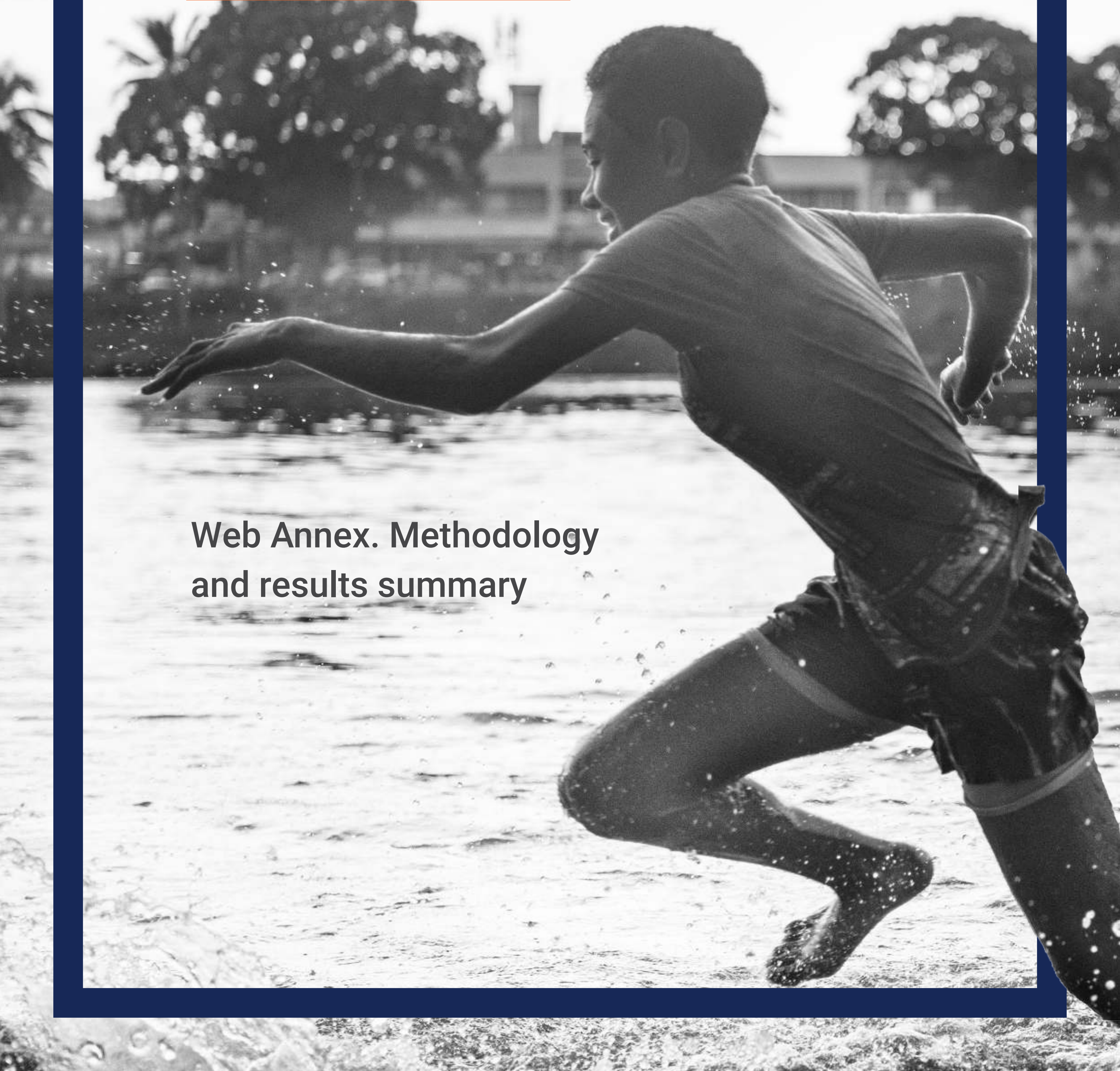
World Health Organization

Hidden depths

The global investment case for drowning prevention



Web Annex. Methodology and results summary

Hidden depths: the global investment case for drowning prevention. Web Annex. Methodology and results summary

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1. Overview and conceptual framework

This report estimates the benefit-cost ratio (BCR) from investing in the scale-up of two drowning prevention interventions: providing day-care for pre-school children and teaching school-age children basic swimming skills. As implied, the BCR requires estimating the economic benefits from implementing these interventions and the costs to scale them up. Both interventions are defined and discussed in detail in the *WHO Guideline on the prevention of drowning through provision of day-care and basic swimming and water safety skills (1)*. The day-care intervention was modelled with a target population of pre-school children aged 1–4 years, while the basic swimming skills intervention was modelled for children aged 5–9 years. The analysis for this report includes 50 low- and middle-income countries (LMICs) with the highest drowning burden determined through a composite index described in a subsequent section.

To reflect the potential economic benefits from scaling up drowning interventions, the value of a statistical life (VSL) approach was used to capture the value that society places on the reduction of mortality and morbidity risks. This approach has been used by several recently published studies in other areas such as obesity *(2)* and immunization *(3),* and international best practices for estimating economic benefits from health interventions *(4)*.

Two alternative scenarios were compared: a business-as-usual scenario reflecting the status quo, where it was assumed baseline intervention coverage of the target population (children aged 1–9 years) was at 5%, and a scale-up scenario where an immediate scale-up to cover 50% of the target population was modelled. In both scenarios, the coverage rates were maintained until 2050. The analysis was performed for 2020–2050 to illustrate a lifecycle approach to the costs and benefits of drowning prevention.

Utilizing the coverage rates for each scenario and the respective intervention effect sizes, the reduction in the number of fatal and nonfatal drowning cases were obtained and used to calculate averted economic losses (value of mortality and morbidity risk reductions). Intervention costs were calculated from an estimated per child cost for each intervention, and multiplied by the number of children covered. The summary measure (BCR) was calculated by dividing the net present value (NPV) of averted economic losses from 2020–2050, with the net present value of total intervention costs through the same period (both using a discount rate of 3%).

2. Data Sources

This report utilizes data from a variety of sources including literature reviews, databases, guidelines *(1,5)* and other literature summarized in Table W.1.

Table W.1. Summary of data sources and parameters used

Parameter	Description	Source
Population		
Country population	2020–2050 population for each country disaggregated by age and sex	UN World Population Prospects *(6)*
Median workforce age	Median age of workforce population for each country used in deriving the value of statistical life year (VSLY)	International Labour Organization *(7)*
Mortality and morbidity		
Drowning mortality rate	Five-year average of drowning death rates disaggregated by sex and age (2015–2019)	WHO Global Health Estimates *(8)*
Incidence rate of nonfatal drowning	Five-year average of nonfatal drowning incidence rates disaggregated by sex and age (2015–2019)	IHME GBD *(9)*
Severe nonfatal drowning	Approximately 18% of nonfatal drowning cases result in severe sequalae with long-term disability	Bell et al. *(10)* Bratton et al. *(11)*
Valuation		
VSL	Value of Statistical Life (VSL) used in estimating the monetary value of health risk reductions	Viscusi and Masterman *(12)*
Disability weight	Weight of 0.247 used in calculating the economic value of severe nonfatal drowning cases by adjusting the VSLY	Salomon et al. *(13)*
Other		
Inflation rate	Annual rate of inflation (2020–2027)	IMF *(14)*
Discount rate	3% discount rate used in estimating NPV	Analyst's assumption
Scale up target	50% scale up of Basic swimming and water safety skills and Day-care interventions	Analyst's assumption

GBD: Global Burden of Disease, IHME: Institute of Health Metrics and Evaluation, IMF: International Monetary Fund, WHO: World Health Organization, UN: United Nations

3. Country selection

An index was developed to determine the 50 countries with the highest drowning burden among low- and middle-income countries (LMICs). The drowning burden index uses a point system that is assigned based on three criteria applied to populations aged 1–19 years: annual number of deaths attributed to drowning, the drowning death rate per 100 000 population, and the ranking of drowning in the list of leading causes of death for each country (Table W.2). Data for this index were sourced from the WHO Global Health Estimates *(8)*. Total scores ranged from 2 to 11 points, with higher scores indicating higher burden.

Table W.2. Point system for the drowning burden index

	Description	Points
1. Number of drowning deaths per year (2019)		
Rank	*Number of deaths*	*Points*
Highest	≥ 3000	5
High	2000–2999	4
Medium	1000–1999	3
Low	100–999	2
Lowest	< 100	1
2. Drowning death rate per 100 000 population (2019)		
Rank	*Death rates (range)*	*Points*
High	≥ 20	3
Medium	10–19	2
Low	< 10	1
3. Rank of drowning as a leading cause of death (2019)		
Rank	*Rank of drowning as a leading cause of death*	*Points*
High	1–3	3
Medium	4–6	2
Low	7–10	1
No score	>10	0

Countries included in the analysis for this report had scores of at least five points and are listed by WHO region in Table W.3.

Table W.3. High-burden countries included in the analysis, by WHO region

WHO Regions	Countries
African Region	Angola, Benin, Burundi, Chad, Democratic Republic of the Congo, Ethiopia, Guinea, Kenya, Madagascar, Malawi, Mali, Mozambique, Niger, Nigeria, Rwanda, Seychelles, Sierra Leone, Somalia, South Sudan, Uganda, United Republic of Tanzania, Zambia
Region of the Americas	Bolivia (Plurinational State of), Brazil, Haiti
South-East Asia Region	Bangladesh, India, Myanmar, Nepal, Sri Lanka, Thailand
European Region	Belarus, Kazakhstan, Russian Federation, Tajikistan, Ukraine, Uzbekistan
Eastern Mediterranean Region	Afghanistan, Egypt, Pakistan, Sudan
Western Pacific Region	Cambodia, China, Indonesia, Lao People's Democratic Republic, Micronesia (Federated States of), Papua New Guinea, Philippines, Solomon Islands, Viet Nam

4. Estimating intervention costs

The initial unit cost for implementing each intervention was sourced from Rahman et al. *(15)* (see Table W.4). These costs were inflated to 2020 dollars using IMF inflation data. Based on the analysis from the study, and from a similar assessment done by Alfonso et al *(16)*, the two interventions had front-loaded costs which include substantial fixed costs (e.g. conversion of pool for trainings, and conversion of houses for day-care), and other upfront variable costs (e.g. training costs). These costs were estimated to be incurred in the first year of implementation (2020) and running costs (salaries, consumables, etc.) were incurred in subsequent years. To adjust for this, it was assumed that an annual 25% of total implementation costs were incurred as running costs over the modelled time horizon. The additional amount required to implement each intervention was obtained by subtracting the estimated intervention costs of the baseline scenario from the scale-up scenario (the costs of increasing coverage from 5% to 50% of the target population). Country level costing was not possible due to data and capacity limitations.

Table W.4. Summary of intervention parameters

Intervention	Description	Source
Basic swimming and water safety skills intervention		
Cost of intervention	US$ 16.66 (in 2020 dollars) per year of participation per child 5–9 years old	Rahman et al. *(15)*
Effect size	RR = 0.072 (CI: 0.017 – 0.307)	Rahman et al. *(15)*
Day-care intervention		
Cost of intervention	US$ 26.34 (in 2020 dollars) per year of participation per child 1–4 years old	Rahman et al. *(15)*
Effect size	RR = 0.181 (CI: 0.057 – 0.577)	Rahman et al. *(15)*

5. Estimating health impact

The health impact from scaling up drowning prevention interventions was estimated through the number of fatal and nonfatal drowning cases averted. The effect sizes used for both interventions are detailed in Table W.4 and were also sourced from Rahman et al. *(15)*. The calculated health impacts were assumed to be independent and additive since the target population for each intervention belong to different age groups. Drowning rates were assumed to remain constant throughout the simulation period.

To estimate the number of fatal drowning cases averted for each country and year analysed, the relative risk reduction (RRR) of drowning deaths from each intervention was applied to the drowning incidence rate and the projected population size of the target age groups *(6)*. This approach has been used in previous economic analyses for breastfeeding (*17,18*) and tobacco (*19*). Incidence rates for fatal drowning were obtained from the WHO Global Health Estimates *(8)* while the incidence rates for nonfatal drowning were obtained from the Institute of Health Metrics and Evaluation (IHME) Global Burden of Disease (GBD) *(9)*.

A similar approach was used for nonfatal drowning cases, where in addition, an incidence rate of 18% was applied to estimate the number of severe nonfatal cases resulting in life-limiting disability Evidence suggests that most common sequalae to nonfatal drowning include hypoxic brain injury, and injuries to the lungs and kidneys *(10,11,20)*.

The change (reduction) in the number of fatal and nonfatal drowning cases under the scale-up scenario was then used to estimate the averted economic losses in the following sections.

6. Estimating averted economic losses

A value-of-statistical-life (VSL) approach was used to estimate the economic benefits from averted drowning cases *(4,12,21,22)*. This approach was chosen to capture the value that society places on the reduction of mortality and morbidity risk from drowning, or gains in societal welfare.

A value-of-a-statistical life (VSL) estimate was needed for each country, which were obtained from Viscusi and Masterman *(12)*. These were estimated by extrapolating the VSL estimate for the United States of America (US$ 9.6 million) to the target country adjusting for income (Gross National Income per capita), assuming an income elasticity of 1.0 *(23)*.

6.1 Estimating welfare gained from mortality risk reductions

For fatal drowning cases, the total economic value of reduced mortality can be estimated from the potential years of life lost (YLL) due to premature death (number of averted deaths multiplied by life expectancy) multiplied by the VSLY.

Following the *Reference Case Guidelines for Benefit-Cost Analysis in Global Health and Development (4),* a constant VSLY for each country was calculated by dividing the obtained VSL estimate with the life expectancy of the median aged worker. The approach reflects recommendations on adjusting the adult VSL, in the absence of VSL estimates for children *(4,24)*. This is important as the targets for the specified drowning prevention interventions are very young populations. Using this approach, the per annum VSLY does not vary based on the age of those whose lives are saved *(3)*. Hence, depending on the age at death, projected total economic loss using the VSLY would vary.

6.2 Estimating welfare gained from morbidity risk reductions

The change in total years lived with a disability (YLD) as a result of scaling up each intervention was estimated by applying the disability weight to the change in number of severe drowning cases, and multiplying this with remaining life expectancy. The constant VSLY value was then multiplied to this figure to estimate the economic value of averting nonfatal drowning cases resulting in severe outcomes *(4)*.

7. Results

If the status quo is maintained from 2020 to 2050 and if current drowning trends persist, 26 million drowning cases (7 million fatal and 19 million nonfatal) in all age-groups are projected over this period (Table W.5). If the two proposed interventions are scaled up immediately to 50% coverage, more than 1.7 million drowning cases would be averted by 2050 (980 000 from the day-care intervention and 788 000 from the basic swimming skills intervention). Looking at each intervention, providing day-care would avert about 536 000 deaths and 444 000 nonfatal cases, while the basic swimming skills intervention would avert about 238 000 fatal and 549 000 nonfatal drowning cases.

Table W.5. Health impact from drowning prevention interventions analysed, high-burden countries, 2020–2050

Scenarios	Fatal	Nonfatal	Total
Projected drowning cases under the business-as-usual scenario	7 204 250	19 130 564	26 334 814
Projected drowning cases averted in the scale-up scenario	774 176	993 124	1 767 300
Day-care intervention	535 533	444 212	979 745
Basic swimming skills intervention	238 643	548 912	787 555

The estimated economic benefits under both scenarios, as well as the implementation costs of each intervention are summarized in Table W.6. For 2020–2050, the total costs to implement both interventions to cover half of their respective target populations amount to US$ 50 billion. The net economic benefits from the day-care and basic swimming skills interventions are US$ 255 billion and US$ 180 billion respectively, totalling to US$ 435 billion when combined. The benefit-cost ratio from implementing both interventions as specified is estimated to be US$ 8.66 for every US$ 1 invested.

Table W.6. Economic benefits and benefit-cost ratio from drowning prevention interventions analysed, high-burden countries, 2020–2050

Intervention	Implementation costs (US$ billions)	Net economic benefits (US$ billions)	Benefit-cost ratio
Combined drowning interventions	50.23	435.37	8.66
Day-care intervention	33.28	255.36	7.67
Basic swimming skills intervention	16.95	180.00	10.62

8. Limitations

There are different methods to estimate VSL and VSLY, and the calculated economic benefits may vary significantly depending on the specific method chosen. Other approaches value economic and societal losses using a GDP per capita multiplier *(25,26)*, however this was deemed less appropriate for drowning prevention interventions as the target populations are very young age-groups. Given the limited timeframe, applying this method for this analysis would mean accruing benefits only after around 10 years have passed, which would greatly underestimate the value of preventing drowning cases.

Instead, the estimation approach outlined in the *Reference Case Guidelines for Benefit-Cost Analysis in Global Health and Development* was used to estimate VSL and VSLY *(4)*. While this method has its own limitations, it was considered a better fit with the interventions analysed. This also aligns with more recent publications with VSL estimation of other health interventions *(2,3,27)*. A sensitivity analysis comparing the results from both methods confirms that the results are very sensitive to the method chosen, which should be taken into consideration when interpreting these results.

Results from this modelling exercise are indicative only and relevant only at aggregated level across 50 modelled countries. Given the limited data on implementation costs of these interventions, further analysis and country contextualization should be undertaken to fully grasp the costs and health benefits of scaling up interventions in countries.

REFERENCES

1. WHO guideline on the prevention of drowning through provision of day-care, and basic swimming and water safety skills. Geneva: World Health Organization; 2021 (https://apps.who.int/iris/handle/10665/343075, accessed 21 July 2023).
2. Okunogbe A, Nugent R, Spencer G, Powis J, Ralston J, Wilding J. Economic impacts of overweight and obesity: current and future estimates for 161 countries. BMJ Glob Health. 2022;7(9):e009773. doi:10.1136/bmjgh-2022-009773.
3. Watts E, Mak J, Patenaude B. Benefit-cost ratios of continuing routine immunization during the COVID-19 pandemic in Africa. J Benefit Cost Anal. 2022;13(1):91-106. doi:10.1017/bca.2021.13.
4. Robinson LA, Hammitt JK, Cecchini M, Chalkidou K, Claxton K, Cropper M, et al. Reference case guidelines for benefit-cost analysis in global health and development. SSRN. 2019. doi:10.2139/ssrn.4015886
5. Preventing drowning: practical guidance for the provision of day-care, basic swimming and water safety skills, and safe rescue and resuscitation training. Geneva: World Health Organization; 2022 (https://apps.who.int/iris/handle/10665/352699, accessed 21 July 2023).
6. World Population Prospects 2019 [online database]. United Nations, Department of Economic and Social Affairs, Population Division; 2019 (https://population.un.org/wpp/Download/Standard/MostUsed/, accessed 10 September 2022).
7. ILOSTAT explorer [online database]. Geneva: International Labour Organization; 2019 (https://www.ilo.org/shinyapps/bulkexplorer37/?lang=en&segment=indicator&id=EMP_2EMP_SEX_GEO_ECO_NB_A , accessed 10 September 2022).
8. Global health estimates: leading causes of death. Geneva: World Health Organization; 2020 (https://www.who.int/data/gho/data/themes/mortality-and-global-health-estimates/ghe-leading-causes-of-death, accessed 21 July 2023).
9. GBD Results [online database]. Seattle, WA: Institute for Health Metrics and Evaluation (IHME), University of Washington; 2020 (https://vizhub.healthdata.org/gbd-results/, accessed 10 September 2022).
10. Bell TS, Ellenberg L, McComb JG. Neuropsychological outcome after severe pediatric near-drowning. Neurosurgery. 1985;17:604–8. doi:10.1227/00006123-198510000-00012.
11. Bratton SL, Jardine DS, Morray JP. Serial neurologic examinations after near drowning and outcome. Arch Pediatr Adolesc Med. 1994;148:167–70. doi:10.1001/archpedi.1994.02170020053008.
12. Viscusi WK, Masterman CJ. Income elasticities and global values of a statistical life. J Benefit Cost Anal. 2017;8:226–50. doi:10.1017/bca.2017.12.
13. Salomon JA, Haagsma JA, Davis A, de Noordhout CM, Polinder S, Havelaar AH, et al. Disability weights for the Global Burden of Disease 2013 study. Lancet Glob Health. 2015;3:e712–23. doi:10.1016/S2214-109X(15)00069-8.
14. World Economic Outlook Database [online database]. Washington, DC: International Monetary Fund (IMF); 2023 https://www.imf.org/en/Publications/WEO/weo-database/2023/April, accessed 21 July 2023).
15. Rahman F, Bose S, Linnan M, Rahman A, Mashreky S, Haaland B, et al. Cost-effectiveness of an injury and drowning prevention program in Bangladesh. Pediatrics. 2012;130:e1621–8. doi:10.1542/peds.2012-0757.
16. Alfonso YN, Hyder AA, Alonge O, Salam SS, Baset K, Rahman A, et al. Cost-effectiveness analysis of a large-scale crèche intervention to prevent child drowning in rural Bangladesh. Injury Epidemiology. 2021;8:61. doi:10.1186/s40621-021-00351-9.
17. Bartick M, Schwarz E, Green B, Jegier B, Reinhold A, Colaizy, T, et al. Suboptimal breastfeeding in the United States: Maternal and pediatric health outcomes and costs. Matern Child Nutr. 2017;13(1):e12366. doi:10.1111/mcn.12366.

REFERENCES

18. Pokhrel S, Quigley MA, Fox-Rushby J, McCormick F, Williams A, Trueman P, et al. Potential economic impacts from improving breastfeeding rates in the UK. Arch Dis Child. 2015;100(4):334-340. doi:10.1136/archdischild-2014-307264.
19. Hutchinson B, Brispat F, Calderón Pinzón LV, Sarmiento A, Solís E, Nugent R, et al. The case for investment in tobacco control: lessons from four countries in the Americas. Rev Panam Salud Publica. 2022;46:e174. doi:10.26633/RPSP.2022.174.
20. Suominen PK, Vähätalo R. Neurologic long term outcome after drowning in children. Scand J Trauma Resusc Emerg Med. 2012;20:1–7. doi:10.1186/1757-7241-20-55.
21. Akobundu E, Ju J, Blatt L, Mullins CD. Cost-of-illness studies. Pharmacoeconomics. 2006;24:869–90. doi:10.2165/00019053-200624090-00005.
22. Hodgson TA, Meiners MR. Cost-of-illness methodology: a guide to current practices and procedures. Milbank Mem Fund Q Health Soc. 1982;429–62. doi:10.2307/3349801.
23. Hammitt JK, Robinson LA. The income elasticity of the value per statistical life: transferring estimates between high and low income populations. J Benefit Cost Anal. 2011;2(1):1-1. doi:10.2202/2152-2812.1009.
24. Narain U, Sall C. Methodology for valuing the health impacts of air pollution: discussion of challenges and proposed solutions. Washington DC: World Bank; 2016 Retrieved from World Bank eLibrary: 2016 (https://elibrary.worldbank.org/doi/abs/10.1596/24440, accessed 21 July 2023).
25. It's time to invest in cessation: the global investment case for tobacco cessation: methodology and results summary. Geneva: World Health Organization; 2021 (https://apps.who.int/iris/handle/10665/348531, accessed 21 July 2023).
26. Saving lives, spending less: the case for investing in noncommunicable diseases. Geneva: World Health Organization; 2021 (https://apps.who.int/iris/handle/10665/350449, accessed 21 July 2023).
27. Sim SY, Watts E, Constenla D, Brenzel L, Patenaude BN. Return on investment from immunization against 10 pathogens in 94 low- and middle-income countries, 2011-30. Health Aff (Millwood). 2020;39(8):1343-1353. doi:10.1377/hlthaff.2020.00103.

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