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APPLYING MACHINE LEARNING ALGORITHMS TO PREDICT LOW WEIGHT GAIN IN SEVERE ACUTE MALNUTRITION TREATMENT UNDER A SIMPLIFIED PROTOCOL IN EMERGENCY SETTINGS OF NIGER

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BACKGROUND AND OBJECTIVES

A non-randomized controlled trial in Diffa region in Niger, demonstrated that applying the ComPAS* simplified protocol to treat Severe Acute Malnutrition (SAM) achieves higher cure rates than the Community Management of Acute Malnutrition (CMAM) standard protocol (96.6% vs. 87.4%), with lower discharge errors (3.2% vs. 10.9%), therefore being a cost-efficient intervention [1, 2].

With the objective of evaluating the possible socio-economic differences between the groups of individuals treated in each protocol and their influence on the treatment results, a socioeconomic survey was carried out among a subsample of participants.

The aim of this secondary analysis was to identify which variables best predict low weight gain during treatment applying machine learning algorithms that consider the simultaneous influence of all the variables analysed to better reflect the reality of complex settings.

*MUAC of <115 mm as a sole diagnostic criteria for admission and discharge, fixed dose of RUTF (ready-to-use therapeutic food) 2 sachets/day, except children < 5kg, who received 1 sachet/day RUTF

Amina Gambo mother of Amina Youra. Village Oudi Peulh, Kableva district, Diffa Region. Niger.

METHODS

295 children cured of uncomplicated SAM between 6-59 months were included. A total of 57 variables were analysed (51 related to socio-economic and healthcare access and 6 related to anthropometry, vaccination, and comorbidities at admission).

After a variables selection through VSURF algorithm[3] based on random forest, an ensemble method was applied to predict weight gain (g/kg/day). This machine learning method used multiple learning algorithms to obtain better predictive performance than could be obtained from any of the constituent learning algorithms alone[4].

The stacking process involves training a model (final predictor) to combine the predictions of several other learning algorithms (based predictors). A detailed workflow can be seen in **Figure 1**. A split into train/test and repeated cross-validation was used to assess model prediction.

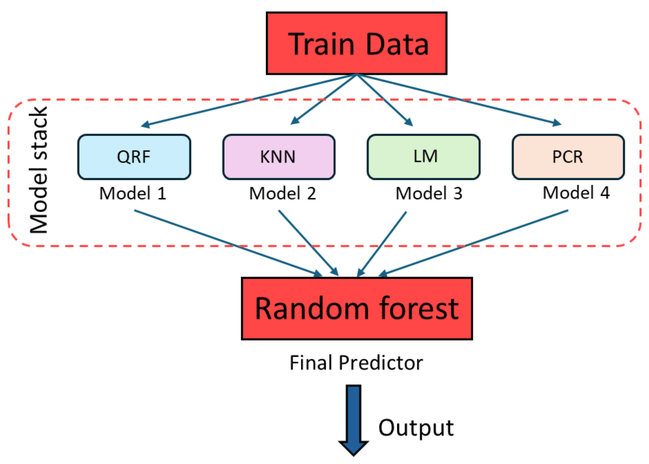

Figure 1. Stacking process workflow. QRF: Quantile Regression Forest; KNN: K-Nearest Neighbors; LM: Linear Model; PCR: Principal Components Regression.

RESULTS

78% of cases showed weight gain lower than 8g/kg/day in the simplified group and 56% in the CMAM group. Train/test data split lead to a Simplified test set of 49/60 individuals with a weight gain lower than 8g/kg/day, and a CMAM test set of 14/26 individuals.

Variables selection

VSURF algorithm selected the most related variables with weight gain (g/kg/day) during treatment with CMAM and simplified protocol. These selected key variables were different between both treatment groups. For the simplified group four key variables were identified as key: the type of housing (owned, rented, leased), the cost associated with transportation to the treatment site, the primary source of drinking water and the time spent to collect it. Whereas, for the CMAM group, while the source of drinking water was also key, the other four main variables related to the main caregiver (age, occupation, days, and hours-per-day worked).

Ensemble method

The ensemble methodology was first trained with the train set of individuals using the key variables identified by VSURF algorithm and adjusting by sex, age, vaccination, MUAC and weight at admission and presence of comorbidities. Afterwards, using the trained meta-model, the prediction of expected weight gain in the test set of individuals was performed. 92.9% (13/14) of children with weight gain <8g/kg/day in the CMAM protocol group and 85.7% (42/49) in the simplified group were correctly predicted. Root-Mean-Squared Error was around 1.8-2.3 and individual R^2 of each model increased from 0.4 to 0.7 of the ensemble model.

Figure 2 displays the regression line of the final ensemble models for CMAM and Simplified protocols in which the dispersion of the individuals along it could be evaluated.

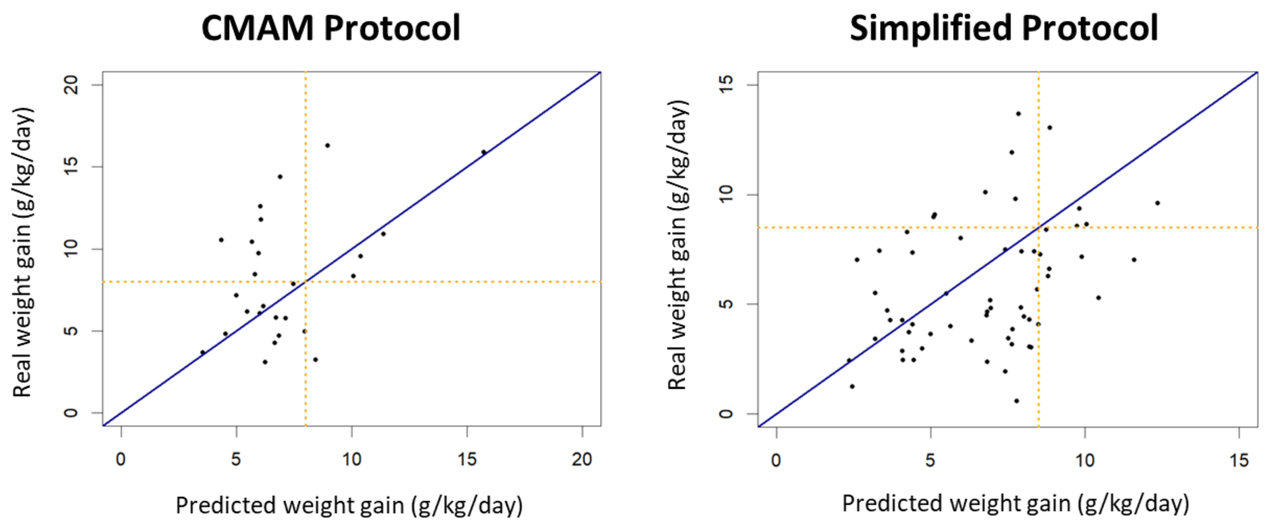

Figure 2. Plots showing the correspondence between the real and the predicted values of weight gain in the test set of children. Orange lines identify the 8 g/kg/day cut-off points.

CONCLUSION/DISCUSSION

- Weight gain did not reach the values of 8/gr/kg/day recommended by the WHO in any of the cases. A higher % of children in the group treated with the simplified protocol did not reach this standard, which may be related to a statistically significant higher weight at admission.
- The present work has demonstrated that matching learning can predict the socio-economic factors associated with lower weight gain during SAM treatment. The type of housing, the cost associated with transportation to the treatment site, the primary source of drinking water and the time spent to collect it were selected as key variable predictors. The primary source of drinking water was also a key predictive variable in the CMAM group.
- Policy makers could prioritise interventions to improve access to water, reduce housing and health costs, and gender programmes to have a positive impact on the cost-efficiency of treatment programmes.

ETHICS STATEMENT

The study was conducted according to the guidelines laid down in the Declaration of Helsinki, and all procedures involving research study participants were approved by the National Health Research Ethics Committee of Niger with the reference number 013/2020/CNERS

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