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Stability of Metabolic Factor before and after Bariatric Surgery

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Abstract

Purpose. A new metric called Metabolic Factor (Resting Metabolic Rate/Weight) has previously been established that can differentiate between people who are obese, overweight, and of normal weight. Previous studies were re-analyzed and found that people who lost weight did not experience a change in their Metabolic Factor.

Materials and Methods. The current study measured the Metabolic Factor of 18 individuals before and after bariatric surgery.

Results. As expected, individuals lost nearly 100 pounds and therefore lowered their Resting Metabolic Rate from 2,614.3 to 1,954.4 kcal ($p < 0.05$). However, the pre-operative Metabolic Factor of 8.1 (1.1) calories/pound did not change significantly as it slightly increased to 8.6 (0.88) after surgery ($p = 0.19$). Weight loss was not statistically significantly correlated with change in Metabolic Factor ($r = 0.22$). The follow up Metabolic Factor negatively correlated with post-operative BMI, $r = -0.48$ ($p < 0.05$), indicating the higher the Metabolic Factor, the lower the post-operative BMI.

Conclusions. This study seems to establish the possibility that Metabolic Factor is not simply a function of one's current weight, but instead might be a stable characteristic unique to each individual.

Keywords: Metabolic Factor, bariatric surgery, obesity

INTRODUCTION

Resting Metabolic Rate (RMR) provides information about the number of calories an individual will burn at rest in a given day and offers guidance about the caloric intake required to lose weight. Direct calorimetry, which is a process of measuring heat produced by an organism, was utilized in the late 1800's to assess RMR despite its lack of practicality [1]. Simple RMR predictive equations became popular for their ease of use in the 1900's, but have fallen out of favor due to their inaccuracies [2]. Indirect calorimetry, which is a process that measures the volume of oxygen inhaled and volume of carbon dioxide exhaled to assess RMR, has emerged as a viable alternative to direct calorimetry and predictive equations.

Although RMR is important, it has limited usefulness. For example, RMR is not able to describe whether a person could be considered to have a "fast" or "slow" metabolism. In other words, RMR does not assess the efficiency with which a person processes calories. The ratio called Metabolic Factor (MF) was first introduced by Davis et al [3] to account for this limitation of RMR and be useful in bariatric research. This new metric is calculated by dividing RMR by current weight in pounds. For example, an individual with an RMR of 2,000 kcal and a weight of 200 lbs. will have a MF of 10 calories/pound. Davis et al found differences in MF were correlated with an individual's weight. Obese people had an average MF (with standard deviation in parenthesis) of 8.3 (1.5) calories/pound while the MF of overweight individuals was 10.6 (1.5) calories/pound and normal weight people was 12.8 (1.9) calories/pound. This finding provides support for the idea that people who are obese are more efficient in processing food than people who are of a normal weight. Whereas an obese individual only requires 8.3 calories for every pound they weigh, someone of normal weight requires 12.8. During times of famine, survival will favor individuals who are more efficient in processing food and therefore require fewer calories. Obese individuals might fare better than normal weight individuals because they require less food to sustain themselves. However, in times of surplus, those same people will be predisposed to gain excess weight because of the availability of food and their efficiency in processing it. Theoretically, these results pointed to the possibility that MF may have significant influence on an individual's weight, especially considering the strong negative correlation between MF and weight (r = -0.63). The question remained as to the temporal relationship between weight and MF, namely whether MF might be the cause of weight gain or lost or whether MF was the result of an individual's weight. Now, with indirect calorimetry being readily available for more clinicians to use in order to assess RMR and MF being calculated so simply, clinicians are more prepared to help individuals understand their unique metabolism and lose weight.

In order to clarify the issue of temporality, an area of future research suggested by Davis et al was to test the stability of MF in the face of significant weight loss. A review of the literature found 4 studies that examined changes in RMR based on weight fluctuations [4-7]. Data from these studies were run deriving the MF based upon their measure of RMR and weight. The studies involved 20 to 69 participants who lost between 11 and 48 lbs. from surgery or behavioral programs. The follow up measurement of their RMR occurred between 6 weeks and 42 months. When the data was re-analyzed using t-tests for summative data, there was never a significant change in MF in any of the studies involving weight loss. In one study with a group of people who gained weight and another group who maintained their weight, people who gained weight experienced a decrease in their MF and people who maintained their weight did not have a change in their MF. Interestingly, the MF of the obese individuals in these four studies ranged from 6.8 to 8.3, which is consistent with the results from Davis et al. A summary of the results can be seen in Table 1. These results suggest that MF is resistant to weight loss and may indeed be a key factor in setting an individual's weight. It appears possible that MF is a stable measure within a subject, which might be useful in future research.

Although these four studies allowed for the calculation of MF, it was not explicitly illustrated in the articles. Therefore, the current study aimed to display the presence of MF in this previous data and replicate the findings using more extreme weight loss. The hypothesis was that significant changes in MF would not occur after one year of weight loss from bariatric surgery. If such a result was to happen, then it would support the theory of the stability of MF.

METHODOLOGY

Participants

The research protocol was approved by Touro College's Health Science IRB and informed consent obtained from each subject prior to inclusion in the study. The participants met with the lead author for bariatric surgery pre-operative psychological evaluations. The initial data was collected as a routine part of those assessments. The subjects agreed to return post-operatively for a regular checkup and to participate in the study. Of the initial 69 candidates, 0 refused to participate, 8 did not proceed with surgery, 24 were known to have had surgery but did not follow up, and 19 did not respond to follow up queries. The remaining group of 18 participants consisted of 11 females and 7 males. All 18 individuals were obese with a mean pre-operative weight of 326.3 lbs. (91.3). The 18 participants had an average height of 67.5 in. (4.3). The average age was 48.7 years (11.2), with an age range from 19 to 64. All subjects in the study were Caucasian. The average initial BMI for the subjects was 49.8 (10.9) and the BMI ranged from 35.7 to 73.0. The sleeve gastrectomy was used for 16 participants, while the other 2 had the gastric bypass. A control group was not utilized because one could not ethically assign a control group of subjects who were requesting major surgery for health threatening conditions. In addition, the purpose of the study was to see if there was a change in MF when challenged by a major weight loss.

Measurements

This study, unlike others, was a prospective, pretest-posttest study design model to analyze whether significant post bariatric surgery weight loss was associated with a change in MF. The design involved first calculating obese subjects' MF by taking their weight and measuring their RMR. Secondly, subjects were treated with bariatric surgery. Lastly, subjects' RMR was measured after they had lost significant weight. Pre-operative and post-operative RMR was measured by indirect calorimetry (ReeVue indirect calorimeter, Korr Medical Technologies, Salt Lake City, UT) with participants in a supine position. The pre-operative RMR was obtained during the psychological evaluation that determined their appropriateness for surgery. While the environmental conditions were comfortable and all participants were tested in the same position, the pre-operative assessment did not involve a routine screening for fasting, nicotine, caffeine, and physical activity as recommended by Compher, Frankenfield, Keim, and Roth-Yousey [8].

The RMR of the participants was again measured between 9 and 19 months post-operatively. The follow up assessment more closely followed the recommendations as participants were asked to fast and avoid caffeine use for four hours prior to testing. Participants did not exercise prior to the assessment and none were smokers. Weight was measured by a digital scale and height was self-reported.

RESULTS

The initial weight for the 18 participants was 326.3 lbs. (91.3). Post-surgically the average weight dropped to 229.3 lbs. (48.0) ($p < 0.01$). The average weight lost was 97.0 lbs. (67.4). The initial mean BMI of the participants was 49.8 (10.9) and was reduced to 35.3 (6.8) after surgery, which was statistically significant ($p < 0.01$). Prior to surgery, the average RMR was 2,614.3 (767.1) kcal whereas the post-operative RMR average was 1,954.4 (379.7) kcal ($p < 0.05$). As expected, the correlation between weight and initial RMR ($p < 0.001$) as well as weight with the follow up RMR ($p < 0.001$) were both statistically significant. The average time since surgery was not statistically significantly correlated with change in MF ($r = -0.24$).

As for the primary hypothesis that MF would not change after weight loss, Figure 1 shows that the pre-operative MF was 8.1 (1.1) and only slightly increased to 8.6 (0.88) after surgery ($p = 0.19$). The average change in MF was 0.51 (0.94). There was not a statistically significant difference between pre-operative and post-operative MF even though the distribution was skewed because one individual increased his MF by 2.9 after losing 233 pounds, which was over half of his original body weight. Without this outlier, the mean differences would have been even smaller. In addition, the change in weight was not statistically significantly correlated with change in MF ($r = 0.22$). The follow up MF negatively correlated with post-operative BMI, $r = -0.48$ ($p < 0.05$), indicating the higher the MF, the lower the post-operative BMI.

CONCLUSIONS

The current study aimed to display the presence of MF in previous data and replicate the findings using more extreme weight loss. Consistent with the previous studies, the Metabolic Factor of the participants in the current research did not change despite an average weight loss of nearly 100 lbs. one year after bariatric surgery. **Although the small sample size limits generalizability, these** ~~These~~ results suggest stability of MF. While a change in RMR occurs with weight loss, that same phenomenon does not appear to occur with MF. This study also seems to establish the possibility that MF is not simply a function of one's current weight, but instead might be a stable characteristic unique to each individual. The results point to the possible usefulness of MF as a measure which can be used in future research.

The most notable ~~A~~ limitation of this study was the small sample size**, which restricts the ability to generalize the results until further research with more participants can be conducted. Although promising, the results should be interpreted with caution.** ~~and that the~~ **The** sample**'s** ~~was homogenous~~ **homogeneity** in regards to race **also limits generalizability**. In addition, children and the elderly were excluded. Another limitation involved the differences in following the recommended protocol for indirect calorimetry from the initial assessment to the retesting. The absence of a control group did not allow for a comparison to be made between the group with surgical intervention and a group without intervention.

DISCUSSION

Understanding the MF is important for a number of reasons. It suggests that obese people could be "super absorbers" who tend to be more efficient with their processing of food. Using the average MF for each weight class, as reported by Davis et al, in order to achieve maintenance, the obese only need 8.3 calories for every pound of weight whereas people of normal weight require 12.8 calories. They are fully 35.2% more efficient than people of normal weight.

MF could play a role in determining treatment strategies for obesity as well as goals. In the situation of an obese individual with a MF of 12.8 calories/pound, the person is biologically predisposed to have an average weight. In that case, the evidence seems to support the belief that obesity for them can largely be attributed to emotional or behavioral issues, or at least not to any underlying difficulty related to a slow MF. However, **the best treatment for** someone who is **morbidly** obese and has a MF of 8.3 calories/pound ~~is in the weight range expected given that person's biological makeup. The best treatment for this kind of individual~~ may involve bariatric surgery as well as psychotherapy to focus on emotional, cognitive, and behavioral changes that need to occur or acceptance of their physical characteristics. **An appropriate weight goal, given the low MF, would be a BMI in the low 30's.** Given the efficiency of digesting food among people with low MF, surgical procedures that produce malabsorption might be more appropriate than those that are merely restrictive. Expectations for surgical outcome could be influenced by knowledge of MF as it accounted for 23% of the variance in BMI from before to after surgery in this study. Following the 18 to 24-month period of rapid weight loss after surgery, it is important for surgical patients to understand that their body's efficiency in processing food has not changed despite the beneficial tool surgery offers. Failing to understand this underlying factor could lead to regaining the weight and eventually the failure of surgery. Even if people choose not to pursue surgery, the MF is a good indicator of what kind of weight loss could reasonably be expected. For someone with a MF indicating obesity, setting a goal to lower their weight to the normal, or even overweight, range may not be realistic and could be a setup for failure. Instead, aiming for a BMI in the low 30's is likely the most realistic goal.

Perhaps the most important contribution of the establishment of MF is its potential to reduce the stigma and shame associated with obesity. This research**, although preliminary,** lends support to the idea of a genetic predisposition to a certain weight category. While the importance of healthy eating habits and exercise are undeniable, knowledge of MF offers validation for being in a particular weight range. In addition, this predisposition emphasizes the need to manage the disease of obesity with a healthy lifestyle similar to the need to manage Multiple Sclerosis with exercise and lower stress or to manage Type II Diabetes with reduced sugar intake. Of course, future research is needed to determine what causes MF, whether it be genetic, early diets, behaviors, or some other factor.

Given that research on MF is in its infancy, the primary area of future research is replicating these findings. The applicability of the concept across ethnic groups, at the extremes of ages, and at the extremes of weight should also be further examined. If a low MF is shown to be stable and correlate with obesity, an adolescent would benefit greatly from this knowledge as it could guide health decisions across the lifespan. In addition, a longitudinal study to examine the possibility of a change over a period of years may be in order. This research is needed given the importance and relevance of Metabolic Factor in weight problems as suggested by the present study. Metabolic Factor may prove to be a valuable tool in the struggle to understand and treat obesity and to help patients and medical personnel make informed choices as to treatment interventions.

Conflict of Interest Notification

Funding for this study was obtained from American Association of Bariatric Counselors. However this funding had no impact on the results. Neither Dr. Davis nor Dr. Indelicato have any conflicts of interest.

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Ethical Approval

All procedures performed in this study were in accordance with the ethical standards of Touro College and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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Table 1: Changes in MF based on weight fluctuations.

STUDY	**N**	**Weight Change**	**Initial MF**	**Retest MF**	**Change**	**Level of Significance**
Heshka et al (1990) [4]	35	-40	6.8 (1.7)	7.4 (2.2)	+0.6	NS
Del Genio et al (2007)a [5]	20	-48	7.6 (1.1)	7.9 (1.4)	+0.3	NS
Del Genio et al (2007)b [5]	20	-31	8.0 (1.4)	7.8 (1.4)	-0.2	NS
Thomas et al (2012)a [6]	69	-11	8.1 (2.0)	8.0 (1.8)	-0.1	NS
Thomas et al (2012)b [6]	69	-17	8.1 (2.0)	8.2 (2.0)	+0.1	NS
Ravussin et al (1988)a [7]	15	+22	7.4 (0.9)	6.8 (0.4)	-0.6	$p < 0.05$
Ravussin et al (1988)b [7]	111	+0.2	8.2	8.3	+0.1	NS

Figure 1. Pre-operative and post-operative Metabolic Factor measurements.