Application of neural networks for final height prediction based on pre-treatment data in children with growth hormone (GH) deficiency treated with GH

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Disclousure statment: nothing to disclose

Introduction

Prediction of the effectiveness of growth hormone (GH) therapy in children with short stature is an important clinical problem, usually solved by creating multiple linear regression (MLR) models [1]. Artificial neural networks (ANN) seem to be promising tool for this purpose, since - in contrary to MLR - they enable modelling complex, nonlinear dependencies between variables, with no need to fulfil any statistical assumptions concerning the data and with no previous knowledge about the character of relations between input and output variables.

Objectives

The aim of the study was to compare ANN models of GH therapy effectiveness, based on the data available at therapy onset with MLR model.

Methods

Artificial neural networks (ANN) are complex, biologically inspired computational systems, considered one of the leading tools of machine learning or even artificial intelligence. Their development is based on modelling structure and communication of neurons (Fig. 1). The process in which ANN model is derived (learning) is computationally complex and is usually done by dedicated software; for details see [2].

Retrospective analysis comprised the data of 150 short children (101 boys), diagnosed with isolated GH deficiency, who were treated with GH for at least 2 years, up to the attainment of final height (FH). The following parameters (input variables) were assessed before treatment for each patient: gender, height/hSDS, chronological age (CA), bone age (BA), mothers' and father's height (hm/hmSDS, hf/hfSDS), pubertal status (pub st), height velocity (HV), GH peak after falling asleep and in 2 stimulation tests, IGF-I/IGF-I SDS and IGFBP-3 concentration, birth weight (BW) and gestational age (GA). The output variable was FH or FH SDS.

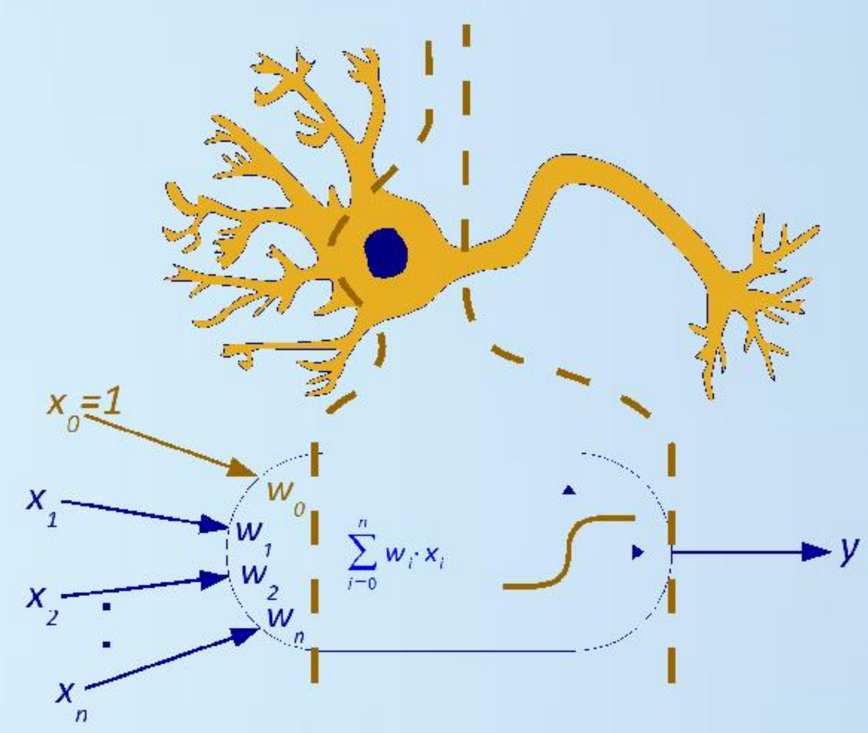

Fig. 1: Scheme of artificial neuron from multilayer perceptron (MLP) – type of ANN used in present study

Results

MLR lead to the following model: FHSDS = 0.683 + 0.529 · hSDS – 0.286 · IGF–I SDS – 0.152 · HV + 0.146 · hmSDS + 0.163 · hfSDS

The model explained **44%** of variability of FH SDS in learning group and **36%** in testing group, with root mean square error (RMSE) of predicted FH **3.5 cm** and **3.8 cm**, respectively; for details see [3].

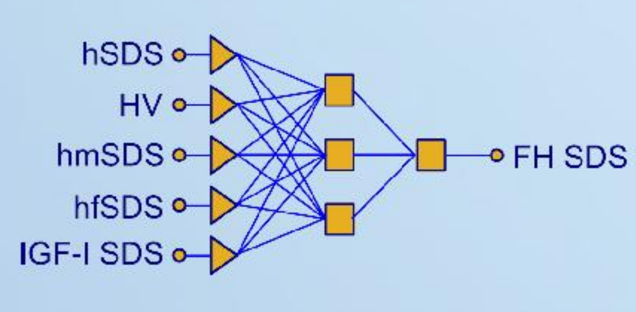

Fig. 2: MLP 5:5-3-1:1

ANN model for the same input variables as MLR model (Fig. 2) explained **43%** of variability of FH SDS for learning group and **40%** for testing group with RMSE **3.6 cm** and **3.7 cm**, respectively.

The best ANN model for unprocessed data (Fig. 3) explained **86%** of variability of FH SDS for both learning and testing group with RMSE **3.2 cm** and **3.4 cm** respectively and eliminated GH peak after falling asleep and father's height as redundant (insignificant) variables.

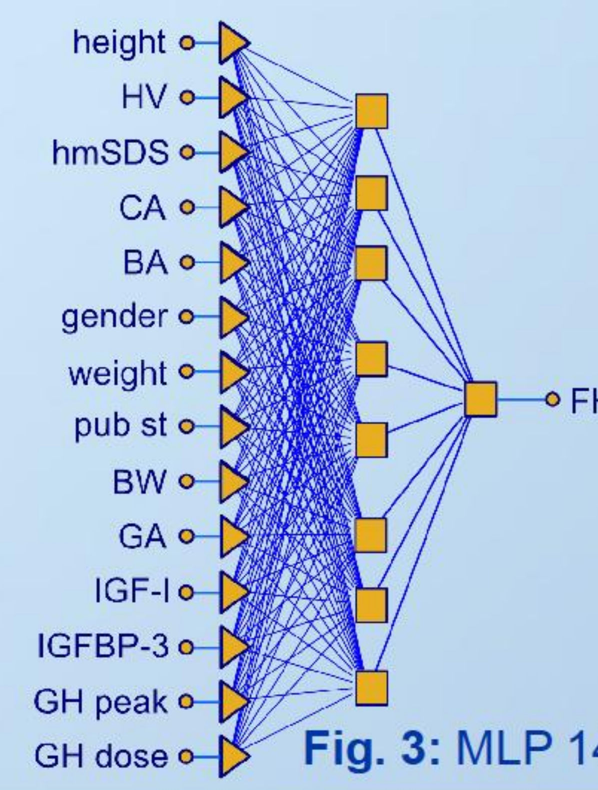

Fig. 3: MLP 14:14-8-1:1

Conclusions

Neural networks are more accurate in FH prediction and explain more variability of FH in children with isolated GH deficiency than linear regression models.

References:

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DOI: 10.3252/pso.eu.54espe.2015
Poster presented at: