CIRUGÍA ESPAÑOLA

www.elsevier.es/cirugia

Original article

Is Body Mass Index a prognostic factor of survival in colonic cancer? A multivariate analysis☆

Miguel Juan Garcia-Oria Serrano,[a,] Manel Armengol Carrasco,[b] Aránzazu Caballero Millán,[c] Christine D. Ching,[d] Antoni Codina Cazador[e]*

[a]*Servicio de Cirugía General y Digestiva, Hospital Universitario de Getafe, Madrid, Spain*
[b]*Cátedra de Cirugía, Universitat Autònoma de Barcelona, Servicio de Cirugía General y Digestiva, Hospital Universitari Vall d'Hebron, Barcelona, Spain*
[c]*Servicio de Urgencias, Hospital Clínico Universitario Lozano Blesa, Zaragoza, Spain*
[d]*Surgical Oncology, Palo Alto Medical Foundation, California, United States*
[e]*Servicio de Cirugía General y Digestiva, Hospital Universitari de Girona Dr. Josep Trueta, Girona, Spain*

ARTICLE INFORMATION

Article history:
Received August 11, 2010
Accepted December 5, 2010

Keywords:
Colorectal neoplasia
Obesity
Body mass index
Prognostic factors
Survival

ABSTRACT

Introduction: The long-term survival of patients operated on for colonic cancer depends on many factors. Obesity decreases the life expectancy of the general population who suffer from it, but it is not clear whether obesity, measured by the Body Mass Index (BMI), is a prognostic factor of survival for patients operated on for colonic cancer.

Material and methods: The patients included in this study had TNM stage I, II y III, and were subjected to elective surgery for cancer of the colon in the Girona University Hospital between 1990 and 2001. The BMI was classified according to the WHO classification. A total of 38 different variables were studied using a bivariate analysis with BMI. A Cox model was subsequently constructed with the most clinically relevant parameters, and with those most strongly associated with survival in the bivariate analysis.

Results: BMI was not associated with survival in the bivariate analysis. Neither did the multivariate analysis show that BMI was an independent prognostic factor of long-term survival in cancer of the colon without metastasis, but it did show that the TNM stage, ASA score, surgical technique, age at surgery, and the immune cell response were prognostic factors.

Conclusions: The body mass index is not a prognostic factor of the long-term survival of patients with colonic cancer.

☆This study is prepared with data from the first author's doctoral thesis, read on 11 June 2009 and carried out in the Universitat Autònoma de Barcelona (Autonomous University of Barcelona).

*Corresponding author.
E-mail address: miguel.garcia.oria@gmail.com (M.J. Garcia-Oria Serrano).

0009-739X/$ - see front matter

¿Es el índice de masa corporal un factor pronóstico de supervivencia en el cáncer de colon? Análisis multivariable

Palabras clave:
Neoplasia colorrectal
Obesidad
Índice de masa corporal
Factores pronósticos
Supervivencia

RESUMEN

Introducción: La supervivencia a largo plazo de los pacientes intervenidos por cáncer de colon depende de múltiples factores. La obesidad disminuye la expectativa de vida de la población general que la padece, pero no está claro si la obesidad, medida con el índice de masa corporal (IMC), es un factor pronóstico de supervivencia para los pacientes intervenidos por cáncer de colon.

Material y métodos: Hemos incluido en este estudio a pacientes en estadios TNM I, II y III, sometidos a cirugía electiva por cáncer de colon en el Hospital Universitari de Girona entre 1990 y 2001. El IMC se ha categorizado siguiendo la clasificación de la OMS. Hemos estudiado 38 parámetros distintos realizando un estudio bivariable con el IMC. El modelo de Cox ha sido construido posteriormente con los parámetros más clínicamente relevantes y con los más fuertemente asociados con la supervivencia en el estudio bivariable.

Resultados: El IMC no se asoció con la supervivencia en el análisis bivariable. El análisis multivariable tampoco mostró que el IMC sea un factor pronóstico independiente de supervivencia a largo plazo en el cáncer de colon sin metástasis, pero sí lo fueron el estadio TNM, la puntuación ASA, la técnica quirúrgica, la edad a la cirugía y la respuesta inmunitaria celular.

Conclusiones: El IMC no es un factor pronóstico de supervivencia a largo plazo en pacientes con cáncer de colon.

Introduction

Colorectal Cancer (CRC) is the second leading cause of cancer-related deaths in North America and Western Europe.[1,2] The long-term survival of patients with CRC depends on many factors and the main ones are associated with the tumour,[3] but there are other factors involved such as age, comorbidities,[4] and humoral factors such as the levels of carcinoembryonic antigen.[5] Nagel and Göke[6] published a study showing that the tumour seems to progress more quickly in patients with diabetes mellitus type 2 (DM2). Other factors such as the surgical technique, type of hospital[7] and type of adjuvant therapy[8] have also been found to be involved in the prognosis of patients with cancer of the colon (CC). Even economic and social factors such as poverty or race have been found to be associated with the prognosis of CRC.

We know that as obesity increases in the general population, their life expectancy decreases.[9,10] This is mainly due to the physiopathological changes that occur in obese patients making them more susceptible to suffer from a series of diseases known as obesity-related comorbidities, which reduce their life expectancy.[9] Some of these are very significant such as cardiovascular comorbidities (arterial hypertension, ischaemic heart disease, stroke), as well as hyperuricaemia, dyslipaemia, DM2 and sleep apnoea syndrome.

Birmingham et al[11] have recently published that leptin, a hormone produced by the adipocytes and found at elevated levels in obese patients, may cause tumours to progress and metastasise. This is because it stimulates the vascular endothelial growth factor (VEGF). Several studies have tried to assess the impact that these factors have on the long-term survival of CC patients; however, it is not completely clear which effect obesity has on the long-term outcomes of patients undergoing surgery for CC.[12]

The objective of this study is to determine whether obesity is among the main prognostic factors of survival in patients undergoing elective surgery for CC.

Patients and methods

The patients included in the study were those undergoing elective surgery for colon cancer in the *Dr Josep Trueta Hospital Universitari de Girona* (Dr Josep Trueta University Hospital of Girona) between 1990 and 2001. They had TNM stage I, II and III and their weight and size had been recorded preoperatively (93.2% of the total).

Follow-up

The patients were seen by a surgeon during a medical visit to the hospital 1, 3, 6, 12, 18 and 24 months after being discharged and annually thereafter. The patients' health was assessed during these check-ups, as well as systematic blood tests, CEA and CA19.9 markers, and the chest x-ray and abdominal ultrasound. A colonoscopy and/or CT scan was only carried out if a relapse of the tumour was suspected.

Parameters of the study

A total of 38 parameters were analysed. The level of obesity was assessed using the body mass index (BMI).

This parameter was grouped together following the ranges set out by the WHO[13]: underweight, BMI<18.5; normal weight, 18.5-24.99; pre-obesity (overweight), 25-29.99, and obesity >30. The other parameters studied were sex, age, prior history of surgery, location of tumour, cell-mediated immune response measured using a commercial test (Multitest IMC®; Rhône-Poulenc), preoperative protein levels (normal, >6.6 g/dl), preoperative albumin levels (normal, >3.4 g/dl), perioperative transfusions, type of surgery, surgical technique, intraoperative complications, postoperative complications, hospital stay, tumour stage according to the TNM classification,[14] mortality during the first month, laboratory parameters (levels of immunoglobulin G, A, M, complement C3, C4, haptoglobin, transferrin, α_1-antitrypsin, CEA, CA 19-9, TPA (tissue polypeptide antigen).

Tumour parameters

Tumour recurrence was evaluated during the follow-up and was defined as a new loco-regional or distant neoplastic disease, confirmed by clinical, biological, radiological or surgical methods. Survival was assessed using the tumour stage during the last medical visit or on the date of death. Comorbidities and the associated-risk of death were assessed using the Yancik et al classification[15] (this classification considers 29 groups of comorbidities and their impact on survival) and the ASA (American Society of Anesthesiologists) score[16].

Study plan

A single surgeon (ACC) prospectively collected all the data while the patient was in hospital and during the follow-up (end date of the study, September, 1 2003), except for the data regarding comorbidities and perioperative mortality, which were not included in the original database. These data were studied retrospectively by the first author, who reviewed all the patients' medical histories.

Statistical method

Firstly, a univariate analysis of all the patients was carried out, and then later, a bivariate analysis was performed where the influence of each variable on patient survival was analysed.

The SPSS 10.0 software for Windows was used for the statistical analysis. The continuous variables are presented with the mean (confidence interval [IC] of 95%) and the minimum and maximum of the distribution. The ANOVA test with the *post-hoc* Scheffé Test was used to assess whether there were any overall differences in the different groups. A $P<.05$ was considered to be statistically significant.

Pearson's chi-square test or Fisher's exact test was used to analyse if there were any possible differences between the groups for the categorical variables.

A Cox model was constructed with 12 variables from the 38 studied. The variables that were most strongly associated with survival in the bivariate study were included as well as others which were considered clinically relevant.

Table 1 – The risk of death by comorbidities, assessed with the Yancik et al scale[15]

Risk	No. (%)
No risk	7 (3.6)
Insignificant	17 (8.7)
Low	24 (12.2)
Moderate	77 (39.1)
High	72 (36.6)

Results

Univariate study

A total of 213 patients were underwent surgery for CC: 122 (57.3%) males, 91 (42.7%) females. They had a mean age of 66.2±10 (36-87) years. The mean BMI was 25.6±3.8 (18-37). The BMI distribution is shown in Table 4. Nearly 50% of the patients were in the normal weight range and the preoperative levels of plasma proteins were found to be pathological (<6.6 g/dl) in 94 patients (44.1%).

The delayed cell-mediated immune response was normal in 25 (11.7%) patients, and 36 (16.9%) had hypoergy and 91 (42.7%) had anergy.

The mean number of comorbidities in CC patients was 3.2±2 (0-11). The risk of death by comorbidities assessed using the Yancik et al scale[17] is shown in Table 1. Using this method, the mean number of comorbidities per patient was 3.2±2.2 (0-11) and more than 75% were at a moderate or high risk of death according to this scale.

Nine (4.6%) patients had an ASA score of I, 89 (45.6%) ASA II, 77 (39.5%) ASA III and 20 (10.3%) ASA IV.

Surgery-related data

A colon and rectal surgeon operated on 84 (39.4%) patients, general surgeons, who do not only perform colon and rectal surgery, operated on 85 (39.9%) patients and 44 (20.7%) were operated on by young surgeons under the supervision of an expert surgeon. A right hemicolectomy was performed on 82 (38.5%) patients, left hemicolectomy on 24 (11.2%), sigmoidectomy on 74 (34.7%), Hartmann's operation on 8 (3.8%) and other colectomies on 24 (11.3%). All the different types of surgery were performed via laparotomy (open surgery).

A total of 50 (23.5%) patients suffered complications during the first 30 days following the operation: respiratory complications, 7 (3.3%); heart complications, 4 (1.9%); wound infection, 18 (8.5%); evisceration, 1 (0.5%); suture failure, 3 (1.4%); fistulae, 6 (2.8%); haemorrhage, 8 (3.8%); stoma complications, 1 (0.5%), and miscellaneous complications, 7 (3.3%). Two (0.9%) patients died during the postoperative period.

Tumour-related data

These data have been previously published.[17] The histological type of tumour was adenocarcinoma in the majority of cases, 200 (93.9%). Well-differentiated tumours made up 46.9% of

the cases; 45.5% were moderately differentiated and 3.8% were poorly differentiated.

The tumour was located in the right colon in 87 (40.9%) cases, in the left colon in 121 (56.8%) cases and 5 (2.4%) patients had double or triple cancers. The tumour was in stage I in 10 (4.7%) patients, II in 25 (58.7%) patients and III in 78 (36.6%). There were no statistical differences in the tumour stage between the different BMI groups.

Follow-up

The follow-up of CC lasted for 13.2 years, with an average of 5.8 years, and 59 patients (23.5%) had a recurrence of the tumour during the follow-up period. The mean survival rate by BMI group is shown in Table 4.

Bivariate study

The effect that each variable had on the sample survival is shown in Table 2. The survival curves (Kaplan-Meier) by BMI groups are shown in the Figure. Among the values that were significantly associated with survival, it is important to mention cell-mediated immunity; however, the levels of C3, C4, IgG, IgA or IgM or haptoglobin did not affect survival. Survival was, however, affected by protein and albumin levels, as well as α_1-atintrypsin levels (P=.001). The presence of complications and the need for a transfusion were associated with survival as were the parameters associated with the tumour stage, as was expected. It is important to observe that the presence of comorbidities had a strong impact on survival, whether measured using the Yancik method or the ASA classification.

Table 2 – Bivariate study of survival

Factor	*P*
Age	<.001
Sex	.343
Previous history of surgery	.561
Test for cell-mediated immunity	.046
BMI	.691
Total preoperative proteins	<.001
Preoperative albumin levels	<.002
Other laboratory parameters (only the significant values are shown)	
CA19-9	.012
Transferrin	.042
α_1-antitrypsin	.001
Haemoderivative transfusions	.007
Type of surgery	.115
Surgical technique	.041
Days spent in hospital	.056
Intraoperative complications	.015
Postoperative complications	.031
TNM tumour stage	.027
Tumour location	.287
Histological type	.05
Degree of tumour differentiation	.987
Type of tumour infiltration	.01
Number of lymph nodes studied	.055
Number of lymph nodes affected	<.001
Tumour recurrence	<.001
Total number of comorbidities	.013
Comorbidity-associated risk of death	.072
ASA score	<.001

BMI indicates body mass index.

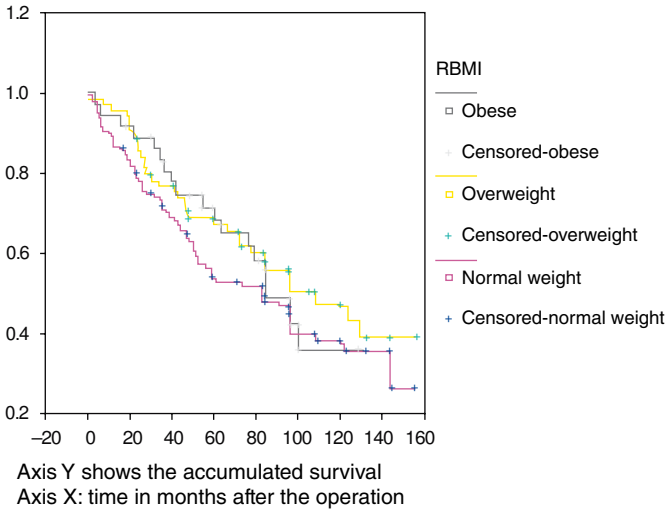

Figure – Survival curves (Kaplan-Meier) according to BMI.

Multivariate analysis

The variables included in the final Cox model as well as their relative effect on survival are presented in Table 3. The variables associated with survival in our Cox model (multivariate analysis) were: the TNM stage, the preoperative ASA score, preoperative cell-mediated immune status and the surgical technique used.

Discussion

There is scientific evidence that obesity and excess weight decreases the life expectancy of the general population who suffer from it.[18] BMI is the most internationally accepted method for assessing the level of obesity due to its ease-of-use, among other reasons.[13] However, it does have limitations in assessing obesity (e.g. people with high muscle mass are included in the obese category).

At present, it is necessary to carry out a personalised assessment to gauge the risk of morbidity and mortality that a patient may have according to their excess weight. This risk mainly depends on the distribution of body fat, how much excess weight the individual has and the presence of other comorbidities, especially those which are cardiovascular risk factors.[19] Furthermore, the comorbidities a CC patient has may also affect diagnosis and treatment.[15,20] As a result, it is essential that a detailed analysis is performed to find out if any of these comorbidities exists, just as we did on each of the patients of our series. For this analysis we used the ASA classification and the Yancik et al comorbidity index,[15] which was presented by these authors in order to assess the impact of these comorbidities on the survival of CC patients.

Table 3 – Cox Model and its relative impact on survival

Variable	HR (CI 95%)	P
Age	1.02 (1.00-1.05)	.034
BMI		
Normal weight	1	
Overweight	0.64 (0.38-1.09)	.103
Obese	0.8 (0.42-1.52)	.509
ASA score	1.59 (1.17-2.17)	.003
Surgical technique		
Right hemicolectomy	1	
Left hemicolectomy	1.11 (0.66-1.86)	.682
Hartmann's operation	3.72 (1.41-9.78)	.008
Other techniques	1.43 (0.7-2.93)	.322
TNM	1.31 (1.13-1.52)	<.001
Cell-mediated immunity	0.72 (0.58-0.91)	.007
Transfusions		
No	1	
Yes	1.37 (0.83-2.26)	.215
Surgeon		
Colon and rectal surgeon	1	
General surgeon	1.3 (0.81-2.08)	.269
"Young" supervised surgeon	1.74 (0.81-3.73)	.149
α_1-antitrypsin	1.13 (0.67-1.88)	.636
CA19-9		
Normal <50	1	
Pathological >50	1.36 (0.81-2.28)	.241
Total preoperative proteins		
Normal >6.6	1	
Pathological <6.6	1.14 (0.72-1.81)	.577

BMI indicates body mass index; CI, confidence interval; HR, hazard ratio; IgA, immunoglobulin A.

In our study we found that survival in CC is influenced by the number of comorbidities the subject has, whether assessed using the ASA score or the Yancik et al system.[15] These results coincide with the results we were expecting. It would, therefore, seem obvious that obese patients must have a worse survival rate as they have a greater number of comorbidities with serious repercussions on their health. However, our results do not support this statement, as obesity measured with BMI was not found to be a significant prognostic factor of survival in CC in the bivariate or multivariate study.

There are other studies that have not only found that obesity assessed using BMI was not a factor for poor prognosis, but it may in fact have a positive effect on survival. This is the case in Ogino et al's studies where obese patients with CC were found to have a higher survival rate when they had p27 gene alterations. This situation was found in 84% of the obese patients of the study. An increased STMNI gene expression was also found to have a positive effect on survival rates.[21,22] No significant differences in survival rates were found between groups of obese patients and non-obese patients in Healy et al's recent study, although in this study patients with CC and RC were assessed together.[23]

Table 4 – BMI and months of survival with CC

	Patients, no. (%)	Months of survival[a]
Normal weight	105 (49.3)	85 (6) 1-156
Overweight	70 (32.9)	98.6 (7.2) 1-157
Obesity	36 (16.9)	85.5 (7.6) 4-131

[a]Median (CI 95%) (min.-max.) No significant differences, *P*=.691.

Haydon et al's 2006 Australian study[24] on 526 patients with colorectal cancer who were monitored for 5 years, also analysed the effect of obesity on survival and just like our results, the study did not find that obesity had a negative effect on survival. Obesity was also assessed in this study using BMI. However, in this same study, when obesity was assessed using waist circumference or body fat by bioelectrical impedance, the patients with the largest waist or highest body fat percentage did have a worse survival rate. Therefore, it would seem that the influence that obesity has on survival is more closely related with other parameters that measure the type of adiposity better than BMI. However, in that study, different to our own study, weight, height and the other anthropometric parameters were not measured during the diagnosis or before the operation, but were taken when the patients were recruited with another objective in mind (studies on the influence of epidemiological factors and cancer). As a result, the individual's level of obesity may have changed during the period, which in some cases lasted for years.

Meyerhardt et al,[12] however, published a study which showed that obesity, measured using BMI, did have a significant effect on overall survival of patients with CC, but only in female patients. We did not find that BMI had an effect on survival when women and men were analysed separately, although this may have been due to the lower number of cases in our series (n=213) compared with Meyerhardt et al's series (n=3759).

This study differed from our study in other aspects making it impossible to compare them. They measured the patient's weight and height when starting chemotherapy, and not preoperatively like us, and they also excluded patients in stage I (we included them). Moreover, the sample was made up of the patients included in a clinical trial to compare different adjuvant regimes.

In 2008 Meyerhardt et al[25] published a new study with 1053 patients in stage III CC and this time they found that BMI did not have an effect on long-term mortality. Sinicrope et al[26] in 2010 did find differences in survival rates according to BMI in 4381 patients with CC treated with chemotherapy. In this study, male patients with a BMI>35 and women with a BMI of 30-35 had a worse overall survival rate. We did not find these differences, although this may be because our study had fewer patients.

Not only is the data on whether BMI has an effect on the survival of CC patients inconclusive, but we must also ask ourselves whether BMI is the best measurement of obesity as it does not differentiate between different types of body fat distribution.

There are a number of studies[27] that state the enormous influence this has on the prognosis of obese patients. This is particularly pertinent for the cardiovascular risk. Thus, in Spain a hip-waist ratio >1 in males and >0.9 in females is associated with a higher cardiovascular risk.

Metabolic syndrome (MS) is defined as a series of comorbidities that are associated with abdominal obesity (arterial hypertension, atherogenic dyslipidemia and insulin resistance).[28] This syndrome is very significant because MS patients have a high risk of diabetes and/or cardiovascular disease and this undoubtedly has negative repercussions on their life expectancy.

Age must also be considered when defining obesity, given that as people age, their weight as well as their ideal weight increases. This fact can be seen in epidemiological studies such as the SEEDO 2007.[19] The mean age of our series was 66.3 years. Therefore, it would seem that the WHO obesity classification or the SEEDO classification are not entirely appropriate for this subpopulation, given that their actual ideal weight may be higher than that stated in these classifications. In fact, this "error" in the definition of obesity, by not adjusting the patient's ideal BMI to age, is quite a widespread problem in studies that deal with this topic.

This can also be seen in the Heiat et al's meta-analysis,[29] which found that excess weight affected the elderly population's health less than the general adult population's.

One of the limitations of our study was that the original database was not created for the study in question and therefore, the majority of the data was collected prospectively; however, this was not the case for comorbidities and perioperative mortality. These data were analysed retrospectively with the limitations that this entails. Furthermore, only the patients whose weight and height were recorded prior to the operation were included in the study meaning that there was a small bias as 6.8% of our patients were excluded.

Therefore, we can state as a result of our analysis that BMI is not a prognostic factor of long-term survival in CC patients. However, the following are prognostic factors: biology of the tumour, ASA score, surgical technique, age and cell-mediated immunity status.

The need to establish a suitable method and time to measure obesity cannot be overlooked. It may be possible to show that obesity has a negative effect on the long-term survival of patients with CC by using, besides BMI, other measurements of obesity which focus more on abdominal obesity.

Conflict of interest

The authors affirm that they have no conflict of interest.

Acknowledgements

We would like to thank all the staff of the *Cirugía General y del Aparato Digestivo* (general and digestive tract surgery) department, *Hospital Universitari de Girona*, where all of the patients included in this study were looked after excellently. Many thanks as well to Dr. Maria Garcia Gil for the statistical analysis of the data.

REFERENCES

1. Dorudi S, Steele RJ, McArdle CS. Surgery for colorectal cancer. Br Med Bull. 2002;64:101-18.
2. Media back-grounder. Colorectal Cancer Statistics. [Internet]. Canadian cancer society 2008 [updated May 2008; cited 1 Dec 2008]. Available from: http://www.cancer.ca/Canada-wide/About%20cancer/Cancer%20statistics.aspx?
3. Sternberg A, Sibirsky O, Cohen D, Blumenson LE, Petrelli NJ. Validation of a new classification system for curatively resected colorectal adenocarcinoma. Cancer. 1999;86:782-92.
4. Thun MJ, Calle EE, Namboodiri MM, Flanders WD, Coates RJ, Byers T, et al. Risk factors for fatal colon cancer in a large prospective study. J Natl Cancer Inst. 1992;84:1491-500.
5. Arfa N, Hamdani I, Gharbi L, Ben AS, Ghariani B, Mannai S, et al. Survival and prognostic factors of colorectal adenocarcinoma: analytic multifactor review of 150 cases. Ann Chir. 2006;131:104-11.
6. Nagel JM, Goke B. Colorectal carcinoma screening in patients with type 2 diabetes mellitus. Z Gastroenterol. 2006;44: 1153-65.
7. Rogers SO, Wolf RE, Zaslavsky AM, Wright WE, Ayanian JZ. Relation of surgeon and hospital volume to processes and outcomes of colorectal cancer surgery. Ann Surg. 2006;244:1003-11.
8. Gordon PH, Nivatvongs S. Principles and practice of surgery for the colon, rectum, and anus. 3rd ed. Informa Healthcare USA, Inc; 2006.
9. Kopelman PG. Obesity as a medical problem. Nature. 2000;404:635-43.
10. Morales MM, Llopis A, Rodriguez R, Bori T. Geographic distribution of mortality from cancer of the stomach and the colon in Spain. Rev Esp Enferm Dig. 1993;84:1-7.
11. Birmingham JM, Busik JV, Hansen-Smith FM, Fenton JI. Novel mechanism for obesity-induced colon cancer progression. Carcinogenesis. 2009;30:690-7.
12. Meyerhardt JA, Catalano PJ, Haller DG, Mayer RJ, Benson AB, Macdonald JS, et al. Influence of body mass index on outcomes and treatment-related toxicity in patients with colon carcinoma. Cancer. 2003;98:484-95.
13. World Health Organization Consultation on Obesity (1998). Preventing and managing the global epidemic: Report of a WHO consultation on Obesity. Geneva, 3-5 June 1997;1-276.
14. Spiessel B, Harmanek P, Hutter RVP, Atlas TNM. Guía ilustrada de la clasificación TNM/pTNM de los tumores malignos. 3rd ed. Barcelona: Springler-Verlag Ibérica; 1992. 2nd revision.
15. Yancik R, Wesley MN, Ries LAG, Havlik RJ, Long S, Edwards BK, et al. Comorbidity and age as predictors of Risk for early mortality of male and female colon carcinoma patients. A population-based study. Cancer. 1998;82:2123-34.
16. American Society of Anesthesiologists. New classification of physical status. Anesthesiology. 1963;24:111.
17. Garcia-Oria Serrano MJ, Armengol-Carrasco M, Ortiz R, Codina Cazador A. Impacto de la obesidad en las características anatomopatológicas de los tumores colorrectales. Estudio observacional. Cir Esp. 2009;87:33-8.
18. Bonneux L, Reuser M. Overweight and mortality risk: no connection between overweight in middle and older age groups and increased mortality. Ned Tijdschr Geneeskd. 2007;151:2764-9.
19. Rubio MA, Salas-Salvadó J, Barbany M, Moreno B, Aranceta J, Bellido D, et al. Consenso SEEDO 2007 para la evaluación del sobrepeso y la obesidad y el establecimiento de criterios de intervención terapéutica. Rev Esp Obes. 2007;7:7-48.

20. Faivre J, Lemmens VE, Quipourt V, Bouvier AM. Management and survival of colorectal cancer in the elderly in population-based studies. Eur J Cancer. 2007;43:2279-84.
21. Ogino S, Shima K, Nosho K, Irahara N, Baba Y, Wolpin BM, et al. A cohort study of p27 localization in colon cancer, body mass index, and patient survival. Cancer Epidemiol Biomarkers Prev. 2009;18:1849-58.
22. Ogino S, Nosho K, Baba Y, Kure S, Shima K, Irahara N, et al. A cohort study of STMN1 expression in colorectal cancer: body mass index and prognosis. Am J Gastroenterol. 2009;104:2047-56.
23. Healy LA, Ryan AM, Sutton E, Younger K, Mehigan B, Stephens R, et al. Impact of obesity on surgical and oncological outcomes in the management of colorectal cancer. Int J Colorectal Dis. 2010;25:1293-9.
24. Haydon AM, Macinnis RJ, English DR, Giles GG. Effect of physical activity and body size on survival after diagnosis with colorectal cancer. Gut. 2006;55:62-7.
25. Meyerhardt JA, Niedzwiecki D, Hollis D, Saltz LB, Mayer RJ, Nelson H, et al. Impact of body mass index and weight change after treatment on cancer recurrence and survival in patients with stage III colon cancer: findings from Cancer and Leukemia Group B 89803. J Clin Oncol. 2008;26:4109-15.
26. Sinicrope FA, Foster NR, Sargent DJ, O'Connell MJ, Rankin C. Obesity is an independent prognostic variable in colon cancer survivors. Clin Cancer Res. 2010;16:1884-93.
27. Aranceta J, Perez Rodrigo C, Serra Majem L, Ribas Barba L, Quiles Izquierdo J, Vioque J, et al. Prevalence of obesity in Spain: Results of the SEEDO 2000 study. Med Clin (Barc). 2003;120:608-12.
28. Grundy SM, Cleeman JI, Daniels SR, Donato KA, Eckel RH, Franklin BA, et al. Diagnosis and management of the metabolic syndrome: an American Heart Association/ National Heart, Lung, and Blood Institute Scientific Statement. Circulation. 2005;112:2735-52.
29. Heiat A, Vaccarino V, Krumholz HM. An evidence-based assessment of federal guidelines for overweight and obesity as they apply to elderly persons. Arch Intern Med. 2001;161:1194-203.