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COMBINING BIOLOGICAL AND PSYCHOSOCIAL BASELINE VARIABLES DID NOT IMPROVE PREDICTION OF OUTCOME OF A VERY-LOW-ENERGY DIET IN A CLINIC REFERRAL POPULATION

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What is already known about this subject?

- Obesity treatment outcomes are variable and difficult to predict
- It has been suggested that combining biological and psychosocial data should improve prediction

What this study adds

- Several different methods were used in attempting to predict treatment outcomes
- Combining biological and psychosocial data did not improve prediction of VLED outcomes in a clinically relevant participant group

ABSTRACT

Background: Consistent, strong predictors of obesity treatment outcomes have not been identified. It has been suggested that broadening the range of predictor variables examined may be valuable. We explored methods to predict outcomes of a very-low-energy diet (VLED)-based program in a clinically comparable setting, using a wide array of pre-intervention biological and psychosocial participant data.

Methods: 61 women and 39 men (mean ± SD body mass index 39.8 ± 7.3 kg/m^2) underwent an 8-week VLED and 12-month follow-up. At baseline, participants underwent a blood test and assessment of psychological, social and behavioural factors previously associated with treatment outcomes. Logistic regression, linear discriminant analysis, decision trees and random forests were used to model outcomes from baseline variables.

Results: Of the 100 participants, 88 completed the VLED and 42 attended the week 60 visit. Overall prediction rates for weight loss of ≥10% at weeks 8 and 60, and attrition at week 60, using combined data were between 77.8 and 87.6% for logistic regression, and lower for other methods. When logistic regression analyses included only baseline demographic and anthropometric variables, prediction rates were 76.2-86.1%.

Conclusions: In this population, considering a wide range of biological and psychosocial data did not improve outcome prediction compared to simply-obtained baseline characteristics.

INTRODUCTION

Although lifestyle interventions for the treatment of obesity typically result in loss of 5-10% of initial weight over 6 months followed by plateau and regain [1], within any given treatment program, there is considerable variability in outcomes for individual participants [2,3]. It would be useful to be able to accurately predict the likely outcome for each individual embarking on a weight loss program at its outset, in order to target the treatment to those who are likely to derive the most benefit, and redirect others away from a method which is unlikely to suit them. A number of attempts have been made to investigate whether weight outcomes can be predicted prior to commencement of a weight loss program, but disappointingly, findings have not been consistent for the majority of variables examined. Most studies have examined only a small number of either biological or psychological factors, and identified predictor(s) which account for only a small proportion of the variance in weight outcome [4,5]. Similarly, for attrition, consistent, strong predictors have not been identified [6], and often, limited information is collected about people who drop out of weight loss interventions. It seems likely that considering interactions between participants' psychological, social, logistical and behavioural factors is more likely to be fruitful [6], therefore the aim of this study was to explore methods to predict the outcome of a very-low-energy diet-based weight loss program in a clinically applicable setting, using a wide range of pre-intervention biological and psychosocial participant characteristics. Variables for which associations with weight outcomes or attrition have previously been reported [4-7] were chosen as potential predictors.

MATERIALS AND METHODS

Participants

The study was conducted at the Metabolic Disorders Research Unit at the Department of Medicine, Repatriation Hospital in Melbourne, Australia. Weight-stable men and women aged 18-70 years with BMI 30-60 kg/m^2 were recruited by advertisement, and from the waiting list of our hospital's obesity treatment clinic between March 2014 and February 2015. The study was approved by the Austin Health Human Research Ethics Committee and prospectively registered with the Australian New Zealand Clinical Trials Registry (ACTRN12614000197639).

Intervention

Participants underwent an 8-week very-low-energy diet (VLED)-based intervention, with a 12 month follow-up period. During the VLED period, 2 meals per day were replaced with a commercially available VLED formulation (*Optifast*® VLCD, Nestlé Nutrition) and participants consumed one meal consisting of lean protein and up to 2 cups of low-starch vegetables (total daily energy intake approx. 3350 kJ [800 kcal] per day). This was expected to result in 8-15% weight loss over 8 weeks [8]. After a 2-week transition period during which meal replacements were reduced to once daily (with regular food for two meals per day), participants were instructed to follow a diet consistent with Australian Dietary Guidelines [9] for maintenance of weight loss. The dietary pattern recommended included vegetables, fruits, wholegrains and lean protein, and limited saturated fats, added sugars and alcohol. No specific macronutrient ratios or target energy intake were prescribed, but participants were advised to self-monitor their weight regularly, and adjust energy intake accordingly if they were regaining weight. Study visits were scheduled every 2 weeks during the VLED phase, and every 8 weeks for the 12-month follow-up (total duration 60 weeks), and included dietary and exercise counselling, and adjustment of medications as required (for example,

adjustment of diabetes medications to avoid hypoglycaemia). Participants were advised to undertake at least 150 minutes of moderate-intensity physical activity per week.

Data collection and assays

At each study visit, participants were weighed on a calibrated digital scale, barefoot and wearing light clothing, and waist and hip circumferences were measured to the nearest 0.5 cm as the mean of 2 readings using a spring-loaded tape measure. Prior to starting the program (week 0), a fasting blood sample was collected, and participants completed a comprehensive assessment of psychological, social and behavioural factors which have previously been associated with weight loss and/or attrition, using validated questionnaires (**Table 1**). Cronbach's α (and/or mean inter-item correlations as appropriate) indicated acceptable internal consistency for each scale or subscale included in the analyses. Plasma glucose was measured by the hexokinase method (Cobas c, Roche, Mannheim, Germany), insulin and thyroid stimulating hormone (TSH) by electrochemiluminescence immunoassay (Cobas e 602, Roche, Mannheim, Germany), leptin, peptide YY (PYY), glucose-dependent insulinotropic polypeptide (GIP), total amylin and pancreatic polypeptide (PP) with the Human Metabolic Hormone Milliplex kit (Merck Millipore), and total ghrelin using the Bio-Plex Pro Diabetes Panel (Bio-Rad), as per manufacturers' instructions.

Statistical Analyses:

Descriptive data are presented as mean ± standard deviation (SD) unless otherwise indicated. Comparisons of baseline characteristics between men and women were made using independent samples t-tests and Fisher's exact tests as appropriate. To model treatment outcome (loss of ≥10%

of initial weight at weeks 8 and 60 and attrition at week 60) from baseline (pre-treatment) predictor variables, logistic regression analyses were used. Additionally, since promising results for prediction using data mining methods have recently been reported [25], we examined three further methods: (i) linear discriminant analysis (LDA), which seeks linear combinations of predictor variables which best separate participants into subgroups, (ii) decision trees using evolutionary algorithms [26], which do not assume linear relationships between predictor and outcome variables, and employ empirically-driven splitting of predictor variables for classification of participants into week 60 outcome subgroups (drop-out vs completion + weight loss < 10% vs completion + weight loss ≥10%), and (iii) random forests, derived from combining numerous individual decision trees generated from multiple independent random samples of predictor variables, which reduces the tendency to overfitting associated with individual decision trees [27]. To avoid overfitting and issues regarding multicollinearity in logistic regression and LDA analyses, the combined variables included were limited to sex, age, initial weight, body mass index (BMI), waist/hip ratio, biochemical parameters (glucose, insulin, leptin, ghrelin) and 8 questionnaires most suggested to be associated with outcomes [4-6] (indicated in Table 1), and stepwise variable selection was used with the Akaike Information Criterion (AIC) following analyses, to select the most important variables. For logistic regression analyses using only anthropometric data, stepwise variable selection was not performed. Rates of outcome prediction were assessed by the following three methods: ten-fold cross-validation using the logistic regression model, leave-one-out cross-validation for LDA, and the out-of-bag error rate using random forests. 'Overall' prediction rates refer to prediction rates for the entire participant group (n=99-100) for the following binary outcomes: weight loss of ≥10% at week 8 (vs loss of <10% or drop-out), weight loss of ≥10% at week 60 (vs loss of <10% or drop-out), and attrition at week 60 (vs completion). For LDA and random forest analyses, further examination of prediction

rates was made for subgroups of participants with different outcomes (i.e. weight loss ≥10%, loss <10%, completion, drop-out).

RESULTS

Baseline characteristics of the 100 participants who commenced the VLED program are given in **Table 2**. Men were significantly heavier than women, but BMI was not significantly different between sexes.

Outcomes: **Figure 1** depicts the overview of attrition from the study. The 88 participants who completed the 8-week VLED achieved a mean (± SEM) weight loss of 9.6 ± 0.5 kg (8.4 ± 0.4%) at week 8, and among the 42 participants who completed the 12-month follow up, mean weight loss at week 60 was 9.7 ± 1.4 kg (8.9 ± 1.3%). As expected, there was considerable inter-individual variability in weight changes (**Figure 2**), ranging from +1.0 to -20.8 kg (+0.9 to -16.8%) from week 0 to 8 (n=88) and +2.6 to -37.1 kg (+3.0 to -34.0%) from week 0 to 60 (n=42). Of the 100 starting participants, 35 and 17 lost ≥10% of initial weight at weeks 8 and 60 respectively. There was a moderate inverse relationship between weight loss % at week 8, and % weight regain between weeks 8 and 60 ($r=-0.52$, $p<0.001$; Figure 2B).

Prediction of outcomes:

Short-term (week 8) weight loss of ≥10%

Results of the logistic regression analysis for weight loss of ≥10% at week 8, using a combination of biological and psychosocial data following AIC stepwise variable selection, are displayed in **Table 3**. Factors found to be significantly associated with short-term weight loss ≥10% were male sex and

higher 'dream' percentage weight loss (i.e. more weight loss required to achieve 'dream' weight). Conversely, higher initial BMI, waist-hip ratio and score for depression (Beck Depression Inventory) were inversely associated with weight loss ≥10%.

Table 4 shows prediction rates for the different models. Overall prediction rate following 10-fold cross-validation for the logistic regression model incorporating combined biological and psychosocial data was 82.5%. Further exploration of the data using linear discriminant analysis and leave-one-out cross-validation revealed that prediction was stronger for identifying people who did not lose ≥10% initial weight, whereas identifying people who succeeded was difficult (Table 4). For example, LDA correctly predicted 88% of the participants who did *not* lose ≥10% weight at week 8, but only 53% of the participants who did. Random forests had a lower overall prediction rate of 59.6%, and similarly was stronger for classification of people who did not lose ≥10% of initial weight than for those who did. In keeping with the logistic regression analysis using selected variables, the most important variables identified from the full list by random forest analysis were weight-related quality of life, sex and depression score. Mean decrease in accuracy of random forest prediction if these variables were omitted was 17.3, 17.0 and 14.2%, respectively. The 10-fold cross-validation prediction rate for a logistic regression analysis using only demographic and anthropometric data (sex, age, weight, waist/hip ratio) was 79.7%. When examined separately by sex, overall prediction rate for 10-fold cross-validation for logistic regression with combined biological and psychosocial data was 76.9% for men and 80.7% for women.

Longer-term (week 60) weight loss of ≥10% and attrition

Results of logistic regression analyses incorporating combined biological and psychosocial variables for week 60 outcomes (weight loss of ≥10% and attrition) are shown in Table 3. As at week 8, male

sex, higher dream % weight loss, and lower depression score and BMI were associated with achievement of ≥10% weight loss at week 60. Perceived stress was the only variable significantly associated with attrition at week 60 (7% increase in odds of dropping out per unit increase in perceived stress scale score).

Both linear discriminant (LDA) and random forest analyses for prediction of three outcome categories at week 60 (weight loss ≥10%, weight loss <10%, or drop out) had similar difficulty in predicting weight loss success, and favored the prediction of attrition. Overall prediction rates were 53.5% for both (Table 4). As with week 8 weight loss ≥10%, the most important variables selected by the random forests analyses were consistent with logistic regression analyses (for 3-category week 60 outcome, mean decrease in accuracy of model was >10% if any of the following variables were omitted: age, insulin, weight, acceptable % weight loss, hunger (factor 3 of Three Factor Eating Questionnaire), perceived barriers to exercise, and perceived stress; for attrition only, age (34.6% decrease in accuracy), exercise barriers (18.9%) and perceived stress (18.2%) were the most important variables identified in random forest analyses). For logistic regression analyses using only demographic and anthropometric data (sex, age, weight, waist/hip ratio), the prediction rates for week 60 overall outcome and attrition were 86.1 and 76.2%, respectively. When 10-fold cross-validation for logistic regression with combined biological and psychosocial data were examined separately by sex, prediction rates for week 60 overall outcome and attrition were 75.3% and 86.0% respectively for men, and 86.5% and 74.4% for women. Consistent with the results for the whole group, when analysed separately for men and women, logistic regression was more successful for prediction compared with LDA and random forest analyses (data not shown).

A single decision tree (**Figure 3**) for week 60 outcomes indicates interactions between weight goals ('disappointed' % weight loss), age and perceived stress with ≥10% weight loss and attrition. For people who reported a greater % weight loss to be disappointing (n=46), those with higher perceived stress were more likely to drop out (72%; n=26 of 36) than complete the study, whereas those with lower perceived stress scores were more likely to complete (80%; n=8 of 10). For people who would be disappointed by a lower % weight loss, age was a moderating factor, with younger participants (<59 years old) mostly lost to attrition (80%), whereas 90% of older participants completed the study.

DISCUSSION

The wide range of individual responses to treatment for obesity is well recognised [2,3], but to date, reliable predictors of treatment response have not been identified. In order to improve outcomes and optimise resource allocation, it is imperative to develop better predictive models, with a view to matching treatments to patients who are most likely to benefit, and to identify those who may need more assistance. In the present study, which examined a broad range of biological, psychosocial and behavioural attributes using several different models to examine weight loss and attrition among participants using a very-low-energy diet-based program for the treatment of obesity, the main findings were that: 1. male sex, higher percentage weight loss required to achieve 'dream' weight, and lower depression scores were consistently associated with achievement and maintenance of ≥10% weight loss, 2. age and perceived stress were important factors for attrition, 3. none of the models examined were sufficiently accurate to be clinically useful, and 4. combining biological and psychosocial data did not materially improve the ability to account for inter-individual variability in outcomes compared to simple anthropometric measurements.

Many previous attempts to predict weight loss and/or attrition from obesity treatment programs from baseline characteristics have yielded mixed results for most of the variables examined [reviewed in 4-6]. Nonetheless, other reports are consistent with our finding of associations between lower depression scores [28], higher 'dream' percentage weight loss [29] and male sex [30] with weight loss success. The present findings of associations between attrition with younger age [28] and greater perceived stress [31] are also in keeping with other studies. Although male sex was found to be associated with weight loss success, analysing data from men and women separately did not improve prediction of outcome. This may be due to the smaller sample sizes in each subgroup. The whole group results lend support to the argument that ambitious weight goals may not be detrimental [29], and indicate that enquiring about symptoms of depression and stress may identify individuals who are likely to need additional support when undertaking an intensive weight loss regimen.

Although this study did not return a strong predictive model, we believe that it presents a valuable advance in research in this area, for several reasons. Firstly, most previous studies examining pre-weight loss predictors of weight loss or attrition from lifestyle interventions have considered a smaller number of psychological and/or biological factors [7,28,30]. Given the complex, multifactorial nature of obesity, we hypothesised that taking into account a larger number of potentially interacting factors could yield a stronger model; therefore in the present study, we included a wide range of biological, psychosocial, and behavioural characteristics previously linked to obesity treatment response [4,5], and used questionnaires previously employed in obesity/weight management research to collect subjective data. However, we found that using logistic regression

analysis, incorporating the combined data did not result in substantially higher overall 10-fold cross-validation rates for achievement of ≥10% weight loss at weeks 8 and 60, and attrition at week 60 (82.5, 87.6, 77.8%) compared to anthropometric data alone (79.7, 86.1, 76.2%).

Moreover, previous attempts to predict treatment outcomes have often included participants' early response to treatment [25,28,30,32], meaning that people most likely to derive benefit from a particular treatment program can only be identified after they have already embarked on it. While on-treatment progress (e.g. early weight loss, behaviour modifications) has been shown to influence outcomes, our study focused on pre-treatment correlates of outcome, as we believe that this is potentially more useful for decision-making with regard to treatment options, particularly for a resource-intensive intervention such as a medically-supervised VLED.

Furthermore, our intention was to examine factors associated with outcome in a setting more comparable to clinical practice than usually found in clinical trials. For example, weight loss studies often exclude participants with severe obesity, associated medical conditions (e.g. type 2 diabetes and mental illnesses), and medications which may affect weight, and employ run-in periods and retention strategies to minimise attrition [32]. Although these strategies are useful for reducing confounding variables and establishing an adherent participant group in which to determine the effect of an intervention, they limit the generalisability of findings to clinical practice, as these characteristics are common among patients seeking treatment for obesity [3]. We therefore did not apply these exclusion criteria or retention strategies in the current study, resulting in a relatively heterogeneous population and a high attrition, identical to the drop-out rate at 1 year from our hospital's obesity treatment clinic [3].

Additionally, since signal detection methods have recently shown promise for identifying subgroups of participants according to weight loss outcomes [25, 33], we examined not only logistic regression but non-parametric methods, including linear discriminant analysis, decision trees and random forests to examine prediction of weight outcomes and attrition. In this participant group, we did not find these methods superior for outcome prediction compared to logistic regression analysis. However, decision trees did indicate possible moderating relationships between biological and psychosocial variables, particularly with regard to the likelihood of attrition.

There are a number of possible explanations for the present study not finding strong predictors of treatment outcome. Although larger than several other studies of correlates of weight loss [7,34,35], the number of participants in the current study, relative to the number of variables studied, is small, particularly if separated according to sex. Nonetheless, the results highlight some potential useful predictors of outcome that warrant further consideration. Conceivably, efforts pursuing predictors of obesity treatment outcomes on a much larger scale, such as the pan-European Diogenes study [30], and the National Institutes of Health's recently announced ADOPT (Accumulating Data to Optimally Predict obesity Treatment) Core Measures Project [36], will be more profitable.

Although a wide-ranging group of factors was examined in the current study, it is possible that incorporating additional variables could have resulted in a stronger predictive model. For example, associations with weight or metabolic changes during an intervention have been shown for resting metabolic rate [35], and for variants in genetic [37], epigenetic [38] and gut microbial patterns [39],

although the additional equipment, expertise and costs required to measure these parameters would reduce the clinical utility of such a predictive tool.

In the present study, an association between susceptibility to hunger and attrition was identified. In recent years, appetite-reducing medications indicated for the long-term treatment of obesity have become more widely available, therefore, including pharmacotherapy in treatment regimens for future prediction studies will be useful. Furthermore, since the primary purpose of therapeutic weight loss is to reduce the adverse health consequences of excess adiposity, it may be of value to expand the range of outcomes for prediction to include improvements in body composition, quality of life, and meeting behavioral goals (such as physical activity and dietary changes), which were not assessed in the current study.

Undoubtedly, reliable predictors of outcome continue to be elusive in part because of heterogeneity in study treatments and methods, and initiatives aimed at standardising measured constructs and tools, such as the ADOPT project [36], are much-needed. However, given that overweight and obesity affects the majority of adults in many parts of the world, the diversity among people seeking treatment for obesity, and the changeable nature of individual circumstances, inevitably impede the development of a clinically useful tool to predict treatment outcomes. An alternative approach, to devise more flexible treatments that can be tailored to adapt to individual requirements, rather than attempting to match people to rigid treatments [40] may be more successful.

CONCLUSION

Combining a wide range of biological and psychosocial variables did not improve prediction of outcome in a clinically applicable setting, compared to simple baseline demographic and anthropometric data. The search for accurate, clinically useful predictors of outcome continues.

CONFLICTS OF INTEREST STATEMENT: PS has received payment from Novo Nordisk for a lecture unrelated to this paper. KP was employed by University of Melbourne during her involvement with this study, and during that time had no conflicts of interest relevant to this paper. She is currently employed by Novo Nordisk. JP is chairman of the medical advisory board for liraglutide 3 mg and has received payment for consultancy from Astra Zeneca and Eli Lilly, and lectures from iNova pharmaceuticals unrelated to this paper. SK and LP have no conflicts of interest to declare.

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Author contributions: LAP, PS and JP conceived the study; PS, KP and SK carried out the study; PS and LAP analyzed data; all authors were involved in writing the paper and had final approval of the submitted version.

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Parameter	Questionnaire [reference]
Weight loss goals*	Goals and Relative Weights [10]
Weight-related quality of life*	Impact of Weight on QOL-Lite [11]
Depression*	Beck Depression Inventory II [12]
Perceived stress*	Perceived Stress Scale [13]
Self-motivation*	Self-Motivation Inventory [14]
Eating behaviours*	Three-Factor Eating Questionnaire [15]
Self-efficacy for control of eating*	Weight Efficacy Lifestyle Questionnaire [16]
Perceived barriers to exercise*	Exercise Benefits/Barriers Scale [17]
Self-Esteem	Rosenberg Self-Esteem Questionnaire [18]
Ways of coping with stress	Ways of Coping Checklist – Revised [19]
Personality traits	Big Five Inventory [20]
Perceived social support	Social Provisions Scale [21]
Binge eating	Binge-Eating Scale [22]
Strength of eating habits	Self-Report Habit Index [23]
Perceived self-efficacy for exercise	Self-Efficacy for Exercise Behaviors Scale [24]

Table 1: Scales used to assess psychological, social and behavioural parameters at baseline.

* indicates scales included in logistic regression and LDA analyses.

	All (n=100)	Women (n=61)	Men (n=39)	p-value
Age (y)	48.2 ± 12.5	49.2 ± 12.4	46.6 ± 12.6	0.32
Weight (kg)	113.5 ± 25.9	105.3 ± 21.0	126.3 ± 28.0	<0.001
BMI (kg/m^2)	39.8 ± 7.3	40.1 ± 7.3	39.4 ± 7.2	0.68
Heart rate (bpm)	74.8 ± 11.0	76.6 ± 10.1	72.1 ± 12.2	0.05
Systolic BP (mmHg)	133.6 ± 16.5	133.1 ± 18.1	134.4 ± 14.0	0.69
Diastolic BP (mmHg)	83.1 ± 10.0	81.7 ± 10.9	85.4 ± 8.1	0.07
Waist circumference (cm)	115.8 ± 13.5	111.9 ± 12.9	121.9 ± 12.1	<0.001
Hip circumference (cm)	129.5 ± 16.2	131.6 ± 15.6	126.2 ± 16.7	0.11
Comorbidities	*%*	*n (%)*	*n (%)*	
Diagnosed with T2DM/pre-diabetes/insulin resistance	24	12 (19.7)	12 (30.8)	0.24
Treated for diabetes/insulin resistance	11	5 (8.2)	6 (15.4)	0.33
Diagnosed with hypertension	35	18 (29.5)	17 (43.6)	0.20
Treated for hypertension	29	14 (23.0)	15 (38.5)	0.12
Diagnosed with mental illness	23	14 (23.0)	9 (23.1)	1.00
Treated for mental illness	14	8 (13.1)	6 (15.4)	0.77

Table 2. Baseline characteristics (mean ± SD, or % where indicated). p-values are given for comparisons between men and women using independent samples t-tests for physical measurements, and Fisher's exact tests for comorbidities.

	Week 8			Week 60		
	OR	**95% CI**	**p-value**	**OR**	**95% CI**	**p-value**
Weight loss ≥ 10%						
Male sex	**41.0**	6.8, 351.1	<0.001	**12.1**	2.2, 99.9	0.009
BMI (kg/m^2)	**0.78**	0.66, 0.89	0.001	0.82	0.66, 0.99	0.05
WHR (%)	**0.84**	0.75, 0.93	0.001			
Dream % weight loss	**1.12**	1.02, 1.25	0.02	**1.28**	1.02, 1.67	0.04
Depression score	**0.87**	0.79, 0.95	0.003	**0.86**	0.76, 0.95	0.01
IWQOL score	0.97	0.93, 1.01	0.14			
Insulin				**0.87**	0.78, 0.96	0.01
Accept % weight loss				**1.58**	1.09, 2.55	0.03
Happy % weight loss				0.64	0.37, 1.00	0.07
Self-motivation score				1.03	0.99, 1.07	0.15
Attrition						
Perceived stress				**1.07**	1.01, 1.15	0.03
Age				0.96	0.93, 1.00	0.06
Hunger				1.14	0.99, 1.31	0.07
Self-motivation				1.02	1.00, 1.05	0.09
Weight				1.02	1.00, 1.05	0.10

Table 3: Factors associated with outcomes at weeks 8 and 60 in logistic regression analyses using combined biological and psychosocial data. OR=odds ratio, CI=confidence interval; WHR (%) = waist-hip ratio expressed as a percentage (i.e. OR is for 1% increase in WHR); depression = Beck Depression Inventory score; IWQOL = impact of weight on quality of life (Lite) total score; Self-

motivation = self-motivation inventory score, Perceived stress = perceived stress scale score; Hunger = factor 3 of three factor eating questionnaire.

Outcome	**Logistic regression (10-fold cross-validation) % correct**	**LDA (leave-one-out cross-validation)**		**Random forests**	
		n correct	**%**	**n correct**	**%**
Weight loss ≥10% week 8					
Overall (n=100)	82.5	77	77	59	59.6
Yes (n=32)		17	53.1	16	50
No (n=68)		60	88.2	43	64.2
Weight outcome week 60					
Overall (n=99^)	87.6	53	53.5	53	53.5
Lost ≥10% (completed; n=17)		4	23.5	4	23.5
Lost <10% (completed; n=25)		3	12.0	6	24.0
Dropped out (n=57^)		46	80.7	43	75.4
Attrition week 60					
Overall (n=100)	77.8	64	64.0	55	55.6
Completed (n=42)		20	47.6	15	35.7
Dropped out (n=58)		44	75.9	40	70.2

Table 4: Prediction rates for the different models for outcomes at weeks 8 and 60 based on combined biological and psychosocial variables. For logistic regression and linear discriminant analysis (LDA), a reduced number of variables (selected via Akaike Information Criterion) were used. For random forests, all variables were included. For logistic regression analyses, 'overall' rates refer to prediction rates (% of participants correctly classified) for the entire group (n=99-100), for the following binary outcomes: weight loss ≥10% at week 8 (yes vs no [lost <10% or dropped out]), weight outcome at week 60 (lost ≥10% vs did not [lost <10% or dropped out]), and attrition at week 60 (yes vs completed). For weight outcome at week 60, LDA and random forest analyses modeled

three outcome groups (loss ≥10%, loss < 10%, and dropped out). ^n=99 because logistic regression model selected insulin as an important variable, and biochemical data were missing for 1 participant.

FIGURE LEGENDS

Figure 1: Participant flow chart

Figure 2: Individual weight trajectories showing range of % weight changes (A) and inverse relationship between % weight loss and % weight regain. Weight regain was calculated as weight change between weeks 8 and 60, expressed as a percentage of weight lost between weeks 0 and 8.

Figure 3: Decision tree for ≥10% weight loss and attrition at week 60

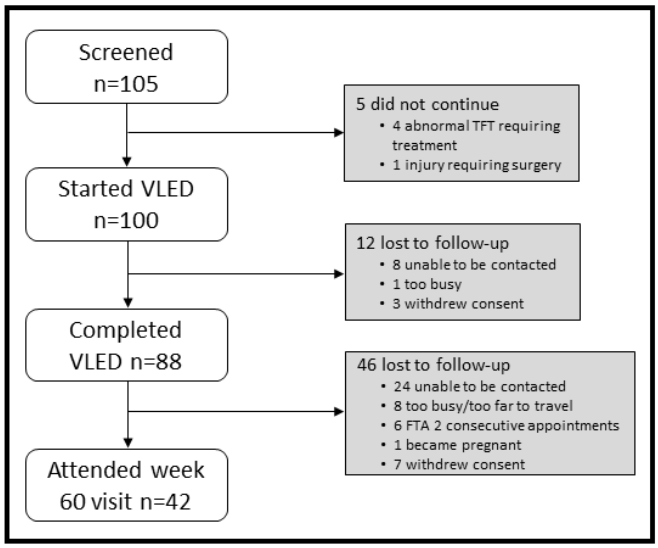

Figure 1. Participant flow chart

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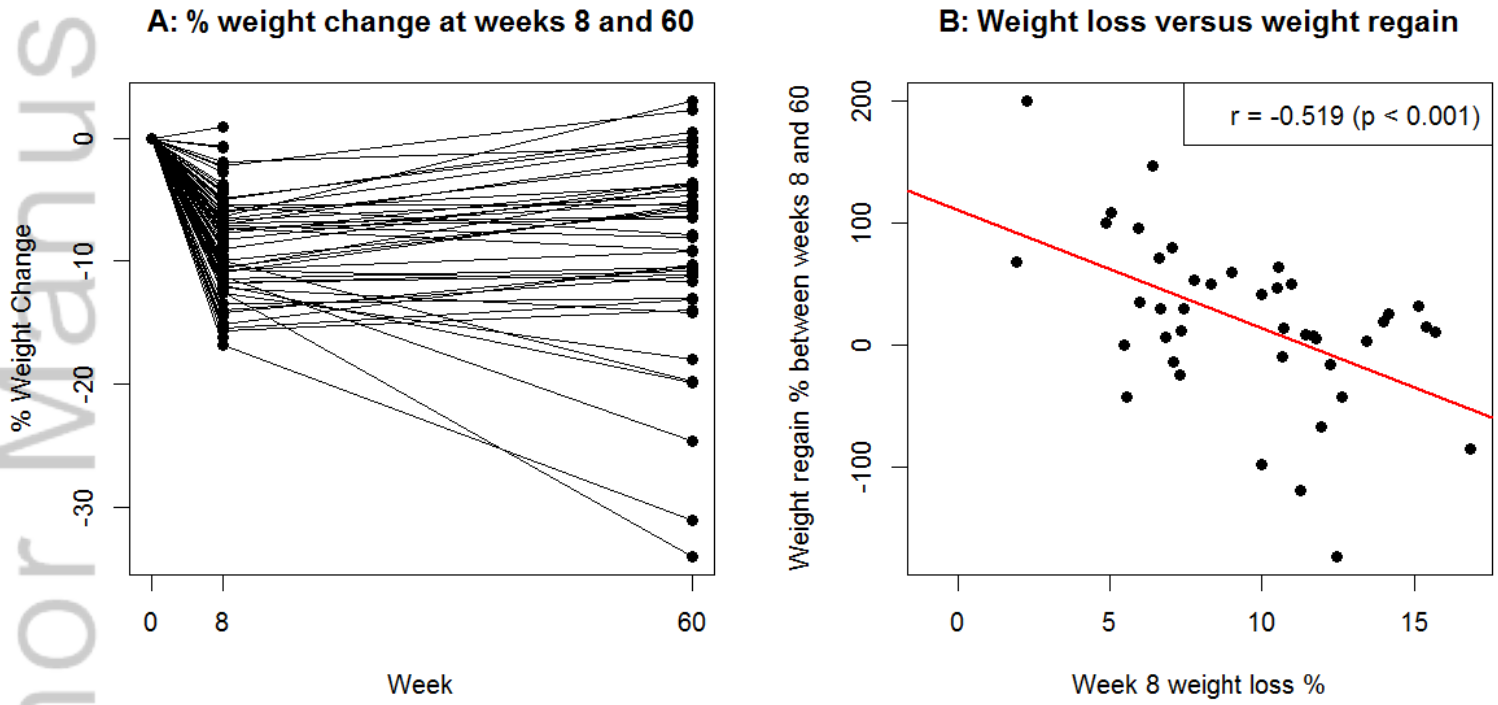

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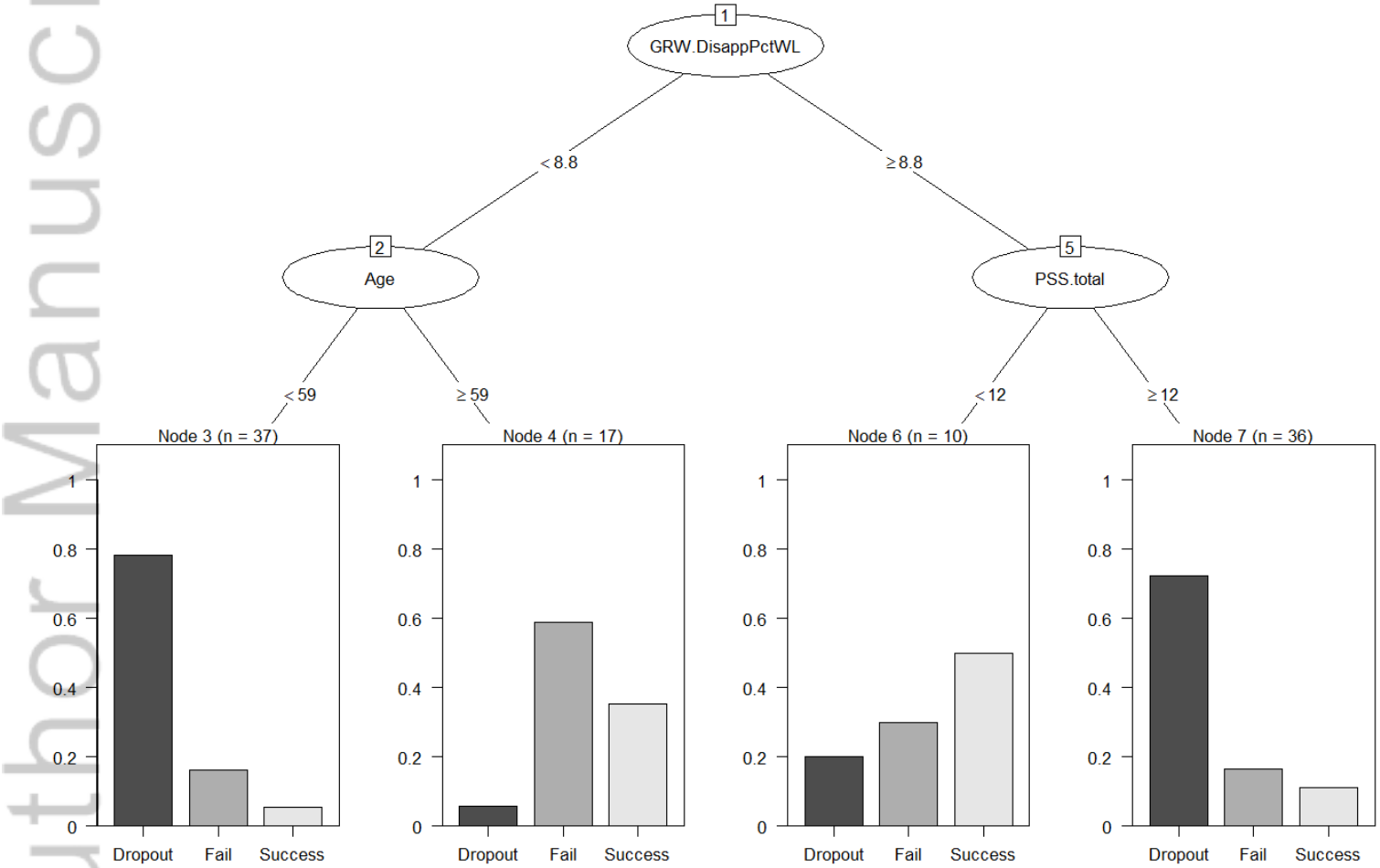
Figure 3: decision tree for ≥10% weight loss and attrition at week 60



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