Cluster survey evaluation of coverage and risk factors for failure to be immunized during the 1995 National Immunization Days in Egypt

Mary R Reichler, Ahmed Darwish, George Stroh, John Stevenson, Mahmoud Abu Al Nasr, Said Ali Oun and MH Wahdan

Background  In 1995, Egypt continued to experience endemic wild poliovirus transmission despite achieving high routine immunization coverage with at least three doses of oral poliovirus vaccine (OPV3) and implementing National Immunization Days (NIDs) annually for several years.

Methods  Parents of 4188 children in 3216 households throughout Egypt were surveyed after the second round of the 1995 NIDs.

Results  Nationwide, 74% of children are estimated to have received both NID doses, 17% one NID dose, and 9% neither NID dose. Previously unimmunized (47%) or partially immunized (64%) children were less likely to receive two NID doses of OPV than were fully immunized children (76%) (P < 0.001). Other risk factors nationwide for failure to receive NID OPV included distance from residence to nearest NID site >10 minute walk (P < 0.001), not being informed about the NID at least one day in advance (P < 0.001), and residing in a household which does not watch television (P < 0.001). Based on these findings, subsequent NIDs in Egypt were modified to improve coverage, which has resulted in a marked decrease in the incidence of paralytic poliomyelitis in Egypt.

Conclusions  In selected situations, surveys can provide important information that is useful for planning future NIDs.

Keywords  Poliomyelitis, immunization survey, Egypt, eradication, National Immunization Days

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From 1988 to 1995, the incidence of paralytic poliomyelitis decreased markedly worldwide, including a 66% decline in reported cases (from 2342 to 789) in the Eastern Mediterranean region of the World Health Organization (WHO).1-3 These achievements are the result of implementing three major poliomyelitis eradication strategies in all six WHO regions: (1) achieving high vaccination coverage among children with at least three doses of oral poliovirus vaccine (OPV) delivered through the routine programme; (2) administering supplementary doses of OPV to all young children during National Immunization Days (NIDs) and door-to-door vaccination campaigns in high risk areas ['nipping up']; and (3) developing sensitive systems of epidemiological and laboratory surveillance.1,3-5

In nearly all polio-endemic countries where these strategies have been fully implemented, wild poliovirus transmission has been markedly reduced or interrupted within a few years. Egypt, however, continued to experience endemic wild poliovirus transmission until very recently despite sustaining high (>85%) coverage with at least three routine doses of OPV (OPV3) since 1987 and implementing NIDs annually since 1990.6,7

Reasons for the less than optimal impact of supplementary immunization activities in Egypt have not been firmly established. It has been suggested that one factor which may have lessened the impact of certain NIDs in Egypt is the fact that in some years fewer than two NID rounds were conducted, and not all NID rounds were conducted during the low season for enterovirus transmission.3-7,8 We conducted a nationwide survey following the second round of the 1995 NIDs in Egypt to
Table 1 Characteristics, routine immunization coverage, and National Immunization Day (NID) coverage of the survey population nationwide and in each stratum

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Nationwide</th>
<th>Cairo high-risk</th>
<th>Cairo general</th>
<th>Upper Egypt urban</th>
<th>Upper Egypt rural</th>
<th>Lower Egypt urban</th>
<th>Lower Egypt rural</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of households</td>
<td>3216</td>
<td>373</td>
<td>298</td>
<td>570</td>
<td>800</td>
<td>533</td>
<td>642</td>
</tr>
<tr>
<td>No. of children</td>
<td>4188</td>
<td>450</td>
<td>350</td>
<td>310</td>
<td>762</td>
<td>1130</td>
<td>650</td>
</tr>
<tr>
<td>Age Distribution</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0–11 months</td>
<td>1277 (30)</td>
<td>129 (29)</td>
<td>118 (34)</td>
<td>225 (30)</td>
<td>352 (31)</td>
<td>208 (32)</td>
<td>245 (29)</td>
</tr>
<tr>
<td>12–23 months</td>
<td>1050 (23)</td>
<td>122 (27)</td>
<td>99 (28)</td>
<td>198 (26)</td>
<td>265 (23)</td>
<td>156 (24)</td>
<td>210 (25)</td>
</tr>
<tr>
<td>24–35 months</td>
<td>977 (23)</td>
<td>104 (23)</td>
<td>63 (18)</td>
<td>181 (24)</td>
<td>274 (24)</td>
<td>148 (23)</td>
<td>207 (24)</td>
</tr>
<tr>
<td>36–47 months</td>
<td>864 (21)</td>
<td>95 (21)</td>
<td>70 (20)</td>
<td>158 (21)</td>
<td>239 (21)</td>
<td>138 (21)</td>
<td>184 (22)</td>
</tr>
<tr>
<td>Receiving ≥3 routine doses of OPV</td>
<td>(93)</td>
<td>(97)</td>
<td>(99)</td>
<td>(91)</td>
<td>(89)</td>
<td>(91)</td>
<td>(83)</td>
</tr>
<tr>
<td>Receiving NID1</td>
<td>(84)</td>
<td>(84)</td>
<td>(85)</td>
<td>(78)</td>
<td>(81)</td>
<td>(83)</td>
<td>(86)</td>
</tr>
<tr>
<td>Receiving NID2</td>
<td>(83)</td>
<td>(86)</td>
<td>(81)</td>
<td>(73)</td>
<td>(80)</td>
<td>(81)</td>
<td>(84)</td>
</tr>
</tbody>
</table>

Determine if one or more of the following factors could help explain the less than optimal impact of poliomyelitis eradication efforts in Egypt: (1) achieving lower NID immunization coverage than estimated by administrative methods; (2) failure to reach previously unimmunized children during NIDs; or (3) suboptimal NID immunization coverage in specific age groups. Our study provides estimates of NID OPV coverage nationwide, by geographical region, by prior routine immunization status, and by age group; identifies several risk factors for failure to be immunized during the NIDs; and evaluates the effectiveness of the NID media campaign.

Methods

Study design

To estimate coverage achieved during the 1995 NIDs, to evaluate risk factors for failure to be immunized, and to determine the effectiveness of mass media in promoting community awareness of NIDs, a stratified multi-stage cluster survey was conducted one month after the second NID round. Because it was expected that coverage could vary between the three geographically distinct sectors of Egypt (Upper Egypt, Lower Egypt, and Greater Cairo) and between urban and rural areas, six mutually exclusive strata of the population in Egypt were delineated: (1) high-risk population of Greater Cairo, (2) general population of Greater Cairo, (3) urban Upper Egypt, (4) rural Upper Egypt, (5) urban Lower Egypt, and (6) rural Lower Egypt. The design and sample size selected for this study were sufficient to provide estimates of coverage, risk variable frequency and media effectiveness nationwide and by stratum, as well as sub-stratification of variables at the national level, but generally did not permit sub-stratification of variables at the stratum level.

In Greater Cairo, peri-urban slums and other areas with difficult access to routine immunization services were designated as high risk, and all other areas were designated as general population. In Upper Egypt and Lower Egypt, district capitals were designated as urban, and all other areas as rural.

Greater Cairo was divided into mutually exclusive and exhaustive strata. Independently, within each stratum (1 and 2) the smallest population units were listed, and 30 of these units were selected systematically, with probability proportional to estimated total population. Within each of the 30 selected population units, one household was randomly selected, and 52 consecutive neighbouring households were visited. Information was collected on all eligible children in these households.

For strata 3–6, two governors were selected from each stratum, with probability proportionate to total population. Urban and rural strata in selected governors were subdivided into exhaustive and mutually exclusive population units (villages in the rural strata and wards in the urban strata). Thirty units in each stratum were then systematically selected proportional to population. Within each population unit, 52 neighbouring households were selected as described above.

A standard questionnaire was used to collect information from a parent in each selected household for all children 0–47 months of age (born between 1 April 1991 and 1 April 1995). Information was collected on NID OPV receipt, NID centre location, sources of information for the NIDs, and routine OPV coverages. Vaccination data were ascertained by card and/or history.

Statistical analysis

Data management and testing were done with SAS, Excel, SUDAAN, and Epi-Info software. Analysis was performed with corrections for cluster survey design effect and multiple comparisons.

Results

Population characteristics and immunization coverage

Table 1 presents the population characteristics, routine immunization coverage, and NID round one and two coverage of children in the six survey strata.

A total of 4185 children (range by stratum, 350–1130) residing in 3216 households (range by stratum, 258–360) were surveyed. Overall, children 0–11 months, 12–23 months, 24–35 months, and 36–47 months of age represented 30%, 25%, 23% and 21% of the survey population, respectively. The age distributions of surveyed children were similar in all six strata.
OPV3 coverage among children in the survey population was high nationwide (93%; 95%, confidence interval [CI]: 91.5–94.6) and in all six strata (range, 83–99%).

Although greater than 80% of the target population nationwide is estimated to have received OPV during each NID round (84% [95% CI: 82.1–86.4] for NID1 and 83% [95% CI: 80.4–84.8] for NID2), coverage by stratum ranged from 78–86% for NID1 and from 73–86% for NID2 (Table 1).

The proportions of children in the target population receiving 0, 1 and 2 NID doses nationwide and by strata are presented in Figure 1. Nationwide, fewer than three-quarters (74%; 95% CI: 71.4–77.3) of children received both NID doses. The highest proportion receiving the first NID dose (range by stratum, 64–78%), 52% (95% CI: 48.9–55.2) received two NID doses. The Upper Egypt urban stratum had the lowest proportion of children receiving both NID doses (64%; 95% CI: 57.9–70.9) and the highest proportion receiving neither NID dose (14%; 95% CI: 10.4–17.7) (Figure 1). Coverage with two NID doses was higher in Greater Cairo (75%; 95% CI: 70.5–79.4) and Lower Egypt (73%; 95% CI: 71.2–79.4) than in Upper Egypt (66%; 95% CI: 60.9–71.4). In both Upper Egypt and Lower Egypt, the proportion of children receiving two NID doses was higher in rural than in urban areas (71% versus 64% in Upper Egypt and 76% versus 74% in Lower Egypt; differences not statistically significant).

**NID immunization coverage according to routine vaccination status**

As shown in Figure 2, previously unimunized or partially immunized children were less likely to receive two NID doses than were children who had received at least three OPV doses through the routine programme prior to the NID. Nationwide, 76% (95% CI: 72.8–78.5) of fully immunized children and 48% (95% CI: 29.8–65.9) of previously unimmunized or partially immunized children received both NID doses (P < 0.001).

Findings were similar in each of the six strata (range in relative risk by stratum, 1.25–2.18) and differences were statistically significant in all strata except Cairo general) (Figure 2).

**NID immunization coverage according to age group**

Nationwide and in most strata, children in the youngest and/or oldest target age groups (0–11 months and 36–47 months of age) were somewhat less likely to receive two NID doses than were children in the two intermediate age groups. Nationwide, coverage with two NID doses among children 0–11 months, 12–23 months, 24–35 months and 36–47 months of age was 72%, 79%, 74% and 73%, respectively (P < 0.01, comparing children 0–11 month and 36–47 months of age with those 12–35 months of age).

**Other risk factors for failure to be immunized during the NIDs**

As illustrated in Table 2, six additional risk factors for failure to receive OPV doses during the 1995 NIDs in Egypt were identified. Nationwide, parents of children who received two NID doses were more likely to: (1) reside <10 minutes walk from the nearest NID immunization centre (P < 0.001); (2) be informed about the NIDs (P < 0.001); (3) be informed about the NIDs at least one day in advance (P < 0.001); (4) have a radio in the household (P < 0.01); (5) have a television in the household (P < 0.001); and (6) watch television (P < 0.001), compared with those who received one or no NID doses. The relative importance of individual risk factors varied by stratum.

**Reasons for failure to receive NID OPV**

Among 737 surveyed children not immunized during NID1 and 817 surveyed children not immunized during NID2, more than 12 different reasons for not being immunized were given by parents. For both NID rounds, the most frequent reason stated was that they were not informed (53% for each round). Only a small proportion of parents listed problems with vaccine delivery (absence of vaccinator, lack of vaccine, failure of NID site staff to vaccinate a sick child, or long waiting time at the NID site) as reasons for failure to receive NID OPV (5% for NID1 and 6% for NID2). Other reasons for not taking the
Table 2 Risk factors for failure to be immunized during the 1995 National Immunization Days (NIDs) in Egypt. Characteristics of children nationwide and in each stratum receiving 0 versus 1 versus 2 NID doses

<table>
<thead>
<tr>
<th>Characteristic (%)</th>
<th>Nationwide NID doses</th>
<th>Cairo high-risk NID doses</th>
<th>Cairo general NID doses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nearest NID site &lt;10 minutes walk</td>
<td>39 50 54***</td>
<td>46 44 63</td>
<td>31 44 31</td>
</tr>
<tr>
<td>Informed about NID</td>
<td>47 76 100***</td>
<td>44 48 100</td>
<td>44 80 100***</td>
</tr>
<tr>
<td>Informed at least 1 day prior to NID</td>
<td>31 53 64***</td>
<td>26 45 48</td>
<td>38 63 75***</td>
</tr>
<tr>
<td>Radio in household</td>
<td>72 69 77***</td>
<td>91 81 92</td>
<td>92 83 92</td>
</tr>
<tr>
<td>Household listens to radio</td>
<td>59 65 66</td>
<td>58 56 54</td>
<td>61 81 81</td>
</tr>
<tr>
<td>Television in household</td>
<td>84 86 94***</td>
<td>86 87 98***</td>
<td>96 98 99</td>
</tr>
<tr>
<td>Household watches television</td>
<td>83 88 96***</td>
<td>69 81 96***</td>
<td>100 100 99</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Characteristic (%)</th>
<th>Upper Egypt urban NID doses</th>
<th>Upper Egypt rural NID doses</th>
<th>Lower Egypt urban NID doses</th>
<th>Lower Egypt rural NID doses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nearest NID site &lt;10 minutes walk</td>
<td>43 51 53</td>
<td>43 30 36</td>
<td>46 50 51</td>
<td>43 64 72***</td>
</tr>
<tr>
<td>Informed about NID</td>
<td>46 80 100</td>
<td>48 68 100***</td>
<td>58 75 100***</td>
<td>50 81 100***</td>
</tr>
<tr>
<td>Informed at least 1 day prior to NID</td>
<td>37 59 82***</td>
<td>17 31 49***</td>
<td>40 54 73***</td>
<td>23 50 62***</td>
</tr>
<tr>
<td>Radio in household</td>
<td>65 67 63</td>
<td>64 77 77</td>
<td>85 83 83</td>
<td>72 76 84</td>
</tr>
<tr>
<td>Household listens to radio</td>
<td>54 47 45</td>
<td>54 63 60</td>
<td>67 77 70</td>
<td>58 65 75</td>
</tr>
<tr>
<td>Television in household</td>
<td>82 89 91</td>
<td>64 78 83***</td>
<td>87 89 88</td>
<td>64 72 89***</td>
</tr>
<tr>
<td>Household watches television</td>
<td>78 86 90</td>
<td>65 77 82***</td>
<td>87 90 95</td>
<td>78 83 94***</td>
</tr>
</tbody>
</table>

* P < 0.05, ** P < 0.01, *** P < 0.001.

child included being too busy (10%), because the child was sick (11%), because the child was fully immunized (4%), inconvenient vaccination time (5%), vaccination site too far away (1%), NID vaccination not important (0.5%), and being afraid (0.5%).

Effectiveness of information sources

The potential to use television or radio as a source of information was measured by evaluating the frequency that these media were present in survey households (Table 3). Access to television—add to a lesser extent radio—was very good in most strata. Nationwide, 92% (95% CI: 90.0–94.2) of the survey population had a television (range by stratum, 80–99%) and 94% (95% CI: 91.9–94.8) of children's parents reported that they watched television (range by stratum, 79–99%). Nationwide, 85% (95% CI: 81.9–88.2) of the survey population had a radio, but only two-thirds (68%; 95% CI: 64.0–72.4) of parents reported that they listened to radio (range by stratum, 47–81%).

Table 3 shows the frequency of NID information by source nationwide and for each stratum. Although national television was the source which informed the greatest number of households, only a little more than half (56%; 95% CI: 52.1–60.6) of survey children's parents were informed through this source (range by stratum, 30–81%). Considerably fewer parents were informed via announcements at the mosque (28%; 95% CI: 24.1–34.4; range by stratum, 2–64%), newspapers (1%; range by stratum, 0–2%), or radio (2%; range by stratum, 1–4%). Health workers informed an estimated 22% (range by stratum, 18–50%) of parents, and an estimated 27% (range by stratum, 11–48%) were informed by neighbours. The relative importance of individual information sources varied by region and stratum, and differed for rural and urban areas (Table 3).

Discussion

In 1995, Egypt continued to experience endemic wild poliovirus transmission over a wide geographical area despite implementing NIDs on an annual basis for several years.\textsuperscript{2,4,7} Our study of the 1995 NIDs in Egypt identified several factors which may have contributed to the less than optimal impact of this strategy in Egypt.

Nationwide, fewer than one-quarter of surveyed children received both NID doses during the 1995 NID in Egypt, and the coverage was considerably lower in certain strata. Although the minimum coverage necessary for an NID to be effective has not been established, it is generally recommended that >90% of the target population be immunized in each NID round.\textsuperscript{8,10,11} This recommendation is supported by herd immunity models, which provide evidence that population immunity levels in excess of 90% are required to prevent the spread of wild poliovirus in settings with poor sanitation and overcrowding.\textsuperscript{12} such as are found in Egypt. Recent outbreaks in well immunized populations in Jordan and Oman underscore the importance of achieving high population immunity to infection in all geographical areas.\textsuperscript{13,14} Thus, to interrupt wild poliovirus transmission in Egypt, it is critically important that the pool of susceptible children be minimized by achieving high coverage in the target population uniformly throughout all areas of the country during future NIDs.

During the 1995 NIDs in Egypt, coverage was low among previously unimmunized and partially immunized children.
Although these children represented a rather small proportion of the NID target population in Egypt nationwide (8%), in certain strata as many as 17% of children were estimated to be incompletely immunized. Thus, failure to immunize previously unimmunized and partially immunized children during NID may have substantially increased the pool of susceptible children, contributing to ongoing transmission of wild poliovirus. Moreover, these hard-to-reach children are the very children who are most important for NIDs to reach. The critical importance of reaching previously unimmunized children during NIDs has been recognized in other settings, and the great success of NIDs in China and Pakistan has been linked to achieving high coverage during NIDs among children not reached through the routine programme. The importance of achieving high coverage in all community subpopulations during NIDs is further highlighted by a recent study in Jordan which demonstrated that the effectiveness of NIDs is largely due to greater immunogenicity of campaign OPV doses compared with routine OPV doses. Thus, finding ways to achieve high coverage among previously unimmunized and partially immunized children may be a particularly important factor in the success of future NIDs in Egypt.

During the 1995 NID in Egypt, children <1 year of age and >3 years of age were somewhat less likely to receive NID OPV than were children 1–2 years of age. Lower coverage with NID doses of OPV among children in one or both extremes of the target age group has also been noted in other studies. Despite some protection conferred by maternal antibody, many infants remain susceptible to wild poliovirus infection, and paralytic poliomyelitis has been reported in children as young as 6 weeks of age. Furthermore, it was recently demonstrated in China that NIDs which excluded children 36–47 months of age were less effective in eliminating poliomyelitis. Thus, achieving high coverage in all target age groups is important to interrupt wild poliovirus transmission.

Although the reasons for lower coverage in the youngest and oldest members of the target age group are unclear in the present study, factors which have contributed to low coverage in other settings include social taboos against bringing very young infants outside the home, reluctance to administer vaccines or other foreign substances to young infants, restricted mobility among mothers of young infants, and unawareness of the precise birthdate of older children. To ensure high coverage throughout the target population during future NIDs, it may be useful to modify the information provided to parents through the mass media and other sources to emphasize the importance and safety of immunizing young infants and the need to include older children.

In our study, more than 80% of surveyed children resided less than a 20-minute walk, and more than 90% less than a 30-minute walk, from the nearest NID site. Thus, most children lived within easy walking distance of an NID site. Nevertheless, children residing less than a 10-minute walk from the nearest NID site were more likely to be immunized. Close proximity to an NID site was also associated with an increased likelihood of receiving NID OPV in a study conducted in 1994 in Pakistan. One possible explanation for these findings is that the visibility of NID activities at sites which are nearby may attract parents’ attention and serve as a reminder—or as a primary source of information about the NIDs—and contribute to improved coverage.

Parents of the majority of surveyed children not immunized during the 1995 NIDs reported that they had not been informed, which suggests that the media campaign did not reach a sizeable segment of the population. Yet the potential to provide NID information to all sectors of the population in Egypt is high. More than 90% of surveyed children’s parents nationwide had access to television, and two-thirds had access to radio. The high literacy rate in Egypt suggests that newspaper advertisement could be another effective means of reaching parents. In addition to traditional mass media, announcements in mosques—very effectively used to advertise NIDs in other settings—have the potential in Egypt to reach a high proportion of parents. Our findings suggest that announcements in mosques may be particularly effective in rural areas.

Our study suggests that several factors limited the effectiveness of the media campaign for the 1995 NIDs in Egypt. First,
there were very few information sources, and television and mosques were the only mass media used. Although health workers were another significant source of information, more than one-quarter of surveyed children's parents were informed about the NIDs indirectly—through neighbours or friends. Studies in other countries have demonstrated that the use of multiple media to advertise NIDs is necessary to reach all segments of the population, since small subsets may be informed only through media other than television and radio. In an effective multi-media campaign in one country, information sources included television, radio, newspapers, mosque announcements, posters and schools. Secondly, the media which did advertise the 1995 NIDs in Egypt were underutilized; television—the only medium which provided NID information to more than half of surveyed children's households—failed to reach many parents who reported watching television. This suggests that the content or timing of media messages could be improved. Thirdly, the timing of NID information was not optimal: nationwide, fewer than 60% of surveyed parents reported receiving information at least one day in advance, potentially limiting their ability to set aside time for this activity.

On the basis of preliminary findings from this study, Egyptian health authorities modified planning and implementation of subsequent NIDs to improve coverage. A comprehensive multi-media advertisement campaign was launched one month prior to NID conducted in December 1996 and January 1997, and the content of media messages was improved to emphasize the need for all children <4 years of age to receive NID OPV regardless of prior immunization status or age. Information used to advertise these campaigns included television, radio, newspapers, posters, minivans with megaphone messages, and announcements in schools, mosques and churches. In addition, special banners were used to mark NID sites, increasing their visibility. Furthermore, special efforts were made to identify and administer NID OPV doses to previously unimmunized and partially immunized children. As a result of these efforts, the 1996–1997 NIDs in Egypt were a great success, with very high coverage (>95%) achieved in each round in all governorates. Egypt's very effective 1996–1997 NIDs and other improvements in the polio eradication programme have been associated with a marked decrease in the incidence of paralytic poliomyelitis, with only eight confirmed cases reported for the first 9 months of 1997 compared with 60 cases reported during the same time period in 1996, a decrease of 87%.

Our study demonstrates that surveys can provide important information about the characteristics of children not immunized in NIDs and about media effectiveness which can be used to improve vaccine delivery during subsequent campaigns. Although not recommended routinely, a survey such as the one presented in this report may be particularly useful in countries where NID have not had the anticipated impact on the incidence of poliomyelitis, and where contributing factors cannot be adequately delineated through analysis of existing data. Other settings where surveys may be useful to supplement programme estimates of NID coverage include a country's first NIDs, in districts where focal transmission of wild poliovirus persists, and in other identifiable high risk areas within a country. Since NIDs are an essential polio eradication strategy, finding ways to improve NID quality is important to ensure the success of the global polio eradication initiative.

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