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

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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-fataliy 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-fataliy 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
This article is included in the Disease Outbreaks gateway.

This article is included in the TDR gateway.

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**Introduction**

In 2017, a cross-sectional study\(^1\) 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\(^1\) 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\(^1\)).

The study setting was described in detail before\(^1\). 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 1\(^{st}\) 2013-April 30\(^{th}\) 2014); during (June 1\(^{st}\) 2014-April 30\(^{th}\) 2015); and after Ebola (June 1\(^{st}\) 2016-April 30\(^{th}\) 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 \(X^2\) test (Chi square). Levels of significance were set at \(P \leq 0.05\).

**Results**

Country-wide trend in out-patient consultations for under-five morbidities

Figure 1 shows country-wide trends in outpatient consultations for malaria, ARI, 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, measles 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.

Morbidity and case-fatality for four under-five morbidities

Table 1 shows numbers of cases, deaths and case-fatality (per 1000) for malaria, ARI/pneumonia, watery diarrhoea and measles. 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 (\(P<0.0001\)). 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, \(P<0.0001\)).

**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. Despite a dramatic increase in measles cases post-Ebola, there was a significant mortality reduction, suggesting overall improvements in clinical care.

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\(^1\) of the Government of Sierra Leone with enhanced financial, technical and training support.

**Ethics and consent**

Ethics approval was obtained from the Sierra Leone Ethics and Scientific Review Board (dated 14 December 2018) and the Union Ethics Advisory Group (International Union against Tuberculosis and Lung Disease, Paris, France; EAG number: 68/18). As the study used anonymous data, there was no need for informed consent.
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></th>
<th>Pre-Ebola n</th>
<th>Ebola N</th>
<th>Post-Ebola N</th>
<th>P-value1</th>
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<tr>
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<td></td>
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<td>Cases</td>
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<td>Deaths/1000</td>
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<td>1.7</td>
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<td></td>
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<td>ARI/Pneumonia</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cases</td>
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<td>Watery Diarrhoea</td>
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<tr>
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<td>203520</td>
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<td>242</td>
<td></td>
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<tr>
<td>Deaths/1000</td>
<td>1.8</td>
<td>1.2</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td>Measles</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cases</td>
<td>525</td>
<td>962</td>
<td>6245</td>
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<tr>
<td>Deaths</td>
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<td>6</td>
<td>0.5</td>
</tr>
<tr>
<td>Deaths/1000</td>
<td>1.9</td>
<td>16.6</td>
<td>1.0</td>
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</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.

Figure 1. Trends in consultations for childhood morbidities in the pre-Ebola (1 June 2013–30 April 2014), intra-Ebola (1 June 2013–30 April 2014), and post-Ebola (1 June 2016–30 April 2017) periods, Sierra Leone.
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\(^1\). 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\(^%\)\(^5\) while pre-Ebola this was at a low 78.6\(^%\).\(^6\) 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\(^%\).\(^7\)\(^8\). 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/](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](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_databindictionary.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

The programme was funded by the Special Programme for Research and Training in Tropical Diseases hosted at the World Health Organization (TDR).

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

Acknowledgement

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References

6. Statistics Sierra Leone (SSL) and ICF International: Sierra Leone Demographic and Health Survey 2013. Freetown, Sierra Leone and Rockville, Maryland, USA; SSL and ICF International. 2014. [Reference Source](https://www.siemarecovery.msfi.org/documents/10180/24239/NERS_Sierra+Leone+FEB+2018.pdf)

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The authors of this paper have looked at trends in the pediatric morbidity and mortality prior to, during and after the 2014-15 Ebola outbreak in West Africa. The impact of large scale outbreaks on health systems remains a critical area of research, and the authors should be congratulated in contributing to this area of work. The comments below are intended to better contextualize the analysis and conclusions proposed by the authors.

- The authors divide the paper into three distinct time periods, with ‘post-Ebola’ defined as beginning in June 2016 and extending through April 2017. While the end of the Ebola outbreak in Sierra Leone was declared in November 2015, there continued to be additional Ebola clusters in the country and the region into the ‘post-Ebola’ study period. The policy of mandatory Ebola testing for all deaths also continued until June 2016.

- During the ‘post-Ebola’ time period in the paper, there was an enormous influx of funding to improve health systems at both the facility and community levels that was organized under the Presidential Recovery Plan. This funding supported the national and sub-national health systems but was also supplemented by NGO and other non-governmental health services. By the end of 2017, there were substantial reductions in the funds available for health systems and service delivery.

- The continued specter of Ebola transmission and the rapid scale-up in health resources likely had both negative and positive impacts on health systems utilization that are difficult to quantify. The authors have documented significantly lower case fatality rates for three diseases than the pre-Ebola time period which would support the conclusion that there was regained community trust in the health services. However, those services were not the same ones available prior to the Ebola outbreak and the services are difficult to maintain with reduced external resources.

- In order to compare the pre and post-Ebola periods, I would recommend that the analysis be extended to the immediate post-Ebola period included in this paper as well as a longer-term
post-Ebola period through 2018 which would better capture the more sustainable health system in Sierra Leone rather than the one served by a short-term, high-volume influx of external funding.

- Aside from the clear spikes in measles consultations, Figure 1 is difficult to interpret when displayed by time period. The differences may be more impactful if compared by disease instead.

- The analysis supports the conclusion that measles surged during and post-Ebola and this is backed up by other research and program documentation. However, it does not necessarily support the recommendation to extend the cut off age for vaccination. The recommendation to conduct laboratory confirmation for measles is also not necessarily supported by the data presented. Is this because a number of the measles outbreaks were determined to be rubella which is currently not on the vaccine schedule? If yes, this should be documented by the data. What would be the impact on measles morbidity if there was increased diagnostic versus syndromic management of measles?

Is the work clearly and accurately presented and does it cite the current literature?
Partly

Is the study design appropriate and is the work technically sound?
Partly

Are sufficient details of methods and analysis provided to allow replication by others?
Yes

If applicable, is the statistical analysis and its interpretation appropriate?
Yes

Are all the source data underlying the results available to ensure full reproducibility?
Yes

Are the conclusions drawn adequately supported by the results?
Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Infectious disease epidemiology

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.
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