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ORIGINAL ARTICLE

A path model analysis on predictors of dropout (at 6 and 12 months) during the weight loss interventions in endocrinology outpatient division

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Abstract

Introduction This study aimed to identify the dropout rate at 6 and 12 months from the first outpatient visit, and to analyze dropout risk factors among the following areas: biochemical examinations, anthropometric measures, psychological tests, personal data, and life attitude such as smoking, physical activity, and pathologies.

Methods This is a retrospective longitudinal observational study. Patients undergo an outpatient endocrinology visit, which includes collecting biographical data, anthropometric measurements, physical and pathological history, psychological tests, and biochemical examinations.

Results The sample consists of 913 subjects (682 women and 231 men), with an average age of 50.88 years (±15.80) for the total sample, with a BMI of 33.11 ± 5.65 kg/m^2.

51.9% of the patients abandoned therapy at 6 months after their first visit, and analyzing the dropout rate at 12 months, it appears that 69.5% of subjects abandon therapy. The main predictor of dropout risk factors at 6 and 12 months is the weight loss during the first 3 months ($p < 0.05$). As regards the hematological predictors, white blood cell and iron level stated dropout at 12 months. Patients who introduced physical activity had a reduction of – 17% (at 6 months) and −13% (at 12 months) of dropout risk ($p < 0.05$). As regards the "worker" status, patients classified as"retired" had a decrease risk of dropout vs. other categories of worker ($i = 0.58$; $p < 0.05$). Dropout risk at 12 months decrease in patients with a previous history of cancer, Endocrine and psychic and behavioral disorders ($p < 0.001$).

Conclusions The main factor that predisposes patients to continue therapy or to abandon it is the success (or failure) of the diet in the initial period, based on weight lost (or not lost) in the early months of the initiation of therapy. Furthermore, considerable differences were found in different categories of "workers", and with previous "pathologies". The level of physical activity and previous diseases also seem to be predictors of dropout.

Keywords Dropout · Obesity · Overweight · Cancer · Endocrinology · Diet

Introduction

The search for the most effective treatment of obesity, given the critical metabolic consequences that this pathology entails, is a very studied topic. However, today the balanced low-calorie diet, associated with regular physical activity, remains the treatment recommended by all the international guidelines for the treatment of obesity [1], although over time the literature has shown that adherence to the hypocaloric diet is very low. Dropout is a great problem in all weight loss interventions. Identification of predictors of dropout could be important to enhance recruitment in vulnerable groups, as well as to develop strategies to prevent dropout among those at high risk [2].

The current literature shows that dropout is more frequent among adult subjects than among adolescents [3] and early weight loss and age were identified as significant variables for predicting attrition in weight loss trials [4].

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Dropout also has uncaptured consequences such as demoralization of therapists, burden on patients' loved ones, longer wait times for patients who desire treatment, and lost clinical time and administrative resources for clinics [5].

Also patients with higher scores for symptoms of anorexia and total cholesterol or shape concern, job condition, parenting care, and organization, predicted dropout of weight loss intervention for overweight or obesity [6, 7].

So the dropout topic has been much discussed in literature in recent years. However, the studies currently published have varied by sample size, type of diet program, length of treatment, risk evaluated, and definition of dropout.

Given these critical issues, the aim of this study is to identify the dropout rate at 6 months and at 12 months after the first outpatient visit in a large sample size. The secondary purpose of the study is the evaluation of the largest possible type of dropout risk by a structural equation model that has allowed to have a significant overview of many variables, such as hematochemical examinations, anthropometric measures, psychological tests, demographic variables, lifestyle (smoke, alcohol consumption, physical activity), and diseases, such as metabolic syndrome, cancer, endocrine/metabolic/nutritional diseases, diabetes, thyroid diseases, dyslipidemia, psychological and behavioral disorders, nervous system diseases, vascular dementia, circulatory system diseases, respiratory system diseases, digestive system diseases, locomotor system diseases.

Materials and methods

Sample and setting of intervention

This study was conducted among obese and overweight patients (BMI ≥ 25 kg/m^2) who consulted the endocrinology outpatient division service of the Azienda Servizi alla Persona "Santa Margherita" Hospital of Pavia from January 2007 to May 2017.

Study design

This is an observational retrospective longitudinal study made on the database of the outpatients of the endocrinology Unit of the Azienda Servizi alla Persona "Santa Margherita" Hospital of Pavia.

Definition of dropout

In this study we refer to early dropout if the dietetic therapy is abandoned by patients within 6 months from their first visit, and we refer to late dropout for those patients who instead abandoned the therapy within 12 months from the first visit.

Nutritional assessment

During the first visit, the following data are collected through the compilation of a clinical folder:

- Personal data
- *Family history* of the patient, analyzing if they have close relatives with obesity, diabetes mellitus, hypertension, cardiovascular diseases, cancer or any other disease.
- *Pathological history*, for which the patient is asked about their personal diseases
- *Pharmacological anamnesis*, in which the patient is asked about what medications they are taking in the current period.
- *Physiological history*, for which the patient is asked about information such as intestinal regularity, diuresis, pregnancies, abortions.
- *Personal history*, for which to the patient is asked about their lifestyle (physical activity, smoking etc.)
- *Weight history*, in which the patient is asked about weight at birth, their habitual weight during childhood, adolescence and adulthood, the moment of onset of overweight or obesity or when a progressive increase of weight began; previous attempts to lose weight and their characteristics (self-managed diets or supervised by a doctor or dietitian, results obtained, frequency).
- *Eating habits*, in which the patient is asked about the quality and quantity of food that they usually consume at breakfast, lunch and dinner, if they usually have snacks, if they usually consume alcohol and in what amount, which foods they don't like, how much water they usually drink per day, the frequencies of consumption of second courses (meat, fish, cheese, legumes etc.), and if they usually consume coffee, milk, yogurt, tea, and juices.

After the collection of these data, the hematochemical exams are analyzed: blood exam, lipid profile, thyroid profile, proteins, electrolytes, vitamins.

Finally the patient is visited by the doctor and anthropometric data are assessed.

Anthropometric data assessment

Body weight: the weight is measured using a scale that must be periodically calibrated. The patient is weighed in light clothes (underwear) and without shoes.

Height: the height is measured (and not asked) with a Harpendend statimeter. The subject should be without shoes, feet joined and parallel to each other with the horizontal head aligned to the Frankfurt plane.

BMI: BMI is detected by calculating the ratio between body weight and the square of height in meters. The patient is classified as underweight if BMI < 18.5, normal weight if BMI is from 18.5 to 24.9, overweight if BMI is from 25 to 29.9, suffering from obesity of first degree if BMI is from 30 to 34.9, suffering from obesity of II grade if BMI is from 35 to 39.9 and suffering from obesity of III grade if BMI ≥ 40 [8].

Waist circumference: through the use of a measuring tape, waist circumference is determined. The waist circumference is measured in the intermediate area between the last rib and the iliac crest. There is increased cardiovascular risk for the European population when the waist circumference exceeds 94 cm in men and 80 cm in women [8].

Administration of psychometric tests

Psychometric tests are delivered to the patients during the first visit and are autoadministrated and then delivered back during the first check visit: The tests are:

- BES (Binge Eating Scale): if the score is from 0 to 16 the presence of Binge Eating Disorder is unlikely; if the score is from 17 to 27 the presence of BED is possible; if the score is higher than 27 the presence of BED is likely [9].
- BDI (Beck Depression Inventory): a score ranging from 10 to 19 indicates a slight depression; a score ranging from 20 to 29 indicates a moderate depression; a score higher than 30 indicates a serious depression [10].

Setting of rehabilitation program

For each patient an individualized program is set up. It consists of a dietetic-behavioural treatment composed of:

- personalized balanced hypocaloric diet aimed at inducing a weight loss of 0.5–1 kg/week [11]. The diet is characterized by a caloric quantity corresponding to the basal metabolism of the patient, calculated with Schofield formulas, multiplied by the patient's level of physical activity. The average diet administered to patients is composed of five meals, of which three are main meals and two are snacks: meals are balanced in nutrients and try as much as possible to meet the food habits of the patient. The diet is composed of a protein quantity corresponding to 0.8–0.9 g pro kg of body weight, a lipid percentage of 25–30% of the total energy and a carbohydrate percentage of 55–60% of the total energy (simple sugars under 15%). Modifications and adjustments are carried out depending on the specific situation of the patient and their pathologies.
- Behavioural guidance aimed at achieving a healthy lifestyle: these indications include recommendations on the frequencies of consumption of foods, on which foods to maximize and which to reduce or to avoid, on methods of cooking and seasoning, on swaps, on how much water to drink, and on physical activity.

Revaluation

Patients are followed with regular check visits, at variable intervals depending on the specific situation of each individual patient.

Statistical analysis

All statistical analyses were carried out with the program SPSS version 21.00. (IBM)

Continuous variables are expressed as the mean ± standard error (SE). A p-value < 0.05 was considered statistically significant.

Descriptive and categorical variables were described with counts and percentages: quantitative with mean and standard deviation (sd), if normally distributed, or median and interquartile range (IQR).

The dropout rate at 6 and 12 months was also assessed with percentage on total sample.

For the prediction of dropout at 6 and 12 months, we conducted univariate linear regression modeling to evaluate the association of predictors (anthropometric, blood chemistry) from T0 visit to last follow-up visit in patients who dropout vs. non-dropout. The predictor was taken to be weight change expressed as change in BMI z score from T0 visit to last follow-up visit.

Predictor variables included demographics (age, sex) and anthropometrics (BMI, normalized waist, and hip circumferences). The number of follow-up visits and time from baseline to last visit were also considered as possible predictors.

Each predictor was first considered by itself in a univariate linear regression model. Predictors found to be significantly associated at p-value < 0.05)

Odds ratios (OR) and 95% confidence intervals were reported (95% CI), together with p-values, which were considered significant if below 0.05 to evaluate dropout risk in patients with previous diet attempts, physical activity, etc.

Results

As shown in Table 1, the sample is composed by 912 subjects, of which 682 were women and 231 were men, with an

average age of 50.88 years (±15.80), mean age of 51.54 years (±15.72) for women, and 48.93 years (±15.92) for men.

The average of the BMI was 33.11 kg/m^2 (±5.65), with an average BMI of 32.98 kg/m^2 (±5.61) for women and an average BMI of 33.53 kg/m^2 (±5.74) for men, and an average waist circumference of 107.32 cm (±13.10) with values of 105.15 cm (±12.89) for women and 113.75 cm (±11.50) for men. From these data, the average of the sample is affected by grade I obesity (Table 2).

Of the 912 subjects studied, 473 (51.9%) of whom 354 women and 119 men, abandoned the therapy within 6 months of their first visit. Among women, 52% of the total sample abandoned treatment within 6 months while among men the dropout level at 6 months was 51.3%. Analyzing the dropout level within 12 months, it appears that 69.5% of the subjects abandoned the therapy: among women, the percentage reaches 70.6% while among men it reached 66.8% (Table 1).

The average weight loss obtained by these subjects at 3 months from their first visit is −3.08 kg (±2.91), of −3.98 kg (±3.07) for men and of −2.70 kg (±2.77) for women. The decrease in BMI at 3 months was −1.16 kg/m^2 (±1.09) for the totality of the subjects, −1.33 kg/m^2 (±1.01) for men and −1.08 kg/m^2 (±1.12) for women (Table 2).

The average of weight loss obtained at 6 months from their first visit is −5.06 kg (±4.85), in particular −5.81 kg (±6.12) in men and −4.89 kg (4.52) in women, corresponding to a BMI decrease of −1.99 kg/m^2 (±1.86) for the total sample, of −1.98 kg/m^2 (±2.02) for men and −1.99 kg/m^2 (±1.84) for women.

On the other hand, the weight loss obtained at 12 months from their first visit is −7.05 kg (±5.46) for the totality of the subjects, of −8.81 kg (±6.51) for men and −6.22 kg (±4.77) for women, corresponding to a BMI decrease of −2.67 kg/m^2 (±1.97) for the total sample, of −3.00 kg/m^2 (±2, 13) for men and −2.51 kg/m^2 (±1.90) for women (Table 2).

All biochemical characteristics are shown in Table 3.

Tables 4 and 5 show the predictors of dropout.

Analyzing weight loss and BMI at 3 months from the beginning of the diet, it appears that subjects who dropout within 6 months lose 1.28 kg less than those who continue treatment ($p < 0.05$), losing 0.49 kg/m^2 of BMI less than those who remain adherent to the therapy ($p < 0.05$).

Also for subjects who discontinue treatment within 12 months, data related to weight loss and BMI are significant: these subjects have a weight loss of 1.08 kg lower than those who do not abandon ($p < 0.05$) and a BMI loss of 0.41 kg/m^2 lower than the group that continues the therapy ($p < 0.05$).

By examining 6-month weight loss and BMI decrease for patients who abandon the therapy 1 year after their first visit,

Table 1 Dropout rate at 6 and 12 month divided for gender

	To 6 months	To 12 months
Women		
100% (682)	52% (354)	70.6% (481)
Men		
100% (231)	51.3% (119)	66.8% (152)
Total		
100% (912)	51.9% (473)	69.5% (634)

Table 2 characteristics of the sample as regards anthoropometric measures

Variable	Men	Women	Total
Age	48.93 ± 15.92	51.54 ± 15.72	50.88 ± 15.80
Height (h)	1.72 ± 0.08	1.57 ± 0.06	1.61 ± 0.09
Weight (kg)	99.28 ± 19.93	81.9 ± 14.52	86.27 ± 17.74
BMI (kg/m^2)	33.53 ± 5.74	32.98 ± 5.61	33.11 ± 5.65
Δ weight 3 months (kg)	−3.98 ± 3.07	−2.70 ± 2.77	−3.08 ± 2.91
Δ weight 6 months (kg)	−5.81 ± 6.12	−4.89 ± 4.52	−5.06 ± 4.85
Δ weight 12 months (kg)	−8.81 ± 6.51	−6.22 ± 4.77	−7.05 ± 5.46
Δ BMI 3 months (kg/m^2)	−1.33 ± 1.01	−1.08 ± 1.12	−1.16 ± 1.09
Δ BMI 6 months (kg/m^2)	−1.98 ± 2.02	−1.99 ± 1.84	−1.99 ± 1.86
Δ BMI 12 months (kg/m^2)	−3.00 ± 2.13	−2.51 ± 1.90	−2.67 ± 1.97
Wrist circumference (cm)	18.96 ± 2.15	16.86 ± 1.33	17.38 ± 1.82
Arm circumference (cm)	35.37 ± 3.64	33.92 ± 3.96	34.28 ± 3.93
Calf circumference (cm)	40.24 ± 3.88	38.83 ± 3.80	39.19 ± 3.87
Waist circumference (cm)	113.75 ± 11.50	105.15 ± 12.89	107.32 ± 13.10
Hip circumference (cm)	110.44 ± 10.25	113.39 ± 10.71	112.66 ± 10.67
WHR	1.02 ± 0.06	0.92 ± 0.07	0.95 ± 0.09

Table 3 Descriptive characteristics of Biochemical values

Variable	Men (mean; sd)	Women (mean; sd)	Total (mean; sd)
WBC (K/μL)	7.34 ± 1.91	7.01 ± 1.67	7.10 ± 1.74
RBC (M/μL)	5.13 ± 0.87	4.57 ± 0.43	4.71 ± 0.62
HGB (g/dl) (12–16)	14.78 ± 1.42	15.77 ± 6.26	15.52 ± 3.84
HCT (%) (36.0–46.0%)	43.81 ± 4.52	40.34 ± 12.27	41.20 ± 10.96
MCV (fl)	86.91 ± 6.89	87.61 ± 6.61	87.48 ± 6.67
PLT (*n*)	235.78 ± 68.00	261.83 ± 65.97	255.37 ± 67.38
LINF TOT (*n*)	2.47 ± 0.72	2.37 ± 0.86	2.39 ± 0.84
Total protein (*n*)	7.73 ± 6.20	7.08 ± 0.46	7.25 ± 3.16
Albumin g(gr/dl) (4.02–4.76)	4.28 ± 0.34	4.13 ± 0.35	4.16 ± 0.35
Albumin %	60.07 ± 3.96	58.16 ± 3.84	58.62 ± 3.95
COL TOT (mg/dl) (<200)	200.08 ± 41.60	211.07 ± 43.82	208.10 ± 43.47
COL HDL(mg/dl)	45.37 ± 11.31	56.83 ± 13.59	53.87 ± 14.01
TRG (mmol/l) (<200)	150.81 ± 88.80	122.22 ± 73.45	129.70 ± 78.77
COL LDL(mg/dl) (<200)	122.44 ± 35.33	131.68 ± 39.61	129.29 ± 38.73
Sideremia (mcg/dl)	100.92 ± 31.04	83.10 ± 30.97	86.49 ± 31.72
TIBC	175.00 ± 90.34	391.56 ± 43.76	369.90 ± 79.95
Glycemia (mg/dl) (70–110)	106.13 ± 32.26	95.47 ± 17.39	100.8 ± 24.83
HOMA	4.45 ± 3.13	2.87 ± 2.06	3.66 ± 2.60
Hb glycosylate (%) (4–6)	7.64 ± 1.19	6.34 ± 1.23	6.99 ± 1.21
VES	10.62 ± 11.49	22.80 ± 16.64	16.71 ± 14.10
BIL TOT (mg/dl) (0.2–1.1)	2.25 ± 0.64	0.57 ± 0.27	1.41 ± 0.46
AST (U/r)	24.70 ± 11.07	19.46 ± 8.35	22.08 ± 9.71
Uric acid (mg/dl) (2.6–6.0)	6.12 ± 1.40	4.57 ± 1.31	5.35 ± 1.36
Azotemia (mg/dl) (15–50)	38.36 ± 14.87	34.67 ± 11.50	36.51 ± 13.19
Creatinine (mg/dl)	0.98 ± 0.25	0.77 ± 1.17	0.88 ± 0.71
K (mmol/l) (3.6–5.5)	4.34 ± 0.47	4.35 ± 0.40	4.35 ± 0.44
Na (mmol/l) (136–145)	140.50 ± 2.35	140.04 ± 2.29	140.27 ± 2.32
Cl (mmol/l) (98–112)	105.14 ± 5.77	104.02 ± 2.89	104.58 ± 4.33
Ca (mmol/l) (8.4–10.2)	8.72 ± 2.12	9.22 ± 1.09	8.97 ± 1.61
Phosphates (DU)	5.34 ± 0.61	3.33 ± 0.48	4.34 ± 0.55
Folic acid	8.38 ± 6.98	6.93 ± 3.14	7.66 ± 5.06
Homocysteine (mol/l)	16.35 ± 8.24	12.43 ± 8.78	14.39 ± 8.51

Table 4 Predictors of dropout at 6 months

Variable	B and CI 95% (dropout vs. not-dropout)	*p*-value
Δ weight 3 months (kg)	1.28 (0.34; 2.21)	***p* < 0.05**
ΔBMI 3 months (kg/m^2)	0.49 (0.13; 0.85)	***p* < 0.05**
Waist circumference (cm)	0.51 (−1.4; 2.43)	0.6/NS
BMI (kg/m^2)	−0.06 (−0.8; 0.67)	0.86/NS
WHR	0.002 (−0.008; 0.01)	0.74/NS
N drugs	0.11 (0.09; 0.13)	0.58/NS
BQ	−0.37 (−0.42; −0.31)	0.67/NS
BES	203.54 (193.43; 212.32)	0.32/NS

[a]Adjusted by sex and age

Bold values indicate p < 0.05

the data are not statistically significant but suggestive: the weight loss is 1.86 kg lower than the adherent group ($p = 0.07$) while BMI loss is 0.71 kg/m^2 lower ($p = 0.06$). Weight loss and BMI at 12 months are neither significant nor suggestive ($p = 0.33$ and $p = 0.27$, respectively) (Tables 4 and 5).

By considering hematochemical values, those who leave therapy within 6 months have white blood cells of 0.45 million/l higher than those who do not abandon ($p = 0.001$). There are also suggestive data, though not statistically significant, regarding AST values (1.33 UI/l lower in dropout subjects), and those of FT4, 1.17 ng/dl higher in the dropouts ($p = 0.07$ $p = 0.051$, respectively) (Table 6).

On the other hand, those who leave within 12 months have similar data on white blood cells, with values of 0.32 million/l higher than the dropouts ($p < 0.05$), as well as for lymphocytes whose values, in the dropouts, are 0.18 g/dl higher compared to the non-dropouts ($p < 0.05$). Significant data also emerge in the case of sideremia: dropouts have blood iron values of 7.45 mcg/dl lower than the non-dropouts ($p < 0.05$).

AST and FT4 values are also significant. Dropouts have AST values of 1.64 UI/l lower and FT4 values of 1.53 ng/dl higher than non-dropouts ($p < 0.05$ in both cases). However, data on total cholesterol and creatinine appear to be statistically significant, with dropout subjects having cholesterol

Table 5 Predictors of dropout at 12 months

Variable	B and CI 95% (dropout vs. not-dropout)	*P*-value
Δ weight 3 months (kg)	1.08 (0.19; 1.96)	**$p < 0.05$**
Δ weight 6 months (kg)	1.86 (−0.12; 3.76)	0.07/NS
Δ weight 12 months (kg)	5.61 (−5.79; 17.00)	0.33/NS
Δ BMI 3 months (kg/m^2)	0.41 (0.07; 0.74)	**$p < 0.05$**
ΔBMI 6 months (kg/m^2)	0.71 (−0.04; 1.46)	0.06/NS
Δ BMI 12 months (kg/m^2)	2.31 (−2.00; 6.51)	0.27/NS
Waist circumference (cm)	0.01 (−2.06; 2.08)	0.99/NS
BMI (kg/m^2)	0.06 (−0.86; 0.74)	0.90/NS
N drugs	−0.01 (−0.02; 0.02)	0.97/NS
BQ	0.34 (0.22; 0.42)	0.70/NS
BES	126.42 (122.43; 144.42)	0.55/NS

[a]Adjusted by sex and age

Bold values indicate p < 0.05

values of 6.35 mg/dl lower than non-dropouts ($p = 0.06$) and values of creatinine of 0.03 mg/dl higher ($p = 0.09$) (Tables 7 and 8).

Taking into account the physical activity data, its introduction is significant, both for early and late dropout. Those who introduce physical activity are more likely to continue the diet than those who do not introduce it. Practicing it before the beginning of the therapy or not practicing it at all do not seem to have an influence on the dropout level (Tables 9–12).

Another suggestive fact would appear to be marital status, in relation to a 6-month dropout: categorizing the sample into three different groups (married subjects, singles, subjects who still live in family) it emerges from a score analysis from 0 to 1 that the category most likely to dropout is the one of patients still living in family, while married women appear to be the least likely to dropout ($p = 0.064$) (Tables 13–15).

Regarding a participant's profession, the category most likely to dropout within the year is intellectual job, followed in descending order by the unemployed, by housewives, by manual laborers and by retirees ($p < 0.05$). Also, through a pair analysis, the patients have dropped dietary less than those with intellectual and manual job, with a statistically significant score of 0–1 ($p < 0.05$). Analyzing the same data in relation to the dropout at 6 months, no statistical significance emerges (Table 16).

From the analysis of pathologies it emerges that for women, having a tumor or the presence of endocrine, metabolic or nutritional illness or psychological and behavioral disorders lead to a significant drop in the dropout level within 6 months and within 1 year from the beginning of the dietary therapy ($p < 0.001$ for tumors and for psychic and behavioral disorders, $p < 0.05$ for endocrine, metabolic, and nutritional diseases). On the other hand, considering

Table 6 Blood chemistry Predictors of dropout at 6 months

Variable	B and CI 95% (dropout vs. not-dropout)	*p*-value
WBC (K/μL)	0.45 (0.19; 0.70)	**0.001**
RBC (M/μL)	−0.01 (−0.09; 0.08)	0.85/NS
HCT (%) (36.0–46.0%)	0.50 (−1.13; 2.13)	0.55/NS
MCV (fl)	−0.26 (−1.41; 0.90)	0.66/NS
PLT	8.75 (−1.12; 18.62)	0.08/NS
Total lymphocytes (1.5–3.5 × 10^9/L)	0.10 (−0.07; 0.27)	0.24/NS
Lymphocytes %	−19.49 (−59.44; 20.47)	0.34/NS
Total protein (*n*)	0.29 (−0.33; 0.90)	0.36/NS
Alb g (gr/dl) (4.02–4.76)	−0.06 (−0.13; 0.02)	0.13/NS
Alb %	−0.47 (−1.25; 0.30)	0.23/NS
Col tot (mg/dl) (<200)	−4.4 (−10.77; 1.97)	0.18/NS
HDL (mg/dl)	0.05 (−1.95; 2.06)	0.96/NS
TRG (mmol/l) (<200)	−2.80 (14.71; 9.10)	0.64/NS
LDL (mg/dl) (<200)	−1.88 (−8.27; 4.51)	0.56/NS
Sideraemia (mcg/dl)	−2.50 (−9.44; 4.43)	0.48/NS
Transferrin (mg/h)	−21.94 (−60.21; 16.34)	0.25/NS
Ferritin (mcg/l)	2.88 (−30.54; 36.29)	0.87/NS
TBC	−19.86 (−101.02; 61.31)	0.57/NS
GLIC (mg/dl) (70–110)	2.05 (−1.12; 5.23)	0.21/NS
Insulin	−0.79 (−6.19; 4.62)	0.77/NS
HOMA	0.19 (−0.60; 0.97)	0.64/NS
Hb GLIC (%) (4–6)	−0.75 (−2.07; 0.58)	0.27/NS
VES	0.45 (−3.77; 4.67)	0.83/NS
Bil tot (mg/dl) (0.2–1.1)	0.54 (−0.84; 1.92)	0.44/NS
AST (U/R)	−1.33 (−2.76; 0.09)	0.07/NS
ALT (U/R)	−0.85 (−5.32; 3.63)	0.71/NS
gGT (U/l)	−0.51 (−6.78: 5.76)	0.87/NS
Uric acid (mg/dl) (2.6–6.0)	−0.004 (−0.25; 0.24)	0.97/NS
Azotemia (mg/dl) (15–50)	−0.22 (−2.24; 1.80)	0.83/NS
Creatinine (mg/dl)	0.01 (−0.02; 0.04)	0.37/NS
K (mmol/l) (3.6–5.5)	0.004 (−0.08; 0.09)	0.93/NS
Na (mmol/l) (136–145)	−0.18 (−0.68; 0.33)	0.50/NS
Cl (mmol/l) (98–112)	−0.47 (−1.44; 0.50)	0.34/NS
Ca (mmol/l) (8.4–10.2)	0.12 (−0.20; 0.45)	0.46/NS
Phosphates (DU)	−1.63 (−5.12; 1.87)	0.35/NS
B12	24.34 (−216.45; 265.14)	0.82/NS
Folic acid	−0.80 (−6.41; 4.82)	0.76/NS
Homocysteine (mol/l)	0.85 (−1.75; 3.45)	0.52/NS
FT3 (pg/lm)	0.10 (−0.09; 0.28)	0.32/NS
FT4 (ng/dl)	1.17 (0.006; 2.34)	0.051/NS

Bold values indicate p < 0.05

nervous system disorders, for women, the presence of this kind of pathology would lead to an increase in the abandonment of therapy ($p < 0.001$ by analyzing the data within 6 months of $p < 0.05$ by analyzing the data within 12 months). Thyroid diseases and hypercholesterolemia

Table 7 Blood chemistry predictors of dropout at 12 months

Variable	B and CI 95% (dropout vs. not-dropout)	*P*-value
WBC (K/μL)	0.32 (0.05; 0.60)	***p* < 0.05**
RBC (M/μL)	−0.01 (−0.10; 0.08)	0.80/NS
HCT (%) (36.0–46.0%)	−0.03 (−1.77; 1.71)	0.98/NS
MCV (fl)	−0.32 (−1.53; 0.90)	0.61/NS
PLT	0.87 (−9.71; 11.44)	0.87/NS
Total lymphocytes ($1.5–3.5 \times 10^9$/l)	0.18 (0.003; 0.35)	***p* < 0.05**
Lymphocytes %	15.82 (−26.21; 57.85)	0.46/NS
Total protein (*n*)	0.24 (−0.42; 0.90)	0.48/NS
Alb g (gr/dl) (4.02–4.76)	0.05 (−0.12; 0.03)	0.26/NS
Alb %	−0.36 (−1.18; 0.46)	0.39/NS
Col tot (mg/dl) (<200)	−6.35 (−13.07; 0.38)	0.06/NS
HDL (mg/dl)	−0.72 (−2.83; 1.40)	0.51/NS
TRG (mmol/l) (<200)	−2.42 (−14.95; 10.10)	0.70/NS
LDL (mg/dl) (<200)	−4.63 (−11.31; 2.05)	0.17/NS
Sideraemia (mcg/dl)	−7.45 (−14.82; −0.08)	***p* < 0.05**
Transferrin (mg/h)	−12.30 (−58.76; 34.16)	0.59/NS
Ferritin (mcg/l)	−8.23 (−44.19; 27.72)	0.65/NS
TBC	58.91 (−84.66; 202.48)	0.35/NS
GLIC (mg/dl) (70–110)	2.51 (−0.84; 5.86)	0.14/NS
Insulin	−3.17 (−9.05; 2.71)	0.29/NS
HOMA	−0.28 (−1.10; 0.54)	0.50/NS
Hb GLIC (%) (4–6)	−1.26 (−2.68; 0.17)	0.09/NS
VES	−0.50 (−4.97; 3.98)	0.83/NS
Bil tot (mg/dL) (0.2–1.1)	0.37 (−1.12; 1.86)	0.63/NS
AST (U/R)	−1.64 (−3.13; −0.14)	***p* < 0.05**
ALT (U/R)	−1.72 (−6.43; 2.98)	0.47/NS
gGT (U/l)	0.30 (−6.39; 7.00)	0.93/NS
Uric acid (mg/dl) (2.6–6.0)	−0.10 (−0.35; 0.16)	0.45/NS
Azotemia (mg/dl) (15–50)	0.26 (−1.90; 2.42)	0.82/NS
Creatinine (mg/dl)	0.03 (−0.01; 0.06)	0.09/NS
K (mmol/l) (3.6–5.5)	0.02 (−0.07; 0.12)	0.62/NS
Na (mmol/l) (136–145)	−0.10 (−0.64; 0.44)	0.72/NS
Cl (mmol/l) (98–112)	−0.40 (−1.44; 0.64)	0.45/NS
Ca (mmol/l) (8.4–10.2)	0.18 (−0.17; 0.52)	0.32/NS
Phosphates (DU)	−1.82 (−5.26; 1.63)	0.29/NS
B12	110.28 (−135.41; 355.97)	0.32/NS
Folic acid	−2.05 (−8.06; 3.97)	0.47/NS
Homocysteine (mol/L)	1.82 (−0.94; 4.58)	0.20/NS
FT3 (pg/lm)	0.03 (−0.17; 0.23)	0.78/NS
FT4 (ng/dl)	1.53 (0.29; 2.76)	***p* < 0.05**

Bold values indicate p < 0.05

Table 9 Risk of dropout divided for physical activity at 6 months

	Dropout	Non dropout	*p*-value
No physical activity	59%	50.9%	NS
Introduced physical activity	23.7%	7.7%	***p* < 0.05**
Yes physical activity	25.4%	33.3%	NS

Bold values indicate p < 0.05

Table 10 Risk of dropout divided for physical activity at 12 months

	Dropout	Non dropout	*p*-value
No physical activity	58.3%	46.8%	NS
Introduced physical activity	12%	24.9%	***p* < 0.05**
Physical activity	29.7%	28.3%	NS

Bold values indicate p < 0.05

Table 11 Risk of dropout divided for "smoke" at 6 months

	Score from 0 to 1 (from not dropout to dropout)	*p*-value
No smoker	0.52 (0.47; 0.56)	NS
Ex smoker	0.50 (0.43; 0.57)	
Smoker	0.54 (0.46; 0.61)	

Table 12 Risk of dropout divided for "smoke" at 12 months

	Score da 0 a 1 (from not dropout to dropout)	*p*-value
No smoker	0.70 (0.66; 0.74)	NS
Ex smoker	0.66 (0.60; 0.63)	
Smoker	0.71 (0.64; 0.78)	

Table 13 Risk of dropout divided for "Marital status" at 6 months

	Score from 0 to 1 (from not dropout to dropout)	*p*-value
Married	0.44 (0.39; 0.49)	NS
Single	0.48 (0.41; 0.55)	
In family	0.62 (0.48; 0.77)	

Table 14 Risk of dropout divided for "Marital status" at 12 months

	From 0 to 1 (from not dropout to dropout)	*p*-value
Married	0.62 (0.57; 0.66)	NS
Single	0.69 (0.62; 0.76)	
In family	0.70 (0.56; 0.84)	

Table 8 Dropout risk ratio in patients with a previous history of diet interventions

Variable	Risk T6	*p*-value T6	Risk T12	*p*-value T12
Pregress diet (women)	0.93	0.75/NS	0.97	0.92/NS
Pregress diet (men)	1.18	0.68/NS	1.43	0.37/NS

Table 15 Risk of dropout divided for "Profession" at 6 months

	From 0 to 1 (from not dropout to dropout)	*p*-value
Intellectual	0.52 (0.44; 0.59)	NS
Manual job	0.56 (0.49; 0.64)	
Housewife	0.51 (0.38; 0.64)	
Retired	0.47 (0.39; 0.55)	
Unemployed	0.48 (0.35; 0.61)	

Table 16 Risk of dropout divided for "Profession" at 12 months

	From 0 to 1 (from not dropout to dropout)	*p*-value
Intellectual	0.76 (0.69; 0.83)	$p < 0.05$
Manual job	0.70 (0.64; 0.77)	
Housewife	0.71 (0.59; 0.83)	
Retired	0.58 (0.51; 0.63)	
Unemployed	0.72 (0.60; 0.84)	

[a]Pair analysis shows that: the retired relative to intellectual and manual work has a statistically significant score of 0 to 1 (p-value < 0.05)

also appear to be protective factors in women for early dropout ($p = 0.001$ and $p < 0.05$, respectively). Significance at 12 months is repeated for thyroid diseases ($p < 0.05$) but not for hypercholesterolemia. All other pathologies do not seem to have any influence on the dropout level.

The same analysis, for men, display different results: having a tumor or the presence of endocrine, metabolic or nutritional diseases or psychological and behavioral disorders would lead to an increase in dropout within 6 months ($p < 0.05$). However, these data are not statistically significant if analyzed within 12 months from the first visit. Also, from the analysis of nervous system diseases, data are similar, in agreement with those found in women: the presence of this kind of pathology would in fact lead to an increase in the abandonment of the treatment. Unlike women, however, these data are not statistically significant but suggestive ($p = 0.06$ by analyzing the data within 6 months and $p = 0.07$ by analyzing the data within 12 months). Even looking at the data on metabolic syndrome in men, there are some suggestive results, although not statistically significant: it appears that the presence of this syndrome would lead to a greater dropout within 12 months ($p = 0.08$) (Tables 17–20).

Discussion

This is the study with the largest number of obese patients (913 subjects) currently published in the literature that evaluates dropouts from dietary program. Moreover, this study analyzes, by a structural equation model that allowed to have a significant overview of many variables, the largest possible numbers of factors which can cause or predict a premature abandonment of dietary therapy. The main data taken into consideration concern age, sex, weight, and BMI measured before the start of the dietary treatment and their variation in the first few months. Other data analyzed are the waist circumference, the number of drugs taken, hemato-chemical values changes, the pathologies of the patient, previous attempts to follow a diet, habits like smoking or physical activity, marital status, occupation, and score of psychological tests BQ and BES.

Table 17 Risk of dropout divided for "Diseases in women" at 6 months

		Dropout	Not dropout	*p*-value
Metabolic syndrome	Yes	32.4%	30.8%	0.55/NS
	No	67.6%	69.2%	
Cancer	Yes	2.9%	7.9%	**$p < 0.001$**
	No	51.4%	61.3%	
Endocrine/metabolic/ nutritional diseases	Yes	4.7%	10.1%	**$p < 0.05$**
	No	95.3%	89.9%	
Diabetes	Yes	6.2%	6.2%	0.64/NS
	No	93.8%	93.8%	
Thyroid diseases	Yes	11.5%	23.8%	**0.001**
	No	88.5%	76.2%	
Hypercholesterolemia	Yes	15.2%	24.7%	**<0.05**
	No	84.8%	75.3%	
Psychic and behavioral disorders	Yes	4.8%	8.8%	**<0.001**
	No	48.9%	60.1%	
Nervous system disorders	Yes	3.4%	2.7%	**<0.001**
	No	50.3%	66.2%	
Vascular dementia	Yes	1%	0.4%	0.47/NS
	No	99%	99.6%	
Circulatory system diseases	Yes	46.9%	46.7%	0.97/NS
	No	53.1%	53.3%	
Respiratory system diseases	Yes	6.8%	7.5%	0.78/NS
	No	93.2%	92.5%	
Digestive diseases	Yes	23.4%	18.9%	0.26/NS
	No	76.6%	81.1%	
Diseases of the osteomuscolar system	Yes	34.2%	39.2%	0.28/NS
	No	65.8%	60.8%	

Bold values indicate $p < 0.001$

Percentage of dropout

The percentage of dropout resulting from the statistical analysis corresponds to a 51.9% at 6 months and to a 69.5% at 1 year from the first visit, in agreement with the data of the study of Grossi et al. [12], according to which the dropout percentage emerging from the scientific literature is generally between 10% and 80% (depending on the type of the study and the time after which this data is measured).

Table 18 Risk of dropout divided for "Diseases in men" at 6 months

		Dropout	Not dropout	*p*-value
Metabolic syndrome	Yes	50%	45.3%	0.55/NS
	No	50%	54.7%	
Cancer	Yes	3.4%	2.7%	***p* < 0.05**
	No	45.8%	62.5%	
Endocrine/metabolic/ nutritional diseases	Yes	13.8%	4.1%	***p* < 0.05**
	No	86.2%	95.9%	
Diabete	Yes	10.3%	6.8%	0.47/NS
	No	89.7%	93.2%	
Thyroid diseases	Yes	5.2%	2.7%	0.47/NS
	No	94.8%	97.3%	
Hypercholesterolemia	Yes	12.1%	16.4%	0.48/NS
	No	87.9%	83.6%	
Psychic and behavioral disorders	Yes	5.1%	2.7%	***p* < 0.05**
	No	44.1%	62.5%	
Nervous system disorders	Yes	1.7%	0.9%	0.06/NS
	No	47,5%	63.4%	
Vascular dementia	Yes	1.7%	0%	0.26/NS
	No	98.3%	100%	
Circulatory system diseases	Yes	44.8%	43.8%	0.91/NS
	No	55.2%	56.2%	
Respiratory system diseases	Yes	8.6%	5.5%	0.48/NS
	No	91.4%	94.5%	
Digestive diseases	Yes	12.1%	13.7%	0.78/NS
	No	87.9%	86.3%	
Diseases of the osteomuscolar system	Yes	15.5%	12.3%	0.60/NS
	No	84.5%	87.7%	

Bold values indicate p < 0.001

Table 19 Risk of dropout divided for "Diseases in women" at 12 months

		Dropout	Not dropout	*p*-value
Metabolic syndrome	Yes	30%	34.5%	0.47/NS
	No	70%	65.5%	
Cancer	Yes	2.9%	10.0%	***p* < 0.001**
	No	54.1%	61%	
Endocrine/metabolic/ nutritional diseases	Yes	5.8%	11.3%	***p* < 0.05**
	No	94.2%	88.7%	
Diabetes	Yes	6.5%	5.6%	0.31/NS
	No	93.5%	94.4%	
Thyroid diseases	Yes	14.1%	26.1%	***p* < 0.05**
	No	85.9%	73.9%	
Hypercholesterolemia	Yes	18.5%	23.9%	0.19/NS
	No	81.5%	76.1%	
Psychic and behavioral disorders	Yes	4.8%	11.5%	***p* < 0.001**
	No	52.3%	59%	
Nervous system disorders	Yes	3.1%	3%	***p* < 0.05**
	No	53.9%	67.5%	
Vascular dementia	Yes	0.7%	0.7%	0.98/NS
	No	99.3%	99.3%	
Circulatory system diseases	Yes	45.1%	50%	0.34/NS
	No	54.9%	50%	
Respiratory system diseases	Yes	6.9%	7.7%	0.74/NS
	No	93.1%	92.3%	
Digestive diseases	Yes	22.7%	17.6%	0.22/NS
	No	77.3%	82.4%	
Diseases of the osteomuscular system	Yes	36.7%	37.3%	0.14/NS
	No	63.3%	62.7%	

Bold values indicate p < 0.001

This means that after 6 months from the first visit, approximately one patient out of two failed to come to the check visits and that after 1 year, more than two patients out of three have abandoned the therapy. Taking into consideration the data about the 6 months, our results are lower than the study of Colombo et al. [13] (57%), but significantly higher compared to the study of De Panfilis et al. [14] (32.6%). Considering the data of 1 year, instead, the dropout rate of this study appears to be higher than the study of Elfhag et al. [15] (63%) and of Grossi et al. [12] (62%), but lower than the study of Inelmen [16] (77.3%) and of Busetto et al. [17], in which we can observe a percentage of 77% among the adult population and of 72% among the elderly. Taking into consideration other studies, the comparison is not always easy, because they analyze the data in different moments compared to the ones considered here: the dropout rate is in fact included between 24% and 31% in the studies where it is examined only after 16 weeks from the beginning of the therapy [18–20], whereas other studies considered the data at a greater distance in time: the study of [21] examined dropout at 2 years, observing a quite low result (53%), while the study of [22] obtained a 84.7% at 3 years.

Taking gender into consideration, women record a higher dropout, both early and later in time, in agreement with many other studies [8, 9, 23–26], data explained by the fact that women, having major difficulty in losing weight, could be discouraged earlier than men.

Age and occupation

Among the different factors analyzed, age remains one of the most significant data: in agreement with many other works in the scientific literature, the older the patients are the more they seem to remain adherent to the therapy. There are different explanations for these data: both a greater sense of responsibility matured with age, and a greater concern for their own health, which may have declined compared to their youth [8–10, 13–20, 22–25, 27–29]. Only a few studies have found a higher dropout rate associated to

Table 20 Risk of dropout divided for "Diseases in men" at 12 months

		Dropout	Not dropout	*p*-value
Metabolic syndrome	Yes	53%	39.1%	0.08/NS
	No	47%	60.9%	
Cancer	Yes	2.6	3.8	0.18/NS
	No	50%	61.5%	
Endocrine/metabolic/ nutritional diseases	Yes	11.2%	3.9%	0.14/NS
	No	88.8%	96.1%	
Diabetes	Yes	8.8%	7.8%	0.86/NS
	No	91.3%	92.2%	
Thyroid diseases	Yes	5%	2%	0.38/NS
	No	95%	98%	
Hypercholesterolemia	Yes	13.7%	15.7%	0.76/NS
	No	86.3%	84.3%	
Psychic and behavioral disorders	Yes	3.9	3.8	0.17/NS
	No	48.7%	61.5%	
Nervous system disorders	Yes	2.0	0.0	0.068/NS
	No	50.7%	64.1%	
Vascular dementia	Yes	1.2%	0%	0.42/NS
	No	98.8%	100%	
Circulatory system diseases	Yes	41.2%	49%	0.38/NS
	No	58.8%	51%	
Respiratory system diseases	Yes	6.2%	7.8%	0.73/NS
	No	93.8%	92.2%	
Digestive diseases	Yes	11.2%	15.7%	0.46/NS
	No	88.8%	84.3%	
Diseases of the osteomuscolar system	Yes	13.7%	13.7%	0.99/NS
	No	86.3%	86.3%	

the older patient [30, 31] while several others have not found association [12–23, 26, 27, 32–34].

A greater adherence associated with the advanced age may also be reconfirmed if we consider the data relating to the professional categories. In our study it is shown in fact that the category less inclined to dropout is that of the retired, in accordance with the study of Inelmen et al. [16]. The second category less inclined to dropout is that of those who carry out manual labor, followed by housewives, data confirmed by the study of Inelmen et al. [16]. Retired people and housewives thus would seem to be two of the categories more capable of following a diet for longer; in fact, the study of Inelmen et al. [16], together with the works of Huisman et al. [35], prove that a job outside home, especially if it is a full time job, brings a lower disposition toward the sacrifices and commitment required to follow a dietary treatment, if only because they have too little time to cook and prepare meals according to the dietary prescriptions. In all of this, coupledom seems to help: married people are more adherent compared to those who live alone (even if the association is suggestive but not significant), as emerges from the study of Busetto et al. [17], perhaps because they can count on the help of another person in the preparation of the meals. This data, however, appear to be in disagreement with other studies [17–20], where an opposite correlation was observed, while others have not found any significance [12, 13, 16, 28, 33, 35–37]. Our study has also analyzed a third category, which considers people still living within a family: these people are the most inclined to attrition if compared to those who are married and those who live alone.

Returning to the jobs categories, the more inclined to attrition seem to be those who do an intellectual work. The unemployed are situated in an intermediate position in disagreement with the study of Elfhag et al. [15], according to which the unemployment would be one of the strongest predictors of dropout at 1 year.

Weight loss

Another fundamental fact for the analysis of dropout seems to be the initial success of the therapy: the decrease in weight and BMI at 3 months from the first visit seem to be protective factors both in the early and late dropout, as easily predictable. In fact the achievement of concrete and satisfactory results after a short period of time from the beginning of the treatment motivates the patient to continue the therapy. This is in agreement with numerous other studies [4, 14, 19, 26, 28, 38, 39]. The influence of the decrease in weight and BMI at 6 months from the beginning of the therapy on late dropout is not statistically significant, but still very suggestive, in accordance with the studies of Colombo et al. [13] and Greenberg et al. [26], while the decrease in weight and BMI at 12 months does not seem to affect the level of dropout, demonstrating that the results obtained in the first period are the ones to have an influence on the motivation of the patient.

Anthropometry

Analyzing instead the initial weight of the subject, this does not seem to have a statistically significant influence on the abandonment of the treatment. Regarding this factor, in the scientific literature there are conflicting data: as in our study, there are many other cases in which a significant association has not been found [4, 14, 16, 18, 21, 29, 34, 40–44] while other works reported that a bigger initial weight would be associated with a lower level of adherence to therapy [20, 26, 45–47]. There are then other studies that report opposed data [16, 19, 45, 48].

The initial BMI has no statistical significance in our study either, but it was observed, instead, in other studies that have provided however conflicting data: according to the study of Inelmen et al. [16]. a lower BMI would seem to

be a predictor of dropout, while according to the study of Greenberg et al. [26]. a higher BMI is what encourages an early interruption of the diet.

The measurement of waist circumference was not statistically significant, too, in agreement with another study [49], while another work shows that a smaller waist circumference would be associated with a higher dropout [12, 13, 16, 21, 32, 50].

Pathologies

Taking into consideration the different categories of pathologies and evaluating their influence on early dropout, having a tumor and the presence of endocrine, nutritional, and metabolic diseases appear to be significant data. As for women these pathologies result as protective factors against dropout, in agreement with many other studies according to which the presence of diseases would lead patients to a greater concern for their own health and therefore a greater adherence to the therapy [16, 51, 52]. This particularly affects women more than men probably because after menopause, women feel more changes in their bodies and accompanying deterioration of some physical conditions, so they become more inclined to follow the treatments prescribed. These data are repeated considering the late dropout.

Regarding the psychological health, still in relation to women, our study has found no significant association with the scores obtained by the BDI test, while it has found a correlation with the presence of mental and behavioral disorders: for women a negative correlation is observed, so the presence of these disorders would lead to a reduction in the level of dropout. This can be explained by the fact that people with this type of problem are often accompanied by a caregiver, or by the fact that even this kind of pathology, as others have already taken into consideration, would lead patients to a greater concern for their own health and consequently a greater disposition to follow the therapy, even the dietary one [16]. Also in this case the data are overlapping between early and late dropout.

But the surprises in our study is the fact that completely opposed data were found in the male sample, for whom having a tumor and the presence of endocrine, metabolic, and nutritional diseases or psychic and behavioral disorders would lead the subject to leave the diet prematurely. This result is concordant with the studies of [12, 21], according to which the presence of pathologies (in addition to obesity) would lead patients to a lower adherence in both sexes.

As for women, the presence of thyroid diseases and hypercholesterolemia seems to be a protective factor for early dropout and, in the case of thyroid disease, also for late dropout. There are no studies in literature on this specific topic.

Our study, however, did not find significance in relation to diseases of the circulatory system, in accordance with the study of Greenberg et al. [26], nor with diseases of the skeletal muscle system, as already highlighted by the study of Inelmen et al. [16], but in disagreement with the study of Busetto et al. [17] according to which the presence of this kind of pathology, in particular osteoarthritis, would increase the probability of a premature abandonment. There was no significance even considering diabetes, as happened in the studies of Honas et al. [18], Greenberg et al. [26], and Gripeteg et al. [49], while according to the study of Busetto et al. [17], diabetes would have a protective role. Also in the case of vascular dementia and diseases of the respiratory system and the digestive system no statistical significance was found.

As for the metabolic syndrome, our study has not found any significance; however the data about the late dropout and limitedly to men, seem to have a suggestive value that indicates a greater predisposition to dropout in subjects suffering from this syndrome, in agreement with the other data analyzed for the male sample according to which the presence of some pathologies, also of different nature, makes it more difficult to adhere to the diet. The men in this sample, taking into consideration more diseases, therefore appear to overlap to the sample of the study of Melin et al. [21]. in which it is the conjunction of different diseases to make patients less predisposed to the difficulties that the dietetic therapy entail.

Psychological evaluation

Considering only the category of mental and behavioral disorders, the result is confirmed by some studies [14, 20, 53] according to which the psychological disturbances and psychiatric diseases seem to be the main predictors of dropout, again in both sexes.

Specifically considering depression, the results inherent to the BDI score, as already mentioned, is not significant, neither for men nor for women, as for other studies [43, 46, 54]. On the contrary, several other studies have found significance: depression is a risk factor [28, 33, 38, 44, 47] while it is a protective factor according to the study of Inelmen et al. [16].

Another category of pathologies which proves to be significant is the one of neurological diseases which, according to the data of our study, predispose the patient to early abandonment. This result is the same in both sexes, even if in the case of men the datum is suggestive but not significant.

A further disturbance taken into consideration is the Binge Eating Disorder, analyzed through the BES questionnaire (Binge Eating Scale): from the analysis of data no significance emerges, as happened in other studies [28, 43, 55] despite

several others, as predictable, they have found a significant association with a higher dropout, since a patient with major problems of self control in regard to food has more difficulties in following the prescriptions [20, 29, 54, 56].

Previous attempts to follow a diet

By analyzing previous attempts to follow a diet, this study has found no significant association with the level of dropout, in agreement with other three studies [14, 28, 57], while the study of Yass-Reed et al. [39]. reports that a fewer number of past attempts to lose weight is associated with greater dropout. There are several other studies according to which the more attempts have been made to follow a diet, the higher the probability of dropout, as to demonstrate that the more a person has failed in the past, the more likely it is that they would fail again [4, 20, 24, 36, 38, 58, 59].

Number of drugs

Also the number of drugs taken by patients revealed no significance, as already registered in the study of Clark et al. [30], while the study of Graffagnino et al. [40] reports that the higher the number of drugs taken, the bigger the adherence to the therapy, confirming the hypothesis that the more sick a person is, the more they are willing to follow the treatments prescribed.

Biochemical examinations

In our study we also analyzed the biochemical examinations. The value of leukocytes is the only one that resulted in significance considering both early and late dropout: the higher the value, the less the patient seems to be brought to continue the therapy. Higher values of leukocytes can often indicate an infection, or may be predictive of stress and chronic fatigue, which is why there is a possibility that the patient is less disposed to follow a diet therapy [60]. In relation to the late dropout, even a higher value of total lymphocytes is correlated with greater abandonment, still explained by the fact that patients with high values of lymphocytes tend to deal with the same problems of those who have high values of leukocytes [61].

Also, the level of sideremia is significant, even if only for the late dropout: in patients who leave the treatment sideremia appears lower than in other patients. Low levels of iron in blood are frequently caused by unhealthy nutrition, something that some authors have associated with higher attrition. Low values of iron can also influence intellectual capacities, which can lead to lower energy and productivity, and to difficulty with concentration and asthenia [62–64], aspects which could have consequences on adherence to the diet.

Physical activity

From the analysis of data we observed that the only significant datum is the introduction of physical activity after the beginning of the diet. The habit of exercise before the start of the treatment, or the decision not to introduce it at all, do not record any significant differences between the dropout subjects and the non dropout subjects, as found in many studies in the literature [4, 26, 37, 65]. On the contrary, its introduction, which is an index of good will of the patient and propensity to effort and commitment, seems to be a protective factor: among these subjects, and in fact, the level of dropout appears to be significantly lower.

Only a few studies succeeded in demonstrating a correlation between the habit of physical activity before the beginning of the diet, and a lower level of dropout [18, 20, 30].

Smoke

The last data taken into consideration refer to the habit of smoking, in which it seems that the smoker is more inclined to early attrition, even if this result has no statistical significance: even the studies of [10, 16] have not found significance, while other studies have found a statistical correlation between this habit and the level of dropout, explained by the fact that smoker tend to concern less for their health [20, 30, 37].

The main strength of this study remains the extent of the sample, composed of 912 subjects. This sample is also homogeneous for what concerns the weight, because the study considered only patients who were overweight and obese BMI (mean; sd) $33.11 \pm 5.65\ kg/m^2$. There are, however, some limitations, such as the lack of regular intervals for the outpatient checks, which, over the course of years have been increasingly spaced in time, due to the increasing number of patients. This could also be one of the main causes of a rather high level of dropout: a range of 3 or 4 months between check visits, as well as the difficulty in creating an empathic relationship between therapists and patients, precisely because of the large number of them, may reduce the motivation that pushes patients to remain adherent to the prescribed program. Despite the measured dropout, as already explained, being rather high, it remains similar or even lower than the one reported by several studies in the scientific literature. In addition, the sample is very heterogeneous for what concerns the age.

Conclusions

In conclusion, this is the study with the largest number of obese patients (913 subjects) currently published in the

literature that evaluates dropouts from dietary program. Moreover, this study analyzes, by a structural equation model that allowed to have a significant overview of many variables, the largest possible numbers of factors which can cause or predict a premature abandonment of dietary therapy. In this study we observed the percentage of dropout that agrees with scientific literature, also regarding the partition of sex. It also seems that the main factors that predispose patients to continue therapy are age and the success (or failure) of the diet in the initial period, as evidenced by weight lost (or not lost) in the early months of the initiation of the therapy. Furthermore, considerable differences between men and women emerge, with the first more willing to abandon the diet in case of diseases, compared to women, who are more worried about their own health.

From the clinical point of view, it is important to consider how to prevent the dropout due to the lack of weight loss. Many choices may be: recommend very low calories ketogenic diet? start immediately with a pharmacological prescription (liraglutide or pupropione/naloxone)? These opportunities must be studied.

The problem of dropout in the context of weight loss, though discussed for several decades, remains a little explored theme in literature and it needs further study, so a more precise identification of the causes and predictors of early abandonment of dietary therapy can allow the development of more specific methods for the identification of patients most at risk. This would improve the effectiveness of the treatment and also reduce costs, providing patients with all the support they need.

Compilance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

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