# Biochemical Feedback for Successful Weight Loss

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## Abstract

Current treatments for obesity are having modest success rates and it is widely acknowledged that novel approaches to this problem are required. Mobile health technologies are increasingly used as tools to assist in weight loss and this is reflected in the number of healthcare apps available for smart phones. Digital food/activity diaries are widely available, but much of the information is self-reported and especially underreporting of calorie intake is problematic. We propose that tracking molecular markers that reflect metabolic state, food-intake and physical activity integrated alongside an electronic life-style diary will aid weight loss efforts.

## Introduction

Our lives are full of habits, good ones (i.e. healthy levels of exercise) and bad ones (i.e. over eating unhealthy foods). The imbalance in these habits is particularly evident in the world-wide prevalence of obesity. Shifting the balance between bad and good habits can therefore prevent disease and enhance well-being. Effective strategies are needed to help individuals to lose weight and to maintain the lower weight levels. The success of current weight loss programmes is variable and the complexities associated with them are highlighted by high rates of attrition that occur in such programmes [1]. Recent studies have suggested positive benefits in using technology assistance, such as the Internet and mobile technologies [2, 3]. We here propose to go one step further and combine the use of mobile applications to record diet and anthropometric data with the measurement of a metabolic marker that will provide immediate feedback on actions such as food intake and exercise. Here, we present our results on measuring the metabolic markers insulin and lactate in urine.

## Methods

### Study Design

Participants over the age of 18 were recruited into the study. A total of 52 participants took part in the study. The Warwick Medical School Ethics committee BSREC approved the study (protocol identification REGO-2014-1318). Participants were given two meal plan options (Table 1). A mobile health platform was designed and developed to enable study participants to

| | Breakfast (B) | Lunch (L) | Dinner (D) |
|---|---|---|---|
| **Meal Plan 1** | Meal 1 (any) | Meal 2 (low/no carbohydrates) | Optional Snack (S) <200kcal |
| **Meal Plan 2** | Meal 1 (any) | Optional Snack (S) <200kcal | Meal 2 (low/no carbohydrates) |

**Table 1:** Meal plans for the study.

maintain diaries of weight, urine sample collection, physical activity and food intake. The mobile application was developed using Intel XDK, a framework that allows building of cross-platform mobile applications, including Android, iOS and Windows along with a web browser interface https://personalhealth.warwick.ac.uk. Each participant had their own account that allowed them to store their information securely and access it either through a web browser based interface or a mobile application. The mobile health platform creates a timeline of the logs or events that are entered by the user. Participants were provided with information on the study, starter packs that contained a beaker for urine volume determination and labelled sample collection tubes and directions or arrangements for sample drop off. Measurements were carried out and analysed with samples collected over 24-hr periods and participants were encouraged to provide multiple days of samples, without requirement of the days to be consecutive.

**Insulin and lactate measurements**

Insulin in samples was measured using a Mesoscale Discovery Human Insulin Kit (catalog number: K151 BZC-2) containing 96-well plates coated with insulin antibody. The plates were analysed on a SECTOR Imager 6000 system. Lactate was measured using lactate dehydrogenase (LDH) assay.

## Results

The timestamps of every event (e.g. food/liquid intake, urine collection, physical activity) enabled a closer analysis of the temporal aspects of these life-style events (Figure 1). Data shows a spike in events at 7 and 18 o'clock relating to breakfast and dinner with more calories consumed at dinner than at breakfast. Distinct insulin and lactate profiles in urine were observed for each 24-hr period measured across all participants and in the case of insulin an increase was observed soon after food consumption (Figures 2). In total 34 variables were extracted from events logged by participants and from the insulin and lactate profiles. The correlation matrix of Pearson correlation coefficients shows association between the different variables measured is shown in Figure 3.

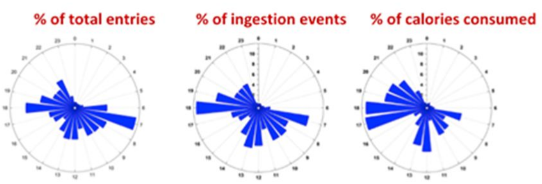


**Figure 1**. Analysis of time stamps

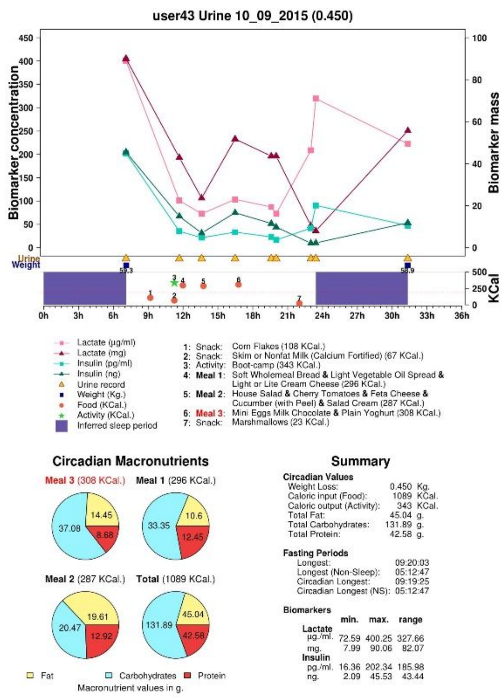


**Figure 2**. Insulin and lactate profiles

Of particular interest are those variables correlating with weight loss, as these may be used as biochemical feedback to optimize weight loss efforts. These are last insulin, maximum insulin, insulin before meal 1, lactate before meal 2, and following day lactate values.

# Discussion

Insulin and lactate can be successfully measured in urine and their concentrations correlate with weight loss. The dynamic profiles are informative and can be used as food intake reporters thus potentially eliminating the under reporting of calories that is widely observed during weight loss trials. The main indicator of successful weight loss is through regular tracking of weight, which is prone to errors and is only possible with a time-delay post eating behaviour (usually the next day). In addition, there are concerns about the negative psychological consequences that tracking weight may have on the motivation of an individual to continue with the diet especially if weight loss is slow or non-existent [4].

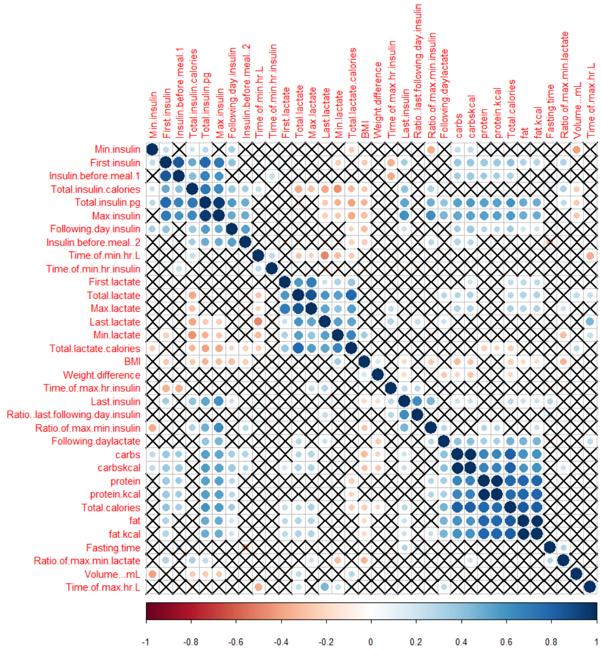


**Figure 3.** Correlation matrix ($p < 0.05$)

# Conclusion

We have obtained proof-of-concept that insulin and/or lactate values can potentially replace weight measurements as the only “outcome” based parameters while dieting. Future trials will investigate if molecular feedback to individuals produces greater levels of attainment to weight loss programmes.

# References

1. Holzapfel C, Cresswell L, Ahern AL, et al. The challenge of a 2-year follow-up after intervention for weight loss in primary care. *Int. J. Obesity*. 2014; 38: 806-11.
2. Hutchesson MJ, Rollo ME, Krukowski R, et al. eHealth interventions for the prevention and treatment of overweight and obesity in adults: a systematic review with meta-analysis. *Obesity Reviews* 2015; 16: 376-92.
3. Tang J, Abraham C, Stamp E and Greaves C. How can weight-loss app designers' best engage and support users? A qualitative investigation. *British J. Health Psy*. 2015; 20: 151-71.
4. Cooper Z and Fairburn CG. A new cognitive behavioural approach to the treatment of obesity. *Beh. Res. Ther*. 2001; 39: 499-511.