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Baseline respiratory quotient predicts weight change in overweight and obese young women

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TITOLO

Il quoziente respiratorio è predittivo delle variazioni di peso in giovani donne in sovrappeso ed obese

KEY WORDS

Respiratory quotient, resting energy expenditure, weight gain, indirect calorimetry

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Quoziente respiratorio, spesa energetica a riposo, incremento ponderale, calorimetria indiretta

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Summary

Background/Aims: The identification of behavioural and metabolic risk factors of weight gain is a continuous challenge. This study wants to assess the predictive value of non-protein respiratory quotient (NPRQ) and resting energy expenditure (REE) on changes of body weight after a 3 years follow-up in overweight and obese young women. *Methods:* Thirty-four women of age 25.7 ± 5.8 years and BMI of 31.06 ± 3.72 , which were measured weight, height, body composition, resting energy expenditure and non-protein respiratory quotient, started a weight loss programme and they attended individual, monthly follow-up visits for an average time of 7 months. After 36 months from baseline, subjects were contacted and invited to the clinic for a set of new measurements. *Results:* After 36 months weight change (weight loss) was 3.08 ± 9.8 kg. The NPRQ showed a significant increase at the follow up ($p < 0.05$). Change (Δ) in body weight (BW) was significantly correlated with Δ_{NPRQ} ($p < 0.01$) and Δ_{REE} ($p < 0.001$). The multiple regression analysis showed that Δ_{BW} was predicted by baseline NPRQ and high baseline values were associated with weight gain after 36 months. *Conclusion:* Baseline NPRQ was a significant predictor of weight change in overweight young women.

Riassunto

Scopo del lavoro: L'identificazione di fattori di rischio metabolici e comportamentali nell'incremento ponderale è un obiettivo auspicabile. Questo studio valuta se il Quoziente respiratorio non-proteico (QRNP) e la Spesa energetica a riposo (SER) sono fattori predittivi delle variazioni ponderali dopo un follow up di 36 mesi in un campione di giovani donne in sovrappeso ed obese. *Metodi:* Trentaquattro giovani donne di età 25.7 ± 5.8 anni e IMC di 31.06 ± 3.72 kg, a cui furono rilevati il peso, l'altezza, la composizione corporea, la spesa energetica a riposo (SER) ed il quoziente respiratorio non-proteico (QRNP), iniziarono un programma dietetico ipocalorico e furono controllate mensilmente per un tempo medio di 7 mesi. Dopo 36 mesi dalla prima visita i soggetti furono contattati ed invitati per una ripetizione delle indagini. *Risultati:* Dopo 36 mesi la perdita di peso fu di 3.08 ± 9.8 kg. Il QRNP mostrò un aumento significativo ($p < 0.05$) al follow up. Cambiamenti (Δ) nel Peso Corporeo (PC) furono correlati significati-

vamente con Δ_{QRNP} ($p < 0.01$) e Δ_{SER} ($p < 0.001$). L'analisi della regressione multipla mostrò che elevati valori basali del $\text{QRNP}_{\text{basale}}$ erano associati con il guadagno di peso. *Conclusioni:* il $\text{QRNP}_{\text{basale}}$ è risultato essere un significativo fattore predittivo delle variazioni di peso in giovani donne in sovrappeso.

Introduction

The obesity epidemic is a worldwide phenomenon and dietary and lifestyle factors have been identified as main determinants of this phenomenon although inter-individual susceptibility to weight gain remains an unsolved issue (1, 2). Genetic and metabolic studies have unravelled some of these questions by identifying monogenic causes of obesity and genetic polymorphisms involved in the regulation of energy balance (3, 4). On the other hand, epidemiological studies have produced controversial results on the association between energy expenditure (EE), substrate oxidation and risk of weight gain. Cross-sectional studies observed an inverse association between obesity and non-protein respiratory quotient (NPRQ) – a measure of substrate oxidation – whereas longitudinal studies reported an increased risk of weight gain when the NPRQ increases (5). In normal conditions the NPRQ values are between 0.71 and 1 and at each value there is a specific ratio of carbohydrate and

fat oxidation (6). The lower is the NPRQ the higher is the proportion of fat oxidized and therefore subjects with lower values of NPRQ have a greater capacity of mobilizing body fat (7).

This study investigated the predictive effects of baseline measurement of REE and NPRQ, measured with indirect calorimetry, on changes in body weight after a 36-month follow-up in a population of healthy overweight and obese young women.

Methods

Thirty-four pre-menopausal, overweight and obese (BMI range: 25.4-7.3 kg/m²) Caucasians women (18-35years) attended the outpatient clinic of the Dietetic and Nutrition Physiology unit of the University of Naples "Federico II". Subjects were recruited from a sample of consecutive patients who had a baseline measurement of body composition and energy expenditure. Subjects were asked to return to the outpatient clinic after

36 months and they were not included if they have changed their level of physical exercise, if they were smoking and had any of the following conditions: major chronic diseases (diabetes, coronary heart disease, kidney diseases, liver diseases, neurological disorders, etc), pregnancy, breastfeeding, drugs influencing energy and evidence of eating disorders. A weight change higher than 3 kg in the previous two months was also considered as an exclusion criterion. One hundred and ten patients were contacted and ~30% (n=34) of them met the inclusion criteria and returned for a second set of measurements after 37±4 months. Subjects signed a written consent to take part to the study.

At the baseline visit subjects were prescribed a hypocaloric diet to create a 500 kcal deficit. Afterwards they returned for monthly follow-up visits. Subjects attended on average 7±2 follow-up visits and they achieved an average weight loss of 5.6±5.2 kg (data not shown). The protocol of the weight loss programme has been described

elsewhere (8). Weight and height were measured to the nearest 0.1 kg and 0.1 cm, respectively. Body composition (fat mass, fat free mass) was assessed with a single frequency (50Hz) tetrapolar bioimpedance system (BIA 101, Akern-RJL System, Chicago, USA). Resting energy expenditure (REE) was measured by indirect calorimetry using a canopy system gas collector (VMAX 29n, Sensor Medics, Yorba Linda, CA, USA). Measurements were performed at baseline and after 36 months. Further details on the measurement procedures in our laboratory have been described elsewhere (9). Carbon dioxide production (VCO_2) and oxygen consumption (VO_2) were measured and non-protein respiratory quotient (NPRQ) was calculated (VCO_2/VO_2).

Data have been expressed as mean and standard deviation (s.d). A Wilcoxon sign ranked test has been used to detect significant differences after 36 months. Spearman rank correlation and multiple regression analysis have been performed to identify baseline predictors of weight and BMI change (dependent variables) after 36 months. Normality distribution was checked with Shapiro-Wilkinson test and variables were log-transformed to meet normality assumptions. Data analysis was performed with Stata 8 for Windows (Stata Corporation, 2001, USA). A p-value of <0.05

was considered as being statistically significant.

Results

After 36 months subjects' body weight was on average lower than base-line of 3.08 ± 9.8 Kg ($-3.4 \pm 11.1\%$; $p < 0.05$). Fourteen (41%) subjects gained more than 5 kg and eleven (32%) subjects lost the same amount of weight. Body mass index decreased alongside body weight but only 6 obese subjects were able to lower their BMI below 30 kg/m^2 . Fat mass and fat free mass did not significantly change (FM = $-2.0 \pm 10.1 \text{ kg}$; FFM = $-1.8 \pm 3.7 \text{ kg}$) at the end of the follow-up. Respiratory quotient in-

creased significantly after 36 months ($p < 0.05$) but we did not observe significant changes in REE and REE/FFM (Table 1).

Subjects with a baseline NPRQ lower than 0.85 experienced an average weight loss of $10.7 \pm 9.5 \text{ kg}$ but those with a value higher than 0.85 gained on average $1.6 \pm 6.5 \text{ kg}$ (data not shown). The correlation analysis showed that baseline NPRQ was directly associated with weight change ($\rho = 0.69$; $p < 0.001$) and an increase in the NPRQ was associated with a smaller weight loss ($\rho = -0.65$; $p < 0.001$).

The multiple regression analysis showed that baseline NPRQ was the only significant predictor ($p < 0.05$) of weight change after 36 months. The other baseline inde-

Table 1 - Anthropometry, body composition and metabolic characteristics of the population

Age (years)	25.76±5.83		
Height (cm)	161.0±6.1		
	Baseline	36 months	Δ
Weight (kg)	81.06±12.95	77.98±13.89	-3.08±9.8
Fat mass (kg)	31.86±9.20	29.87±11.00	-1.99±10.1
Fat mass (%)	38.61±6.32	37.90±6.63	-0.71±7.3
Fat free mass (kg)	49.19±5.34	48.11±5.70	-1.8±3.75
NPRQ (VCO_2/VO_2)	0.85±0.06	0.89±0.05	0.03±0.07*
REE (kcal*24h ⁻¹)	1532±229	1547±269	15±205.3
REE/FFM (kcal*24h ⁻¹ *kg ⁻¹)	31.21±3.80	32.14±3.97	0.92±4.5

Body mass index (BMI) = weight (kg)/height (m²); ΔΔ = X_{36months} - X_{Baseline}

Mean±s.d. are shown. Statistical significance: * p<0.05

REE - Resting Energy Expenditure

FFM - Free Fat Mass

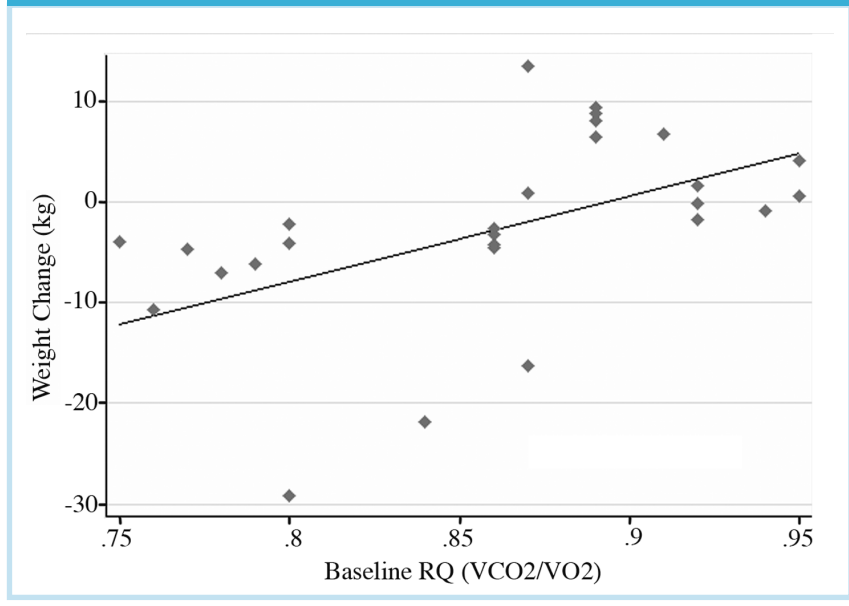
pendent variables (FM, FFM, REE) were not significant predictors of weight gain and the model explained 30% of the variance (Table 2).

Table 2 - Multiple regression analysis of baseline values in FM, FFM, NPRQ and REE (independent variables) on changes in body weight (dependent variable) after a 36month follow-up

Δ Weight F (4, 29) = 3.24; P < 0.05; R ² = 0.30			
	B	SEE	p value
Intercept	3.01	3.52	NS
FM _{Baseline}	0.08	0.27	NS
FFM _{Baseline}	-0.19	0.64	NS
NPRQ _{Baseline}	-2.23	0.92	0.02
REE _{Baseline}	0.05	0.68	NS

FM = Fat Mass; FFM = Fat Free Mass, NPRQ= Non Protein Respiratory Quotient;
REE = Resting Energy Expenditure; NS = Not Significant

Figure 1 - Association between baseline respiratory quotient and weight change after a 36-month follow-up (rho= 0.69, p<0.001)



Discussion

This study has shown that baseline respiratory quotient is a significant predictor of weight gain because it showed that subjects with higher baseline NPRQ values were more likely to gain weight after a 3-years follow-up.

The different weigh change associated with different NPRQ could be associated to a defect of some subjects in the oxidation of carbohydrate and lipid which has an important impact on energy balance (10, 11). Individual predisposition to dispose of these nutrients by a differential modulation of metabolic pathways involved in the metabolism of fat and carbohydrate could determine the capacity of some individuals to adjust more efficiently their energy balance and be able to maintain their body weight in the long term.

Zurlo et al (12) investigated the risk of weight gain in Pima Indians and they observed that NPRQ was positively correlated with weight gain after a follow-up of 25 months and, in another study, obese subjects with a NPRQ greater than 0.75 were less able to maintain the weight loss achieved with a very low calorie diet (13). In addition, previous studies in non-obese subjects showed that a high fasting NPRQ carried a greater risk of weight gain after 3–10 years of follow-up (14, 15).

The results of this study may have been affected by the lack of information on macronutrient intake and physical exercise and their impact on individuals' energy balance. However, we have assumed that baseline distribution of physical activity level would have been similar to the level at the end of the follow up and the exclusion of subjects with recent weight loss could have prevented the inclusion of subjects in negative energy balance.

In conclusion, we observed that baseline NPRQ was a significant predictor, and a potential marker, of weight change in overweight and obese young women after 36 months. The assessment of NPRQ could assist in the development of weight loss and follow-up strategies intended for subjects with higher values of NPRQ who may experience more difficulties in losing weight or maintaining their weight loss in the long-term.

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