Paediatric morbidity and mortality in Sierra Leone. Have things changed after the 2014/2015 Ebola outbreak? [version 1; peer review: awaiting peer review]

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Abstract

Background: Sierra Leone was severely affected by the 2014/2015 Ebola outbreak and is likely to have had longer term repercussions on the health system including on paediatric morbidity and mortality. We thus assessed under-five morbidity and mortality for malaria, acute respiratory infections (ARI)/pneumonia, watery diarrhoea and measles during the post-Ebola period in Sierra Leone and compared this with the pre- and intra-Ebola periods.

Methods: This was a retrospective cross-sectional study using program data from the District Health Information system (DHIS2) and sourced from 14 districts in Sierra Leone. It included under-five children from 1,200 health facilities country-wide. Study periods included: before (June 1st, 2013-April 30th, 2014); during (June 1st, 2014-April 30th, 2015); and after Ebola (June 1st, 2016-April 30th, 2017).

Results: Malaria, ARI/pneumonia and diarrhoea consultations declined during Ebola but recovered to pre-Ebola levels in the post-Ebola period. During the post-Ebola period, there was a highly significant reduction in case-fatality for the first three morbidities compared to the pre-Ebola period (P<0.0001). Average number of measles cases increased from 48/month in the pre-Ebola period to 568/month (12-fold increase) post-Ebola. Although there was no difference in measles case-fatality between the pre- and post-Ebola periods, case-fatality post-Ebola was significantly lower than during Ebola (Relative Risk: 0.05, 95% confidence interval 0.02-0.15, P<0.0001).

Conclusions: Consultations for under-five children at health facilities in Sierra Leone recovered to pre-Ebola levels and case-fatality for common childhood illnesses declined significantly. This is a change for the better. However, the high level of reported measles cases in the post-Ebola period indicates gaps in immune status and needs focused attention.

Keywords
Sustainable Development Goals, Outbreak response, Universal Health Coverage, Operational Research, SORT IT
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- **Sesay T:** Conceptualization, Data Curation, Formal Analysis, Investigation, Methodology, Project Administration, Resources, Software, Supervision, Validation, Visualization, Writing – Original Draft Preparation, Writing – Review & Editing;
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- **Zachariah R:** Conceptualization, Formal Analysis, Funding Acquisition, Methodology, Resources, Software, Supervision, Validation, Writing – Original Draft Preparation, Writing – Review & Editing

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Introduction
In 2017, a cross-sectional study documented country-wide morbidity for four common childhood illnesses: malaria, acute respiratory infections (ARI)/pneumonia, watery diarrhoea and measles. There were two main findings. First, during the Ebola outbreak, health facility visits for malaria, ARI and watery diarrhoea dropped significantly nation-wide, without returning to pre-Ebola levels post-outbreak. As these morbidities have similar symptom patterns as Ebola, people may have avoided accessing formal health services to avoid being considered "an Ebola case". Second, measles cases increased dramatically by six-fold during Ebola and the immediate post-Ebola periods. This was attributed to cessation of measles vaccination activities during the Ebola outbreak.

The outbreak was declared over in November 2015. Since then, there have been considerable investments into the health system by Government and development partners. One of the limitations of the 2017 study was that it only included the immediate six-month period after the Ebola outbreak, which might have been too early to assess health system recovery. It is now expected that the country would have fully recovered from the outbreak, but there has been no formal evaluation in this regard.

We thus conducted a similar country-wide study assessing morbidity and mortality for the same childhood illnesses using a longer post-Ebola period and compared this data with the pre- and intra Ebola periods.

Methods
This was a retrospective analysis using routine program data from the District Health Information system (DHIS2) and sourced from all 14 districts in Sierra Leone (see Underlying data).

The study setting was described in detail before. In brief, the health infrastructure is tiered into tertiary hospitals, district hospitals and Peripheral Health Units (PHUs). PHUs include Community Health Centres (CHCs), Community Health Posts (CHPs) and Maternal and Child Health Posts (MCHPs). The Ministry of Health and Sanitation provides free primary health care for children under five across 1,250 health facilities nationwide.

The study population included all children under-five years attending public health facilities nationwide. No children were excluded.

Study periods included: before (June 1st 2013-April 30th 2014); during (June 1st 2014-April 30th 2015); and after Ebola (June 1st 2016-April 30th 2017).

We exported data on health facility visits and mortality for malaria, (ARI)/pneumonia, watery diarrhoea and measles from the DHIS2 to Microsoft excel (2016) for analysis. Differences between groups were assessed using Pearson’s χ² test (Chi square). Levels of significance were set at P ≤ 0.05.

Table 1 shows numbers of cases, deaths and case-fatality (per 1000) for malaria, ARI/pneumonia, watery diarrhoea and measles. Consultations followed a seasonal pattern with an overall decline during Ebola. In the post-Ebola period (assessed six months after the end of the outbreak), consultations reached pre-Ebola levels. In contrast, consultations increased during the last six months of the Ebola outbreak and this trend continued into the post-Ebola period. Average numbers of measles cases were 48/month in the pre-Ebola period, increasing to 87/month in the Ebola period and 568/month (12-fold increase) post-Ebola. Measles cases peaked in March 2017 with 853 cases.

Discussion
This study shows that health facility consultations for malaria, ARI/Pneumonia and watery diarrhoea recovered to pre-Ebola levels and were accompanied by significant country-wide reductions in case-fatality compared to the pre-Ebola period (P<0.001).

For measles, there was a total of 525 cases pre-Ebola, 962 cases during Ebola and 6245 cases post-Ebola. Although there was no difference in measles case-fatality between the pre- and post-Ebola periods case-fatality post-Ebola was significantly lower than during Ebola (Relative Risk: 0.05, 95% confidence interval 0.02–0.15, P<0.0001).

A study strength is that we included data from 1250 health facilities and for similar periods before, during and after the outbreak. A limitation is that our data did not include private health facilities resulting in possible underestimation of disease burden.

There were two key findings. First, the reductions in case fatality from malaria, ARI and watery diarrhoea could be associated with improved post-Ebola health seeking behaviour and re-establishment of community confidence in the health system. The post-Ebola recovery plan of the Government of Sierra Leone with enhanced financial, technical and training
Table 1. Morbidity and case-fatality for four under five morbidities before, during and after the Ebola outbreak in Sierra Leone.

<table>
<thead>
<tr>
<th>Morbidity</th>
<th>Pre-Ebola</th>
<th>Ebola</th>
<th>Post-Ebola</th>
<th>P-value¹</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>N</td>
<td>N</td>
<td></td>
</tr>
<tr>
<td>Malaria</td>
<td>989068</td>
<td>724881</td>
<td>1056354</td>
<td></td>
</tr>
<tr>
<td>Cases</td>
<td>2564</td>
<td>1205</td>
<td>2112</td>
<td></td>
</tr>
<tr>
<td>Deaths</td>
<td>2.6</td>
<td>1.7</td>
<td>2.0</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>ARI/Pneumonia</td>
<td>717345</td>
<td>521860</td>
<td>735836</td>
<td></td>
</tr>
<tr>
<td>Cases</td>
<td>849</td>
<td>794</td>
<td>568</td>
<td></td>
</tr>
<tr>
<td>Deaths</td>
<td>1.2</td>
<td>1.5</td>
<td>0.8</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Watery Diarrhoea</td>
<td>200006</td>
<td>124100</td>
<td>203520</td>
<td></td>
</tr>
<tr>
<td>Cases</td>
<td>361</td>
<td>150</td>
<td>242</td>
<td></td>
</tr>
<tr>
<td>Deaths</td>
<td>1.8</td>
<td>1.2</td>
<td>1.2</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Measles</td>
<td>525</td>
<td>962</td>
<td>6245</td>
<td></td>
</tr>
<tr>
<td>Deaths</td>
<td>1</td>
<td>16</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Deaths/1000</td>
<td>1.9</td>
<td>16.6</td>
<td>1.0</td>
<td>0.5</td>
</tr>
</tbody>
</table>

¹ Pre-Ebola: June 1st 2013 – April 30th 2014; Ebola: June 1st 2014 – April 30th 2015; Post-Ebola: June 1st 2016 – April 30th 2017.

² Chi-square comparing the pre-Ebola and post-Ebola periods.
support from partners may also have contributed. Furthermore, community health worker activities including early identification and referrals of ill children were promoted which in turn would contribute to reducing mortality.

Second, increased measles cases during and after Ebola could be attributed to vaccination service cessation during Ebola in line with the recommendation to avoid invasive procedures as a way of minimizing Ebola-related occupational risks. Many children would have missed their measles vaccination, resulting in a reduction in herd immunity as well as an accumulation of unvaccinated children. Measles coverage among children under two years in 2017 (post-Ebola) stood at 80% while pre-Ebola this was at a low 78.6%. This implies that measles vaccination coverage was already below the desired level prior to Ebola and remained below desired levels after Ebola. This calls for measles vaccination campaigns at a higher age cut-off (6 months–15 years) to increase vaccination coverage to at least 95%. Laboratory confirmation is also needed to ensure that reported cases are not being mis-diagnosed since measles diagnosis is largely clinical.

In conclusion, consultations of under-five children at health facilities in Sierra Leone recovered to pre-Ebola levels and case-fatality for common childhood illnesses declined significantly. This is a change for the better. However, the high level of reported measles cases in the post-Ebola period needs focused attention.

Data availability
Source data

The Sierra Leone Health Management Information Systems, the District Health Information System 2 (DHIS2), is accessible with a Ministry of Health and Sanitation (MOHS) login through https://sl.dhis2.org/. The Directorate of Policy, Planning, and Information (DPPI) can be contacted to arrange access through Dr. Francis Smart (drfsmart@gmail.com), Director, DPPI, MOHS.

Underlying data

Repository: Dataset 1. Sesay_Tom_SORTIT2_paed_data. https://doi.org/10.17605/OSF.IO/SYP7G

This project contains the following underlying data:

- Sesay_T_casefatality_data.xlsx (case fatality data)
- Sesay_T_morbidity_data.xlsx (morbidity data)
- Sesay_T_paed_datadictionary.xlsx (data dictionary)

Data are available under the terms of the Creative Commons Zero “No rights reserved” data waiver (CC0 1.0 Public domain dedication).

Grant information

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The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

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