Machine Learning Identifies Key Risk Factors of Linear Growth Faltering and Death in Young Children With and Without Diarrhea

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Introduction
- Stunting: height-for-age (HAZ) z-score >2 standard deviations below population mean (1).
- ~140 million children stunted globally (2).
- Short-term: Stunting leads to worse health, delayed cognitive development, and increased expenses (medical care, lost work) (3).
- Long-term: Stunting contributes to adult comorbidities, including obesity, reproductive issues, lower school performance, decreased work ability (3).
- The causes of stunting are multifaceted, including national, neighborhood, household, individual factors (4).
- 13.5% of all stunting is attributable to diarrhea disease (4).
- Seeking care for any cause (i.e. diarrhea) is an opportunity to identify children at risk for negative outcomes (e.g. growth faltering, death).
- Aim: Use machine learning methods to identify key risk factors predictive of growth faltering and death for children with and without diarrhea in low and middle income countries (LMICs).

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Predictive Models of Growth Faltering and Death

<table>
<thead>
<tr>
<th>Predictive Model Building</th>
<th>Outcome/Measure</th>
<th>AUC (95% CI)</th>
<th>Top 10 Predictors</th>
</tr>
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<tbody>
<tr>
<td>Logistic regression</td>
<td>Mortality</td>
<td>0.67 (0.66, 0.69)</td>
<td>HAZ, MUAC, Respiratory Rate, Temperature, Age, # ppl house, # sleeping rms, Water source, Age</td>
</tr>
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Conclusions
- We were able to predict with moderate discriminative ability which children experienced growth faltering, especially in the youngest children.
- Risk factors and predictive ability were the same for cases and controls.
- Any healthcare contact represents an opportunity to identify children most at risk of growth faltering.
- We had good ability to predict child mortality when children sought care for acute diarrheal disease.
- When children present for acute diarrheal care, we can identify children most likely to die at the hospital and after discharge.

References
1) WHO Child Growth Standards.
2) https://data.unicef.org/topic/nutrition/mahnnutrition/#-t=text-in%202017/05/26/21.3586/per+cent.195%2520in+develop+30+20+44.4%20in+develop/2

Global Enteric Multicenter Study (GEMS)

Gates Foundation funded study of children’s diarrheal conducted in 7 different countries (5) Data collected 2007-2011 in children <5 years Case-control study of children <60months seeking care for acute moderate or severe diarrheal Acute diarrheal: >3 loosen than normal stools within 24 hours Each case matched with 3-6 community controls without diarrheal Clinical & epidemiological info collected from cases and controls at enrollment and ~60 days later 150+ possible predictors explored

Results
- The youngest children (0-11 mo) experienced the most growth faltering and death.
- There were few deaths in controls, but growth faltering was prevalent in the youngest controls.
- Top predictors were similar for growth faltering and death across cases, controls, and age categories, and included child descriptors, individual symptoms, and household socio-economic status markers.
- Using this data, we had moderate discriminative ability to predict growth faltering in cases across all age groups (AUC ~ 0.6).
- Our models had lightly higher ability to predict growth faltering in controls (AUC ~ 0.7).
- There was good discriminative ability to predict death in cases (AUC ~ 0.8), but poor ability in controls.