




Nutritional knowledge in patients with severe obesity during a residential rehabilitation: the relationships with socio-demographic variables

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Abstract

Background This study was aimed at evaluating the enhancement of nutritional knowledge in severely obese patients participating in a residential rehabilitation program, by means of the Moynihan Questionnaire (M.Q.). It further explored the association between learning outcomes and socio-demographic variables.

Method A cohort of 2888 obese patients (mean Body Mass Index, BMI: 44 ± 7 kg/m², mean age 59 yrs.), admitted to Auxologico Piancavallo for metabolic rehabilitation was investigated. Patients underwent an educational course on nutrition and completed the M.Q. upon both admission and discharge. A subgroup of 230 patients, admitted twice, provided additional insights into the sustained impact of the intervention. The analysis utilized a linear regression model (ANCOVA) to identify determinants of score changes during the initial hospitalization and an ANOVA for repeated measurements to assess differences in score changes between the first and second hospitalizations. Multivariate techniques were employed to examine the influence of potential variables on nutritional knowledge outcomes.

Results The rehabilitation program led to a significant improvement in M.Q. at discharge, corroborating the effectiveness of the educational intervention in enhancing nutritional knowledge. While a similar improvement was observed during second admissions, the magnitude of this improvement was notably less than that recorded during initial admissions. Interestingly, score improvements were more pronounced in women, younger patients, those with higher educational levels, married individuals, and participants with higher initial scores. No significant correlation was found between BMI and learning outcomes.

Conclusion The M.Q. documented improvements in nutritional knowledge among severely obese patients undergoing educational interventions in a residential setting. Our findings emphasize the influence of socio-demographic variables on the efficacy of nutritional education, highlighting the need for tailored approaches in dietary rehabilitation programs to optimize patient outcomes.

Keywords Obesity · Nutritional knowledge · Socio-demographic aspects · Residential rehabilitation · Moynihan questionnaire

Introduction

In Europe, according to data collected by Eurostat, the prevalence of obesity ranges from 11% to 28% in the adult population of both sexes. This is in line with the global scenario,

which shows an increasing prevalence of obesity, right from the youngest segments of the population [1, 2]. In addition, obesity-related conditions such as diabetes mellitus, cardiovascular disease, obstructive sleep apnea, steatohepatitis, and cancer significantly contribute to increased mortality

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rates [3]. Furthermore, severe obesity often results in a disabling condition, imposing a significant economic burden due to both healthcare costs and reduced work productivity. Recognizing the importance of preventive measures, the Italian Ministry of Education, in 2015, mandated the integration of nutritional education into the national curriculum [4]. This initiative aims to mitigate the growing incidence of obesity among young people by promoting early food awareness and healthy eating habits. In contemporary obesity treatment paradigms, changes in dietary habits are essential. Techniques aimed at improving patients' eating behaviors emphasize empowerment through cognitive and behavioral strategies [5, 6]. Nutritional knowledge plays a fundamental role in influencing food choices, underlining the importance of educational interventions in diet management [7–9]. A thorough understanding of nutrition science is critical to promoting a healthy diet and informed food choices. In this context, the Moynihan Questionnaire (M.Q.), a tool designed to evaluate the effectiveness of nutritional education programs, is widely used. The M.Q. was validated by Moynihan et al. in 2007 on a population of elderly residents in sheltered housing [10]. The Italian adaptation of the M.Q., validated by Vico et al. in a study on a small cohort of hospitalized patients with an average BMI of 25.2 kg/m², evaluates the nutritional knowledge of adults [11]. Furthermore, the M.Q. has found application in cardiac rehabilitation, evaluating levels of nutritional education in patients with significant cardiovascular events [12]. In contrast with the availability of a vast number of questionnaires investigating eating habits and behaviors in the population, M.Q. is one of the very few instruments available in Italy to assess dietary knowledge, a very important concept inserted in the broader context of health literacy. For severe obesity, multidisciplinary hospital programs are utilized, including metabolic, nutritional, physical, psychological, and educational rehabilitation. Within these programs, nutritional re-education is essential to help patients plan their diet and manage daily meals independently. Obesity rehabilitation programs often incorporate educational modules aimed at improving patients' knowledge about nutrients, balanced meal construction, and the diet-disease link. Initial and final assessments of nutritional knowledge, facilitated by the M.Q. or equivalent tools, provide healthcare professionals with valuable feedback on rehabilitation outcomes.

Nutritional knowledge is recognized as a fundamental component of health literacy, defined as the ability of individuals to access, understand, and apply health-related information [13]. In the context of severe obesity, nutritional knowledge can be considered a prerequisite for effective lifestyle changes [14]. In the context of multidisciplinary rehabilitation, educational interventions aimed at delivering nutritional knowledge enable patients with the

cognitive tools needed to actively participate in treatment, enhance adherence to dietary recommendations, and sustain behavioural change even after discharge [15]. This study was therefore conceived within the broader framework of health literacy, in which knowledge transmission represents a fundamental element of patient empowerment.

The aim of this work was to evaluate the change in nutritional knowledge, through modifications of the M.Q. scores, during a residential rehabilitation and the possible relationships with several social, demographic and anthropometric variables (educational qualification, social status, age, gender, BMI, weight) in a large population of severely obese patients. Differences in nutritional knowledge acquired during the first and second hospitalization were also studied.

Material and method

Moynihan questionnaire

The Moynihan Questionnaire (M.Q.) is an instrument spontaneously filled in by the subjects, composed of 15 questions, characterized by a mixture of closed-ended, open-ended and multiple-choice formats; furthermore, some elements require answers in graphical forms, such as grids or pie graphs. These answers are scored using a unique criterion: a correct answer scores 0.1, while an incorrect answer yields 0.2. Open-ended or singular-choice queries are scored on a binary scale, awarding 1 point for accuracy and 2 points for inaccuracies. As a result, the cumulative score ranges from 15 to 30, outlined as a continuous quantitative metric. With this scoring methodology nutritional literacy is inversely correlated with the total score, meaning that high scores reflect lower understanding of healthy nutrition practices. The M.Q. is self-administered and has a compilation time of about 20 min.

Study design

A cohort study, including 2888 patients, hospitalized at the Istituto Auxologico Italiano Piancavallo during the period from January 2018 to January 2020, was performed. We included obese patients admitted to a rehabilitation program without other admissions in the previous two years. In our approach patients with particularly high BMI often need more than one hospitalization; the same strategy is frequently applied to patients who demonstrate a tendency to weight regain during post-discharge follow-up. Recruitment occurred within two days from hospital admission. A subgroup of patients with at least two hospitalizations during the quoted period was considered in order to analyze the differences in nutritional knowledge acquired during

the first and the second hospitalization. Subjects who were unable to read and write and/or did not understand the Italian language or had a severe cognitive deficit were excluded from the study. All patients gave their informed consent to participate in the study, that had been approved by the Ethics Committee of Istituto Auxologico Italiano. The approval code is 2019_04_16_06. Patients were administered the M.Q. (see Moynihan questionnaire paragraph) within the first week from admission to the hospital, before starting the nutritional education lessons (see Nutritional education interventions paragraph). Close to discharge, in particular at the end of the nutritional rehabilitation phase, the operators administered the M.Q. again to each individual. A trained dietitian was assigned to ensure the completeness and accuracy of responses, adhering to the established scoring guidelines, and subsequently recorded the data in a database.

Multidisciplinary interventions

Standardized diet therapy was set up by calculating baseline metabolism through the Mifflin equation, and considering a caloric deficit of about 15%. All patients were provided with a balanced, hypocaloric, low sodium Mediterranean diet, comprising three daily meals. The macronutrient distribution included 18–20% protein, 27–30% fat (with less than 8% as saturated fat), 50–55% carbohydrate (with less than 15% as simple sugars), and 30 g of fibre sourced from fresh vegetables. Micronutrient intake was aligned with Italian dietary reference values (LARN 2025). Compliance with the 4-week dietary protocol was monitored by trained personnel from the nutritional service team, through preset diagrams to be filled in at the end of each meal. The multidisciplinary rehabilitation program comprised personalized nutritional interventions, supervised physical activity, psychological support, all provided throughout the duration of the hospital stay. Under the supervision of a physical therapist, the subjects performed an average of 90 min per day of physical activity done in different ways (e.g., walking, recline cycling, and arm ergometer exercises). The goal was to improve and maintain adequate muscle tone, ameliorate joint mobility and enhance cardiorespiratory fitness. Psychological counselling was an essential component of the program, aimed at educating patients on emotional regulation, eating behaviour, and strategies to achieve better control over their food intake.

The educational component was delivered through direct and interactive sessions led by expert dietitians. These sessions were supplemented with printed educational materials, covering a broad spectrum of topics including the pathophysiology of obesity, identification of food groups, understanding the food pyramid, biological hunger signals, energy requirement calculations, and principles of

diet management. Additionally, the curriculum emphasized behavioral strategies for addressing dietary challenges and provided instruction in interpreting labels on food packaging. The educational component consisted of five sessions per week, each lasting approximately 60 min, over the 4-week hospital stay. To monitor participant attendance, the operator collected attendance records for each educational session. Compliance was assessed at 85% for all meetings, and 89% participated in 4 out of 5 meetings.

Statistical analysis

Continuous variables were reported as mean and standard deviation (SD) and categorical ones as absolute and relative frequencies. The comparison between mean M.Q. score between admission and discharge of first hospitalization was performed by means of t-test for paired data. The effect of sociodemographic and anthropometric variables on mean M.Q. score change (M.Q. score at admission – M.Q. score at discharge) was estimated by an ANCOVA model including all collected variables and the M.Q. score at admission. Standardized regression coefficients (standardized β) were reported in order to compare the impact of variables characterized by different measurement units. In this way β is reported in number of standard deviations. Similarly, we investigated the association between the increment (from admission to discharge) of nutritional knowledge and the weight at discharge. Controlling for weight at admission, gender, age, educational level, married status. Finally, an ANOVA model for repeated measures was implemented to analyze the difference between mean of M.Q. scores of first and second hospitalization. The model included the same covariates of the ANCOVA model. In order to control the inflation of type I error due to multiple testing when considering the contrasts about admission, discharge and changes between hospitalizations and about first discharge vs. second admission, the false discovery rate approach was applied [16]. All tests were two-sided and p-value less than 0.05 was considered statistically significant. The analysis was performed using Statistical Analysis Software (9.4 version SAS NY).

Results

Our study analyzed a cohort of 2888 patients with severe obesity, who were recruited during the study period and had no recent prior hospitalizations for metabolic rehabilitation. The mean length of hospital stay was 27 ± 2.5 days. Among these patients, 230 individuals experienced two hospitalizations at our Institute. The demographic and anthropometric profiles of the cohort are detailed in Table 1. On average,

Table 1 Socio-demographic, anthropometric and metabolic characteristics of the whole cohort of 2888 patients admitted to Auxologico Piancavallo in 2018–2020

Characteristics	
Age, years, <i>mean (SD)</i>	59 (14)
Gender, <i>N (%)</i>	
Male	1139 (39%)
Female	1749 (61%)
Educational level, <i>N (%)</i>	
No title/primary school	379 (13%)
Secondary school	1055 (37%)
High school or more	1454 (50%)
Marital status, <i>N (%)</i>	
Unmarried	1418 (49%)
Married	1470 (51%)
Weight, Kg, <i>mean (SD)</i>	116 (23)
BMI, Kg/m ² , <i>mean (SD)</i>	44 (7)
Waist circumference, cm, <i>mean (SD)</i>	124.41 (14.25)
Triglycerides, mg/dL, <i>mean (SD)</i>	152.57 (70.71)
HDL, mg/dL, <i>mean (SD)</i>	47.29 (17.28)
Glycemia, mg/dL, <i>mean (SD)</i>	114.47 (36.35)
Systolic Blood Pressure, mmHg, <i>mean (SD)</i>	139.74 (18.79)
Diastolic Blood Pressure, mmHg, <i>mean (SD)</i>	84.54 (17.00)

Continuous data are shown as mean and standard deviation while categorical ones as absolute and relative frequency

BMI=Body Mass Index, SD=Standard Deviation

Table 2 Change in metabolic parameters after 4 weeks of nutritional rehabilitation (2888 patients)

Difference (Discharge – Admission)	
Weight, Kg, <i>mean (SD)</i>	-5.54 (3.33)
BMI, Kg/m ² , <i>mean (SD)</i>	-2.05 (1.23)
Waist circumference, cm, <i>mean (SD)</i>	-5.09 (6.59)
Triglycerides, mg/dL, <i>mean (SD)</i>	-24.74 (54.62)
HDL, mg/dL, <i>mean (SD)</i>	-5.73 (15.60)
Glycemia, mg/dL, <i>mean (SD)</i>	-16.24 (31.07)
Systolic blood pressure, mmHg, <i>mean (SD)</i>	-15.42 (19.12)
Diastolic blood pressure, mmHg, <i>mean (SD)</i>	-7.76 (18.30)

The changes are shown as mean and standard deviation

BMI=Body Mass Index, SD=Standard Deviation

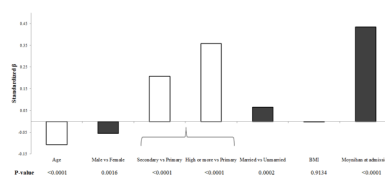
Table 3 Moynihan score at admission and at discharge of first hospitalization of the whole cohort of 2888 patients admitted to auxologico Piancavallo in 2018–2020

A	B
At admission mean (SD)	At discharge mean (SD)
23.56 (3.22)	22.33 (3.48)

The data are shown as mean and standard deviation

Test B vs. A (mean = -1.23, SD = 2.52): P-value of T-test paired < 0.0001. SD = standard deviation

patients were 59 years old, with male representation of 39%. Half of them achieved a high level of education and 51% were married. The mean weight was recorded at 116 ± 23 kg, with a mean body mass index (BMI) of 44 ± 7 kg/m². The

**Fig. 1** Standardized regression coefficients of variables on mean change of Moynihan score during first hospitalization of whole cohort of 2888 patients admitted to Auxologico Piancavallo in 2018–2020. The effect of sociodemographic and anthropometric variables on the change in mean M.Q. score was assessed using an ANCOVA model, which included all collected variables and the baseline M.Q. score at admission. Standardized regression coefficients (standardized β) were reported to facilitate comparison of the impact of variables measured in different units

subjects included in this study exhibited blood parameters compatible with the metabolic alterations typically associated with obesity (Table 1). Table 2 shows the changes in metabolic parameters after the 4 weeks of nutritional rehabilitation carried out in residential care. We observed a reduction in weight since admission and an improvement in all metabolic parameters assessed.

Table 3 shows the significant reduction in mean M.Q. score from admission to discharge observed during the first hospitalization (23.56 ± 3.22 vs. 22.33 ± 3.48 , $p < 0.0001$). This indicates an overall improvement in nutritional knowledge post-hospitalization. Figure 1 presents standardized estimates from the multivariate ANCOVA model, illustrating the linear relationships between sociodemographic and anthropometric variables and the change in mean M.Q. scores. Notably, patients older than 65 years as well as males showed a significantly lower improvement in dietary knowledge than their younger and female counterparts (p -value < 0.0001 and p -value = 0.0040, respectively). An increasing trend in education levels was positively correlated with improved nutritional understanding during hospitalization (p -trend < 0.0001). Furthermore, married individuals showed a more significant increase in nutritional knowledge than unmarried ones (p -value = 0.0010), underscoring the influence of marital status on nutritional education outcomes. The most important predictor of better dietary knowledge was M.Q. score at admission, revealing that patients with higher initial scores demonstrated greater gains in dietary knowledge at discharge. Moreover, the increment of nutrition knowledge was significantly associated with lower weight at discharge ($\beta = -0.048$, p -value = 0.0447).

As regards the subgroup of 230 patients with two hospitalizations, Table 4 reports the mean M.Q. scores and changes in both hospitalizations. During the first hospitalization a significant decline in M.Q. scores (p -value = 0.0002) suggested an initial improvement. At the second admission, the M.Q. scores were significantly higher than at first discharge

Table 4 Moynihan score and at admission and at discharge of first and second hospitalizations of a sub cohort of 230 patients admitted to auxologico Piancavallo in 2018–2020

1st hospitalization			2nd hospitalization		
At admission mean (SD)	At discharge mean (SD)	Change mean (SD)	At admission mean (SD)	At discharge mean (SD)	Change mean (SD)
23.32 (3.28)	21.89 (3.26)	1.43 (2.46)	22.35 (3.32)	21.78 (3.46)	0.57 (2.32)

The data are shown as mean and standard deviation

SD=Standard Deviation

(p -value=0.0002), indicating a slight regression in dietary knowledge. However, a significant reduction (improvement) in M.Q. scores were also detected during the second hospitalization (p -value=0.0003). In this latter the M.Q. change showed a statistically significant reduced extent compared to the change observed during the first hospitalization (p -value=0.0004), indicating a differential impact of hospitalizations on improved dietary knowledge. No significant difference was found between M.Q. scores at first and second discharge (p -value=0.8994), suggesting a stabilization of improvements in dietary knowledge between hospitalizations.

The mean weight and BMI measured at the beginning of the second hospitalization were slightly and not significantly higher than those observed at the discharge from the first hospitalization. The same held true for waist circumference. No correlation was found between the amount of these small increases and the degree of the improvement in nutritional knowledge during the first hospitalization.

Discussion

The objective of this study was to investigate dietary knowledge in a population with severe obesity using the M.Q. and its correlation with sociodemographic factors. In particular, we had the opportunity to address this issue in a setting of residential rehabilitation, which proved able to induce significant weight loss and amelioration of several metabolic parameters. Specifically, participants experienced significant reductions in systolic and diastolic blood pressure, fasting blood sugar, and triglyceride levels, all while maintaining the same medication protocol.

Our study demonstrated a significant improvement in nutritional knowledge as a result of in-hospital metabolic rehabilitation in a very large number of severely obese patients. In particular, as far as we know, this is the first study to investigate the usefulness of M.Q. in evaluating the changes in nutritional knowledge obtained after educational

courses in such a great number of patients suffering from morbid obesity.

In our study, younger age, female gender, higher level of education and marital status were linked to a better improvement in knowledge in the field of nutrition. The relationship between nutritional knowledge, age and level of education confirms what has already been described in the literature in other subjects [15, 17–19]. Regarding the younger age (≤ 65 years), our results are also in line with what was originally reported during the validation of the Italian version of M.Q. in patients different from ours [11]. The better performance obtained by subjects with a higher education qualification is widely reported in the scientific literature with a variety of questionnaires: it is known, in fact, that education allows for a better ability to interpret, acquire and report information [7, 17, 18, 20, 21]. No connection was found between the initial BMI and the performance of our patients in completing the questionnaire. As a possible interpretation, it can be hypothesized that higher BMI values may be associated with two contrasting situations, that is, on the one hand, with greater nutritional knowledge deriving from repeated dietary attempts but also, on the other, with a greater degree of prejudices and wrong ideas about food. The impact of BMI on dietary knowledge is poorly investigated in the literature, which mainly focuses on the influence of weight. Regarding this issue, while several studies have failed to find a relationship between weight and nutritional knowledge, Scalvedi et al. have recently reported an inverse correlation with BMI, however in a population completely different from ours (parents of primary school pupils) and with a questionnaire different from the M.Q. [19, 21, 22] In our opinion, in obese patients, BMI may be a more reliable indicator than weight. The improvement in knowledge was better in women than in men, probably because, in accordance with the cultural traditions of the Italian population to which our patients belonged, the former were mainly involved in the purchase and management of food for the preparation of meals [23, 24]. Previous studies have also shown that there is a difference in nutritional knowledge between the sexes, with women having a higher degree of cognition [23, 25]. The lower degree of nutritional knowledge observed in unmarried patients confirms what has been reported in previous studies, suggesting that a stable marriage can somehow reduce misconceptions about food [26, 27]. This point of view is called into question by the well-known weight gain observed following marriage and, even more so, cohabitation [28, 29]. Lastly, during the first hospitalization the patients who performed better in filling the M.Q. were those who displayed a lower weight at discharge. This is somewhat surprising, considering that all patients followed a week designed diet and could not freely choose foods. It is more conceivable that the same degree of

motivation led to both weight loss and learning in the field of nutrition. From a theoretical point of view, the different weight loss obtained by patients during the hospital stay might be due to complete or incomplete consumption of the food planned in the designed diet. Actually, the described control exerted by trained professionals aimed at encouraging the full consumption of meals reduces, in our opinion, the impact of this possible bias.

As regards patients undergoing repeated hospitalizations (a smaller but still numerically significant group), our data demonstrate that, at the beginning of the second period of residential rehabilitation, nutritional knowledge was better than that assessed at the time of the first hospitalization, and that it could improve further, although to a significantly lesser extent than what observed in the first period. Mean weight and waist circumference remained substantially stable during the period spent at home between the two hospitalizations.

From the results reported above we can conclude that during the analyzed period (2 years) the knowledge acquired during the first hospitalization was maintained. When interpreting these results, it must be considered that the content of the training courses was similar in the two periods of residential rehabilitation. Future implementation of higher-level teaching program for patients undergoing a second hospitalization will likely enhance the improvement of nutritional knowledge throughout the entire treatment period.

Our findings must also be interpreted within a broader theoretical framework. Nutrition education in residential rehabilitation does not aim to raise validated nutritional knowledge scores, but rather to endow patients with the skills needed to consciously manage their diet and health in daily life. From this perspective, the acquisition of nutritional knowledge is not a secondary endpoint, but an essential outcome of the rehabilitation process [30]. The observed influence of sociodemographic factors on knowledge gain underscores the need to tailor educational strategies to individual patient profiles. Moreover, previous evidence indicates that greater nutritional knowledge can translate into measurable modifications in eating habits and clinical markers [31]. Integrating personalized educational programs into a multidisciplinary approach is consistent with the concept of health literacy as a key determinant of long-term health outcomes, highlighting the clinical and public health relevance of structured nutrition education in obesity care.

The clinical relevance of our findings lies in the potential of nutritional education to reinforce long-term weight management and reduce relapse risk in patients with severe obesity. Improved nutritional knowledge equips patients with the ability to make more informed food choices after discharge, thereby supporting continuity of care beyond the residential setting. Importantly, the observed influence

of socio-demographic variables on knowledge acquisition suggests that educational strategies should be tailored, for example by designing age-specific and education-specific modules. In addition, for patients undergoing repeated hospitalizations, the reduced improvement observed may reflect a memory effect or diminished responsiveness to repeated content. This highlights the need to adapt and diversify educational programs over successive admissions in order to maintain engagement and effectiveness. Overall, our results support the integration of structured, personalized nutritional education into standard rehabilitation protocols for severe obesity.

This study has some limitations. One of them is certainly represented by the fact that the educational content offered during the courses conducted by dietitians is not changed. For the future, we find it important to differentiate the type of nutritional education according to the number of admissions to our facility performed by the patient. As previously said, another limitation is the possible memory effect in patients undergoing repeated hospitalizations, which may have influenced the apparent stabilization of knowledge at the second admission.

In any case, to the best of our knowledge, this is the first study to investigate the performance of M.Q. in evaluating the improvement of nutritional knowledge during a residential rehabilitation program involving such a large series of severely obese patients. Furthermore, in our opinion, a merit of this study is represented by the investigation of the influence of anthropometric, demographic and social variables on the data obtained, factors that are often not adequately considered in this kind of studies [32, 33].

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Declarations

Conflict of interest The authors declare no conflict of interest.

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