

Cost-Effectiveness of an Injury and Drowning Prevention Program in Bangladesh

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KEY WORDS

drowning, injury, mortality, cost-effectiveness, LMIC

ABBREVIATIONS

CI—confidence interval

DALY—disability-adjusted life-year

DSS—demographic surveillance system

\$Int—international dollars

LMICs—low- and middle-income countries

PRECISE—Prevention of Child Injuries through Social-Intervention and Education

TASC—The Alliance for Safe Children

UNICEF—United Nations Children's Fund

WHO-CHOICE—World Health Organization—CHOosing Interventions that are Cost Effective

Drs F. Rahman, A. Rahman, Mashreky, and Linnan were responsible for intervention design, and maintaining data integrity for the DSS and PRECISE data sets; Drs F. Rahman, A. Rahman, and Mashreky were responsible for field operations and oversight of data collection; Dr Haaland was responsible for developing the primary statistical analysis used to calculate the relative risks of the interventions; Drs. Bose and Finkelstein were responsible for the cost-effectiveness analyses, the secondary data analyses presented in the Supplemental Information, and for writing the first draft of the paper; all authors reviewed, commented, and suggested revisions to the manuscript.

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WHAT'S KNOWN ON THIS SUBJECT: Drowning is a leading cause of death for children in low- and middle-income countries. However, few childhood mortality reduction programs target drowning because of a lack of evidence on costs and effectiveness of these interventions.



WHAT THIS STUDY ADDS: This study presents the cost-effectiveness results of a low-cost injury and drowning prevention program in Bangladesh. We show that child care centers and swimming lessons are highly cost-effective interventions that could be scaled to other countries.

abstract



OBJECTIVE: Interventions that mitigate drowning risk in developing countries are needed. This study presents the cost-effectiveness of a low-cost, scalable injury and drowning prevention program called Prevention of Child Injuries through Social-Intervention and Education (PRECISE) in Bangladesh.

METHODS: Between 2006 and 2010, the 2 components of PRECISE (Anchal, which sequestered children in crèches [$n = 18\,596$ participants], and SwimSafe, which taught children how to swim [$n = 79\,421$ participants]) were implemented in rural Bangladesh. Mortality rates for participants were compared against a matched sample of non-participants in a retrospective cohort analysis. Effectiveness was calculated via Cox proportional hazard analysis. Cost-effectiveness was estimated according to World Health Organization—CHOosing Interventions that are Cost Effective guidelines.

RESULTS: Anchal costs between \$50.74 and \$60.50 per child per year. SwimSafe costs \$13.46 per child. For Anchal participants, the relative risk of a drowning death was 0.181 ($P = .004$). The relative risk of all-cause mortality was 0.56 ($P = .001$). For SwimSafe, the relative risk of a drowning death was 0.072 ($P < .0001$). The relative risk of all-cause mortality was 0.750 ($P = .024$). For Anchal, the cost per disability-adjusted life-year (DALY) averted is \$812 (95% confidence interval: \$589–\$1777). For SwimSafe, the cost per DALY averted is \$85 (\$51–\$561). Combined, the cost per DALY averted is \$362 (\$232–\$1364).

CONCLUSIONS: Based on World Health Organization criteria, PRECISE is very cost-effective and should be considered for implementation in other areas where drowning is a significant problem. *Pediatrics* 2012;130:e1621–e1628

The burden of drowning for children in low- and middle-income countries (LMICs) has become a leading public health problem.¹ Swimming lessons have been shown to reduce drowning risk in developed countries.² However, evidence is lacking that swimming lessons are effective in LMICs.³ The lack of effectiveness and cost-effectiveness data has precluded the adoption of drowning prevention as a core component of child survival programs in LMICs. The high rates of drowning are an impediment to achieving Millennium Development Goal 4, which calls for major reductions in early childhood mortality.⁴

Bangladesh is a largely rural low-income country with most households located near bodies of water. Many children are unable to swim and families are large, leading to decreased adult supervision. These factors combine to make drowning the leading cause of child death after infancy.^{5,6} The drowning mortality rate, 28.6 deaths per 100 000 child-years, is 22 times greater than in the Americas.⁴

Effective interventions that mitigate drowning risk in Bangladesh will improve health outcomes. Yet, interventions that are effective in high-income countries,⁷ such as fencing around pools,⁸ lifeguards, and flotation devices,^{9,10} are not feasible in rural Bangladesh because of cost and other concerns. However, low-cost strategies that take advantage of community resources¹¹ may be both effective and cost-effective.

This study presents the effectiveness and cost-effectiveness of Prevention of Child Injuries through Social-Intervention and Education (PRECISE), an injury prevention program in rural Bangladesh with an emphasis on drowning prevention. The program has 2 components, Anchal and SwimSafe, targeted at children of different age groups.

The Anchal component, which focused on children ages 1 to 5, involved

village-based crèches (child care centers). A study in Bangladesh found that children in this age range have a significantly increased risk of fatal injury between 9 AM and 3 PM when they are often supervised by older siblings because of parents working inside or outside the home.⁵ Anchal designated particular houses as crèches, and each was staffed by 2 women from the community, one trained as the head and one trained as her assistant. Enrollment into a crèche was voluntary and there were no contributions expected from the family. The target population for each crèche was ~25 children (on average each crèche had 27 children). This, together with the number of children aged 1 to 5 who wanted to enroll, determined the total number of crèches in a given location.

Anchal was expected to reduce drowning and other injuries owing to increased supervision. While at the crèche, children were also provided with early childhood development stimulation, preschool education, and supplemental nutrition, and they were taught health messages such as the importance of hand-washing and the use of latrines. Under Anchal, each crèche operated from 9 AM to 1 PM daily except Friday. Additionally, the head spent 2 hours a month visiting homes of children from her crèche to train parents about household safety and to identify in-home hazards. Parents with children <18 months also received playpens to sequester children when necessary.

SwimSafe consisted of basic swimming, water safety, and safe rescue skills for children aged 4 to 12 years. A formal curriculum, developed specifically for children in LMICs, was delivered over 3 weeks by trained local instructors in village ponds modified with submerged platforms to facilitate safe training.¹²

PRECISE also incorporated community education programs that reinforced injury prevention and other health

messages. Furthermore, whenever an injury death occurred in a participating village, a social autopsy was performed to analyze what led to the death and what steps could be taken to prevent a similar death in the future. The family of the deceased child, neighbors, and the village elders were present during this discussion. All participating villages had an injury prevention committee of local leaders who participated in planning and promotional activities.

METHODS

In January 2006, a demographic surveillance system (DSS) was introduced in 3 upazilas (regions) in rural Bangladesh: Raigangj, Sherpur, and Manohordi. These upazilas include 20 unions, each containing ~7200 households. The DSS started with a baseline census and then periodically (monthly in 2006–2008, semiannually in 2009–2010) captured all deaths via in-home interviews. When a death occurred, the date and mechanism were ascertained. At baseline, there were 733 637 individuals represented in the data aged 40 days to 84 years; they were followed with a near-perfect retention rate.¹³ When a death occurred, the date of death and, if an injury death, the mechanism of death were ascertained via interviews with family members and neighbors. The last date when follow-up data were available for all individuals in the DSS was August 31, 2010 and was therefore used as the end point of the analysis.

Beginning in January 2006, PRECISE was rolled out to households in the 3 upazilas covered by the DSS. The only inclusion criterion was the presence of a child in the household who met the age requirements. There were no exclusion criteria. PRECISE was not implemented in every union. It was expanded over time with the goal of reaching as many unions as possible. The gradual expansion of PRECISE participants and

nonparticipants, all tracked by the DSS, made possible a retrospective cohort study that allowed for comparing mortality outcomes between those who did or did not participate. The control cohort comprised all children in the DSS who did not receive either component of PRECISE. The DSS was funded independently from PRECISE.

Effectiveness

Mortality risks for Anchal and SwimSafe participants versus nonparticipants was compared by using a stratified Cox proportional hazards model with delayed entry times (Fig 1).¹⁴ Strata were generated based on every unique combination of gender, location, and birth cohort, with 3 months separating each new cohort. For Anchal participants, time at risk was from date of

Anchal enrollment to date at departure from the Anchal, death, or end of data collection (whichever came first). For SwimSafe participants, time at risk was from age at SwimSafe enrollment to age at death or the end of data collection (whichever was first). For nonparticipants, their time at risk was defined until their age at death or the end of data collection (whichever came first).

Hazard ratios, or instantaneous relative risks, for death from drowning, injuries (including drowning), noninjuries, and all causes were calculated separately. Injury deaths included deaths from drowning, road traffic, burns, falls, poisoning, suffocation, choking, animal bites, hypothermia, hyperthermia, or suicide. Noninjury deaths included all deaths from other causes. As a sensi-

tivity analysis, relative risk estimates were recalculated by using a propensity score-matching approach as described in the Supplemental Information. Propensity score matching is an alternative technique commonly used to control for observable differences between cases and controls in nonrandomized studies. We chose the Cox model as our primary methodology because it makes use of all PRECISE participants having comparable controls instead of forcing a nearest-neighbor match, which occurs with propensity score matching. Analyses were performed in R version 2.11.1 (R Foundation for Statistical Computing, Vienna, Austria).

Costs

Costs were from a societal perspective. Per capita costs were calculated by dividing total implementation costs in 2010 by the total number of participants in each component. All costs were recorded in Bangladeshi Taka and then converted to international dollars (\$Int) by using the World Bank's International Dollar conversion rate (2010) for Bangladesh.¹⁵ An international dollar has the same purchasing power in all countries.

Costs for Anchal included costs for upgrading homes to crèches, maintenance costs, supplies (soap, books, toys, and playpens), salaries, and training costs. First-year costs were slightly higher than in subsequent years because of the purchase of durable goods and because of the initial staff training costs. SwimSafe included costs to modify ponds for safe teaching, purchase of kickboards and t-shirts, salaries for trainers, and yearly refresher training.

Cost-effectiveness

Cost-effectiveness was estimated by extrapolating the cost and effectiveness data to the entirety of rural Bangladesh.¹⁶ To do this, a hypothetical cohort of rural children aged 1 to 12 in Bangladesh

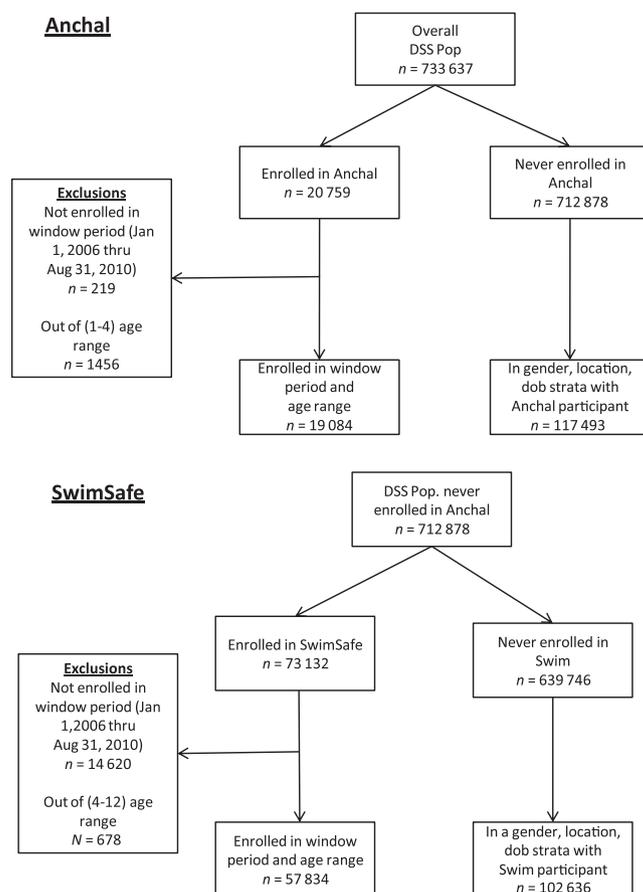


FIGURE 1
Anchal and Swimsafe analysis sample and matched controls.

was followed in a population model until the children turned 19. The number of rural children of each age was obtained from census data.¹⁷ Age-specific drowning, injury, and overall death rates were generated from raw data from a previously published survey investigating childhood mortality in Bangladesh.¹⁸ These data were used to calculate baseline disability-adjusted life-years (DALYs) attributable to drowning, injuries, and overall mortality. The relative risks for each component of PRECISE were then applied to the hypothetical cohort to determine the number of DALYs averted. The DALY is a measure of overall disease burden, expressed as the number of years lost because of ill health, disability, or early death. In our analysis, we make a conservative calculation of DALYs by focusing solely on mortality.

To estimate the combined effects of both components of PRECISE, the relative risk estimated for Anchal was applied to the death rates for ages 1 to 5 and that for SwimSafe was used for ages 6 to 18. DALYs were calculated according to World Health Organization–CHOosing Interventions that are Cost Effective (WHO-CHOICE) guidelines and, as with costs, were discounted at 3% per annum.¹⁹ Cost-effectiveness ratios were also calculated assuming PRECISE was only effective in preventing drowning deaths and assuming costs were twice as expensive as reported in the data. The doubling of costs was used to estimate a likely upper bound of actual costs if the program were to be expanded nationwide.

Role of Funding Source and Institutional Review Board

Staff of United Nations Children's Fund (UNICEF) and The Alliance for Safe Children (TASC) were involved in study design. Thomas Dunn (TASC database administrator) was involved in data collection and Dr Michael Linnan (TASC

technical director) was involved in data collection, analysis, and manuscript development. PRECISE was approved by the Ethical Review Committee, Centre for Injury Prevention Research, Bangladesh. Informed consent was obtained from all participants. The analysis of the data was approved by the institutional review board of the National University of Singapore. Study reporting conforms to Strengthening the Reporting of Observational Studies in Epidemiology guidelines.²⁰

RESULTS

Effectiveness

Retention rates for PRECISE were high. Dropout rates for Anchal were <1% for children aged 1 to 4 years. SwimSafe graduation rates were 100%. Unadjusted age-specific drowning and overall mortality rates for nonparticipants and Anchal and SwimSafe participants are shown in Table 1. Drowning and overall mortality rates are highest for children ages 1 and 2. For children not in PRECISE, the drowning mortality rate is 120.8 (95% confidence interval [CI]: 92.6–157.6) per 100 000 person-years in children aged 1 and 65.5 (CI: 44.4–105.9) per 100 000 person-years in children aged 2. Beyond age 2, drowning mortality rates steadily decrease with increasing age for both participants and nonparticipants becoming not statistically different from zero by age 11. Before this age, the unadjusted drowning mortality rate is greater for nonparticipants. Unadjusted overall mortality rates, which range from a high of 551.6 (CI: 486.8–624.9) deaths per 100 000 persons-years in 1-year-old nonparticipants to a low of 49.4 (CI: 33.9–71.8) deaths per 100 000 person-years in SwimSafe participants age 12 years, are also greater for younger children and for nonparticipants.

Table 2 presents relative risks for each cause of death based on results of the Cox model. For Anchal participants, the

relative risk of a drowning death was 0.181 (CI: 0.057–0.577, $P = .004$); the relative risk of injury and noninjury deaths were 0.123 (CI: 0.039–0.390, $P < .0001$) and 0.829 (CI: 0.565–1.216, $P = .338$), respectively. The relative risk of all-cause mortality was 0.556 (CI: 0.388–0.797, $P = .001$). For SwimSafe, the relative risk of a drowning death was 0.072 (CI: 0.017–0.307, $P < .0001$); injury and noninjury mortality relative risks were 0.347 (CI: 0.206–0.587, $P < .0001$) and 1.009 (CI: 0.757–1.345, $P = .953$). The relative risk of all-cause mortality was 0.750 (CI: 0.585–0.962, $P = .024$).

Costs

First-year Anchal participants cost an average of \$60.50 per child, and, in subsequent years, the cost averaged \$50.74. Eighty-eight percent of the costs are related to running/staffing the crèche. One-time SwimSafe costs averaged \$13.46 per child, with 77% dedicated to providing swimming lessons (Table 3).

Cost-effectiveness

Anchal averted 7 drowning deaths, and SwimSafe averted an additional 18 deaths. Extrapolating the costs and relative risks to the rural population of Bangladesh, Anchal is projected to prevent 34 926 (CI: 18 039–40 214) drowning deaths (44% of projected total drownings; CI: 22%–51%) and 74 561 (CI: 34 090–102 773) deaths from all causes (11% of projected total deaths; CI: 5%–15%) by the time the cohort reaches adulthood at a cost of 2.1 billion dollars (\$233 million per year). The cost per death averted is \$27 606 (CI: \$20 028–\$60 379), and the cost per DALY averted is \$812 (CI: \$589–\$1777) (Table 4).

SwimSafe is projected to prevent 49 874 (CI: 37 245–52 830) drowning deaths (63% of projected total drowning deaths; CI: 47%–67%) and 138 270 (CI:

TABLE 1 Age-Specific Overall and Drowning Mortality Rates for PRECISE Participants and Nonparticipants

Age	Non-PRECISE			Anchal			SwimSafe		
	Deaths	Person-Years	Death Rate (95% CI) ^b	Deaths	Person-Years	Death Rate (95% CI) ^b	Deaths	Person-Years	Death Rate (95% CI) ^b
Overall^a									
1	284	54 770.9	518.5 (460.0–582.5)	2	740.8	270.0 (32.7–975.3)			
2	157	47 796.9	328.5 (279.1–384.1)	11	2591.7	424.4 (211.9–759.4)			
3	113	40 102.4	281.8 (232.2–338.8)	7	4669.1	149.9 (60.3–308.9)			
4	76	33 556.2	226.5 (178.4–283.5)	4	5811.1	68.8 (18.8–176.2)	13	1792.2	725.4 (386.2–1240.4)
5	67	29 828.5	224.6 (174.1–285.3)	3	2339.3	128.2 (26.4–374.8)	8	3899.8	205.1 (88.6–404.2)
6	58	27 797.4	208.7 (158.4–269.7)				12	6935.2	173.0 (89.4–302.2)
7	69	26 302	262.3 (204.1–332.0)				12	10 441.6	114.9 (59.4–200.8)
8	62	29 163.4	212.6 (163.0–272.5)				13	13 334	97.5 (51.9–166.7)
9	38	35 015.9	108.5 (76.8–149.0)				10	14 631.4	68.3 (32.8–125.7)
10	40	43 964.8	91.0 (65.0–123.9)				10	15 212.9	65.7 (31.5–120.9)
11	39	53 045.3	73.5 (52.3–100.5)				10	14 014.3	71.4 (34.2–131.2)
12	38	59 787.6	63.6 (45.0–87.2)				6	9963.8	60.2 (22.1–131.1)
Drowning^a									
1	68	54 770.9	124.2 (96.4–157.4)	0	740.8	0.0 (0.0–498.0)			
2	31	47 796.9	64.9 (44.1–92.1)	1	2591.7	38.6 (1.0–215.0)			
3	26	40 102.4	64.8 (42.4–95.0)	0	4669.1	0.0 (0.0–79.0)			
4	17	33 556.2	50.7 (29.5–81.1)	0	5811.1	0.0 (0.0–63.5)	0	1792.2	0.0 (0.0–205.8)
5	16	29 828.5	53.6 (30.7–87.1)	2	2339.3	85.5 (10.4–308.8)	0	3899.8	0.0 (0.0–94.6)
6	12	27 797.4	43.2 (22.3–75.4)				0	6935.2	0.0 (0.0–53.2)
7	15	26 302	57.0 (31.9–94.1)				1	10 441.6	9.6 (0.2–53.4)
8	9	29 163.4	30.9 (14.1–58.6)				0	13 334	0.0 (0.0–27.7)
9	6	35 015.9	17.1 (6.3–37.3)				0	14 631.4	0.0 (0.0–25.2)
10	2	43 964.8	4.5 (0.6–16.4)				0	15 212.9	0.0 (0.0–24.2)
11	0	53 045.3	0.0 (0.0–7.0)				0	14 014.3	0.0 (0.0–26.3)
12	0	59 787.6	0.0 (0.0–6.2)				0	9963.8	0.0 (0.0–37.0)

^a Crude death rates reported in this table; no adjustment has made for covariates.

^b Per 100 000 person-years; CIs calculated assuming hazard is approximately constant over 1-year interval.

21 017–229 528) deaths from all causes (21% of projected totals; CI: 3%–35%) at a cost of 416 million dollars (\$46.2 million per year). The cost per death averted is \$3009 (CI: \$1813–\$19 796), and the cost per DALY averted is \$85 (CI: \$51–\$561).

Combined, PRECISE is projected to prevent 70 490 (CI: 47 892–76 567) drowning deaths (89% of total drowning

deaths; CI: 60%–97%) and 196 435 (CI: 52 615–305 084) overall deaths (29% of total deaths; CI: 8%–46%) at a cost of 2.5 billion dollars (\$275 million per year). The cost per death averted is \$12 596 (CI: \$8110–\$47 038), and the cost per DALY averted is \$362 (CI: \$232–\$1364).

Sensitivity Analysis

Table 5 shows results from sensitivity analyses. If effectiveness was limited to reductions in drowning mortality only, the cost-effectiveness ratio for Anchal increases to \$1734 (CI: \$1506–\$3357) per DALY averted. SwimSafe increases to \$235 (CI: \$222–\$315) per DALY averted, and PRECISE overall increases to \$1008 (CI: \$929–\$1477) per DALY averted. Even when PRECISE only affects drowning deaths and costs are twice as expensive as reported, the cost per DALY averted rises to \$3468 (CI: \$3012–\$6715) for Anchal, \$471 (CI: \$444–\$630)

for SwimSafe, and \$2015 (CI: \$1857–\$2954) for PRECISE. Supplemental Table 8 shows that relative risk estimates calculated by using the proportional hazards approach were similar to those using the propensity scoring approach, suggesting that the results are robust to alternative analytic approaches.

DISCUSSION

Interventions with cost-effectiveness ratios less than gross domestic product per capita are considered highly cost-effective, and those with ratios <3 times gross domestic product per capita are considered.²¹ For Bangladesh, these ratios are \$1486 and \$4458, respectively. With a cost-effectiveness ratio of \$362 per DALY averted, PRECISE is highly cost-effective. This conclusion holds even when doubling costs and limiting effectiveness to drowning.

TABLE 2 Relative Risk Estimates Via Cox Model

	RR	95% CI	P
Anchal			
Drowning	0.181	0.057–0.577	.004
Injuries	0.123	0.039–0.390	.001
Noninjuries	0.829	0.565–1.216	.338
Overall deaths	0.556	0.388–0.797	.001
SwimSafe			
Drowning	0.072	0.017–0.307	.001
Injuries	0.347	0.206–0.587	<.0001
Noninjuries	1.009	0.757–1.345	.953
Overall deaths	0.750	0.585–0.962	.024

RR, relative risk.

TABLE 3 Summary of Costs

Components	Cost Per Child (BDT)	Cost Per Child (\$Int)
Anchal intervention costs		
Protective barriers	52.44	1.85
Anchals	1455.57	51.43
Total	1508.02	53.29
Pond modification	48.00	1.70
SwimSafe curriculum		
T-shirts	35.00	1.24
Kickboards	6.96	0.25
Community swimming instructor	94.79	3.35
Master trainer	09.26	3.86
Total	294.00	10.39
Social autopsy	0.39	0.01
Shows		
Theater	25.00	0.88
Video	51.14	1.81
Village safety committee	1.93	0.07
Annual event	8.42	0.30
Total	86.88	3.07
National level		
National coordinator	14.33	0.51
Anchal trainers	37.00	1.31
Office rental	0.55	0.02
Upazila		
Project coordinator	8.66	0.31
Anchal monitoring officer	31.71	1.12
Finance and admin officer	3.37	0.12
SwimSafe + Anchal supervisors	23.08	0.82
Office assistant	1.04	0.04
Total	27.49	4.23
Anchal intervention cost	1508.02	53.29
Community education	86.88	3.07
Administrative	117.13	4.14
Total	1712.03	60.50
SwimSafe Intervention Cost	294.00	10.39
Community education ^a	35.75	1.26
Administrative	51.04	1.80
Total	380.79	13.46

BDT, Bangladeshi Taka.

^a SwimSafe children do not participate in all community education programs.

WHO-CHOICE published a list of interventions deemed to be the most cost-effective in reducing childhood mortality for South East Asia.¹⁸ SwimSafe, which could be implemented as a stand-alone intervention, compares favorably to many of the established interventions. Although Anchal is highly cost-effective based on the WHO-CHOICE

definition, it is less cost-effective than SwimSafe or many of the top interventions listed because, unlike vaccines or teaching a child to swim, it requires continual investment for a child to receive the benefits. However, because Anchal's focus extends beyond drowning, the cost-effectiveness of Anchal is likely further improved

when nonfatal injuries and other health outcomes are considered. Analysis of these outcomes is ongoing. It is also important to note that, although PRECISE is cost-effective, it is not cost-saving; as a result, additional monies are required to fund the interventions. Because of the low incomes of those living in rural Bangladesh, funding will need to come from government, donors, or other sources.

This analysis is subject to several limitations. The primary limitation is that it was not a randomized trial, and, therefore, differences in the composition of the intervention and non-intervention participants may provide potential bias. As shown in Supplemental Table 6, there were differences in average age and gender between participants and nonparticipants. Anchal participants were older (average age 3.1 vs 2.7 [$P < .001$]) and more likely to be female (52.5% vs 49.3% [$P < .001$]). SwimSafe participants were also older (average age 8.0 vs 7.7 [$P < .001$]) but less likely to be female (46.4% vs 50.7% [$P < .001$]). We accounted for these differences by matching on age and gender in the analysis (Supplemental Table 7). Despite these efforts to equate the 2 groups, it is possible that unmeasured differences in family or neighborhood characteristics remained and that these differences are influencing the relative risk estimates and therefore the cost-effectiveness results.

It is also possible that SwimSafe graduates rescued both Anchal participants and control individuals from drowning, which would introduce another source of potential bias. However, because Anchal participants and controls were located in the same communities, it is likely that any mortality benefit from rescue would be equal in the 2 groups. It is also conceivable that PRECISE was successful because it occurred in an area particularly prone to drowning. However, the rate of

TABLE 4 Projected Costs and Mortality Outcomes of the Cohort Followed to Adulthood

	Deaths	Deaths Averted	DALYs Averted	Cost (\$Int, millions)	\$Int per Death Averted	\$Int per DALY Averted
Baseline	655 426					
Anchal	580 866	74 561	2 533 455	2058	27 606	812
SwimSafe	517 157	138 270	4 882 617	416	3009	85
Combined	458 992	196 435	6 843 762	2474	12 596	362

TABLE 5 Sensitivity Analyses

	\$/Int per DALY averted	CI
Baseline cost-effectiveness		
Anchals	812	\$589–\$1777
SwimSafe	85	\$51–\$561
Combined	362	\$232–\$1364
Doubled costs		
Anchals	1625	\$1179–\$3554
SwimSafe	170	\$103–\$1121
Combined	723	\$465–\$2729
Drowning only effectiveness		
Anchals	1734	\$1506–\$3357
SwimSafe	235	\$222–\$315
Combined	1008	\$929–\$1477
Drowning only effectiveness + doubled cost		
Anchals	3468	\$3012–\$6715
SwimSafe	471	\$444–\$630
Combined	2015	\$1857–\$2954

drowning in the nonparticipating population of children in these 3 upazilas (25.7 per 100 000 person-years) is lower than the national rate (28.6 per 100 000),¹⁸ suggesting that these results may be generalized to rural Bangladesh as a whole.

Several factors suggest that the cost-effectiveness estimates may be conservative. First, this study focused solely on the mortality benefits of PRECISE. A previous study showed that a significant number of drownings in rural Bangladesh were nonfatal but resulted in significant morbidity.¹⁸

Given the large reduction in drowning mortality risk resulting from both Anchal and SwimSafe, it is likely that PRECISE also reduced risks for nonfatal drownings. It is also possible that children in the control group were exposed to the community education and prevention aspects of PRECISE. If any of the above are true, then the results would be understated.

CONCLUSIONS

This study provides compelling evidence that it is possible to cost-effectively reduce childhood mortality by focusing on

injury and drowning prevention via community crèches for young children and swimming instruction when it becomes age appropriate. Ideally these results will be replicated via randomized trials and tested in other LMICs. If confirmed, PRECISE represents a novel approach for reducing childhood mortality in Bangladesh and in other resource-poor settings with a high drowning risk.

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