

Influences of mental and metabolic disorders on nutritional status and resting energy expenditure

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Abstract

Resting energy expenditure (REE) of human metabolism depends on metabolic and mental traits. Estimation on resting energy expenditure is important for any initial or stage in the attempt of obtaining healthy nutritional balance. The difficulties and scarce resources for measurement of REE using indirect calorimetry made from predictive equations a valuable alternative. Evaluation of predictive equation in comparison with indirect calorimetry measurement in subgroups with special psychological characteristics and various stages of metabolic balance increased their assessment value..

Keywords: *resting energy expenditure, mental disorders, metabolic diseases, predictive equation, nutritional status*

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I. INTRODUCTION

Energy expenditure (EE) of human body is influenced by metabolic and mental conditions. EE includes resting energy expenditure, food induced thermo genesis and energy consumed in physical activity.

Resting energy expenditure (REE) is the minimum amount of energy required for maintaining the life in vigil state. REE depends of body composition, age, gender, physiological and pathological processes, and use of psychoactive and metabolic active drugs. REE is used for nutritional assessment, appraisal caloric requirement, forecast caloric demand and weight management. Psychological states, mental illness as presented by American Psychiatric Association in axis I and II (depressive disorder, anxiety, obsessive – compulsive, bipolar disorders, posttraumatic stress disorders and personality disorders) modify REE in a complex way. For instance anorexia nervosa (AN) with secondary starvation initially decreased REE preserving ingested calories (de Zwaan, Aslam, & Mitchell, 2002). After refeeding in therapeutic phase REE increased and opposed to expected weight gain, raising sometimes the issue of patients food disposal. In mental disorders the attempt of maintaining the normal weight should take into considerations the cognitive and emotional factors that could influence energetic balance. Current medical nutrition therapy should be associated with psychotherapy and eventually medication.

II. REE DEFINITION, MEASUREMENT

Internal organs functions of heart, kidney, liver, brain utilize 70% of REE and only the rest of 30 % is used by the other systems. Adipose tissue has a lower energy requirement (4,5kcal/kg/daily) than muscular tissue (13 kcal/kg/daily) (Elia, 1992). Total fat in normal body composition is between 21 - 35% of body weight (Gallagher et al., 2000). Increasing of adipose tissue percentage in body composition decrease REE comparatively with a low fat body composition at the same weight. Increasing in muscle mass with 1kg produce an increase of REE with 21kcal by modifying protein production. REE is increased in diabetes mellitus by increased glucose oxidation, decrease glucose storage, blunted thermo genetic food effect, increased sympathetic activity. REE increased with glycemic level in metabolic imbalance state as diabetes. Levels of glycemia over 180mg/dl increased REE with 8% (Gougeon, Lamarche, Yale, & Venuta, 2002). Diabetes is a condition frequently associated with cognitive and psychological disturbances (American Diabetes, American Psychiatric, American Association of Clinical, & North American Association for the Study of, 2004). Mental and psychological conditions could modify REE by different mechanism: increasing caloric intake and secondary obesity, decreased caloric intake and starvation, increasing cortisol and hypothalamic-pituitary-adrenal axis activation, activation of

sympathetic nervous system, increased cytokines level, increased inflammatory state. REE is modified in mental illness which associated obesity and when psychotropic drugs are used.

REE could be determined by indirect calorimetry, which is now the highest applicable standard (Compher, Frankenfield, Keim, Roth-Yousey, & Evidence Analysis Working, 2006; Haugen, Chan & Li, 2007). Indirect calorimetry measured the oxygen consumed and carbon dioxide production in expired air, computing on these data caloric requirement in basal condition and respiratory quotient which measure the carbohydrates/fat oxidizing ratio (Kaiyala, 2014). Because measured REE with indirect calorimetry is not accessible to all patients, in general practice predictive equation is used.

Predictive equations used anthropometric parameters (height, weight), age and gender for computing REE. These equations had been computed using data from healthy adults, normal subjects (Henry, 2005). Differences between REE measured with indirect calorimetry and predictive equation elaborated for various pathologic, ethnic, age-related or other subgroups lead to development of new equations. More than 200 equations evolved in the effort for accurate results in specific conditions (Sabounchi, Rahmandad, & Ammerman, 2013). However experts still recommended individual clinical decision in interpretation on REE obtained by a predictive equation (Frankenfield, Roth-Yousey, & Compher, 2005), in special in condition in which previous evaluation was not undertaken. The group on which statistical analysis should be applied for obtaining a mathematic relation should be large enough and well characterized. Several gropes with mental disorder associated or not with other co morbidities as diabetes, obesity had been analyzed and results are still on debate.

Table 1: frequently used predictive equation

Male	
Predictive equation	
Harris- Benedict	$66 + (13,8 \times \text{weight (W)}) + (5 \times \text{height (H)}) - (6.8 \times \text{age (A)})$
Owen	$879 + (10.2 \times \text{W})$
Mifflin StJeor	$(9.99 \times \text{W}) + (6.25 \times \text{H}) - (4.92 \times \text{A}) + 5$
Berstein	$(11 \times \text{W}) + (10.2 \times \text{H}) - (5.8 \times \text{A}) - 1032$
FAO/WHO/ONU 18-30 years	$15.4 \times \text{W} + 27 \times \text{H} + 717$
FAO/WHO/ONU 30- 60 years	$11.3 \times \text{W} + 16 \times \text{H} + 901$
FAO/WHO/ONU) > 61 years	$8.8 \times \text{W} + 11.128 \times \text{H} + 1071$
Female	
Predictive equation	

Harris- Benedict	$655 + (9.5 \times W) + (1.9 \times H) - (4.7 \times A)$
Owen	$795 + (7.18 \times W)$
Mifflin	$(9.99 \times W) + (6.25 \times H) - (4.92 \times A) - 161$
Bernstein	$(7.48 \times W) - (0.42 \times H) - (3 \times A) + 844$
FAO/WHO/ONU)18-30 years	$13.3 \times W + 334 \times H + 35$
FAO/WHO/ONU)30- 60 years	$8.7 \times W + 25. \times H + 865$
FAO/WHO/ONU)> 61 years	$9.2 \times W + 637 \times H + 302$

W- Weight; H-height; A- age

III. REE IN METABOLIC DISORDERS

Predictive equations that proved to be more accurate in metabolic disease are Mifflin St Jeor, Harris-Benedict, Owen and World Health Organization/Food and Agriculture Organization / United Nation University (WHO/FAO/UNU) (Buscemi, Verga, Caimi, & Cerasola, 2007; D. Frankenfield et al., 2005; Hasson, Howe, Jones, & Freedson, 2011).

These equations had been developed from computed data in healthy individuals and their accuracy in special groups with associate mental illness with other pathologic conditions as metabolic diseases is still need further evidences. The accuracy of following equation was assessed for metabolic disease. Mifflin St Jeor equation was developed using a group of obese and normal weight subjects. It predicts better in a range of +/- 10% deviation from assessment by indirect calorimetry for patients with diabetes. It was considered the best predictive equation (Frankenfield et al., 2005; Frankenfield, 2013). Harris – Benedict was developed on a group of normal weight subjects and results are generally overestimating the results obtained by calorimetry in normal weight and overweight diabetic patients. Owen equation was developed in a group of subjects with normal weight and obesity and the prediction range was in +/- 10% around calorimetry, more frequently underestimate. The WHO/FAO/UNU was derived from Schofield equation, included a large number of subjects from military forces, and related ethnicity (Horgan & Stubbs, 2003). Some authors report a tendency on overestimation REE for this equation for some population, others report an underestimation for the same equation (Frankenfield et al., 2005). Other equations were special developed for specific groups as Luhrmann equation for prediction of RMR in elderly population (Noreik et al., 2014) and diabetic patient from special ethnic groups (Ikeda et al., 2013).

Scientific evidence suggests that metabolic syndrome (MS) with obesity is associated with a low energy requirement adjusted to lean mass than obesity alone (Buscemi et al., 2007). In diabetes with obesity, REE is higher than in metabolic syndrome with obesity. Involved mechanism in increased REE in diabetes were considered increase glucose oxidation, decrease glucose storage, increase sympathetic nervous system activity (Seals & Bell, 2004). For decreased

REE with MS were considered increased level of fat and consequent lipotoxicity, decreased mitochondrial function (Sreekumar & Nair, 2007) with decreased level of uncoupling proteins, genetic traits.

IV. REE IN MENTAL DISORDERS

Predictive equations have been compared for different mental illnesses (Scalfi et al., 2001). In patient with severe mental disease and medication with olanzapine the best predictive equation were Mifflin St Jeor and Harris Benedict computed on adjusted body weight as an average between ideal body weight and current body weight (Skouroliakou, Giannopoulou, Kostara, & Vasilopoulou, 2009). In schizophrenia the most precise predictive equation was considered Harris Benedict (Sugawara et al., 2014).

Use of antipsychotic medication reduced REE and physical activity and promotes weight gain (Allison & Casey, 2001; Cuerda, Velasco, Merchan-Naranjo, Garcia-Peris, & Arango, 2014; Procyshyn, Chau, & Tse, 2004). It could highlight a hidden glucose metabolism disorder and transform it in overt diabetes. Association between use of psychiatric medication and diabetes is very common in clinical practice. Mental illnesses and use of antipsychotic medication are associated with metabolic disorders on a common pathway which implicates leptin level and leptin resistance. High levels of leptin and leptin resistance were implicated in brain functionality (Panariello, Polsinelli, Borlido, Monda, & De Luca, 2012). Brain dysfunction could increase caloric intake, augments adipose tissue and consequently raises leptin level. Maintaining normal weight in patients using psychiatric medication is a particular challenge for nutrition specialist. There is also scientific evidence that obesity increased the risk of schizophrenia and Alzheimer disease (Farooqui & Farooqui). Metabolic diseases are frequently associated with mental illness and their diagnostic is difficult and delayed (Lopuszanska, Skorzynska-Dziduszko, Lupa-Zatwarnicka, & Makara-Studzinska, 2014).

AN characterized by fear of weight increased, inadequate body image and severe decrease of caloric intake is associated with reducing of metabolic rate and increased energetic efficiency. In starvation induced by anorexia nervosa REE was reduced also by reducing the metabolic rate of free fat mass (Kosmiski, Schmiede, Mascolo, Gaudiani, & Mehler, 2014; Schebendach, Golden, Jacobson, Hertz, & Shenker, 1997). Tiroxine hormone deiodination decreases T3 hormone in favor of increase rT3 (reduced triiodthronine) which is less metabolically active. Leptin decreased levels induced also RMR reduction. In refeeding process of AN, REE increased to a superior level than expected for free fat mass and correlated positively with anxiety level and negative with depressive level, anxyolytic and antidepressants amplified this effect (Van Wymelbeke, Brondel, Marcel Brun, & Rigaud, 2004).

V. SUMMARY AND CONCLUSIONS

Association of metabolic and mental disorders demands special intervention in clinical practice. Frequently the failure of obtaining desired nutritional status is assigned to deceptive behavior of these patients. Corrections of nutritional imbalances and reestablishment of normal weight for patients with mental disorders should be a joint effort of nutrition specialists and mental health professionals. Estimation of REE as initial evaluation with indirect calorimetry or predictive equation should be followed by estimation of mental disorder influence on decreasing or increasing REE in disease evolution or therapeutic process. Accurate prediction of mental processes influences in energetic balance will allow on target judgment of nutritional intervention and better understanding of issues faced of this specific group in maintaining body weight.

ACKNOWLEDGEMENT

This paper is partly supported by the Sectorial Operational Programme Human Resources Development (SOPHRD), financed by the European Social Fund and the Romanian Government under the contract number POSDRU 141531.

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