganda</td>
<td>524</td>
<td>644</td>
<td>33.4%</td>
<td>0.81 [0.78; 0.84]</td>
</tr>
<tr>
<td>Mghambaet et al., 2022</td>
<td>Tanzania</td>
<td>312</td>
<td>390</td>
<td>33.1%</td>
<td>0.80 [0.76; 0.84]</td>
</tr>
<tr>
<td>Mwai et al., 2022</td>
<td>Kenya</td>
<td>594</td>
<td>612</td>
<td>33.4%</td>
<td>0.97 [0.95; 0.98]</td>
</tr>
</tbody>
</table>

Total (95% CI) 1646 100.0% 0.88 [0.73; 0.97]

Heterogeneity: Tau² = 0.0275; Chi² = 120.13, df = 2 (P < 0.01); I² = 98%

Figure 2

Forest plot of the overall proportion of handwashing in Kenya, Uganda and Tanzania. Each study is represented by a black box and a horizontal line, which correspond to the proportion and 95% confidence.
interval, respectively. $I^2$ shows the degree of heterogeneity with p-value indicating whether there was statistically significance heterogeneity between the studies and among the groups.

**Figure 3**

Forest plot of the overall proportion of vaccine acceptance as an indicator of vaccine uptake in Kenya and Uganda. Studies are plotted alphabetically. Each study is represented by a black box and a horizontal line, which correspond to the proportion and 95% confidence interval, respectively. $I^2$ shows the degree of heterogeneity with p-value indicating whether there was statistically significance heterogeneity between the studies and among the groups.

**Figure 4**

Forest plot of the overall proportion of vaccine hesitance as an indicator of vaccine uptake in Kenya, Uganda and Tanzania. Each study is represented by a black box and a horizontal line, which correspond to the proportion and 95% confidence interval, respectively. $I^2$ shows the degree of heterogeneity with p-value indicating whether there was statistically significance heterogeneity between the studies and among the groups.
Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Supplementaryfile1.docx
- Supplementaryfile2.xlsx
- Supplementaryfile3.docx
- Supplementaryfile4.docx
- Supplementaryfile5.docx
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