Objective prediction of ingested food mass using support vector regression

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Aim – Methods of Monitoring of Ingestive Behavior (MIB) can objectively detect episodes of food intake, differentiate between liquid and solid foods and estimate ingested mass. Unbiased characterization of food intake is performed by processing and pattern recognition of signals collected from wearable sensors which detect chewing and swallowing and ultimately can be used in free living individuals. The aim of the presented work is to evaluate use of linear and non-linear support vector regression for estimation of ingested mass from counts of chews and swallows.

Subjects – Fifteen subjects, 9 males and 6 females (BMI=29.0±7.0 kg/m^2, min=21.6, max=42.1; age=24.8±6.9 yrs, min=18 yrs, max=48 yrs).

Methods – Each subject performed 4 visits on separate days. During visits 1 and 2 subjects consumed a standard-size meal consisting of a slice of cheese pizza, a can of 1% fat yogurt, an apple, a peanut butter sandwich, and water presented in this order. Such food selection represented various physical properties of food. During visits 3 and 4 subjects consumed a 50% larger meal than standard. Subjects were asked to talk during the meal in visits 2 and 4, and remained quiet in visits 1 and 3. Bites, chews and swallows of each subject were monitored by a custom-designed sensor system. The counts of chews and swallows associated with each individual bite, food type and each meal were used to build linear and non-linear models of ingested mass prediction using support vector regression.

Results – The linear regression model based on counts of chews and swallows achieved the average accuracy for estimation of mass of 92.0±3.8% percent for solid foods and 82.7±7.0% for the liquids. Polynomial regression model demonstrated accuracy of 74.8%±15.6% percent for solid foods and 70.1%±11.9% for the liquids.

Conclusion – Counts of chews and swallows can serve as predictors of ingested mass and, in combination with wearable sensors, can be used for objective monitoring of ingestive behavior. The linear support vector regression models demonstrated accuracy close to that of previously reported empirical models (91% solids, 83% liquids) while polynomial models failed due to limited size of the dataset. Future work is needed to test this approach for a larger variety of food types, as well as in free living conditions. With a larger dataset, factors such as saturation and non-linearities in mass of ingested food as a function of chews and swallows can be evaluated.