Appraisal of adaptive neuro-fuzzy computing technique for estimating anti-obesity properties of a medicinal plant

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ABSTRACT

This research examines the precision of an adaptive neuro-fuzzy computing technique in estimating the anti-obesity property of a potent medicinal plant in a clinical dietary intervention. Even though a number of mathematical functions such as SPSS analysis have been proposed for modeling the anti-obesity properties estimation in terms of reduction in body mass index (BMI), body fat percentage, and body weight loss, there are still disadvantages of the models like very demanding in terms of calculation time. Since it is a very crucial problem, in this paper a process was constructed which simulates the anti-obesity activities of caraway (*Carum carvi*) a traditional medicine on obese women with adaptive neuro-fuzzy inference (ANFIS) method. The ANFIS results are compared with the support vector regression (SVR) results using root-mean-square error (RMSE) and coefficient of determination (R^2). The experimental results show that an improvement in predictive accuracy and capability of generalization can be achieved by the ANFIS approach. The following statistical characteristics are obtained for BMI loss estimation: RMSE = 0.032118 and R^2 = 0.9964 in ANFIS testing and RMSE = 0.47287 and R^2 = 0.361 in SVR testing. For fat loss estimation: RMSE = 0.23787 and R^2 = 0.8599 in ANFIS testing and RMSE = 0.32822 and R^2 = 0.7814 in SVR testing. For weight loss estimation: RMSE = 0.00000035601 and R^2 = 1 in ANFIS testing and RMSE = 0.17192 and R^2 = 0.6607 in SVR testing. Because of that, it can be applied for practical purposes.

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1. Introduction

Health issues have come to be an essential part of human life, and the significance of wellness and fitness in modern and developing societies around the world is proven. International health has become an important component of foreign policy and many governments now give emphasis to community health, and encourage organizations, scholars, and the mass media to improve, support and broadcast research projects associated with health promotion and wellness [1]. This superior necessity for health awareness among people brings attention to those features which affect, positively and negatively, both individual and societal health.

One of the most important global health issues is overweight and obesity and their consequences to society in terms of morbidity and mortality are enormous. The use of the word "Globesity" in reports shows the severity of this problem worldwide [2]. Based on World health organization report [8], the term overweight and obesity are defined as BMI greater than 25 and 30 kg/m^2, respectively (Fig. 1). Statistics show that by 2008, the prevalence of obesity had reached up to 1.4 billion adults. Across the OECD (Organization for Economic Co-operation and Development) countries, half of the adult population is currently overweight, and one in six is obese [3]. Fig. 2 shows the projections for overweight population trends in different countries up to 2020.

One of the solutions is treatment with medicinal plants which could offer a safer, more reliable, and also cheaper, approach to addressing concerns of overweight and obesity, than the customary current methods. The application of natural remedies for inducing weight loss has risen radically during the last few decades, and usually includes the addition of certain medicinal plants in the diet on a regular basis to assist an individual to lose weight progressively [5,6]. Henceforth, a randomized placebo-controlled clinical trial was intended to study the antiobesity influence of caraway intake on overweight and obese women in Iran.

Even though several models are projected for modeling the obesity management, there are still disadvantages of the models like very demanding in terms of calculation time. ANN could be applied as alternative to current analytical methods offering advantages including no prerequisite knowledge of core system parameters, solid explanation for multi-variable complications and fast calculation.

In this investigation adaptive neuro-fuzzy inference system (ANFIS) [10], which is a particular form of the ANN family, is applied to estimate the anti-obesity activities of caraway – a potent medicinal plant – in a dietary intervention study. For the currently advanced neural network, overweight and obese women were used as case studies for ANFIS training data. The principal purpose of this research is to analyze the performances of ANFIS for estimation of anti-obesity properties.

ANFIS displays great learning and estimation functions, which change it to a well-organized and effective tool to manage uncertainties faced in different systems. Researchers used ANFIS, as a hybrid intelligent system that boosts the capability to automatically learn, estimate and adjust, in various medical systems [11–13]. Up to now, numerous researches is done on the application of ANFIS for estimation and real-time documentation of various systems [14–16].

In clinical studies, different mathematical approaches such as SPSS software is usually applied as the conventional analysis methods. Also, several functions have been proposed for modeling the anti-obesity properties estimation in terms of reduction in BMI, body fat percentage, and body weight loss. However, there are still disadvantages of the models like very demanding in terms of calculation time, accuracy, and correctness. Consequently, ANFIS and Artificial neural network (ANN) could be applied as a more precise alternative method to current analytical approaches. Moreover, ANN suggests other benefits including no needed information of interior system factors, compact answer for multi-variable issues and fast calculation.

2. Materials and methods

2.1. Study design

A randomized, triple-blinded, placebo-controlled clinical trial was conducted to evaluate the anti-obesity effects of caraway seeds extract (CE) on overweight and obese women in Iran. In this study, 70 healthy adult women with BMI between 25 and 46 kg/m^2 were screened and randomized into a test group and a placebo group. To assure that the number of patients is enough to predict the results statistically, sample size was calculated based on Greenberg formula. Subjects were asked to consume either 30 ml of the CE or placebo samples per day, for 90 days. This trial was approved by the clinicaltrial.gov protocol registration system with the Protocol ID: NCT01833377. The safety of CE has been already approved in previous clinical study [7].

2.2. Body composition measurements

Body composition of the participants including body weight (Kg), and of body fat percentage (%BF), was evaluated by means of a bioelectrical impedance analyzer (BIA) machine with remote control (Beurer digital diagnostic scale, Model BG63, Ulm, Germany). BMI (kg/m^2) was calculated based on the formula (BMI = weight/height^2).

2.3. Adaptive neuro-fuzzy application

ANFIS model is established in this research to estimate obesity according to the three input parameters. There are three outputs:

1. Weight loss $\geq$5%
2. Fat loss $\geq$5%
3. BMI loss $\geq$0.5

Each of the output has different inputs according to results of weight loss, fat loss and BMI loss before and after testing. The ANFIS networks should determine the optimal obesity for a given number of data inputs. Fig. 3 shows an ANFIS structure with thee inputs.