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Economic Impact of Using Fortified Rice in Cambodia's School Feeding Programme

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This assessment was developed by:

Anubhab Gupta, Yoonjung Lee, and Alex Macri of Virginia Tech University

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For more information please contact:

World Food Programme Cambodia
Cambodia House No.108
Street 63/corner Street 208, Sangkat Boeung Raing,
Khan Daun Penh, Phnom Penh, Kingdom of Cambodia
Email: WFP.PhnomPenh@wfp.org

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Introduction

Despite Cambodia's remarkable economic growth and poverty reduction in the last two decades, the country still faces challenges related to malnourishment. The problems of undernutrition are compounded by micronutrient deficiencies, overweight and obesity. Like many other low and middle income countries, Cambodia is in the process of transition in its population's nutritional composition. The country is facing a two-fold nutritional challenge, which is often referred to as the 'double burden of malnutrition'. This is where undernutrition, described by wasting, stunting and micronutrient deficiencies, coexists with overnutrition and obesity, either in the life cycle of an individual and/or within a household, and across communities and regions (Nakphong and Beltran-Sanchez 2021; Popkin et al. 2020; Uwira and Claasen 2020).

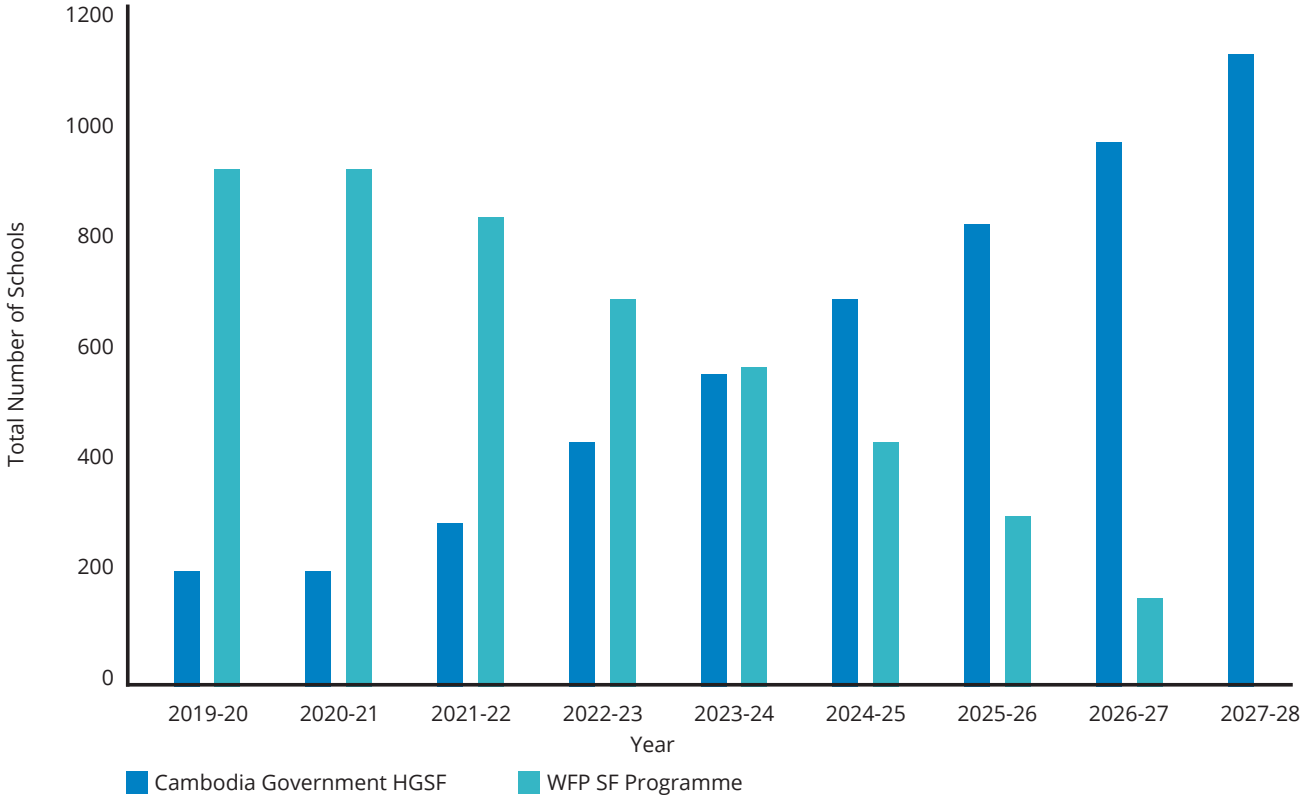
Poor maternal health, low birthweights, and undernutrition among children cause a high prevalence of child stunting and wasting in Cambodia (Wieringa et al. 2016, UNICEF 2021, DHS 2022). Hidden hunger in the form of micronutrient deficiencies, particularly iron, vitamin A, and iodine, is among the highest in Southeast Asia (UNICEF 2021). Coordination efforts and plans to address the prevalence of undernourishment in the country include several national policies and strategies such as the National Strategy for Food Security and Nutrition (2019-2023), National Policy on Infant and Young Child Feeding (revised 2018), and the Nutrition Technical Working Group of the Ministry of Health National Nutrition Programme.

The school feeding programme in Cambodia, which is run by the national government and the United Nations World Food Programme (WFP), has the potential to reduce the burden of diseases caused by micronutrient deficiencies. Providing fortified rice to schoolchildren can potentially be a cost-effective way of improving micronutrient deficiencies in young children. WFP and the Nutrition Improvement Department of the Ministry of Planning partnered with Virginia Tech University between 2022 and 2023 to evaluate the socioeconomic impact of providing fortified rice in Cambodian schools. The analyses conducted by the researchers provide answers to three policy questions:

1. Is providing fortified rice a cost-effective way of improving nutritional outcomes among schoolchildren?
2. Does fortified rice in school meals reduce the burden of disease?
3. What are the economic benefits and the return on investment of serving fortified rice in Cambodian schools?

The Ministry of Education, Youth and Sports, with support from the WFP, started Cambodia's school feeding programme in 1999. Currently 300,000 schoolchildren receive school meals across 10 provinces. WFP, in partnership with the Cambodian government, introduced the country's home-grown school feeding (HGSF) model in 2014, in which food served in schools was sourced locally. In a phased transition plan, WFP has started handing over the school feeding programme to the Cambodian government. At present the WFP hybrid HGSF programme provides fortified rice in school meals (and cash for local procurement), the national government's full HGSF provides unfortified rice procured locally. The schools operated by WFP in the hybrid HGSF programme receive fortified rice which is either imported from the United States of America (USDA fortified rice) or domestically produced using local rice blended with imported rice kernels (locally fortified rice). The per unit cost of procurement and delivery varies across the three modalities. In 2022-23, WFP administered school feeding in 686 schools and the national government's full HGSF programme provided meals in 427 schools. Figure 1 shows how the WFP school feeding programme will be handed over completely to the national government's full HGSF by 2027-28.

Figure 1: Transition of school feeding from WFP to national government



Rice fortified with micronutrients can have a positive impact on children's health. Recent studies show that micronutrients such as iron and iodine help with cognitive development in children, whereas vitamins A and D and folate improve their physical growth (NIH 2021, CDC 2022). An important study in the Cambodian context is a 2012-13 double-blind randomized control trial intervention of providing fortified rice in 20 schools in Kampung Speu province. The study, called Fortified Rice for School Children in Cambodia (FORISCA), was designed to evaluate the impact of fortified rice on health, nutrition and cognitive outcomes. Findings from several reports and published papers from the study suggest that providing fortified rice in school meals in Cambodia significantly reduced the prevalence of vitamin A and zinc deficiencies (Perignon et al. 2014). There were positive impacts on haemoglobin concentration and iron status and overall improvement in cognitive test scores (Skau et al. 2015).

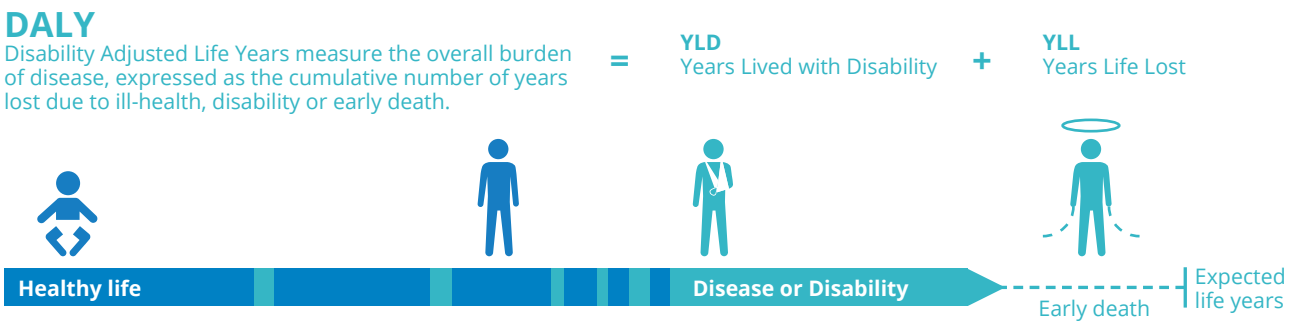
Data & Methodology: The researchers utilized secondary data from several sources including CDHS 2023 and FORISCA 2012-13 to answer the three research questions.

The first step in their research was to evaluate whether providing fortified rice is cost-effective in reducing the prevalence of micronutrient deficiencies. A standard cost-effectiveness analysis (CEA) was used to estimate an incremental cost-effectiveness ratio (ICER). This is a ratio of the net additional cost of providing fortified rice (over unfortified rice) to the changes in micronutrient deficiencies. The ICER is typically used as a decision rule in resource allocation. Lower values of ICER are more attractive for health interventions whereas higher values of ICER need comparison to a certain threshold for the intervention to be deemed cost-effective.

A negative ICER value for a particular micronutrient would indicate that providing fortified rice is highly cost-effective in reducing the prevalence of that micronutrient deficiency. ICER values between US dollars (USD) 0 and USD 1,000 (a threshold value) indicate high cost-effectiveness, values between USD 1,000 and USD 3,000 (three times the threshold) indicate moderate cost-effectiveness, and values higher than USD 3,000 indicate that the intervention of providing fortified rice is not cost-effective.[1]

The next step is to estimate the burden of diseases from micronutrient deficiencies among Cambodian schoolchildren. A disability-adjusted life year (DALY) was estimated for an average schoolchild. Figure 2 provides a schematic of the conceptual idea behind DALY, which estimates the sum of years lived with disability and the years of life lost due to premature mortality as a result of micronutrient deficiency. Calculating DALYs is a multistep process that involves using disability weights from related impairments due to micronutrient deficiencies, their probabilities of infection, and the duration of impairments. The researchers used several existing studies to benchmark their estimates for calculating DALYs (Stein et al. 2005, Murray et al. 2012, Struijk et al. 2013, Plessow et al. 2015). Once DALYs were calculated using the data on the existing micronutrient deficiencies, the researchers estimated the reduction in micronutrient deficiency from providing fortified rice. They used the randomized experimental evidence from FORISCA to estimate the averted DALYs among schoolchildren as a result of providing fortified rice.

Figure 2: Schematic explaining disability-adjusted life years (DALYs)



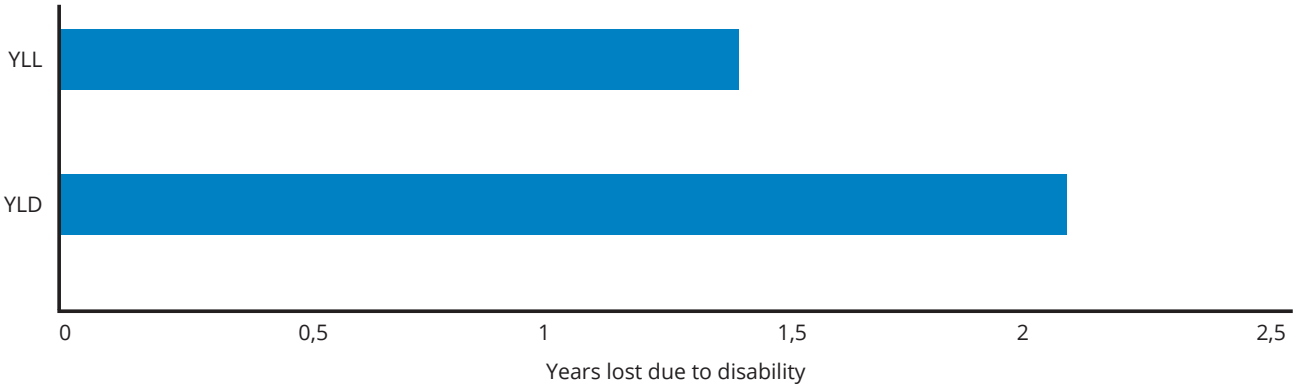
The last step in the research was translating the DALYs from micronutrient deficiencies and the averted DALYs from providing fortified rice, to economic (dollar) values, a cost-benefit analysis (CBA). The Cambodian per capita gross domestic product (GDP) was used for converting every year of life lived with disability to an economic value that is lost per person when a child grows up to be an adult unable to work to their potential. Economic benefits were estimated by multiplying the averted DALYs with per capita GDP. The per student estimate was used to calculate annual losses from DALYs in schools that do not receive fortified rice. To perform the CBA, overall discounted benefits and discounted costs of providing fortified rice were calculated and compared against each other to obtain a return on investment in rice fortification.

Results:

The researchers conducted a CEA to identify the cost of achieving direct short-term health outcomes such as reducing deficiencies of key micronutrients like iron, zinc, folic acid and vitamin A, through rice fortification. They estimated ICERs of rice fortification for their impact on micronutrients. Results indicate that providing fortified rice in school meals is very highly cost effective in reducing zinc, folic acid, and vitamin A deficiencies; highly cost effective in improving cognitive performance, and moderately cost effective in reducing iron-deficiency anaemia.

[1] Threshold values are so chosen that ICER values, higher than three times the threshold, are considered not "cost-effective". No single threshold exists for deciding whether an ICER is acceptable. Typically, the thresholds are determined in relation to per-capita gross national income, e.g., in the United States. ICERs less than USD 50,000 per life are considered cost effective. The authors chose USD 1,000 as the threshold for comparing ICERs in Cambodia.

Figure 3: DALYs per student



To estimate the current burden of disease among schoolchildren in Cambodia, the researchers calculate the DALYs per student between the age of 6 and 12 years. In Cambodia, an average student may lose up to 3.47 years of their productive life due to existing micronutrient deficiency, of which 2.07 years will be lost due to disability, and 1.4 years lost due to early death. Using the Cambodian per capita GDP (current USD) estimate of USD 1,785, the economic cost of DALYs per student is USD 6,194. The economic cost is obtained by multiplying the years lost to DALYs with the per capita GDP estimate.[2] In other words, each student currently in school will not be able to earn USD 6,194 over their lifetime due to morbidity and/or mortality caused by micronutrient deficiencies.

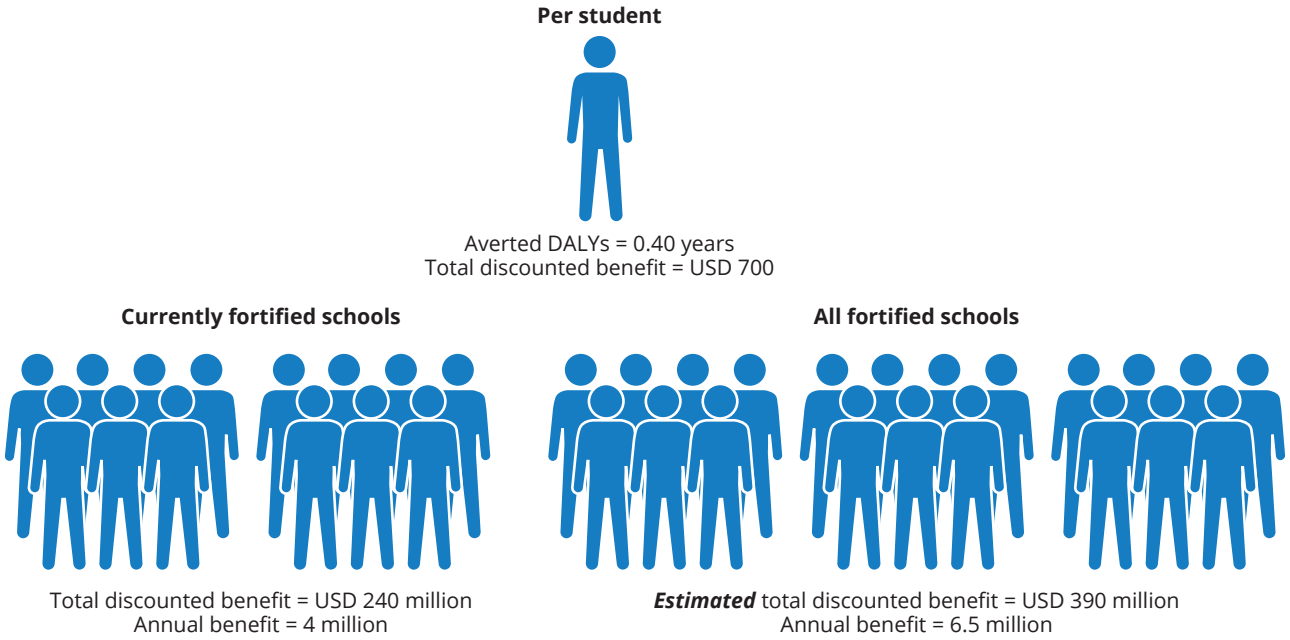
Currently, there are 427 schools under the HGSF school feeding programme where approximately 213,500 children receive unfortified rice. An estimate of the total burden of disease on the children currently enrolled in HGSF schools and without fortified rice, shows that potentially 15,000 productive lives would be lost in DALYs. Translating the DALYs to dollar value and dividing by an average productive life span of 60 years, results in an annual economic loss of approximately USD 22 million due to DALYs from micronutrient deficiencies.[3]

In calculating DALY and DALY averted per student, standard disability weights and duration (in years) were used for each impairment caused due to micronutrient deficiencies from iron, zinc, vitamin B_1, vitamin A, etc., from standard sources such as the United Nations World Health Organization (WHO), Johns Hopkins University and National Center for Biotechnology Information in the United States. The average life expectancy at birth in Cambodia, which is 70.42 years, is used and a discount rate of 3 percent for obtaining the present discounted benefits and losses from DALYs.[4] FORISCA estimated the reduction in incidence rates of micronutrient deficiencies between the follow-up and baseline data, which are used to estimate the DALYs averted from micronutrient deficiencies, thereby reducing the potential reduction in incidence of related impairments. First the averted cost due to each impairment was calculated and then summed up across all impairments to obtain the economic estimate of DALYs averted per student.

Providing fortified rice rich in micronutrients in Cambodian schools has the potential to avert 0.40 years of DALYs per student, which is equivalent to gaining USD 700 in total discounted benefits per student.

[2] Using per-capita GDP to estimate loss per student provides a lower bound conservative estimate of economic loss.
[3] The estimate of 15,000 productive lives is obtained by dividing the total DALYs of 740,845 (from 213,500 children) by an average 60 years of productive life. This gives an estimate of USD 22 million in annual economic loss. No additional discounting is needed because the DALYs measurement already includes discounting.
[4] 'Discount rate' is an interest rate that is applicable to benefits and costs that are expected to occur in the future in order to convert them into a present value. 'Present discounted benefits (losses)' are the amounts of benefits (losses) one should be willing to obtain (incur) in the present for a stream of expected future returns, either benefits or costs.

Figure 4: Averted DALYs due to rice fortification



By serving fortified rice in school meals in the hybrid HGSF programme, WFP is helping gain approximately USD 4 million in total discounted benefits annually. Expanding the fortification programme in all HGSF schools (currently 427), an additional USD 2.5 million per year could be gained by averting DALYs.

There are two sources for procuring fortified rice for school feeding. First, fortified rice could be imported from the United States, which costs 27.5 cents per child per day. Second, fortified rice could be produced locally with Cambodian rice blended with fortificants imported from elsewhere. The second modality costs around 20.4 cents per child per day. The return on investment (ROI) of rice fortification would depend on the procurement modality. The ROI, defined as the ratio of total discounted benefits to total discounted costs, is higher on fortified rice produced with local Cambodian rice compared to fortified rice imported from the United States. Investing in fortified rice gives an economic return of USD 700 in discounted benefits over the lifetime of a student by averting DALYs due to micronutrient deficiencies. The cost of providing a student with locally fortified rice is USD 205 and imported fortified rice is USD 276 over six school years. USD 1 invested in local fortified rice gives a return of USD 3.42 whereas USD 1 in imported rice gives a return of USD 2.54. The difference in ROI is due to the difference in cost of procurement of fortified rice in the two modalities.

Figure 5: Discounted benefits and costs per student

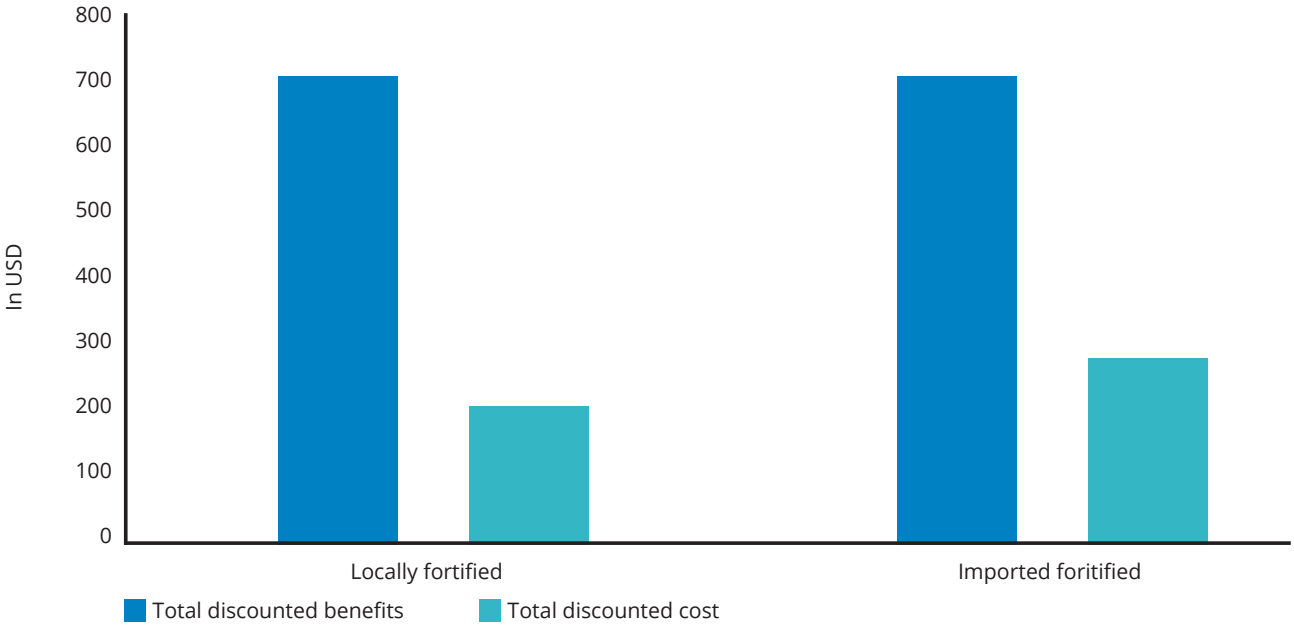


Figure 6: Return on Investment

Conclusions:

There are three clear take-aways from this collaborative research:

1. Providing fortified rice in Cambodian schools is cost-effective in reducing the prevalence of micronutrient deficiencies among schoolchildren.

2. Fortified rice can significantly reduce the burden of diseases caused by impairments due to micronutrient deficiencies.

3. A rice fortification programme gives high economic returns in the future, which outweighs the cost of implementing the programme threefold. The return is higher if rice is locally sourced and fortified domestically compared to importing fortified rice.

This research only evaluates the benefits of rice fortification from a health and nutrition point of view by considering the potential economic losses from micronutrient deficiencies. According to FORISCA and consistent with the nutrition literature, providing fortified rice in schools can improve cognitive outcomes among schoolchildren (Best et al. 2011, Luo et al. 2017). Better cognitive development in early childhood results in higher individual labour market outcomes in the future (Case and Paxon 2008). Considering potential local economy and labour market impacts of producing locally fortified rice will give higher additional benefits from the programme, including economic spill-overs on the local economy. The cognitive or local economy channels are not considered in this analysis, therefore the ROIs calculated in the study are likely to be underestimates of a nationwide rice fortification programme in Cambodian schools.

References

Best, C., Neufingerl, N., Del Rosso, J.M., Transler, C., van den Briel, T. and Osendarp, S., 2011. Can multi-micronutrient food fortification improve the micronutrient status, growth, health, and cognition of schoolchildren? A systematic review. Nutrition reviews, 69(4), pp.186-204.

Case, A. and Paxson, C., 2008. Stature and status: Height, ability, and labor market outcomes. Journal of Political Economy, 116(3), pp.499-532.

Luo, R., Yue, A., Zhou, H., Shi, Y., Zhang, L., Martorell, R., Medina, A., Rozelle, S. and Sylvia, S., 2017. The effect of a micronutrient powder home fortification program on anemia and cognitive outcomes among young children in rural China: a cluster randomized trial. BMC Public Health, 17, pp.1-16.

Murray, C.J., Vos, T., Lozano, R., Naghavi, M., Flaxman, A.D., Michaud, C., Ezzati, M., Shibuya, K., Salomon, J.A., Abdalla, S. and Aboyans, V., 2012. Disability-adjusted life years (DALYs) for 291 diseases and injuries in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. The lancet, 380(9859), pp.2197-2223.

Nakphong, M.K. and Beltrán-Sánchez, H., 2021. Socio-economic status and the double burden of malnutrition in Cambodia between 2000 and 2014: overweight mothers and stunted children. Public Health Nutrition, 24(7), pp.1806-1817.

Lajoie, J., 2013. Understanding the measurement of global burden of disease. Prepared for the National Collaborating Centre for Infectious Diseases August. URL: https://centreinfection.ca/en/wp-content/uploads/sites/2/2015/03/Global_Burden_Disease_Influenza_ENG.pdf

Perignon, M., Fiorentino, M., Kuong, K., Burja, K., Parker, M., Sisokhom, S., Chamnan, C., Berger, J. and Wieringa, F.T., 2014. Stunting, poor iron status and parasite infection are significant risk factors for lower cognitive performance in Cambodian school-aged children. PLOS One, 9(11), p.e112605.

Plessow, R., Arora, N.K., Brunner, B., Tzogiou, C., Eichler, K., Brügger, U. and Wieser, S., 2015. Social costs of iron deficiency anemia in 6–59-month-old children in India. PLOS One, 10(8), p.e0136581.

Popkin, B.M., Corvalan, C. and Grummer-Strawn, L.M., 2020. Dynamics of the double burden of malnutrition and the changing nutrition reality. The Lancet, 395(10217), pp.65-74.

Skau, J.K., Touch, B., Chhoun, C., Chea, M., Unni, U.S., Makurat, J., Filteau, S., Wieringa, F.T., Dijkhuizen, M.A., Ritz, C. and Wells, J.C., 2015. Effects of animal source food and micronutrient fortification in complementary food products on body composition, iron status, and linear growth: a randomized trial in Cambodia. The American journal of clinical nutrition, 101(4), pp.742-751.

Stein, A.J., Meenakshi, J.V., Qaim, M., Nestel, P. and Bhutta, Z.A., 2005. Analyzing the health benefits of biofortified staple crops by means of the disability-adjusted life years approach: a handbook focusing on iron, zinc and vitamin A.

Struijk, E.A., May, A.M., Beulens, J.W., de Wit, G.A., Boer, J.M., Onland-Moret, N.C., van der Schouw, Y.T., Bueno-de-Mesquita, H.B., Hoekstra, J. and Peeters, P.H., 2013. Development of methodology for disability-adjusted life years (DALYs) calculation based on real-life data. PLOS One, 8(9), p.e74294.

UNICEF, 2021. Southeast Asia regional report on maternal nutrition and complementary feeding. Nutrition and Complementary Feeding Regional Report. pdf. https://www. unicef. org/eap/media/9466/file/Mater nal.

Uwira, D. and Claasen, N. Tackling the double burden of malnutrition. Rural 21, (2020), pp. 12-14. https://www.rural21.com/fileadmin/downloads/2020/en-03/rural2020_03-S12-14.pdf (Link Accessed: 10th Oct 2023)

Wieringa, F.T., Dahl, M., Chamnan, C., Poirot, E., Kuong, K., Sophonneary, P., Sinuon, M., Greuffeille, V., Hong, R., Berger, J. and Dijkhuizen, M.A., 2016. The high prevalence of anemia in Cambodian children and women cannot be satisfactorily explained by nutritional deficiencies or hemoglobin disorders. Nutrients, 8(6), p.348.

Acronyms

CBA	Cost-benefit analysis
CDC	Centre for Disease Control
CDHS	Cambodia Demographic Health Survey
CEA	Cost-effectiveness analysis
DALY	Disability-adjusted life year
FORISCA	Fortified Rice for School Children in Cambodia
HGSF	Home-grown school feeding
ICER	Incremental cost-effectiveness ratio
NIH	National Institutes of Health
WFP	World Food Programme
WHO	World Health Organization

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World Food Programme Cambodia
Cambodia House No.108
Street 63/corner Street 208, Sangkat Boeung Raing,
Khan Daun Penh, Phnom Penh, Kingdom of Cambodia
Email: WFP.PhnomPenh@wfp.org