Impact Evaluation of Interventions on Child Health in Nepal

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Economist and Technical Officer
3ie
Rennes, France

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## Diarrhea Prevalence in Nepal

### Table: 2001 Child Diarrhea Prevalence

<table>
<thead>
<tr>
<th>Response</th>
<th>Number</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>5,086</td>
<td>79</td>
</tr>
<tr>
<td>Yes</td>
<td>1,285</td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
<td>6,415</td>
<td>100</td>
</tr>
</tbody>
</table>

*Source: DHS 2001*

### Table: 2006 Child Diarrhea Prevalence

<table>
<thead>
<tr>
<th>Response</th>
<th>Number</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>4,757</td>
<td>87</td>
</tr>
<tr>
<td>Yes</td>
<td>659</td>
<td>12</td>
</tr>
<tr>
<td>Total</td>
<td>5,457</td>
<td>100</td>
</tr>
</tbody>
</table>

*Source: DHS 2006*
# Access to Drinking Water

## 2001 Water Source

<table>
<thead>
<tr>
<th>Source</th>
<th>Number</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piped Water</td>
<td>485</td>
<td>7</td>
</tr>
<tr>
<td>Public tap</td>
<td>1,825</td>
<td>26</td>
</tr>
<tr>
<td>Pvt. Well</td>
<td>135</td>
<td>2</td>
</tr>
<tr>
<td>Public Well</td>
<td>133</td>
<td>2</td>
</tr>
<tr>
<td>Tubewell</td>
<td>1,288</td>
<td>19</td>
</tr>
<tr>
<td>Public tubewell</td>
<td>1,177</td>
<td>17</td>
</tr>
<tr>
<td>Sprong/kuwa</td>
<td>1,267</td>
<td>18</td>
</tr>
<tr>
<td>River/lake/pond</td>
<td>166</td>
<td>2</td>
</tr>
<tr>
<td>Stone tap/dhara</td>
<td>58</td>
<td>1</td>
</tr>
<tr>
<td>Not resident</td>
<td>393</td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>6,929</td>
<td>100</td>
</tr>
</tbody>
</table>

*Source: DHS 2001*

## 2006 Water Source

<table>
<thead>
<tr>
<th>Source</th>
<th>Number</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piped Water</td>
<td>513</td>
<td>9</td>
</tr>
<tr>
<td>Public tap</td>
<td>1,361</td>
<td>24</td>
</tr>
<tr>
<td>Pvt. well</td>
<td>25</td>
<td>0</td>
</tr>
<tr>
<td>Public well</td>
<td>140</td>
<td>2</td>
</tr>
<tr>
<td>Tubewell</td>
<td>2,044</td>
<td>35</td>
</tr>
<tr>
<td>Protected spring</td>
<td>144</td>
<td>2</td>
</tr>
<tr>
<td>Unprotected spring</td>
<td>640</td>
<td>11</td>
</tr>
<tr>
<td>River/dam/pond</td>
<td>376</td>
<td>7</td>
</tr>
<tr>
<td>Stone tap/dhara</td>
<td>205</td>
<td>4</td>
</tr>
<tr>
<td>Not dejure resident</td>
<td>318</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>5,783</td>
<td>100</td>
</tr>
</tbody>
</table>

*Source: DHS 2006*
Access to Sanitation

Table: 2001 Toilet Facility

<table>
<thead>
<tr>
<th>Type</th>
<th>Number</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flush Toilet</td>
<td>511</td>
<td>7</td>
</tr>
<tr>
<td>Trad. Pit Toilet</td>
<td>971</td>
<td>14</td>
</tr>
<tr>
<td>Vent. Pit latrine</td>
<td>116</td>
<td>2</td>
</tr>
<tr>
<td>No facility</td>
<td>4,940</td>
<td>71</td>
</tr>
<tr>
<td>Not resident</td>
<td>393</td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>6,931</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

*Source: DHS 2001*

Table: 2006 Toilet Facility

<table>
<thead>
<tr>
<th>Type</th>
<th>Number</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flush Toilet</td>
<td>1192</td>
<td>21</td>
</tr>
<tr>
<td>Trad Pit Toilet</td>
<td>909</td>
<td>15</td>
</tr>
<tr>
<td>Vent. Pit Latrine</td>
<td>48</td>
<td>1</td>
</tr>
<tr>
<td>No facility</td>
<td>3,250</td>
<td>56</td>
</tr>
<tr>
<td>Not dejure resident</td>
<td>318</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>5,782</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

*Source: DHS 2006*
Diarrhea Prevalence By Child Age in Months

1
Mean = 24.1 Months
Median = 21 Months

2
Mean = 23.13 Months
Median = 19 Months
Diarrhea Prevalence: Access to ”Improved Sanitation”

<table>
<thead>
<tr>
<th>Imp. Toilet</th>
<th>Diarrhea</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>111</td>
<td>1131</td>
</tr>
<tr>
<td>0</td>
<td>548</td>
<td>3993</td>
</tr>
</tbody>
</table>

*Source: DHS 2006*

2

\[
\text{Odds Ratio} = \frac{\frac{P_1}{1-P_1}}{\frac{P_0}{1-P_0}} = 1.46
\]
## Naive Comparison: Access to "Improved Sanitation"

### Table: Naive Comparison: Household Characteristics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Treatment</th>
<th>(Untreated)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipewtr. in house?</td>
<td>23.2%</td>
<td>5%</td>
</tr>
<tr>
<td>Rural</td>
<td>52%</td>
<td>84%</td>
</tr>
<tr>
<td>Head Hd has sec. or more ed.</td>
<td>56%</td>
<td>30%</td>
</tr>
<tr>
<td>House Floor = Cement</td>
<td>29%</td>
<td>3%</td>
</tr>
<tr>
<td>Richest Quintile</td>
<td>54%</td>
<td>4%</td>
</tr>
</tbody>
</table>

*Source: DHS 2006*
1

**Fundamental problem** with program evaluation is that it is physically impossible to observe counterfactual

2

Rubin (1974) gave us the model of identification of causal effects, which relies on the notion of a *synthetic counterfactual* for each observation. The model is based on work by Neyman (1923,1935) and Fisher (1918,1925); see also Tukey (1954), Wold (1956), Cochran (1965), Pearl (2000), and Rosenbaum (2002).
Matching

- Basic idea of matching is to compare outcome of treated and untreated individuals with similar $x'$s and then aggregating across $x'$s to get population average treatment effect. Advantage to regression approach is that it does not assume $x'$s linearly effect outcomes.

- Propensity score matching (PSM)

$$\Delta^M = \frac{1}{N_T} \sum_{i \in (D=1)} [y_{1,i} - \sum_j w(i, j)y_{0,j}]$$

is to estimate the propensity score from the data, and then use that estimate to weight treatment effects for each propensity score accordingly to arrive at average treatment effect.
Comparision of Groups: Before versus After Matching

<table>
<thead>
<tr>
<th>Variable</th>
<th>Treatment</th>
<th>(Untreated)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pipewtr. in house?</td>
<td>23.2%</td>
<td>15%</td>
</tr>
<tr>
<td>Rural</td>
<td>53%</td>
<td>58%</td>
</tr>
<tr>
<td>Head Hd has sec. or more ed.</td>
<td>45%</td>
<td>41%</td>
</tr>
<tr>
<td>House Floor= Cement</td>
<td>30%</td>
<td>33%</td>
</tr>
<tr>
<td>Richest Quintile</td>
<td>52%</td>
<td>52%</td>
</tr>
</tbody>
</table>

Source: DHS 2006
Impact Evaluation: Kernel Matching Results

1

**Table:** 2006 Results for Intervention on Diarrhea

<table>
<thead>
<tr>
<th>Variable</th>
<th>Treatment</th>
<th>(Control)</th>
<th>Δ</th>
<th>S.E.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unmatched</td>
<td>0.091</td>
<td>0.122</td>
<td>-.032</td>
<td>(0.01)**</td>
</tr>
<tr>
<td>Matched</td>
<td>0.091</td>
<td>.143</td>
<td>-0.0524</td>
<td>(0.02)**</td>
</tr>
</tbody>
</table>

*Note: ”Treatment” = Improved Sanitation*

2

\[
\frac{\frac{P_1}{1-P_1}}{\frac{P_0}{1-P_0}} = 1.66
\]
Impact Evaluation: Kernel Matching Results

Table: 2006 Results for Intervention on Diarrhea for Boys

<table>
<thead>
<tr>
<th>Variable</th>
<th>Treatment (Control)</th>
<th>Δ</th>
<th>S.E.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unmatched</td>
<td>0.091</td>
<td>0.132</td>
<td>-.041</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.01)</td>
</tr>
<tr>
<td>Matched</td>
<td>0.091</td>
<td>.151</td>
<td>-0.06</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.035)</td>
</tr>
</tbody>
</table>

Note: ”Treatment” = Improved Sanitation

Table: 2006 Results for Intervention on Diarrhea for Girls

<table>
<thead>
<tr>
<th>Variable</th>
<th>Treatment (Control)</th>
<th>Δ</th>
<th>S.E.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unmatched</td>
<td>0.089</td>
<td>0.111</td>
<td>-.022</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.01)</td>
</tr>
<tr>
<td>Matched</td>
<td>0.089</td>
<td>.1428</td>
<td>-0.0521</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.03)</td>
</tr>
</tbody>
</table>

Note: ”Treatment” = Improved Sanitation
## Diarrhea Incidence Among Very Young Children

### Table: 2001 Child Diarrhea Prevalence Among ≤ 24 Months

<table>
<thead>
<tr>
<th>Response</th>
<th>Number</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>1,911</td>
<td>72.25</td>
</tr>
<tr>
<td><strong>Yes</strong></td>
<td>733</td>
<td>27.7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>2,645</td>
<td>100</td>
</tr>
</tbody>
</table>

*Source: DHS 2001*

### Table: 2006 Child Diarrhea Prevalence Among ≤ 24 Months

<table>
<thead>
<tr>
<th>Response</th>
<th>Number</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>1,744</td>
<td>81.27</td>
</tr>
<tr>
<td><strong>Yes</strong></td>
<td>402</td>
<td>18.7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>2,146</td>
<td>100</td>
</tr>
</tbody>
</table>

*Source: DHS 2006*
Diarrhea Incidence Among Very Young Children

Table: 2006 Results for Intervention for Children ≤ 24 Months

<table>
<thead>
<tr>
<th>Variable</th>
<th>Treatment</th>
<th>(Control)</th>
<th>Δ</th>
<th>S.E.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unmatched</td>
<td>0.151</td>
<td>0.203</td>
<td>-.052</td>
<td>(0.02)**</td>
</tr>
<tr>
<td>Matched</td>
<td>0.151</td>
<td>.261</td>
<td>-0.11</td>
<td>(0.05)**</td>
</tr>
</tbody>
</table>

Note: ”Treatment” = Improved Sanitation

\[
\text{Odds Ratio} = \frac{\frac{P_1}{1-P_1}}{\frac{P_0}{1-P_0}} = 1.75
\]
Nutritional Status and Diarrhea Incidence
# Results

## Impact Evaluation: Nutritional Health and Sanitation

### Table: 2006 Results for **Height for Age Scores**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Treatment (Control)</th>
<th>Δ</th>
<th>S.E.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unmatched</td>
<td>1884.365 1268.91</td>
<td>615.45</td>
<td>(75.44)**</td>
</tr>
<tr>
<td>Matched</td>
<td>1884.365 1621.09</td>
<td>263.27</td>
<td>(165.97)↑</td>
</tr>
</tbody>
</table>

*Note: “Treatment” = Improved Sanitation*

### Table: 2006 Results for **Weight For Age Scores**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Treatment (Control)</th>
<th>Δ</th>
<th>S.E.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unmatched</td>
<td>1523.95 984.97</td>
<td>539</td>
<td>(64.78)**</td>
</tr>
<tr>
<td>Matched</td>
<td>1523.95 1224.52</td>
<td>299.42</td>
<td>(142.12)**</td>
</tr>
</tbody>
</table>

*Note: “Treatment” = Improved Sanitation*
Post-Estimation: Propensity Score Distribution
### Table: Summary Statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pseudo-R$^2$</th>
<th>(LR $\chi^2$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unmatched</td>
<td>0.47</td>
<td>2703.05</td>
</tr>
<tr>
<td>Matched</td>
<td>0.041</td>
<td>154.24</td>
</tr>
</tbody>
</table>

*Source: DHS 2006*

### Table: Abs(Standardized Bias)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>(Median)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before Matching</td>
<td>28%</td>
<td>16%</td>
</tr>
<tr>
<td>After Matching</td>
<td>6.7%</td>
<td>2.6%</td>
</tr>
</tbody>
</table>

*Source: DHS 2006*
Post-Estimation: Rosenbaum Bounds

Table: Mantel-Haenszel bounds for Outcome = Diarrhea

<table>
<thead>
<tr>
<th>Γ</th>
<th>$Q_{MH+}$</th>
<th>$Q_{MH-}$</th>
<th>$p_{MH+}$</th>
<th>$p_{MH-}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Γ = 1</td>
<td>3.05</td>
<td>3.05</td>
<td>.001</td>
<td>.001</td>
</tr>
<tr>
<td>Γ = 1.25</td>
<td>5.12</td>
<td>1.01</td>
<td>0</td>
<td>.15</td>
</tr>
<tr>
<td>Γ = 1.50</td>
<td>6.85</td>
<td>.53</td>
<td>0</td>
<td>.29</td>
</tr>
<tr>
<td>Γ = 1.75</td>
<td>8.34</td>
<td>1.93</td>
<td>0</td>
<td>.02</td>
</tr>
<tr>
<td>Γ = 2.0</td>
<td>9.66</td>
<td>3.16</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Source: MH Bounds using STATA 10

Note: Γ = 1 ≈ No "Hidden" Heterogeneity
Note: $Q_{mh+}$ : Mantel-Haenszel statistic
Note: $Q_{mh-}$ : Mantel-Haenszel statistic
Note: $p_{mh+}$ : significance level