



## **Factors that promote or hinder physical activity participation in patients with colorectal cancer: A systematic review**

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**ABSTRACT:** Different studies of patients with colorectal cancer have shown that physical activity has positive physical and psychosocial effects. However, most patients do not comply with the recommended criteria of physical activity. The aim of the present study was to analyze, by means of a systematic review of the literature, the factors associated with physical activity participation in patients with colorectal cancer. For this purpose, we conducted a search in the databases WEB OF SCIENCE, SCOPUS and SPORTDISCUS up to February of 2016. After the selection process, 23 full-text articles were retained. The results allowed identifying four large categories of factors related to physical activity participation in this population: sociodemographic factors, health factors (specific and nonspecific to the disease), prior experience and preferences, and motivational factors. Among the results obtained, comorbidity and the receipt of adjuvant therapy (with its corresponding side effects, such as fatigue and nausea) were related to less physical activity. Variables such as positive attitude, family support, satisfaction of basic psychological needs, and self-determined motivation were shown to be facilitators of physical activity. Taking into account these results, it is necessary to develop programs of physical activity adapted to the particular characteristics of this population and based on motivational strategies that promote adherence to physical activity.

**Keywords:** physical exercise, motivation, barriers, treatment, health

*Factores que promueven o dificultan la práctica de actividad física en pacientes con cáncer colorrectal: Una revisión sistemática*

**RESUMEN:** Diferentes estudios con pacientes de cáncer colorrectal han demostrado que el ejercicio físico tiene efectos físicos y psicosociales positivos. Sin embargo, la mayoría de pacientes no cumple los criterios de actividad física recomendados. El objetivo del presente estudio fue analizar, a través de una revisión sistemática de la literatura, los factores asociados con la práctica de actividad física en pacientes con cáncer colorrectal. Para ello se realizó una búsqueda en las bases de datos WEB OF SCIENCE, SCOPUS y SPORTDISCUS hasta febrero de 2016. Tras el proceso de selección, se retuvieron 23 artículos a texto completo. Los resultados permitieron identificar cuatro grandes categorías de factores relacionados con la práctica de actividad física en esta población: factores sociodemográficos, factores de salud (específicos y no específicos de la enfermedad), preferencias y experiencias previas, y factores motivacionales. Entre los resultados obtenidos, cabe destacar que la comorbilidad y la recepción de terapia adyuvante (con sus correspondientes efectos secundarios como

fatiga y náuseas), se relacionaron con una menor realización de actividad física. Variables como la actitud positiva, el apoyo familiar, la satisfacción de las necesidades psicológicas básicas y la motivación autodeterminada, se mostraron como facilitadores de la participación en actividad física. Teniendo en cuenta estos resultados, es necesario desarrollar programas de actividad física ajustados a las características particulares de esta población y basados en estrategias motivacionales que favorezcan la adherencia a la práctica.

**Palabras clave:** ejercicio físico, motivación, barreras, tratamiento, salud.

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## INTRODUCTION

Cancer is currently one of the major causes of mortality worldwide. In 2012, there were about 14 million new cases and 8.2 million cancer-related deaths (WHO, 2015). For example, cancer represents the second cause of death in the United States and is expected to exceed cardiovascular disease as the leading cause of death in the coming years (Siegel, Miller, & Jemal, 2015). It was estimated that 595690 Americans would die of cancer in 2016, which translates into about 1630 people per day (American Cancer Society, 2016). In Spain, the estimation 2015 was of 227076 cases, with an increase that occurs to a greater extent in the population  $\geq 65$  years (Spanish Society of Medical Oncology, 2014). Approximately 30% of cancer deaths are related to five behavioral risk factors: high body mass index, low intake of fruit and vegetables, smoking, alcohol consumption, and lack of physical activity (WHO, 2015).

Besides the human suffering involved in cancer, it has been estimated that this disease causes a high economic cost for health systems. For example, the total cost of cancer in 2008 in the United States was around \$ 228 billion. This situation is a serious public health problem, such that research of the factors that can prevent or alleviate the disease is a priority for governments (American Cancer Society, 2010).

Specifically, in the United States, colorectal cancer is the third cause of death by cancer in men and women, and the second cause when both sexes are combined. In Europe, colorectal cancer held the second position in incidence after breast cancer in 2012, and 49190 deaths from colorectal cancer were estimated in 2016 (Spanish Network of Cancer Registers, 2014). Five to ten-year survival rates for patients with colorectal cancer are 65% and 58%, respectively (Siegel et al., 2015).

Due to colorectal cancer, patients live with physical and psychological sequelae that grow worse with treatment. Some of the symptoms are: intestinal dysfunction, surgery pain, stoma, fatigue, muscle weakness, alteration of body image, anxiety, and depression (Downing et al., 2015; Zabora, BrintzenhofeSzoc, Curbov, Hooker, & Piantadosi, 2001). To alleviate these sequelae, there is increasingly more scientific evidence of the physical and psychological benefits of physical activity, both during and after treatment for this disease (Garcia & Thomson, 2014). Specifically, in colorectal cancer, it was found that regular exercise and

improved physical condition are associated with many indicators of quality of life (Courneya, Friedenreich, Arthur, & Bobick, 1999a; Courneya et al., 2004; Courneya, Mackey, & Jones, 2000), with a lower probability of recurrence (Meyerhardt, Heseltine et al., 2006) and lower risk of death (Meyerhardt et al., 2008). In the study of Meyerhardt, Heseltine et al. (2006), it was found that patients who walked at least 6 hours per week at moderate intensity had a 47% higher chance of surviving the disease. Another study (Meyerhardt, Giovannucci et al., 2006) with 600 women diagnosed with colorectal cancer showed that those who increased their physical exercise after diagnosis had a 52% lower chance of dying from the disease compared with those who were not exercising. However, those who decreased the amount of exercise had a 32% higher chance of dying from the disease. Moreover, those who did physical exercise equivalent to walking 6 hours per week were more likely to have a longer life than those who did less or no exercise.

In spite of the described benefits, only 35% of colorectal cancer survivors in the United States perform the recommended physical activity (Blanchard, Courneya, & Stein, 2008), and 17.1% in Canada (Courneya, Katzmarzyk, & Bacon, 2008). In addition, various studies carried out in Canada (see Vallance & Courneya, 2012) show that, after diagnosis, physical activity decreases on average about 2 hours per week, and only 5-10% of the patients participate in physical activity during treatment, and 20-30% after treatment. After overcoming the disease, patients increase their physical activity participation but without reaching the initial levels. There is also a greater decrease of physical activity when combining various treatments such as surgery, chemotherapy, and radiotherapy, in comparison to receiving just one of them (Irwin et al., 2004). However, 80% of the patients feel capable of participating in physical activity, and 70% are interested in it so, in order to develop any intervention, it is essential to know the factors that promote or hinder physical activity participation in this collective (Vallance & Courneya, 2012).

Taking into account that there are already plenty of studies that have analyzed this problem in colorectal cancer patients, the aim of this study was to perform a systematic review to more clearly interpret all the factors related to these patients' participation in physical activity. There are several systematic reviews of the factors related to the physical activity participation in patients with cancer, all of them including different types of cancer (Park & Gaffey, 2007). Some authors have even systematically analyzed the effects of exercise in patients with colorectal cancer (Cramer, Lauche, Klose, Dobos, & Langhorst, 2014; Kampshoff et al., 2014; Husebø, Dyrstad, Søreide, & Bru, 2013). However, to date there is no systematic review of the factors associated with physical activity participation in patients with colorectal cancer, so this is the first one to be performed.

This review is focused on colorectal cancer because it is the second most common type of cancer in Europe and the United States, and the most frequent in some countries like Spain (Spanish Society of Medical Oncology, 2014), presenting a moderate survival rate. Given its high incidence, but at the same time its positive prognosis, we think that it is interesting to focus on this type of cancer to more specifically deepen our knowledge of the factors related to the levels of physical activity. In addition, the variables contributing to predict physical activity

appear to vary as a function of the type of cancer, which indicates the need to analyze each one separately (Vallance & Courneya, 2012).

## METHOD

### *Data sources and search terms*

The electronic search was made by means of the WEB OF SCIENCE, SCOPUS and SPORTDISCUS databases up to February of 2016. The searches included diverse combinations of four sets of terms: 1) Terms related to cancer: colorectal cancer, cancer stage and treatment; (2) Terms about physical activity: physical activity, exercise and training; 3) Influential factors in physical activity participation: facilitators, barriers, sociodemographic and psychosocial factors, motivation and adherence; 4) Motivational theories: theory of planned behavior, self-determination theory, self-efficacy theory, and socio-ecological model. The complete search strategies are not presented for the sake of brevity, but they can be requested from the authors.

### *Consultation of publications and construction of the catalogue*

The selection of the studies focused on the factors associated with physical activity participation in patients with colorectal cancer (Figure 1). We conducted two levels of screening. First, we searched for combinations of all the keywords in all the databases, reaching 19213 identified registers. Another 18 additional registers were identified in the references lists of the articles, obtaining a total of 19231 recordings. We included all the references in the program "EndNote" to detect duplicates, finding a total of 15532, which were deleted. Therefore, 3699 unique citations remained, from which we excluded 3649 after reading the abstracts because they did not analyze the relations between physical activity participation and colorectal cancer, so that finally, 50 articles remained, which were downloaded in full text. We then established the second screening system, which consisted of applying the following exclusion criteria: 1) including other different types of cancer without specifying the results separately for each one; (2) including other healthy behaviors without specifying the results referred to physical activity; 3) focusing on factors or strategies to promote physical activity in order to prevent colorectal cancer, but without using a sample of patients affected with this disease; 4) focusing only on the effects or benefits of physical activity in this population without covering the factors related to physical activity participation. We eliminated 27 registers for meeting these criteria, leaving a total of 23 final registers in the present study.

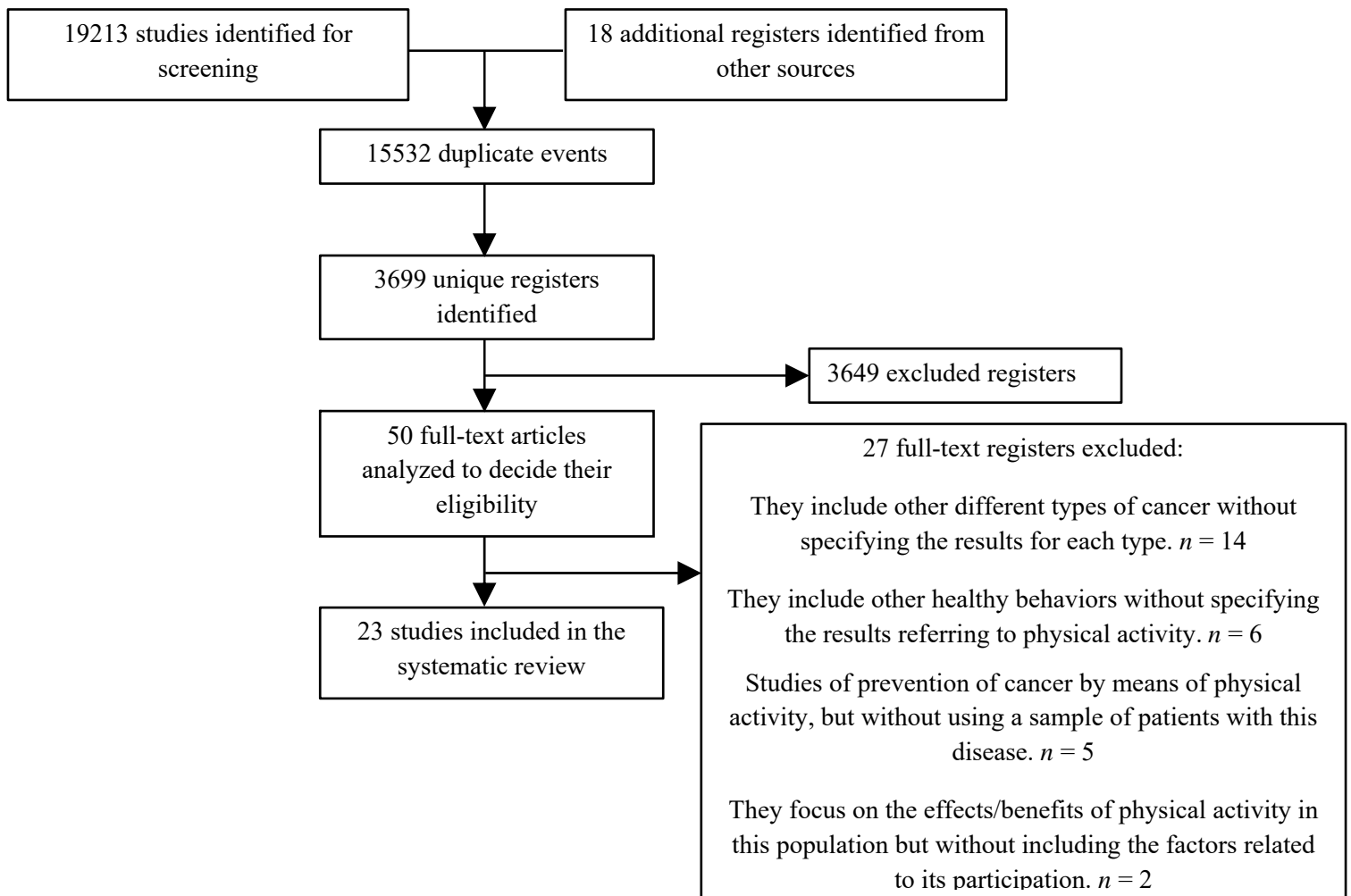


Figure 1. Flow chart of the selection process of the studies.

### *Selection process and data extraction*

The necessary variables to analyze the results are grouped in Table 1. The following data are included: references; total number of patients, of men and women; age; cancer stage at the moment of the study; treatment; theoretical framework; design; measure of physical activity; and results related to the facilitators and barriers for physical activity participation. Cancer stage (see footnote of Table 1), type of treatment (surgery, radiotherapy, chemotherapy) and whether or not they were receiving treatment at the time of the study or it had already concluded were included in this review. In addition, we indicate the design of the studies, dividing them into cross-sectional, longitudinal, experimental, and qualitative. We also aimed to identify whether the studies are supported by a theoretical framework, as this would guide interventions to promote physical activity with this collective in a more structured way, understanding how behavioral change occurs (Biddle, Mutrie, Gorely, & Blamey, 2012). Lastly, we highlight the importance of analyzing how physical activity is measured, either by means of more subjective measures like questionnaires, or more objective measures like accelerometers. All these aspects are important when analyzing the factors that influence physical activity participation in this population.

Table 1. *Studies that Analyze the Factors Related to Physical Activity Participation in Patients with Colorectal Cancer*

REFERENCES	NUMBER OF PATIENTS	AGE (years)	CANCER STAGE	TREATMENT	THEORETICAL FRAMEWORK	DESIGN	MEASURE OF PA	RESULTS
Buffart et al. (2012)	1371 Total 56% males 44% females	$\geq 65 = 69\%$ $M = 69.5, SD = 9.7$	I = 28% II = 39% III = 28% IV = 5%	S = 67.54% RT = 0.07% CT = 1.02% S + RT = 22.90% S + CT = 24.58% S + RT + CT = 6.41%	Not used	Cross-sectional	European Prospective Investigation into Cancer (EPIC) Physical Activity Questionnaire	Being younger, male, employed, not smoking, lower body mass index, being only in chemotherapy treatment and not having comorbidities → ↑MVPA
Chambers et al. (2009)	978 Total 55.8% males 44.2% females	20-49 = 7.6% 50-59 = 20.3% 60-69 = 35% $\geq 70 = 37.2\%$	I = 28.7% II = 30.6% III = 25.8% IV = 0.7%	Not specified	Not used	Longitudinal 5, 12, 24 and 36 months post diagnosis	Active Australia Survey	↑Somatization → ↓PA ↑Negative assessment of the impact of cancer → ↓PA ↑Fatigue → ↓PA ↑Smoking → ↓PA ↑Obesity → ↓PA
Chung et al. (2013)	422 Total 63% males 37% females	$M = 59.69, SD = 10.87$	I = 95 II = 102 III = 103 IV = 16	Unfinished = 31.27 % Finished = 68.72 %	Not used	Cross-sectional	Exercise & Quality of Life Questionnaire	In treatment: Without changes in LPA, MPA and TPA. ↓VPA End of treatment: Without changes in MVPA vs. pre-treatment. ↑LPA and TPA
Courneya et al. (1999b)	66 Total 57.57% males 42.42% females	$M = 60.8, SD = 11.5$	I = 6% II = 29% III = 26% IV = 5%	Did not receive AT = 27.3% RT = 7.6% CT = 46.9% RT + CT = 18%	Theory of planned behavior	Cross-sectional	Godin Leisure Time Exercise Questionnaire (GLEQ)	Intention and pre-diagnosis PA → PA post operation
Courneya et al. (2004)	102 Total 58.1% males 41.9% females	$M = 60.3, SD = 10.4$	III-IV = 80.6%	S = 100% RT = 20.4% CT = 64.5% Only S = 34.4% S + CT = 46.2% S + RT + CT = 19.4% All patients were operated in the past 3 months	Theory of planned behavior	Experimental	Godin Leisure Time Exercise Questionnaire (GLEQ)	Experimental group: Higher levels of PA, behavioral control, lower work status, and less adjuvant treatment → ↑PA Control group: higher levels of PA and more intention → ↑PA
Courneya et al. (2005)	69 Total 56.5% males 43.5% females	< 60 = 39.1% > 60 = 60.9%	Not specified	Only S = 39.1% S + CT = 42% S + RT + CT = 18.8% All patients were operated in the past 3 months	Not used	Experimental	Godin Leisure Time Exercise Questionnaire (GLEQ)	Barriers: Lack of time, adjuvant treatment, side effects and fatigue

D'Andrea et al. (2014)	2378 Total	18-65	Not specified	Not specified	Not used	Cross-sectional	USA National Health Interview Survey	Hispanics and non-Hispanic blacks (vs. Whites) and current smokers → ↓PA Higher educational level, fewer chronic conditions, current drinkers → ↑PA
Dennis et al. (2013)	444 Total 55% males 45% females	36-91 ( <i>M</i> = 69) ≥ 60 = 80%	Not specified	Pre-treatment = 12.16% In treatment = 13.96% Completed 6 months ago = 15.09% Completed more than 6 months ago = 40.1% Cancer-free group = 18.69%	Not used	Cross-sectional	Lifestyle survey for people with colorectal cancer	Preferences: Group-based PA programs Barriers: Stoma and treatment-related fatigue VPA (from - to +): Pre-treatment, in treatment, post-treatment, < 6 months and > of 6 months post-treatment and cancer-free group Barriers: Fatigue, ageing, and comorbidities ↑Barriers → ↓PA
Fisher et al. (2016)	478 Total 59% males 41% females	31-97 ( <i>M</i> = 68)	Not specified	Finished = 73% Not finished = 16% Unknown = 5%	Not used	Cross-sectional	Godin Leisure Time Exercise Questionnaire (GLEQ)	Benefits: improvement of physical condition, improvement of health and maintenance/weight loss
Hawkes et al. (2015)	410 Total 54% males 46% females	<i>M</i> = 66.3, <i>SD</i> = 10.1	Insufficient PA I = 90.2% II = 85.1% III = 89.1% Sufficient PA I = 9.8% II = 14.9% III = 10.9%	S = 96% AT = 24%	Ecological model of health behavior	Experimental	Godin Leisure Time Exercise Questionnaire (GLEQ)	Being retired, having private health insurance, having healthy body weight, pre-diagnosis physical activity, having a habit, high level of self-efficacy, watching less TV, high quality of physical life, feeling well-being and being a part of the intervention group → ↑PA post 12 months
Husson et al. (2015)	1643 Total 56.11% males 43.88% females	< 65 = 28.97% 65-75 = 39.07% > 75 = 31.96%	I = 30.66% II = 36.33% III = 29.66% IV = 3%	Only S = 46.33% S + RT = 24.33% S + CT = 20.66% S + RT + CT = 8.66% Only CT = 1.33%	Not used	Longitudinal	European Prospective Investigation Into Cancer (EPIC) PA Questionnaire	↓Knowledge about health → ↓PA
Kang et al. (2014)	427 Total 63% males 37% females	< 60 = 52.9% ≥ 60 = 47.1%	I = 95 II = 102 III = 106 IV = 18	Unfinished = 30.9% Finished = 67%	Not used	Cross-sectional	Question about participation or not in PA and whether or not recommendations of the ACSM are met	Barriers (from + to -): 1 <sup>st</sup> Fatigue 2 <sup>nd</sup> Low physical condition 3 <sup>rd</sup> Low health status 4 <sup>th</sup> Lack of time and information ↑Treatment → ↓PA

Lynch et al. (2016)	185 Total 55.14% males 44.86% females	18-80 ( $M = 64.2$ , $SD = 10.3$ )	I = 22% II = 28% III = 41%	Only S = 57.84% S + AT = 42.16% Adjuvant therapy finished	Not used	Cross-sectional	Accelerometer	Males, more comorbidities, higher BMI and time slot 6 pm-8 pm → ↑ Sedentary behavior Women, low educational level and lower BMI → ↑ LPA More family income, being employed, lower BMI, younger, and time slots 4 pm-5 pm and 6 pm-10 pm → ↑ MVPA
Lynch et al. (2007)	1966 Total 60% males 40% females	20-49 = 8.5% 50-59 = 19.43% 60-69 = 33.31% 70-80 = 38.25%	Not specified	Not specified	Not used	Longitudinal	Active Australia Survey	High educational level, no smoking, no fatigue → ↑ PA in males Only surgery, healthy BMI, living outside the capital, no smoking, no fatigue → ↑ PA in women
Lynch et al. (2010)	Time 1 538 Total 63% males 37% females  Time 2 403 Total 61.5% males 38.5% females	Time 1 20-49 = 8.9% 50-59 = 19.7% 60-69 = 31.1% ≥ 70 = 40.3%  Time 2 20-49 = 8.9% 50-59 = 19.4% 60-69 = 29.0% ≥ 70 = 42.7%	Time 1 I = 25.5% II = 35% III = 30.6% IV = 8.9%  Time 2 I = 26% II = 38% III = 29.4% IV = 7.1%	Time 1 S = 56.9% S + AT = 43.1%  Time 2 S = 58% S + AT = 41.4%  All the patients were operated in the past 3 months	Ecological model of health behavior	Longitudinal 5 and 12 months post-diagnosis	Not measured	Barriers 5 and 12 months (from + to -): 1 <sup>st</sup> Cancer-specific barriers 2 <sup>nd</sup> Barriers from personal attributes 3 <sup>rd</sup> Barriers from social environment 4 <sup>th</sup> Barriers from physical environment
McGowan, Speed-Andrews, Blanchard et al. (2013)	600 Total 58.33% males 41.67% females	< 65 = 39% ≥ 65 = 61%	44% Early stage diagnosis	RT = 24% 10% still receive treatment	Not used	Cross-sectional	Godin Leisure Time Exercise Questionnaire (GLEQ)	Older, lower educational level, lower yearly income, more time elapsed since diagnosis, fewer relapses, stoma, in treatment and active vs. sedentary → ↓ interest in PA
McGowan, Speed-Andrews, Rhodes et al. (2013)	600 Total 58.3% males 41.7% females	< 65 = 39% ≥ 65 = 61% $M = 67.3$	I = 12.6% II = 11.5% III = 21.5% IV = 11.33% Unknown = 43%	RT = 24.3% CT = 55.5% Not specified when they received treatment	Not used	Cross-sectional	Questions about type, frequency, and duration of PA in the past month	Males, married, social or regular drinkers, good health and ≥ 5 years since the diagnosis → ↑ PA
Morielli et al. (2016)	18 Total 66.7% males 33.3% females	34-73 ( $M = 57.5$ )	72% IIIB	All received neoadjuvant therapy	Theory of planned behavior	Experimental	Godin Leisure Time Exercise Questionnaire (GLEQ)	Benefits: cardiovascular endurance, quality of life, self-esteem, better physical functioning Damage: Fatigue, diarrhea, and skin irritation Barriers: Side effects of neoadjuvant therapy and lack of motivation



Peddle et al. (2008)	413 Total 54% males 46% females	20-80 ( $M = 60$ , $SD = 7.5$ )	48% did not know cancer stage. Nothing more specified	CT = 53%. At least 1 year ago S = 96%. Not specified when they were operated	Self-determination theory	Cross-sectional	Godin Leisure Time Exercise Questionnaire (GLEQ)	↑Educational level, identified and introjected regulation → ↑PA
Speed-Andrews et al. (2014)	600 Total 58.3% males 41.7% females	31-92 ( $M = 67.3$ )	44.2% Early stage diagnosis	RT = 24% CT = 55% Adjuvant therapy completed	Theory of planned behavior	Cross-sectional	Question about level of physical activity	Barriers: physical condition and health status, musculoskeletal issues and treatment Facilitators: having time, doing it with others, proximity to the facilities
Speed-Andrews et al. (2012)	600 Total 58.33% males 41.67% females	31-92 ( $M = 67.3$ ) < 65 = 39% ≥ 65 = 61%	I = 12.66% II = 11.5% III = 21.5% IV = 11.33% Unknown = 43%	RT = 24.3% CT = 55.5% Adjuvant therapy completed	Theory of planned behavior	Cross-sectional	Godin Leisure Time Exercise Questionnaire (GLEQ)	Being younger, unmarried, higher educational and economic level, employed, not smokers, social drinkers, no radiation therapy, disease free, better health and fewer comorbidities → ↑PA
Spence et al. (2011)	10 Total 70% males 30% females	42-74 ( $M = 57.8$ )	II = 40% III = 60%	Chemotherapy completed 4 weeks ago	Not used	Experimental Qualitative	Questions about the level of physical activity: nothing, sporadic (< 3 sessions per week) or regular (≥ 3 sessions per week)	Benefits: Self-esteem, healthy habits, positivity, intention to perform PA, learning about the importance of PA, physical condition, recovering levels of energy prior to treatment and decreasing fatigue. Preferences: Need for trainer supervision. Start PA 2-4 weeks post-treatment, but can also be done during treatment, decreasing the intensity. Post-program PA: introduce strength training and everyone intends to continue.
van Putten et al. (2016)	5375 Total Time 1 = 45.6% of the total Time 2 = 29.32% of the total Time 3 = 25.58% of the total 54.6% males 45.5% females	< 55 = 7.6% 55-74 = 60% ≥ 75 = 32.4% $M = 69.6$ , $SD = 9.5$	I = 31.8% II = 38.6% III = 29.5%	Only S = 49.6% S + RT = 23.1% CT = 20.3% S + RT + CT = 7%	Not used	Longitudinal	European Prospective Investigation into Cancer (EPIC) Physical Activity Questionnaire	Fatigue, dyspnea, side effects of chemotherapy, urination problems, loss of appetite, weight loss, pain, not so young, without partner, obesity, anxiety, depression, worse quality of life and physical functioning → ↓MVPA ↑PA males vs. women

*Note.* ↑ = increase; ↓ = decrease; → = relation; AT = adjuvant therapy; S = surgery; RT = radiotherapy; CT = chemotherapy; PA = physical activity; LPA = light physical activity; MPA = moderate physical activity; VPA = vigorous physical activity; MVPA = moderate and vigorous physical activity; TPA = total physical activity.

Stage I: the tumor affects the wall of the colon or rectum without going through the muscular layer. Lymph ganglia not affected. Stage II: the tumor has infiltrated all the layers of the wall of the colon or rectum. It can invade the surrounding organs. Lymph nodes not observably affected. Stage III: the cancer has invaded the neighboring organs and affects the lymph nodes. Stage IV: the cancer has spread to distant organs of the colon or rectum, such as liver, lung or bones.

**Data analysis**

The information gathered in this review was analyzed by means of a conventional content analysis (Hsieh & Shannon, 2005). First, all of the items selected for the review were carefully read to gain a deep comprehension of all the information. Second, we selected the specific results of each article that represented the most important ideas or concepts for the aim of this review by establishing the factors related to physical activity participation and encoding the information in a text file. Each code was composed of the concrete result of each article and an identification label of its contents and the corresponding bibliographic reference. Lastly, using inductive reasoning, all the codes were classified in a system of categories and subcategories that provided meaning and order to the data and was useful for drafting the results of this study (see Table 2). The data were grouped into four large health categories: 1) Sociodemographic factors; 2) Health factors; 3) Prior experience and preferences; and 4) Motivational factors.

Table 2. *Categories and Subcategories of the Data Analysis*

CATEGORIES	SUBCATEGORIES
Sociodemographic factors	Age, gender, marital status, race, educational level, employment, and economic status.
Health factors	<p>Nonspecific: Obesity, anxiety, depression, quality of life, and healthy habits.</p> <p>Specific: Adjuvant treatment, side effects, benefits of physical activity during the disease, time of diagnosis, and recurrence.</p>
Prior experience and preferences	Experience of physical activity, group activity, type of physical activity, information and advice about physical activity, schedules, facilities, moment of performing the program during the treatment, and supervision of training.
Motivational factors	Self-efficacy, intention, attitude, expectations and beliefs, personal attributes, social and physical environment, basic psychological needs, and types of motivation.

**RESULTS**

The results of the 23 studies reviewed reveal that participation in physical activity in colorectal cancer patients is associated with different factors that we will try to reflect in this section,

taking into account the categories described in the Method section to facilitate the follow-up of the results.

### *Sociodemographic factors*

According to the sociodemographic factors, gender and age influence physical activity participation in patients with colorectal cancer. Thus, being younger and male are associated with meeting the recommendations of moderate and vigorous physical activity by reference institutions such as the American Cancer Society and the American College of Sports Medicine (Buffart et al., 2012; McGowan, Speed-Andrews, Rhodes et al., 2013; Speed-Andrews et al., 2012), and with higher levels of physical activity (Speed-Andrews et al., 2014). However, being older and female are related to less physical activity participation (Downing et al., 2015; Husson, Mols, Fransen, van de Poll-Franse, & Ezendam, 2015). In addition, women perceive themselves as being less fit, having more fatigue and poorer health status, and they show little physical activity interest and experience, which is associated with less exercise (Kang et al., 2014). On another hand, van Putten et al. (2016) found that the intensity of physical activity in colorectal cancer patients was relatively stable during and after treatment but men performed more moderate-vigorous physical activity than women. In this sense, another study revealed that women performed more light physical activity and men spent more time sitting (Lynch et al., 2016).

Examining age differences, the study of Chung et al. (2013) showed that patients under 60 years increased their levels of total physical activity during treatment with regard to the pre-diagnosis values, whereas those over 60 decreased both their total and moderate levels of physical activity during treatment. After finishing treatment, only the youngest patients increased their levels of total and vigorous physical activity. In the study of Kang et al. (2014), patients over 60 perceived more drawbacks to performing physical activity due to lack of physical fitness, whereas patients under 60 indicated a lack of time. In this sense, Fisher et al. (2016) showed that patients over 65 and with more than one comorbidity performed less physical activity and, to a greater extent, perceived ageing and comorbidities as barriers to physical activity participation. Another study indicated that younger patients preferred doing physical activity with their family and friends, receiving information by internet, and they were more interested in participating in a post-treatment program of physical activity (McGowan, Speed-Andrews, Blanchard et al., 2013).

Regarding the influence of marital status and personal relationships, the studies show contradictory results. On the one hand, Speed-Andrews et al. (2012) found greater levels of physical activity in patients who were not married or were single. In contrast, van Putten et al. (2016) showed that having a couple relationship is associated with doing more moderate-vigorous physical activity over time. Husson et al. (2015) observed that patients with fewer personal relationships complied with the recommendations of physical activity to a lesser extent.

However, there is only one study that has analyzed differences in physical activity participation in patients with colorectal cancer as a function of race, finding that Hispanics and non-Hispanic

Blacks were less likely to comply with the recommendations of light to moderate physical activity than were Whites. This reveals the influence of cultural factors in the physical activity participation in this collective (D'Andrea et al., 2014).

Some studies (Peddle, Plotnikoff, Wild, Au, & Courneya, 2008; Speed-Andrews et al., 2012, 2014) found that the higher the educational level, the higher the levels of physical activity shown by colorectal cancer patients. Having higher studies was related to greater participation in light physical activity and more compliance with the recommendations of moderate and vigorous physical activity by the institutions of reference (Buffart et al., 2012). On another hand, patients with a lower educational level were less interested in physical activity, less likely to want to do it at a health center, less interested in receiving information via email or in starting a post-treatment program of physical activity tailored to their characteristics (McGowan, Speed-Andrews, Blanchard et al., 2013).

With regard to the factors related to the work situation, Speed-Andrews et al. (2012) found higher levels of physical activity in employed patients who had a higher economic status. Likewise, other studies (Husson et al., 2015; Lynch et al., 2016; Peddle et al., 2008) found that being employed, having less occupational experience, and higher economic status, respectively, were related to complying with the recommendations of moderate and vigorous physical activity by the institutions of reference. In addition, a lower annual income has been associated with showing less interest in starting a physical activity program for patients with colorectal cancer (McGowan, Speed-Andrews, Blanchard et al., 2013). However, Kang et al. (2014) revealed that working full time entailed more drawbacks to adhere to physical activity, whereas other authors (Hawkes, Patrao, Baade, Lynch, & Courneya, 2015) found that being retired and having private health insurance were associated with doing sufficient physical activity twelve months after diagnosis.

### ***Health factors***

First, we will refer to the health factors non-specific to the disease. Obese patients performed less total physical activity, whereas normo-weight patients performed sufficient physical activity twelve months after diagnosis (Hawkes et al., 2015). With regard to intensity, it has been found that having a lower body mass index is related to performing more moderate and vigorous physical activity (Buffart et al., 2012), whereas the study of Lynch et al. (2016) revealed that men who have a higher body mass index performed more light physical activity and they spent more time sitting. In the same direction, normo-weight patients performed more moderate-vigorous physical activity over time with respect to obese patients (van Putten et al., 2016). Taking into account the results of Speed-Andrews et al. (2012), being obese reduces the likelihood of increasing levels of physical activity after treatment. On another hand, overweight or obese patients perceived surgical complications as obstacles to perform physical activity more than those who had a body mass index within the range of normality (Hawkes et al., 2015).

Regarding health and psychological well-being factors, it was found that the manifestation of physical symptoms of psychological stress (somatization) was related to lower levels of

physical activity 12, 24, and 36 months after diagnosis (Chambers, Lynch, Aitken, & Baade, 2009). In this same study, it was found that high levels of anxiety were related to a lower probability of increasing the levels of physical activity after diagnosis. In this sense, Hawkes et al. (2015) found higher levels of anxiety and lower perceived quality of life in patients who performed less physical activity. With regard to the intensity of the activity, van Putten et al. (2016) revealed that patients with less anxiety and depression, and better quality of life and physical functioning performed more moderate and vigorous physical activity over time.

With regard to health-related habits, various studies found that non-smokers and moderate social drinkers (versus those who drink more regularly) complied to a greater extent with the recommendations of physical activity (D'Andrea et al., 2014; Hussson et al., 2015; McGowan, Speed-Andrews, Rhodes et al., 2013; Speed-Andrews et al., 2012).

On another hand, some specific health factors are related to colorectal cancer and can promote or hinder physical activity participation in this population. Relapse-free patients who were not treated with radiation therapy had less comorbidities and, therefore, better health status, and performed more physical activity (Chambers et al., 2009; Lynch et al., 2016; Speed-Andrews et al., 2012). However, those who had a greater number of comorbidities, besides exercising less, perceived ageing and the comorbidities as a barrier to performing physical activity. Thus, Kang et al. (2014) found that participants who were receiving neoadjuvant (before surgery) or adjuvant (after surgery) radiotherapy and/or chemotherapy were more likely to fear exercising due to the adverse side effects of the treatment, the surgical pain, and their poorer health than those who had completed the treatment. In contrast, Buffart et al. (2012) noted that patients without comorbidities who were receiving chemotherapy (compared to those who were not receiving treatment) performed more moderate and vigorous physical activity, which, in this case, could be due to the fact that the former patients were the healthiest, the youngest, and with fewer comorbidities.

Chung et al. (2013) discovered that patients receiving adjuvant treatment did not change their amount of total or mild and moderate intensity physical activity compared to the pre-diagnosis levels. However, the amount of vigorous physical activity decreased, and fewer patients followed the recommendations of physical activity after diagnosis. Even so, the patients who had finished the treatment increased their levels of mild activity and their amount of total physical activity with regard to the pre-diagnosis levels but there was no significant change in the amount of moderate and vigorous physical activity compared with the pre-diagnosis levels.

The study of Courneya et al. (2005) showed that patients who received adjuvant treatment perceived more difficulties to perform exercise related to side effects such as fatigue and nausea compared to patients who had only undergone surgery. Likewise, Kang et al. (2014) found that patients who had not yet completed the treatment perceived more obstacles to participate in physical activity, such as the lack of time and information, poor health status, a tendency to be inactive, and surgical pain during exercise, in comparison to those who were not in treatment. In line with these results, Courneya et al. (2004) noted that patients who, in addition to having surgery, were treated with adjuvant therapy, participated less in physical activity.

Morielli et al. (2016), in a study with patients undergoing neoadjuvant treatment, found that exercise during chemo-radiotherapy produced improvements in cardiovascular endurance, quality of life, and self-esteem. In addition, after completing the neoadjuvant therapy, the most common perceived benefits of exercise were a better physical functioning and, again, better cardiovascular endurance and quality of life. These perceived benefits could promote participation in physical activity in patients with colorectal cancer. However, the most common perceived negative effects of exercise during chemo-radiotherapy, which can represent a barrier to participate in physical activity, were fatigue, diarrhea, and skin irritation. After completing chemo-radiotherapy, the most common perceived negative effects of exercise were fatigue and the hand-foot syndrome (redness, sensitivity, and possible peeling of the palms and soles which can develop numbness or tingling). The side effects of treatment were the most common difficulty to exercise during chemo-radiotherapy, whereas the lack of motivation was the most common difficulty after treatment.

Regarding the benefits of physical activity for this population's health, other studies found that patients who performed more physical activity showed less fatigue and improved chemotherapy-related side effects such as urination problems, loss of appetite, weight loss, pain, and dyspnea (van Putten et al., 2016); they reported to feel healthier, more physically fit, with fewer musculoskeletal problems (Kang et al., 2014); and they also felt they aged less and had fewer comorbidities (Fisher et al., 2016). The perception of this type of benefits could promote patients' stable acquisition of the habit of exercising. In addition, in a qualitative study, Spence, Heesch, and Brown (2011) found that, through exercise, patients' mental health improved, and their self-esteem, positivity, self-confidence, intention to perform physical activity, domestic tasks, and go back to work all increased. Patients also perceived that their healthy life habits improved and they learned the importance of physical activity, as well as of stretching and modulating the intensity of exercise, something about which they had no prior knowledge. Lastly, the patients felt that they recovered the levels of energy and physical fitness they had before the treatment. In another study, patients who performed more physical activity after diagnosis had better physical quality of life, better recovery after the disease and, therefore, better cancer-specific quality of life, and greater well-being (Hawkes et al., 2015). The study of Fisher et al. (2016) also analyzed the perception of the benefits of participating in physical activity: firstly, improved physical fitness, followed by improved health, maintenance and loss of weight, and lastly, psychological benefits. However, few believed that physical activity was useful to prevent colorectal cancer.

On another hand, the study of McGowan, Speed-Andrews, Blanchard et al. (2013) analyzed patients' interest in starting a post-treatment program of physical activity, reporting less interest in patients who had received the diagnosis a longer time ago, who did not experience cancer recurrence, who had a stoma, and who already participated in physical activity (compared with sedentary patients). In contrast, patients who experienced a cancer recurrence were more interested in the program of physical activity. Lastly, patients who were already disease-free were more interested and felt more capable of participating than those who were still sick.

Lastly, differentiating by gender, the health variables related to doing enough post-diagnosis physical activity in men were: not having fatigue and not smoking, whereas in women they

were: having undergone only surgery (without chemotherapy), not having fatigue, having a healthy body mass index, and not smoking (Lynch, Cerin, Newman, & Owen, 2007).

### *Prior experience and preferences*

Some authors indicate that having more experience of physical activity before diagnosis is related to greater participation in physical activity. Specifically, patients who already performed physical activity on a regular basis complied with the recommendations of the institutions twelve months after diagnosis (Courneya et al., 2004; Hawkes et al., 2015). In this sense, some studies (Fisher et al., 2016; Hawkes et al., 2015) observed that lack of time was the most frequent barrier in patients who did not perform physical activity before diagnosis in comparison with those who already exercised.

With regard to preferences, it was found that many patients felt the need for group-based physical activity programs (Dennis et al., 2013), although we note that patients with a stoma showed less preference for group participation in a fitness center (McGowan, Speed-Andrews, Blanchard et al., 2013). On another hand, a study carried out in Canada found that walking was the favorite physical activity both in summer and in winter (McGowan, Speed-Andrews, Blanchard et al., 2013), whereas another study of Canadian colorectal cancer patients found a greater preference for golf and, secondly, for bowling (McGowan, Speed-Andrews, Rhodes et al., 2013).

In addition, according to the study of McGowan, Speed-Andrews, Blanchard et al. (2013), patients who performed less physical activity showed less interest in doing group activities in a fitness center and in receiving information via email. Most of the patients were interested in receiving information about physical activity after diagnosis; they felt capable of participating in a physical activity program to increase their levels of activity, they preferred receiving information from a fitness expert in a health center, from brochures and printed material and receiving face-to-face personal advice, or from a video. As an example of interventions that have shown the efficacy of personal advice to increase participation in physical activity in this type of patients, we highlight the study of Hawkes et al. (2015), who carried out a 6-month intervention consisting of 11 telephone calls made by nurses, psychologists, or other health professionals. They also included a participant's handbook, motivational postcard prompts, and the use of the pedometer to stimulate and control the level of physical activity. The phone sessions addressed the experience with cancer, cancer symptoms, and strategies to improve health-related behaviors, in line with the recommendations and the individual goals established. The patients who formed part of this intervention group performed sufficient physical activity twelve months after diagnosis, increasing their levels compared to the pre-intervention levels.

Other authors identified that having time, participating with others, and having access to facilities were the most common facilitators of physical activity (Speed-Andrews et al., 2014). Likewise, Dennis et al. (2013) found that the patients considered their family and friends' support important, as well as receiving information about healthy habits from books or magazines.

Regarding time schedule preferences for physical activity in colorectal cancer patients, a study in Australia and Canada, measuring the levels of activity with accelerometers, has recently been carried out (Lynch et al., 2016). The results showed that the patients were less sedentary from eight in the morning until three in the afternoon and more sedentary from six in the afternoon. The percentage of time performing moderate-vigorous physical activity was lower between ten o'clock in the morning and three in the afternoon and higher from four to ten in the afternoon.

Lastly, Spence et al. (2011) carried out a study in Australia, analyzing patients' preferences after chemotherapy by means of semistructured interviews. The patients preferred to choose the type of exercise and a gym with air conditioning to regulate body temperature and be able to make more effort without suffering from the heat. They also preferred to start the physical activity program between 2 and 4 weeks after completing chemotherapy because they thought they needed time to recover from it. However, some preferred to start later but to maintain contact with the hospital during this time of recovery after chemotherapy, so as not to lose their motivation and commitment to the program. On another hand, half of the patients claimed that they could have started the program during the adjuvant treatment but decreasing the intensity. In contrast, the other half said that this would be very difficult due to the fatigue caused by the treatment and the physical and emotional energy required to overcome these symptoms. However, almost everyone believed that if they had performed exercise during treatment, they would have felt better when the treatment was finished.

In this study, the patients also positively valued the supervised individualized training, adapted to their characteristics, being able to choose the schedule, place, type of session, etc. In fact, they expressed difficulty to continue the physical activity program without the trainer's support and follow-up. They all considered the trainer's supervision necessary to achieve greater motivation and increase their levels of self-confidence. Concerning group physical activity, they thought that it would be more economical, they would have more social support, and would share experiences. However, most preferred to carry out the physical activity program individually and, if it was done in a group, they preferred their classmates to be cancer survivors or people whose life had recently been at risk. Lastly, after the program, all the participants intended to continue doing physical activity and proposed to include strength training and to maintain the level of aerobic exercise. They pointed out that it would be difficult to continue the frequency and the intensity of the workouts without the supervision of the trainer.

### ***Motivational factors***

Next, we present the factors associated with the motivational theories that explain human behavior, trying to understand which variables are related to the physical activity participation in this population. On the one hand, some studies have found higher levels of perceived self-efficacy in patients who perform more physical activity (Hawkes et al., 2015). On the other hand, based on the theory of planned behavior, Courneya et al. (1999b) found that the intention to exercise and exercise pre-diagnosis were related to post-surgery exercise. Moreover, the attitude towards exercise was the only variable that correlated significantly with the intention to



exercise. From this same theory, Morielli et al. (2016), trying to understand the influence of prior expectations before the physical activity program, revealed that patients perceived exercise during chemotherapy as more pleasant and less difficult than anticipated.

Continuing with the theory of planned behavior, among the most frequent beliefs about the benefits of physical activity (behavioral beliefs), Speed-Andrews et al. (2014) found that patients believed that physical activity improved physical fitness, it could improve their well-being and energy levels, and they felt better after exercising. With regard to normative beliefs, the most common belief was that physical activity should be approved by the members of the family, the oncologists, and one's best friend. As regards control beliefs, the factors that made them feel less confident of being able to overcome barriers were medical or health problems, pain, and the fact of returning to treatment (Speed-Andrews et al., 2014). In this sense, Courneya et al. (2004) found that patients who perceived less behavioral control, that is, they felt less capable of carrying out activity, showed less adherence to physical activity.

Using the ecological model of health behavior as the conceptual reference framework, Lynch et al. (2010) found that disease-specific barriers (fatigue, not feeling well enough to be physically active, diarrhea, and incontinence) and personal attributes (fear of injury, lack of enjoyment and interest, and being sedentary) were the greatest barriers both at five and at twelve months after diagnosis, followed by social environment (lack of time, not having the support of family, friends, and doctor) and physical environment (lack of access to facilities, the center perceived as unsafe and unattractive). All of these barriers were negatively related to participation in physical activity, except for the disease-specific barriers. Contrary to expectations, participants who showed a higher level of physical activity twelve months after diagnosis also had a greater number or intensity of disease-specific barriers. Perhaps the symptoms and side effects of the disease and treatment had decreased in general in this population, but they were more evident among those who submitted their body to a greater physical burden by exercising.

Lastly, Peddle et al. (2008) analyzed the factors that influenced physical activity participation in these patients from self-determination theory. The results showed that perceived autonomy support in close people was positively linked to satisfaction of the needs for autonomy, competence, and relatedness, and with identified regulation (a kind of motivation characterized by valuing the benefits of an activity). Relatedness positively predicted identified regulation and introjected regulation (a kind of motivation characterized by a feeling of guilt), autonomy positively predicted introjected regulation, and perceived competence positively predicted identified regulation. Both identified regulation and introjected regulation positively predicted physical activity.

## **DISCUSSION AND CONCLUSIONS**

The aim of this study was to provide a global view of the factors that facilitate or hinder the physical activity participation in patients with colorectal cancer by means of a systematic review of the literature. This is the first systematic review that specifically analyzes these factors in colorectal cancer. From all the information collected in this review, we reached

various conclusions that will allow us to establish recommendations for the promotion of physical activity in this population.

First, among the sociodemographic factors, the following favor participation in physical activity in patients with colorectal cancer: being male, white, younger, higher educational level and higher economic status, having a job that does not involve a very extensive work schedule, having less occupational experience, or being retired. However, some contradictory results emerge when analyzing the influence of marital status and personal relationships on physical activity. Speed-Andrews et al. (2012) found that being single is related to doing more physical activity, whereas van Putten et al. (2016) found that having a couple relationship favors the participation in moderate and vigorous physical activity. It is true that conjugal obligations can cause people to have less time to do physical activity, but the partner's support to carry out physical activity during the disease seems essential (Mackenzie, 2015).

With regard to health factors non-specific to the disease, we can conclude that obese patients perform less total physical activity, while patients with lower body mass index perform more moderate and vigorous physical activity. In addition, patients who are overweight or obese perceive surgical complications as barriers to exercise to a greater extent. Among the factors associated with psychological well-being, patients with more stress, anxiety, and depression perform less physical activity whereas those who have better quality of life and physical functioning participate more.

Regarding disease-specific health factors, patients who are not receiving adjuvant treatment, have fewer comorbidities, and perceive better quality of life perform more physical activity. During treatment, patients perceive more barriers to exercise related to the side effects, such as fatigue, diarrhea, or skin irritation (Morielli et al., 2016). Although in general, receiving adjuvant treatment hinders physical activity participation, one study (Buffart et al., 2012) found that chemotherapy was a predictor of moderate and vigorous physical activity. The authors of this study try to explain this result arguing that the patients who received chemotherapy were the healthiest, the youngest, and with fewer comorbidities, and perhaps they also received more advice about physical activity to alleviate the side effects of chemotherapy.

Considering the influence of prior experience and preferences on physical activity, we find that the patients who exercised the most were those who performed physical activity before diagnosis (McGowan, Speed-Andrews, Blanchard et al., 2013). Thus, lack of time was only a drawback for those patients who did not exercise before diagnosis. Moreover, most of the patients felt capable of doing physical activity, they preferred to receive information about physical activity after diagnosis through the personal advice of a fitness expert, and preferred to participate in group-based physical activity programs. Nevertheless, it should be highlighted that patients with a stoma showed less preference for group participation in a fitness center.

Having access to facilities was also a relevant factor for physical activity participation (Speed Andrews et al., 2014), and walking was the favorite physical activity both in summer and in winter (McGowan, Speed-Andrews, Blanchard et al., 2013). This result could be due to the fact that walking is a simple and accessible activity, it does not imply any cost and does not require

much knowledge about methods of physical training. However, some activities could be more recommendable to achieve greater levels of intensity that translate into greater benefits. As pointed out in the literature, physical activity decreases during and after treatment in spite of the fact that 150 minutes per week of moderate activity, or 75 minutes of vigorous activity, or an equivalent combination are recommended (Rock et al., 2012; Schmitz et al., 2010). In this regard, it is likely that patients do not know what other activities they can carry out, and specific programs for this type of patients are probably not provided in fitness centers.

Patients were less sedentary from eight in the morning until three in the afternoon and more sedentary from six in the afternoon, reaching higher levels of vigorous physical activity from four to ten in the afternoon (Lynch et al., 2016). Learning more about the variability of physical activity patterns at different moments of the day may be helpful to consider more appropriate strategies to promote physical activity. In the following section, we propose some recommendations from this evidence.

Lastly, we will discuss the motivational factors related to physical activity behavior in these patients. According to the theory of planned behavior, the attitude towards exercise was the only variable that was related to the intention to exercise, which in turn, was linked to performing more post-surgery physical activity (Courneya et al., 1999b). With regard to beliefs (Speed-Andrews et al., 2014), thinking that physical activity would improve one's physical condition, energy level, and well-being was associated with performing more physical activity. In addition, the patients thought that physical activity should be supported by relatives, friends, and doctors. Lastly, medical or health problems, pain, and relapse and return to treatment, were the most frequently reported control beliefs that hindered physical activity participation. Based on self-determination theory, one study showed that autonomy support, satisfaction of the three basic psychological needs (autonomy, competence and relatedness), and identified and introjected regulations were important variables for physical activity participation in patients with colorectal cancer (Peddle et al., 2008).

The results of this review have allowed us to sort and classify all the existing information on this topic to date. When designing physical activity programs for colorectal cancer patients, sociodemographic features, health factors, prior experience and preferences, as well as certain motivational factors should all be valued. The different conclusions reached should be taken into account for the development of physical activity in this population, considering the important benefits that can be achieved.

## RECOMMENDATIONS

Drawing from the results obtained in this review, we present the following recommendations to promote physical activity in patients with colorectal cancer:

- 1) The existence of a less active profile in these patients, together with the physical and psychological side effects caused both by the disease itself and by the treatment, reveals the need to create specific programs of physical activity targeting this population, which contemplate their personal features. Special attention should be paid to the promotion of physical activity among older patients, women, and patients

with lower socioeconomic status and educational level, because these sectors of the population are less interested in doing physical activity.

- 2) The programs should incorporate motivational strategies to foster a positive climate during the sessions of physical activity, ensuring that the participants feel respected and valued. Social environments should not only be inclusive but also the structure of the exercise facilities should favor the inclusion of patients with colorectal cancer. For example, the incorporation of showers and changing rooms that comply with the privacy of patients with a stoma, who may suffer from a problem related to body image, would be desirable.
- 3) It would be interesting to inform the patients about the benefits of physical activity for their disease, conducting seminars in the health centers. These seminars could include testimonials from patients who have already overcome the disease and who carried out physical activity during its course. This could improve patients' attitude towards physical activity and their intention to exercise.
- 4) Professionals from the sport sciences should be incorporated into the multidisciplinary medical team so that they could advise patients, recommend the best physical activity for each individual, and design individualized training programs. The competence of the professionals in charge of the direction of physical activity programs is essential because colorectal cancer patients are in a delicate health situation and need to be assured that their exercise will be carried out in conditions of safety to obtain the most benefits and take as few risks as possible.
- 5) If future studies with accelerometers confirm that patients with colorectal participate less in physical activity in the morning, programs of active rest during working hours could be designed, and active commuting for everyday trips could be fostered. Likewise, it would be interesting to develop physical activity programs in the afternoon time slots which patients usually dedicate to leisure.
- 6) Group activities to promote social relations among patients who are engaged in exercise programs could be designed, and also adapting the training loads to each person and offering autonomy. Thus, more self-determined motivation would be achieved and, thereby, more involvement and adherence to physical activity. To achieve these goals, it would also be necessary to promote patients' perception of competence, so they will feel capable to participate in physical activity programs.
- 7) Family, friends, health professionals, and other patients/peers should collaborate in the promotion of an active and healthy lifestyle in people suffering from colorectal cancer. Social support can be essential for these patients to acquire habits of physical activity that can contribute to alleviating the symptoms of their disease and to substantially improving their quality of life.

## LIMITATIONS OF THE LITERATURE AND FUTURE RESEARCH DIRECTIONS

In spite of the results found in this review, we also identified important gaps in the literature that we shall detail in the following paragraphs. First, it should be noted that, out of all the reviewed articles, only 5 used an experimental design. There is still a lack of knowledge about the type, frequency, duration, and intensity of physical activity that are necessary to optimize

the physical and psychosocial benefits and reduce the risks in patients with colorectal cancer at different phases of treatment and as a function of the types of treatment. Increasing this knowledge is essential to improve the therapeutic effects of exercise and to promote physical activity participation in these patients. In addition, more studies are needed to implement and analyze the effect of strategies to motivate these patients to participate in physical activity.

It is also necessary to highlight that only one study collected information by means of qualitative techniques. There is a lack of qualitative studies that analyze in depth the reasons that lead patients with colorectal cancer to participate in physical activity, as well as the barriers they find. It would be interesting to combine experimental designs with qualitative techniques of data collection, attempting to confirm the psychosocial effects of specific group-based physical activity programs for this population, as well as to identify possible problems that may arise during the course of such programs. Thereby, we would obtain more vital and comprehensive knowledge to design and implement appropriate programs of physical activity for these patients.

Another of the limitations found in this review is that most of the studies do not use a theoretical framework of reference. Of the 23 articles that make up this systematic review, only 5 studies used the theory of planned behavior, 2 applied the ecological model of health behavior, and only 1 study is based on self-determination theory to analyze the factors that influence adherence to physical activity in patients with colorectal cancer. However, as some authors indicate (Biddle et al., 2012), it is necessary to apply theoretical frameworks that guide the studies and allow us to understand the information accurately and in a structured way. Accordingly, it is striking that only one study applied self-determination theory with colorectal cancer patients, taking into account that this theory has proven to be one of the most relevant to study behavior in health contexts (Ng et al., 2012).

Besides, most of the studies measure physical activity by means of questionnaires, except for one study that incorporated a more objective measure using accelerometry. New studies are necessary to analyze the levels of physical activity in patients with colorectal cancer objectively, in order to determine their relationships with different factors that may increase or decrease them. The increasingly advanced development of wearable devices for tracking physical activity could facilitate this task accordingly.

Lastly, out of the 23 reviewed articles, 11 studies analyzed the factors associated with the performance of physical activity during the complementary treatment to surgery, another 9 were carried out after finishing the treatment or only a minority of patients was in treatment, and 3 studies did not specify the time of treatment. From our viewpoint, the differences between the factors that promote or hinder physical activity participation during and after the complementary treatment to surgery remain unclear. A greater analysis of these factors throughout the entire process of the cancer is necessary (Milne, Wallman, Guilfoyle, Gordon, & Courneya, 2008), even analyzing the barriers that may appear during a “chemotherapy week” compared to a week of rest from chemotherapy, to know more specifically how the side effects of the treatment affect the levels of physical activity. Basically, although knowledge of the factors that promote physical activity participation in patients with colorectal cancer has

advanced, we must continue delving into this so that this population can benefit from the positive effects of physical activity, even more so when taking into account the high incidence and severity of the disease.

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