AI-Based Classification of Nutritional Risk in Low-Income Populations

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Abstract

Malnutrition is much more than a biological state of being in the uproar of Dhaka urban slums and the communities at risk of malnutrition in the delta region of Bangladesh, it is a social economic imprint sewn upon the everyday life. Although the nation has made major strides, the distribution of nutritional results has been disproportional thus indicating the long-standing disparities that have characterized access to food, quality of diets and health over the long term.

Although, stunting in Bangladesh has decreased to 24% as compared to 36 in 2014 and 2022, the gains of this reduction are not even. Nutritional security is a closed door to the poorest households, with lack of income combined with diet high in staple cereals exposes the children and adults to both macronutrient and micronutrient deficiencies.

The issue of malnutrition is being redefined by 2026 with the data science perspectives in mind. The conventional methods of nutrition, which mostly prioritize clinical diagnosis or food supplementation, tend to respond to malnutrition when it has become apparent, physically. Educational Data Mining, Predictive Modeling and Machine Learning (ML) are the resources today that can help uncover nutritional risk before the indicators of stunting, wasting, or low weight set in. Combining household earnings, demographics, environment, and food habits, AI is becoming a so-called digital diet tracker, able to alert vulnerable families beforehand, intervene early, and make the limited resources better.

Malnutrition has strong socioeconomic roots due to its quantitative reality. Results of the analysis of 2025-2026 datasets depict a severe wealth gradient of nutritional outcomes. In the wealthiest households, children have a lower risk of being stunted (by 34.3 percentage points), wasted (by 6.9 percentage points), and underweight (by 32.8 percentage points) than children in the poorest households. This is harder in the geographically vulnerable areas. Stunting in regions of the country, where riverbank erosion or seasonal

flooding is likely to occur, or in so-called char lands, is at 42.8 to underweight prevalence of 50 to almost twice that of the rest of the country. The issue of dietary imbalance remains unresolved among the low population incomes, as the daily intake of pulses, vegetables, and animal-source proteins is usually half or less than the required one. This silent crisis of micronutrient deficiency is that hidden hunger, which, when not addressed, may have future effects on intellectual growth, educational achievement, and general productivity.

In order to overcome reactive care, scientists have now been applying machine learning classification models to identify nutritional risk based on proxy factors. The predictive algorithms are operated on household and maternal characteristics, sanitation, and dietary diversity scores to enable policymakers to take action in advance. Random Forest (RF) is another of the most successful models in the Bangladeshi setting with a high degree of accuracy of 88.3 and 87.7 in stunting prediction and wasting, respectively. The advantage of RF is that it can work with data of high dimensions and in such cases, parental education, household sanitation, maternal BMI, and access to clean water are interacting in complex and non-linear ways that affect child nutrition. Gradient boosting models, including XGBoost, are used to complement RF, whereby the critical "tipping points" are defined, that is, the particular income level, dietary diversity index, or maternal health indicator at which a child is at risk of being malnourished. Such models present the nutritional risk with a subtle perspective and offer interventions, which are highly accurate and sensitive to the context.

It is important to know what factors have the greatest impact on malnutrition to be able to make effective policy. Explainable AI (such as SHAP (SHapley Additive exPlanations)) tools have become an essential element in making the relative significance of predictors known. In Bangladesh, which is low-income, maternal education and maternal height are found to be the most influential factors in determining the birth size and early nutritional status. Household water source and sanitation are some of the environmental variables that are important in the prevention of environmental enteric dysfunction that directly influences nutrient absorption. Risk additionally is modified by birth order and birth spacing especially in low-resource families, where there is a risk that closely spaced births may blur the care and nutrition. Through the measurement of these factors, AI allows prioritizing interventions based on evidence and, as a result, making sure that resources are allocated to the families that are most vulnerable.

One of the research innovations of 2026 is that fairness metrics have been included in the model development due to the risks of algorithmic bias. Most of the urban-trained models in the past have misdiagnosed the nutritional risks of rural or coastal populations. In response, scientists currently use recall parity and re-weighting to make AI equally sensitive to at-risk children regardless of location, geographic and socio-economic status, between the relatively well-performing Khulna division and the more challenged areas of Sylhet and Barisal. These methods mean that, without assuming that being poor means being malnourished, one can identify so-called positive deviants, i.e. households that are not poor but well-

nourished, and learn their strategies, which can be observed, recorded and reproduced in order to educate the wider policy.

Malnutrition is turned into a time sensitive issue that needs to be addressed rather than a gradually developing crisis with its predictive capabilities. Using household data as the input, models can give seven-day lead time to community health workers and classify families to a nutrition-sensitive intervention prior to the onset of clinical signs. This proactive stance allows providing social safety net assistance early in life, be it in the form of cash transfer, food vouchers or micronutrient supplements, which helps to minimize the risk and decrease the ultimate health expenditure.

Artificial intelligence implementation in national nutrition regulation is no less radical. Predictive scores can be used to allocate nutrition sensitive stipends so that the financial resources are directed to those families who are most likely to be benefited. Under National Plan of Action on Nutrition (NPAN2) are smart monitoring dashboards that show real-time visualization of nutritional hotspots, which combines the data created by household surveys, market prices, and crop yields to dynamically map the areas of highest need. Field devices with low prices, including smartphone applications with frontline health workers, can enable real-time risk classification during standard home visits, and make the traditional outreach an informed data-based intervention.

In addition to the direct response, the classification derived with the help of AI facilitates planning and policy development, in the long term. Predictive models can forecast the emergence of vulnerabilities in households and communities through continuous monitoring of household and community-level indicators, e.g. seasonal food insecurity during monsoon or flood seasons. This will help policymakers preposition supplies, create specific feeding plans and introduce region-specific interventions. In addition, to the development of the spatial and demographic information, it is possible to reveal the structural determinants of malnutrition as access to markets, medical services, and drinking water, which contribute to the comprehensive approach to the food insecurity issue.

The use of AI in the nutritional risk assessment continues to be subject to ethical and operational concerns. The most important is the privacy of data, security, and informed consent especially when dealing with vulnerable groups. The involvement of local communities in the process to design and validate predictive models will promote more trust and make sure that interventions are culturally and contextually appropriate and socially acceptable. The intersectoral cooperation of the government agencies, non-governmental organizations, and research institutions can make sure that the AI-based insights can be translated into practical and physical changes in health and nutritional outcomes.

Malnutrition in Bangladesh is not merely a clinical problem, but it is a multidimensional, manifold issue that cuts across the economics, geography, education, and social infrastructure. Scientists and policy-makers

are driving towards a more accurate, fair and active model of nutritional intervention by using machine learning and predictive analytics. AI has the potential to predict risk, prioritize resources to where they can do the most good and customize interventions to local conditions, and nutrition can be a strategic, data-driven field of public health, rather than a reactive one.

Finally, the malnutrition war against low-income populations has entered a new stage when information and AI supplement the traditional approach of the population health strategy. Revealing the socioeconomic and environmental strata of nutritional vulnerability, AI can be utilized to deliver actionable information that can be used to inform early interventions, social protection measures, and policy planning in the long term. Malnutrition is no longer an unavoidable consequence of poverty in the age of the so-called Smart Bangladesh. Rather, it becomes a foreseeable and avoidable situation, an issue that can be dealt with with accuracy, fairness and vision. Through the force of AI, it will be possible not only to make sure that each child, no matter their household income, geographic placement, or environmental situation, will have access to the opportunity to achieve their full nutritional potential but also to guarantee the immediate health and the development of human capital in the long-term.