TNO Quality of Life

Prevention and Health
Wassenaarseweg 56
P.O. Box 2215
2301 CE Leiden
The Netherlands

www.tno.nl

T +31 71 518 18 18
F +31 71 518 19 10
info-zorg@tno.nl

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Exercise in adult cancer patients and survivors

Efficacy of exercise and recommendations for exercise programs in the treatment and survivorship stage

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Author(s) P.Z.A. den Heijer
W.M.A. Jongert
T. Takken

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Exercise in adult cancer patients and survivors

Efficacy of exercise and recommendations for exercise programs in the treatment and survivorship stage

Name student: P.Z.A. den Heijer

Student number: 3140547

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Name university: University Utrecht

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First supervisor: M.W.A. Jongert, MSc

Second supervisor: T.Takken, PhD

Name internship: Netherlands Organisation of Applied Scientific Research (TNO), Department Quality of Life

Place internship: Leiden

Preface

This thesis represents the final stage of the Master of Science Physical Therapy Research. This thesis consists of two articles: *"Efficacy of exercise for adult cancer patients and survivors; A best evidence synthesis of systematic reviews and meta-analysis"* and *"Recommendations for exercise programs for adult adults cancer patients and survivors; a review of determinants of intentions and adherence, group cohesion, barriers, exercise preferences and intensity, frequency, duration of training"***.**

I have worked on this thesis with much effort and enthusiasm. I hope, you read this thesis with as much interest and pleasure.

I especially want to thank Tim Takken and Tinus Jongert for their critical comments during the period I work on this thesis.

20 May 2008

Pamela den Heijer

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Efficacy of exercise for adult cancer patients and survivors

A best evidence synthesis of systematic reviews and meta-analysis

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Title: Efficacy of exercise for adult cancer patients and survivors; A best evidence synthesis of systematic reviews and meta-analysis

Name author 1: P.Z.A. den Heijer, MSc, Physical Therapist, Health Scientist, Student Master of Science Physical Therapy Research, Utrecht University the Netherlands.

Name author 2: M.W.A. Jongert, MSc, Exercise Physiologist, Netherlands Organisation of Applied Scientific Research (TNO), Department Quality of Life, Leiden, the Netherlands

Name author 3: T. Takken, PhD, Medical Physiologist, Department of Pediatric Physical Therapy & Exercise Physiology, Wilhelmina Children's Hospital, University Medical Center Utrecht, the Netherlands

Corresponding author: P.Z.A. den Heijer, email: pdenheijer@gmail.com

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Background

As a result of improved life expectations for individuals suffering from cancer, the past decennium has shown increased attention to the relevance of exercise in the prevention of symptoms like increased fatigue, decreased physical functioning and quality of life.

Objective

To determine the efficacy of exercise on fatigue, physical functioning and quality of life, in adult cancer patients and survivors.

Methods

From January 1981 until January 2008, literature has been searched in Pubmed, Cinahl, PSYCinfo, Cochrane Library and PEDro. In order to include publications, five criteria were addressed: (1) the publication has been written in English, French, German or Dutch, (2) systematic review or a meta-analysis, (3) the research population concerned adult with cancer in the treatment stage or post-treatment stage, (4) the defined intervention related to physical training, and (5) description of one of the outcome measures: fatigue, physical functioning or quality of life. The methodological quality of these publications was assessed by one researcher, by applying the 'Overview Quality Assessment Questionnaire'(OQAQ). Based on this methodological appraisal, a best evidence synthesis was carried out according to the elements of 'Grading of Recommendations Assessment, Development en Evaluation' (GRADE).

Results

The search resulted in 278 publications, of which 238 are excluded based on the title, 17 based on abstract and four based on the design. Besides, two publications were excluded based on the offered intervention and two studies because of the absence of outcome measures relevant to this systematic review. Finally, 15 publications were included. Analysis of these publications have shown that the effect of exercise is inconsistent on fatigue, significant positive on quality of life and physical functioning in the treatment stage and positive on fatigue, quality of life and physical functioning in the post-treatment stage.

Conclusions

Regarding adult cancer patients, analysis have shown high-quality evidence for the effect of exercise on physical functioning and quality of life (only breast cancer) in the treatment stage. However, in the treatment stage low-quality evidence has been found for the effect of exercise on fatigue. In addition, during the post-treatment stage, moderate-quality evidence argues for the effect of exercise on fatigue, physical functioning and high-quality evidence for the effect of exercise on quality of life in cancer survivors.

Keywords: *exercise, systematic review, adults, cancer*

Introduction

The medical treatment for cancer patients exists often of intensive medical treatments, with great physical, emotional and social consequences (1). Cancer-related fatigue is a physical consequence, which exists in 60% to 100% of cancer patients (2;3). As a consequence of the disease and its treatment, worsening of the physical condition is common, that results in a decline in the performance of daily activities (1). Many adult cancer patients and survivors experience a significant decline of physical functioning (1). As a consequence, cancer patients and survivors often have increased risk for becoming physical inactive. One physical consequence, which can cause physical inactivity is decreased physical capacity. This is known as a part of the negative effects of de medical treatment on the cardiopulmonary-, neurological- and muscular system (4-6).

Moreover, there are other reasons for increased risk of physical inactivity during or after the medical treatment for cancer. First, the activity level decreases after being diagnosed for cancer and starting the medical treatment, for the reason that the symptoms and the side effects of the disease and its treatment. Post treatment, individuals rarely reach their level previous to the diagnosis (2;5). Second, insufficient advice to rest causes irreversible loss of energy which greatly influences all organs. This causes a vicious circle of inactivity (2;7;8). Thirdly, inactivity increases the risk for different forms of cancer (e.g. breast cancer and colon cancer). Patients with these types of cancer are inactive before the treatment period and would be inactive during and after treatment (5).

For years, it was usual to prescript rest after the treatment period (2;7;8). However, there is a change under medical specialists. More and more individuals are stimulated for exercise after medical treatment (7). It is suggested that exercise during and after treatment is an effective method for the increased physical and mental functioning (7). Nowadays, there is no general

guideline in which stimulation to stay active during or after their treatment for cancer is circumscribed (7).

Theoretical framework

Moderate intensive physical activity compared with inactivity has a positive effect on physical functioning, fatigue and overall quality of life (1). Based on these findings the model in figure 1 was designed. According to this model, an intensive medical treatment of cancer has a negative influence on physical functioning, quality of live and fatigue. In case a person is physical inactive for the reason of decreased physical functioning, quality of life and increased fatigue, this person becomes in a negative spiral. There is no change in symptoms.

Participating in an exercise program would positively influence physical functioning, quality of life and fatigue in adult cancer patients and survivors. There would also be an indirect effect of increased physical functioning on quality of life. The same indirect effect counts for decreased fatigue on quality of life. There is a statistic significant relationship between cancer related fatigue and decreased physical functioning and quality of life (2).

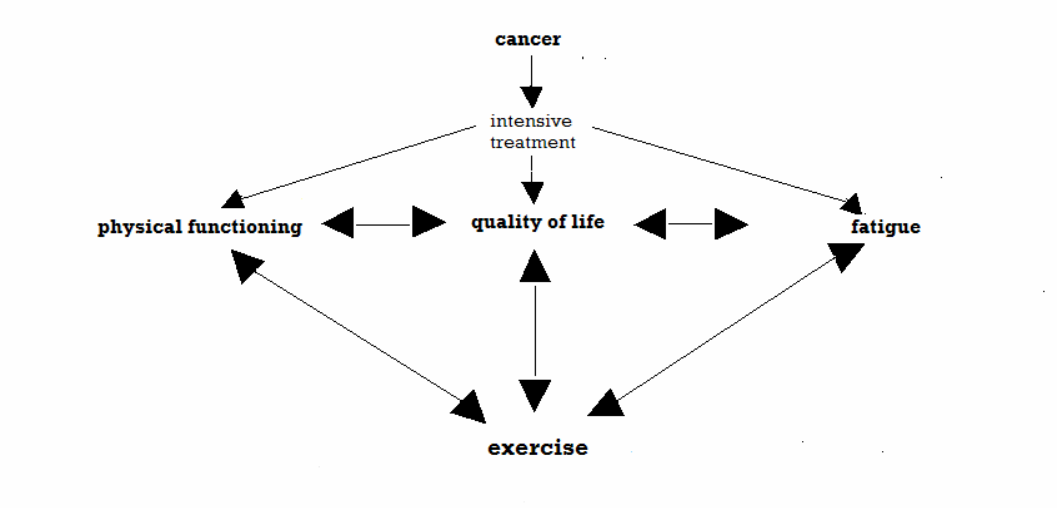

figure 1: model fatigue, physical functioning, quality of life (based on information of Chorus et al.(1))

PEACE

In order to structure the organisation of research on the effect of exercise in cancer patients and survivors, Courneya et al. (9) created a conceptual framework called 'Physical Exercise Across the Cancer Experience' (PEACE). In this framework, two major stages could be distinguished (pre-diagnosis and post-diagnosis) related person's experiences during cancer (figure 2).

These major stages are divided into six time periods (pre-screening, screening, pre-treatment, treatment, post-treatment, resumption) (table 1). There are eight cancer outcome controls formulated (prevention, detection, buffering, coping, palliation, rehabilitation, health promotion and survival). This systematic review is focused on the treatment stage and post-treatment stage (circle figure 2). In the treatment stage, coping is an important outcome of exercise (9). In this stage, exercise can minimize the symptoms of cancer and side effects of the medical treatment, like fatigue. Other important outcomes are quality of life and functional capacity (9). If the medical treatment succeeds, rehabilitation is an important next step in regaining. The function of the rehabilitation stage is to get a person in good health. This means that the person has to recover from all side effects. The main outcomes of interest are physical fitness and quality of life (9).

In 2003 an adapted framework was created. The 'Physical Activity and Cancer Control' (PACC) framework (10;11). In this systematic review the PEACE framework has been used and not the PACC framework. In the PEACE framework physical functioning and quality of life are key outcomes, while the PACC framework focuses on outcomes like illness and treatment effects are outcomes (10;11).

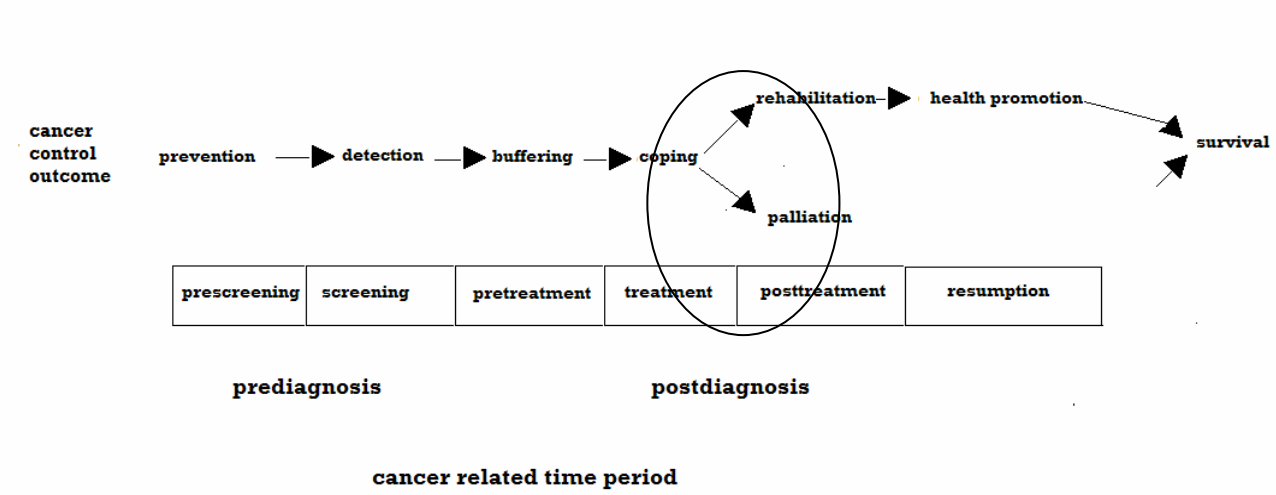

figure 2: PEACE framework (9)

table 1; stage of the PEACE framework (9)

Stage	Description
Pre-screening	Entire time period prior to cancer screening.
Screening	Time from the screening test until definitive result is known.
Pre-treatment	Time period after a definitive cancer diagnosis up until treatment is initiated and may also include the time between successive treatments.
Treatment	Time a person is actively being treated for cancer.
Post-treatment	Time period begins when the acute effects of medical treatments have dissipated and lasts until the person has recovered any major losses in function.
Resumption	Time period begins when the person is considered to have completed short-term recovery and is attempting to resume normal activities.

Reviews (re)considered

As a result of improved life expectations for individuals suffering from cancer, the last decade showed an increasing attention to the relevance of exercise in the prevention of cancer related symptoms like increased fatigue, decreased physical functioning and quality of life (1;12). Consequentially, improved life expectations for individuals suffering from cancer and indications for positive effects of physical activity, quality of life and fatigue, it is essential to know whether exercise is effective in patients suffering from cancer in the treatment and post-treatment stage. It is important to know whether exercise during and after treatment is an appropriate intervention for this group and if exercise can improve the health status of these patients (13).

Different systematic reviews summarized the effect of exercise by adult cancer patients and survivors on fatigue, physical functioning and quality of life (2;4;7;8;12-23). However, as far as I know, there has never been published a systematic review of systematic reviews and meta-analyses about this subject. Courneya et al. (10) published an overview article of all publications of exercise of adult cancer patients and survivors during the past five years. This article also included ten reviews. The scope of this article was not to provide a systematic review of all physical activity and cancer research. The article highlighted the major scientific advances of physical activity and cancer research over the past five years.

Compared with the review of Courneya et al. (10), this review proposes from a systematic perspective an overview of the conclusions made in different reviews and meta-analyses with an additional indication of the quality of evidence. Besides, a systematic review of systematic reviews and meta-analysis, emphasises the evidence on the effect of exercise by adult cancer patients and survivors (figure 3). The proposed effects could be used to indicate the necessity of exercise during and after treatment, to reduce the symptoms en side effects, like increased fatigue, decreased physical functioning an decreased quality of life.

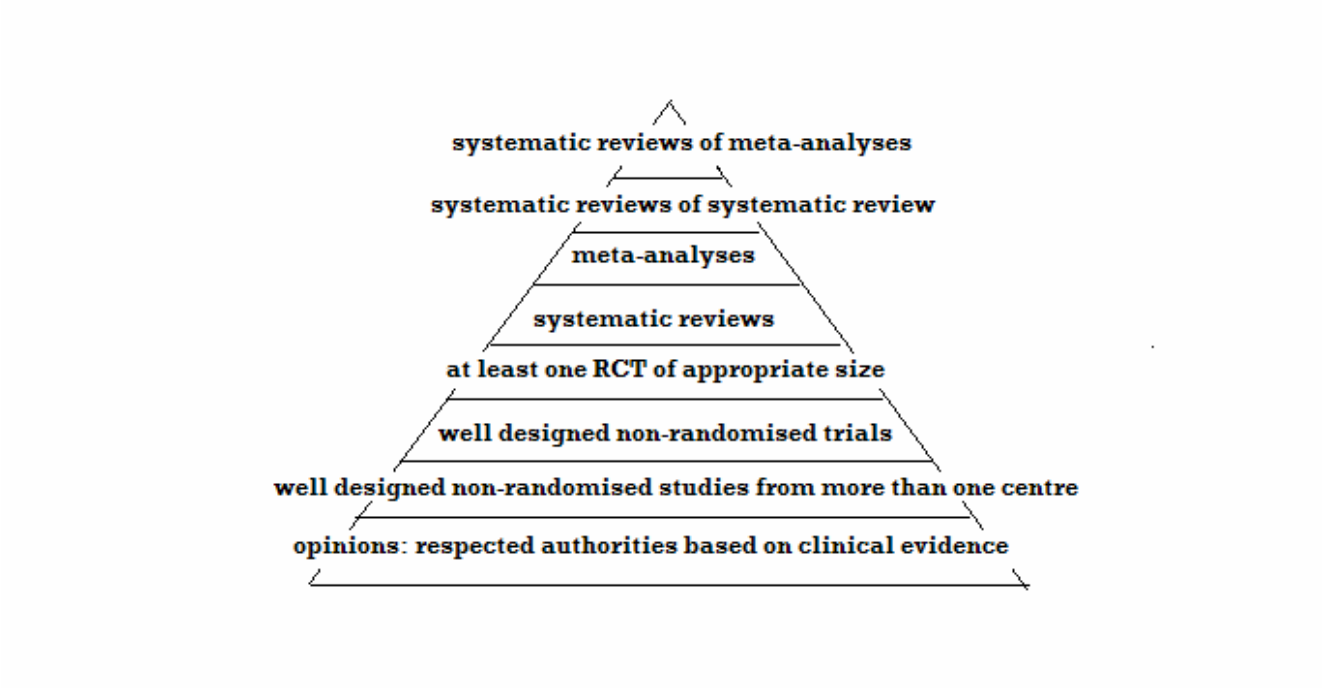

figure 3; hierarchy levels of evidence (24)

Clinical relevance

Supervised exercise can have positive effects on many individuals suffering from cancer, even though these individuals potentially can complete an exercise program (5). There are four surplus values of supervised exercise by a physical therapist. The physical therapist has knowledge of (I) biopsychosocial model, (II) pathology and physiology, (III) co morbidity, (IV) side effect of the treatment of cancer.

In line with the increasing number of individuals treated for cancer or cancer survivors and those experiencing side effects, professionals, like physical therapist, need relevant knowledge of the effects of exercise (13). Determining the effect of exercise per stage (treatment and post-treatment) in this review is crucial. Accordingly, given this stage, the effect of exercise can be reflected on outcome measures fatigue, physical functioning and quality of life.

Research question

What is the best evidence for the effect of exercise in adult cancer patients and survivors, in the treatment stage or post-treatment stage, on fatigue, physical functioning and quality of life?

Method

Search strategy

A computer aided search of Pubmed, Cinahl, PSYCinfo, Cochrane Library and PEDro was performed by one researcher (PdH), in the period January 1981 until January 2008, to identify relevant systematic reviews and meta-analyses. The following keywords where used in different combinations and plural forms: 'adult'; 'neoplasm'; 'tumor'; 'malign neoplasms'; 'neoplasms, malign'; 'malign neoplasm'; 'neoplasm, malign'; 'cancer'; 'activity, motor'; locomotor activity'; 'activity, locomotor'; 'physical activity'; 'activity, physical'; 'exercise, physical'; 'physical exercise'; 'exercise, aerobic'; 'aerobic exercise'; 'exercise, isometric'; 'isometric exercise' 'graded activity'; 'behavioural graded activity'; 'graded exercise'; 'quality of life'; 'life quality'; 'fatigue'; 'lassitude'; 'physical functioning'; 'muscle strength'; 'strength, muscle'; 'physical endurance'; 'endurance, physical'; 'literature, review'; 'state-of-the-art review'; 'review, state-of-the-art'; 'state of the art review'; 'review, systematic'; 'review, tutorial'; 'review, academic'; 'review, multicase'; 'review literature'; 'literature review' (appendix 1).

Selection

All abstracts were studied by one researcher (PdH). If the abstract met the inclusion criteria (table 2), the article was retrieved full-text. After reading the full text version the researcher decided whether the article was included in the review.

Table 2; inclusion criteria

Design: systematic review or meta-analyses
Language: Dutch, German, French or English
Patients: adult cancer patients and survivors (all forms) in the treatment or post-treatment stage
Intervention: exercise
Comparison: Undefined
Outcome: fatigue, physical functioning, quality of life

Definitions

Adults – persons aged 18 years or older.

Treatment – medical treatment for cancer by a medical specialist with one or in a combination with the following methods: surgery, radiotherapy, chemotherapy, hormone therapy, immune therapy, bone marrow transplantation, gene therapy, vaccine therapy or androgen deprivation therapy.

Physical activity – "any bodily movement produced by the skeletal muscles that results in a substantial increase in energy expenditure over resting levels (intensity at least moderate ≥ 50% of maximal exercise capacity)" (11) .

Exercise – "a form of leisure-time physical activity that is usually performed on a repeated basis over an extended period of time" (exercise) with the intention of improving fitness, performance or health (11).

Cancer-related fatigue – "a persistent, subjective sense of tiredness related to cancer or cancer treatment that interferes with usual functioning" (3). Cancer-related fatigue includes both tiredness and fatigue.

Tiredness – "characterized by forgetfulness, impatience, gradual heaviness or weakness in muscles after work, sleepiness alleviated by rest, but no change in social interaction or decreased control over body processes" (25).

Fatigue – "characterized by difficulty in concentrating, anxiety, a gradual decrease in stamina, difficulty sleeping, decreasing control over body processes some of which could be maintained with extra mental effort, and the limitation of social interaction to only those activities of particular significance" (25).

Physical functioning – "ability to ambulate and to perform normal activities of daily living" (2). Physical functioning also include physical fitness in this review.

Physical fitness – "the ability to perform muscular work satisfactorily and commonly includes the components of body composition, cardio respiratory fitness, muscular fitness, flexibility, and agility/balance" (11).

Quality of life – functioning of a person on biopsycosocial side and the subjective evaluation of this functioning.

Systematic review – an empirical research, following a transparent and systematic method, with an explicit research question.

Methodological quality

One reviewer (PdH) assessed the methodological quality with a modified version of the 'Overview Quality Assessment Questionnaire'(OQAQ) (26;27) (table 3). The OQAQ is a validated checklist to assess the methodological quality of systematic reviews (28). This checklist has a strong face validity (28). Nine questions could be rated with 'met', 'unclear/partly met' or 'not met' (27). The overall scientific quality of each systematic review was labelled with 'minor limitations' (high quality, at least seven of the criteria 'met'), 'moderate limitations' (moderate quality, at least four of the criteria 'met') or 'major limitations' (low quality, less than four of the criteria 'met') (27).

Clinical relevance

The clinical relevance is assessed by one researcher (PdH) following the questions presented in table 4 (29). The five questions of clinical relevance could be rated with 'met' (described in the review) , 'unclear/partly met' (not clear described in the review) or 'not met'(not described in the review).

Table 3; modified version of the OQAQ(27)

1) Is the search strategy described in enough detail for the search to be reproducible?
2) Was the search for evidence reasonable comprehensive?
3) Were the criteria used for deciding which studies to include in the review reported?
4) Was bias in the selection of articles avoided?
5) Were the criteria used for assessing the validity of the studies that were reviewed reported?
6) Was the validity of all the studies referred to in the text assessed using appropriate criteria in analyzing the studies that are cited?
7) Were the methods used to combine the findings of the relevant studies (to reach a conclusion) reported?
8) Were the findings of the relevant studies combined (or not combined) and analyzed appropriately relative to the primary question the review addresses and the available data?
9) Were the conclusions made by the author(s) supported by the data and/or the analysis reported in the review?

Table 4; clinical relevance (29)

1) Are the patients described in detail so that you can decide whether they are comparable to those that you see in your practice?
2) Are the interventions and treatment settings described well enough so that you can provide the same for your patients?
3) Were all clinically relevant outcomes measured and reported?
4) Is the size of the effect clinically important?*
5) Are the likely treatment benefits worth the potential harm?

* Interpreted by one researcher (PdH) as a effect that is valuable in the practice of physical therapists. This result might be applied in the practice of the physical therapist.

Data extraction

One researcher (PdH) extracted the relevant study characteristics. In order to compare the similarity of included primary studies per systematic review or meta-analysis the title (including author, date of publication and journal) of every primary studies was extracted. The same researcher executed the qualitative and quantitative data analysis.

Data analyses

Quantitative

The effects on the different outcomes in the included reviews and meta-analysis were compared. In case the effect size was reported, it was adopted as a measure to compare the effects of the different outcomes (table 5). The description of the quantitative results distinguishes systematic reviews of RCTs/CCTs and meta-analyses and systematic review of (quasi)experimental- and non experimental studies.

Table 5; Relative size of Cohen's d(31)

Negligible effect	-0.15-0.15
Small effect	0.15-0.40
Medium effect	0.40-0.75
Large effect	0.75-1.10
Very large effect	1.10-1.45
Huge effect	>1.45

Qualitative

Relevant study characteristics were extracted from the included reviews and presented in tables. These tables make a distinction between systematic reviews of RCTs/CCTs and meta-analyses, and systematic review of (quasi)experimental- and non experimental studies.

Principles from the 'Grading of Recommendations Assessment, Development, and Evaluation' (GRADE) were used to assess the quality of evidence for each outcome (fatigue, physical functioning and quality of life) (27;30). Following the GRADE principles there are four levels of quality of evidence. This levels are presented in tables 6 and 7. The description of the qualitative results distinguished systematic reviews of RCTs/CCTs and meta-analyses, and systematic review of (quasi)experimental- and non experimental studies.

Table 6; quality of evidence based on principles of GRADE (27;30)

High-quality of evidence: one or more updated, high quality systematic reviews that are based on at least two high-quality primary studies with consistent results. *Moderate-quality evidence:* one or more updated systematic reviews of high or moderate quality: - based on at least one high-quality primary study - based on at least two primary studies of moderate quality with consistent results *Low-quality evidence:* one or more systematic reviews of variable quality - based on primary studies of moderate quality - based on inconsistent results in the reviews - based on inconsistent results in primary studies No evidence from systematic reviews: the is no systematic review identified on this topic.

Table 7; definitions of grade evidence (30)

High-quality of evidence: further research is unlikely to change our confidence in the estimate effect. *Moderate-quality of evidence*: further research is likely to have an important impact on our confidence in the estimate effect and may change the estimate. *Low-quality of evidence*: further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.

Results

Selection of reviews

The search strategy resulted in 278 unique articles (figure 7). Two hundred and eighty articles were excluded based on title. Seventeen articles (8;22;32-46) were excluded based abstract and four articles (17;47-49) were excluded based on design. Finally, two articles (50;51) were excluded because of an inappropriate intervention (tai chi). Two articles (52;53) because they did not measure outcomes relevant for this review; they did not reported one of the outcomes fatigue, physical functioning or quality of life. Finally, fifteen articles (2-4;7;12-16;18-21;23;54) were included.

All articles were systematic review, meta-analyses or a combination of both. Five articles (4;7;19;20;23) were systematic reviews of RCTs or CCTs. One article (14) was a meta-analyses. Two articles (13;21) were a combination of a systematic review and a meta-analyses. All other articles (2;3;12;15;16;18;54) were systematic reviews of experimental, non-experimental, quasi-experimental, observational or descriptive studies.

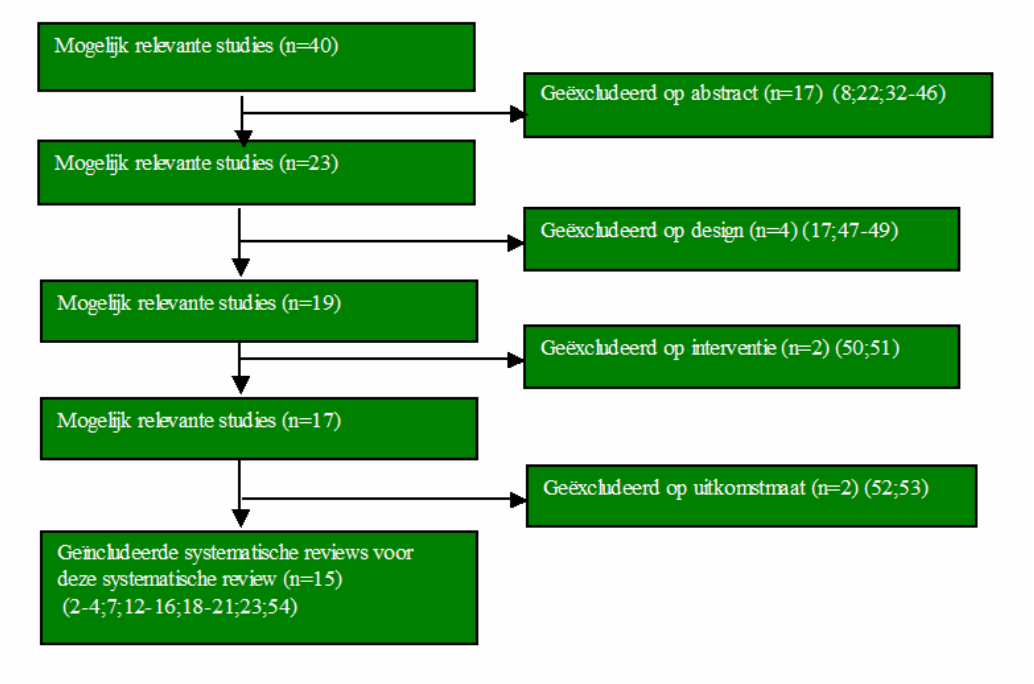

figure 7; flow diagram included reviews

Primary studies per review

The fifteen included reviews and meta-analyses distinguished hundred and twelve primary studies. Of these primary studies, 52 studies were included in only one review (table 8a and 8b). All other articles were reported in two or more reviews.

Description of study characteristics

There is large diversity in the number of primary studies per systematic review (range 9-34). The size of the population per review varies from 365 to 1866 participants There is a large variability of types of cancer included in the reviews, like leukaemia, prostate cancer, colon cancer, lung cancer, Hodgkin, non-Hodgkin, stomach cancer, skin cancer. In every included review breast cancer was described. Medical treatment existed mostly of radiotherapy, chemotherapy, hormone therapy or bone marrow transplantation (table 9a and 9b). The in- and inclusion criteria are presented in appendix 2.

Description of interventions

The exercise interventions were during or after medical treatment. The interventions existed in most studies of aerobic exercise (50-90% maximal heart rate (MHR), 50-85% maximal oxygen consumption (VO_{2max}) or 25-85% heart rate reserve (HRR)), resistance exercise (strength) 8-24 repetitions, 1-3 sets) or a combination of these two.

The intervention period varied from one session to seven sessions per week. The duration of the session varied from 10 to 120 minutes. The intervention was individual or in a group, both with or without supervision (table 10a en 10b). None of the reviews described control of the performance of the exercise and desired intensity.

Description of measurements

Heterogeneity of measurements was common in all systematic reviews and meta-analyse for assessment of the outcomes fatigue, physical functioning and quality of life (table 11).

Table 8a; overview primary studies (RCTs/CCTs) per review

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Allgayer et al.(55)				X											
Battagliani (56)						X	X								
Berglund et al.(57)			X	X	X										X
Berglund et al. (58)			X		X										
Berglund et al. (59)				X	X										X
Berglund et al. (60)					X										
Buettner et al. (61)					X								X		
Burnham et al. (62)	X		X	X	X	X		X		X				X	
Campbell et al. (63)		X			X	X	X								
Coleman et al. (64)			X		X	X			X	X				X	
Coleman et al. (65)					X				X						
Courneya et al. (66)						X							X		
Courneya et al. (67)				X											
Courneya et al. (68)	X		X	X	X		X	X	X						X
Courneya et al. (69)			X	X	X			X	X	X					
Courneya et al. (70)			X	X	X					X					
Crowley (71)		X					X								
Cunningham et al. (72)	X		X	X	X							X	X	X	
Dimeo et al. (73)	X		X	X	X			X				X	X	X	
Dimeo et al. (74)			X	X	X			X		X			X	X	
Dimeo et al. (75)								X		X		X		X	
Dimeo et al. (76)	X		X	X		X		X		X		X		X	
Djuric et al. (77)				X											
Drouin (78)		X			X	X	X								
Fairey et al. (79)			X	X											
Galantino et al. (80)					X										
Hayes et al. (81)			X	X	X										
Hayes et al. (82)			X		X			X						X	
Hayes et al. (83)					X										
Jones et al. (84)				X											
Kolden et al. (85)				X											X
MacVicar et al. (86)		X		X	X					X	X		X		X
MacVicar et al. (87)	X	X	X	X	X		X				X	X	X	X	X
McKenzie et al. (88)			X	X			X								
McNeely et al. (89)			X	X											
Mello et al. (90)			X		X									X	
Mock et al. (91)			X	X	X					X	X		X		X
Mock et al. (92)		X	X	X	X							X	X		X
Mock et al. (93)			X	X					X	X				X	X
Mock et al. (94)		X		X		X	X			X					
Mustian (95)							X								
Na et al. (96)	X		X	X	X										
Nieman et al. (97)			X	X	X		X						X		
Niesen-Vertommen (98)					X										
Oliver (99)					X										
Petersson et al. (100)					X										
Pickett et al. (101)			X	X					X						
Pinto et al. (102)						X									
Pinto et al. (103)			X	X										X	X
Schwartz et al. (104)			X							X					
Segal et al. (105)	X	X	X	X	X		X							X	X
Segal et al. (106)	X		X	X	X	X			X	X					
Segar et al. (107)			X	X	X										X
Thorsen et al. (108)						X									
Wall (109)				X	X										
Windsor et al. (110)				X				X							
Winningham (111)					X						X		X		X
Winningham et al. (112)	X	X	X	X	X						X	X	X		X
Winningham et al. (113)	X		X	X	X							X	X	X	X

Abbreviations: A = Oldervoll et al. (7); B = Brockow et al. (4); C = Knols et al. (19); D = Schmitz et al.(13); E = Stevinson et al. (23); F = Labourey (20); G= McNeely et al. (21); H = Conn et al. (14); I = Luktar-Flude et al. (2); J = Stricker et al. (3); K = Friedenreich et al. (18); L = Courneya et al, (16); M = Courneya et al. (15); N = Douglas (12); O = Kirshenbaum (54)

Table 8b; overview primary studies ((quasi) experimental- en non experimental) per review

	G	H	I	J	K	L	M	N	O
Adamsen et al. (114)				X					
Baldwin et al. (115)							X		
Berger et al. (116)			X						
Berger et al. (117)			X						
Blanchard et al. (118)									X
Blanchard et al. (119)									X
Bremer et al. (120)							X		
Carter et al. (121)									X
Courneya et al. (122)							X		
Courneya et al. (123)								X	
Courneya et al. (124)			X						
Courneya et al. (47)			X						
Craddock et al. (125)		X							
Decker et al. (126)							X		
Dimeo et al. (127)		X					X	X	
Dimeo et al. (128)			X						
Durak et al. (129)		X							
Durak et al. (130)		X							
Durak et al. (131)		X						X	
Gaskin et al. (132)									X
Goodwin et al. (133)		X							
Graydon et al. (134)			X						X
Hayes et al. (135)								X	
Headley et al. (136)			X						X
Holley et al. (137)		X							
Irvine et al. (138)			X						
MacVicar et al. (139)						X			
Mock et al. (140)				X					
Mormont et al. (141)			X						
Nelson (142)					X		X		X
Oldervoll et al. (143)				X					
Peters (144)							X		X
Peters (145)									X
Pfalzer (146)					X		X		
Pinto et al. (147)									X
Pinto et al. (148)	X								
Porock et al. (149)				X					
Schmitz et al. (13)	X								
Schmitz et al. (6)	X								
Schwartz (150)			X						
Schwartz (151)				X		X		X	X
Schwartz (152)				X					
Schwartz (153)				X					X
Schwartz et al. (154)			X	X				X	
Schwartz et al. (155)				X					
Seifert et al. (156)							X		
Segal et al. (157)						X		X	
Sharkey et al. (158)							X		
Tanaka et al. (159)			X						
Turner et al. (160)									X
Wang et al. (161)			X						
Weert et al. (162)			X						
Young et al. (163)					X		X		X

Abbreviations: H = Conn et al. (14); I = Luktar-Flude et al. (2); J = Stricker et al. (3); K = Friedenreich et al. (18); L = Courneya et al. (16); M = Courneya et al. (15); N = Douglas (12); O = Kirshenbaum (54)

Table 9a: study characteristics systematic reviews of RCTs/CCTs en meta-analyses

Article	Design	Databases	Trials (n)	Year	Population (n) (age)	Form of cancer	Medical treatment for cancer	Outcome
Oldervoll et al. (7)	Systematic review of RCTs	Pubmed; psycInfo; cancerlit; cochrane library	12 RCTs	until May 2003	724 (age 18-76)	Breast cancer; prostate cancer; colon cancer; lung cancer; stomach cancer; sacroma; adenocarcinoma; hodgkin; non-hodgkin; germ cell cancer;neuroblastoma; acute leukaemia	Surgery; radiotherapy; chemotherapy; hormone therapy; androgen deprivation therapy	Quality of life, fatigue, physical functioning, physical capacity; strength
Brockow et al. (4)	Systematic review of RCTs	Cochrane Breast Cancer Specialised Register; medline; embase; cinahl; SPORTDiscus; psycINFO; proQuest Digital Dissertations; conference Papers Index	9 RCTs	until July 2006	452	Breast cancer	Surgery; chemotherapy; radiotherapy; rest; hormone therapy	Physical fitness, fatigue, bodycompositon; quality of life; adverse events due exercise; psychological distress,immune functioning; side effects; compliance
Knols et al. (19)	Systematic review of RCTs and CCTs	Medline; cinahl; cancerLIT; PEDro	27 RCTs 7 CCTs	until June 2004	1844	Breast cancer; myeloma; leukaemia; prostate cancer; stomach cancer; head and neck cancer	Chemotherapy; radiotherapy; hormone therapy	Quality of life; psychological well being; physiological outcomes; self-reported functioning and symptoms
Schmitz et al. (13)	Systematic review/meta-analyses van RCTs en CCTs	Medline	32 RCTs/ CCTs	until February 2005	Nr	Breast cancer; colon cancer; lung cancerr; ovarian cancer; leukaemia; lymphoma; testicular cancer; sarcoma; stomach cancer; prostate cancer	Nr	Cardiorespiratoire fitness; fatigue; symptoms, quality of life; mental health; change in body size
Stevinson et al. (23)	Systematic review of RCTs snd CCTs	Medline; embase; cochrane Library; cancerLit; psycInfo; cinahl; sportDiscus	25 RCTs 8 CCTs	until December 2003	Nr	Breast cancer; prostate cancer; colon cancer; ovarian cancer; stomach cancer; melanoma; lung cancer; leukaemia	Radiotherapy; chemotherapy; androgen deprivation therapy; blood cell transplantation bone marrow transplantation; surgery	Physical functioning; fatigue; quality of life; aerobic capacity; body composition; physiological parameters; treatment related symptoms; compliance; psychosocial outcomes
Labourey (20)	Systematic review of RCTs	Pubmed	11 RCTs	Nr	718 (age 18-77)	Borstkanker; melanoom; prostaatkanker	Chemotherapy; radiotherapy	Fatigue
McNeely et al. (21)	Systematic review/meta-analyses of RCTs	Cochrane Library; medline; embase; cinahl; psycInfo; cancerLit; PEDro; sportDiscus	14 RCTs	Nr	717 (age 35-72)	Breast cancer	Radiotherapy; chemotherapy; hormone therapy	Quality of life; cardiorespiratoire fitness; physical functioning; fatigue; body composition; Kwaliteit van leven; cardiorespiratoire fitheid;
Conn et al. (14)	Meta-analyses	Medline; cancerlit; cochrane Library; dissertation Abstracts; psychInfo; sportDiscus; healthStar; clinical Evidence; cinahl; National Institute of Health database	30 articles	Till 2004	(age31-70)	Breast cancer; lymphoma; lung cancer; leukaemia; stomach cancer; colon cancer; prostate cancer; melanoma	Nr	Quality of life; physical functioning; mood state; fatigue; body composition; exercise behaviour; symptoms

Abbreviation: Nr = not reported

Table 9b: study characteristics systematic reviews of (quasi) experimental and non-experimental studies

Article	Design	Databases	Trials (n)	Year	Population (n) (age)	Form of cancer	Medical treatment for cancer	Outcome
Luktar-Flude et al. (2)	Systematic review of experimental and observational studies	Medline; cumulative index to nursing and allied health literature; healthSTAR; allied and complementary; medicine database; exerpta medica database; cochrane library; dissertation abstracts international grey literature; otseeker; PEDro	9RCTs; 4 prospective longitudinal studies; 1 retrospective study; 2 cross-sectional studies; 2 pretest-posttest studies	Until July 2005	1850 (aged 18-84)	Breast cancer; prostate cancer; melanoma; colon cancer; lung cancer; leukaemia; lymphoma	Surgery; chemotherapy; radiotherapy; hormone therapy; androgen deprivation therapy; stem cell transplantation	Fatigue; quality of life; physical functioning
Stricker et al. (3)	Systematic review of descriptive, experimental and quasi- experimental studies	Cinahl; medline; database of abstracts of reviews effects	9 RCTs; 1 quasi-experimental study;10 pretest-posttest studies	1995 until October 2003	882	Breast cancer; non hodgkin; hodgkin; melanoma; prostate cancer; colon cancer	Chemotherapy ; radiotherapy; stem cell transplantation; blood cell transplantation; androgen deprivation therapy	Cancer-related fatigue
Friedenreich et al. (18)	Systematic review of experimental and observational studies	Medline; psychlit; sportdiscus; cinahl	4 RCTs ; 3 quasi-experimental studies; 1 case control study; 1 cohort study	Nr	Nr	Breast cancer	Chemotherapy	Physiological functioning; mental functioning
Courneya (16)	Systematic review of experimental and observational studies	CancerLit; cinahl; heracles ; medline ; psycINFO ; SPORTdiscus	7 RCTs; 4 pretest-posttest studies	Nr	365	Leukaemia; breast cancer; prostate cancer; lymphoma	Chemotherapy; radiotherapy; bone marrow transplantation; stem cell transplantation; hormone therapy	Bio psychosocial outcomes
Courneya et al. (15)	Systematic review of experimental, quasi-experimental and observational studies	CancerLit; cinahl; heracles; medline; psychINFO ; SPORTdiscus	3 cross-sectional studies; 3 retrospective study; 10 quasi-experimental studies; 7 experimental studies	1980 - 1997	1011	Breast cancer; leukaemia; head cancer; neck cancer; colon cancer; non hodgkin; lymphoma	Bone marrow transplantation; surgery; radiotherapy; stem cell transplantation; chemotherapy	Quality of life
Douglas (12)	Systematic review of experimental and observational studies	Medline; embase; cinahl; SPORTdiscus	11 RCTs ; 2 experimental studies; 1 pilot study; 3 pretest-posttest studies; 2 studies different designs; 1 observational study	1985 till April 2004	684	Breast cancer; colon cancer; melanoma; non hodgkin; leukaemia; prostate cancer; carcinoma	Radiotherapy; chemotherapy; bone marrow transplantation; stem cell transplantation; surgery	Physical and mental advantages of exercise
Kirshbaum (54)	Systematic review of experimental, quasi-experimental and non-experimental studies	Medline; embase; cinahl; british nursing index; cochrane library	8 quasi-experimental studies ; 9 RCTs; 6 pretest-posttest studies; 2 case control studies; 2 case studies; 2 cross-sectional studies	1985 till December 2004	1866	Breast cancer	Chemotherapy; surgery; radiotherapy	Physical and mental advantages of exercise

Abbreviation: Nr = not reported

Table 10a;describtion interventions systematic reviews of RCTs/CCTs en meta-analyses

Article	Stage	Intervention	Comparison	Intervention period (range in weeks)	Frequency (range days per week)	Minutes per session (range)	Intensity (range)	Individual or group
Oldervoll et al. (7)	Treatment and post-treatmentstsge	aerobic exercise resistance exercise	No exercise, waiting list for exercise, standard practice, normal activities	2 - 26	3-7	10-35	Aerobic exercise 60-85% HRmax 50-85% HRR 50-85% VO_{2max} Resistance exercise 60-70% of 1-RM two sets of 8-12 repetitions	Individual and group (un)supervised
Brockow et al. (4)	Treatment stage	aerobic exercise combination of aerobic exercise and resistance exercise	No intervention, stretching exercise, flexibility exercise	6 - 26	2-6	10-60	Aerobic exercise 50-85% HRmax 50-60% VO_{2max} 11-12 RPE Resistance exercise 12-15 repetitions, 1-2 sets	Individual and group (un)supervised
Knols et al. (19)	Treatment and post-treatment stage	aerobic exercise combination of aerobic exercise and resistance exercise stretching exercise	Usual care, stretching exercise, self directed exercise, strength exercise	5 - 52	2-6	15-120	Aerobic exercise 50-85% VO_{2max} 50-75% HRR 40-90% HRmax Resistance exercise 60-70% of 1-RM 8-20 repetitions	Individual and group (un)supervised
Schmitz et al. (13)	Treatment and post-treatment stage	aerobic exercise combination of aerobic exercise and resistance exercise	Nr	5 - >12	3-5	20-30	Moderate to vigorous	Mainly supervised group exercise
Stevinson et al. (23)	Treatment and post-treatment stage	aerobic exercise resistance exercise combination of aerobic exercise and resistance exercise	Usual care, stretching, walking, flexibility exercise, group psychotherapy	2 - 26	1-5	Nr	Nr	Individual and group (un)supervised
Labourey (20)	Treatment and post-treatment stage	aerobic exercise resistance exercise	Nr	7 - 28	Nr	Nr	Nr	Individual and group (un)supervised

Abbreviations: HRmax=maximal heart rate ;HRR= heart rate reserve; 1-RM= 1 repetition maximum; VO_{2max} = maximal oxygen consumption; Nr = not reported

Table 10a;describtion interventions systematic reviews of RCTs/CCTs en meta-analyses (continued)

Article	Stage	Intervention	Comparison	Intervention period (range in weeks)	Frequency (range days per week)	Minutes per session (range)	Intensity (range)	Individual or group
McNeely et al. (21)	Treatment and post-treatment stage	aerobic exercise resistance exercise combination of aerobic exercise and resistance exercise	Nr	7 - 28	2-6	10-60	Aerobic exercise 50-85% HRmax 50-75% VO_{2max} Resistance exercise 8-10 repetitions, 1-3 sets	Individual and group (un)supervised
Conn et al. (14)	Treatment and post-treatment stage	aerobic exercise resistance exercise combination of aerobic exercise and resistance exercise flexibility exercise	Nr	Nr	Nr	Nr	Nr	Individual and group (un)supervised

Abbreviations: HRmax=maximal heart rate ;HRR= heart rate reserve; 1-RM= 1 repetition maximum; VO_{2max} = maximal oxygen consumption; Nr = not reported

Table 10b: description interventions systematic reviews of (quasi) experimental and non-experimental studies

Article	Stage	Intervention	Comparison	Intervention period (range in weeks)	Frequency (range days per week)	Minutes per session (range)	Intensity (range)	Individual or group
Luktar-Flude et al. (2)	Treatment and post-treatment stage	aerobic exercise resistance exercise	Usual care, relaxation exercise, psychotherapy	Nr	Nr	Nr	Nr	Individual and group (un)supervised
Stricker et al. (3)	Treatment and post-treatment stage	aerobic exercise resistance exercise interval exercise	Nr	6 - 24	2-6	10-90	Aerobic exercise 60-85% HRrmax 25-50% HRR 70-75% VO_{2max} Resistance exercise 16-24 repetitions	Individual and group (un)supervised
Friedenreich et al. (18)	Treatment and post-treatment stage	aerobic exercise	Nr	5 - 24	2-5	10-45	60-85% HRmax 60-85% HRpeak	Individual and group (un)supervised
Courneya (16)	Treatment stage	aerobic exercise resistance exercise	Nr	5 - 12	3-5	15-30	Aerobic exercise 60-85% HRmax 50-85% HRR Resistance exercise 15 repetitions 60-70% 1-RM	Individual and group (un)supervised
Courneya et al. (15)	Treatment and post-treatment stage	aerobic exercise resistance exercise	Nr	5 - 52	1-7	10-60	60-86% HRmax	Individual and group (un)supervised
Douglas (12)	Post-treatment stage	aerobic exercise resistance exercise	Nr	2 - 26	3-6	10-40	Aerobic exercise 25-85% HRR 60-90% HRmax 50-60% VO_{2max} Resistance exercise 15 repetitions	Individual and group (un)supervised
Kirshbaum (54)	Treatment and post-treatment stage	aerobic exercise resistance exercise stretching exercise	Nr	5 - 26	2-5	10-90	Aerobic exercise 60-85% HRmax intensity 50-75% Resistance exercise intensity 40-70%	Individual and group (un)supervised

Abbreviations: HRmax=maximal heart rate ;HRR= heart rate reserve; 1-RM= 1 repetition maximum; VO_{2max} = maximal oxygen consumption; Nr = not reported

Table 11; measurements

Fatigue	Physical functioning	Quality of Life
Piper Fatigue Scale (PFS) (7;16;19;20;23)	(maximal) Cycle ergometer test (2;7;18;54)	scale RSES (7)
Profile of Mood State (2;16;19;54)	Indirect calorimetry (open circuit) (7)	functional assessment of cancer therapy (FACT) (2;20)
Fatigue scale (FS) (2)	Sit and reachtest (7)	functional assessment of cancer therapy fatigue (FACT-F) (7;19;21;23)
European Organization for Research and Treatment of Cancer (EORTC) (2)	Step ergometrietest (7)	functional assessment of cancer therapy breast (FACT-B) (2;7;12;21;23)
Quality of Life Questionnaire Core 30 (QLQ-C30) (2)	Coopertest (7)	functional assessment of cancer therapy general (FACT-G) (2;7;12;19;21)
Functional Assessment of Chronic Illness Therapy Fatigue Version IV (FACIT-F) (2)	6 minute walk test (19;23)	functional assessment of cancer therapy prostate (FACT-P) (2;7;19;23)
Brief Fatigue Inventory Functional Assessment of Chronic Illness Therapy Fatigue Version IV (FACIT-F) (2)	12 minute walk test (2;7;16;19;23)	functional assessment of cancer therapy head and neck (FACT H+N) (19)
Peason Byars Fatigue Feeling Checklist (PBFFC) (2)	Symptom assessment scale (SAS) (7)	functional assessment of cancer therapy colon cancer (FACT-C) (2;19;23)
Fatigue Relief Scale(2)	Physical exercise leasure score index (19)	Quality of life index for cancer patients(7;18)
Visual Analog Scale (VAS-F) (2)	Dynamometry (19)	Lineaire analogue self-assessment (LASA) (7;19)
	Building Related Illness (BRI) (23)	Medical outcome survey short form (SF-36) (7;12;16;19;21)
	Karnofsky Performance Scale (KPS) (18;23)	Satisfaction with life scale (SWLS) (2;19)
	Leisure Score Index (LSI) (2)	Visual analog scale for quality of life (VAS QOL) (19)
	Rating of Perceived Exertion Scale (RPE scale) (2)	Cancer Rehabilitation Evaluation System (CARES) (23)
	Rotterdam Check List activity level scores(2)	Quality of Life Index for Cancer Patients (QLICP) (23)
	Modified Canadian Fitness Test (mCAFT) (12)	EQRTC QLQ-30 (20)
		FACT Quality of Life Scale(21) Functional Assessment of Chronic Illness Therapy Fatigue Version IV (FACIT-F) (2)
		BFI enjoyment of life scale (2)
		Quality of Life Index for patients with cancer (15;16;18)
		Functional Assessment of Cancer Therapy Whit Life Scale (16)

Assessment methodological quality

Two systematic reviews (4;19) of RCTs/CCTs have an overall scientific quality with minor limitations (table 12). Four systematic reviews of RCTs/CCTs (7;13;21;23) and one meta-analysis (14) have an overall scientific quality with moderate limitations. One systematic review of RCTs/CCTs has an overall scientific quality with major limitations (20).

Two systematic reviews of (quasi) experimental and non-experimental studies (2;54) (table 13) have an overall scientific quality with moderate limitations. The other included systematic reviews of (quasi) experimental and non-experimental studies (3;12;15;16;18) have an overall scientific quality with major limitations.

Clinical relevance

None of the included systematic reviews or meta-analyse described the patients in detail, you can decide whether they are comparable to those you see in your practice. Furthermore, the intervention and treatment setting were not described in enough detail so that you can provide the same for your patients (table 14).

Table 12; methodological quality of systematic reviews of RCTs/CCTs assessed with an modified version of OQAQ

	Detailed search strategy	Compre-hensive search	Inclusion criteria	Avoidance of bias	Assessing validity	Adequate assessing of validity	Methods to combine findings	Analysis appropriate	Conclusion	Limitation
Oldervoll et al. (7)	-	-	+	+/-	-	+/-	+	+	+	Moderate
Brockow et al. (4)	+	+	+	+	+	+	+	+	+	Minor
Knols et al. (19)	+	+	+	+	+	+	+	+	+	Minor
Schmitz et al. (13)	-	+/-	+	+/-	-	+/-	+	+	+	Moderate
Stevinson et al. (23)	+/-	+/-	+	+/-	+	-	+	+	+	Moderate
Labourey (20)	-	-	+/-	-	-	+/-	-	+/-	+/-	Major
McNeely et al. (21)	+/-	+/-	+	+/-	+	+	+	+	+	Moderate
Conn et al. (14)	+	+/-	+	+	-	+/-	+	+	+	Moderate

Abbreviations: + = 'met'; +/- = 'unclear/partly met'; - = 'not met'

Table 13; methodological quality of systematic reviews of (quasi) experimental and non-experimental studies assessed with an modified version of OQAQ

	Detailed search strategy	Compre-hensive search	Inclusion criteria	Avoidance of bias	Assessing validity	Adequate assessing of validity	Methods to combine findings	Analysis appropriate	Conclusion	Limitation
Luktar-Flude et al. (2)	+/-	+/-	+/-	+/-	+	+	+	-	+	Moderate
Stricker et al. (3)	-	-	+/-	-	-	+/-	-	+/-	+/-	Major
Friedenreich et al. (18)	-	-	-	-	-	-	-	-	-	Major
Courneya (16)	+/-	+/-	+/-	+/-	+/-	-	-	+/-	+/-	Major
Courneya et al. (15)	+/-	+/-	+/-	+/-	-	-	-	+/-	+/-	Major
Douglas (12)	+/-	+/-	-	+/-	-	-	-	+	+	Major
Kirshenbaum (54)	+/-	+/-	+	+/-	+	+	+/-	+	+	Moderate

Abbreviations: + = 'met'; +/- = 'unclear/partly met'; - = 'not met'

Table 14; assessment of clinical relevance

	Desciption patients	Description treatment	Clinical relevant outcomes	Size effect clinically important	Benefits worth potential harms
Oldervoll et al. (7)	+/-	+/-	+	+	+
Brockow et al. (4)	-	+/-	+	+	+
Knols et al. (19)	-	+/-	+	+	+
Schmitz et al. (13)	-	+/-	+	+	+
Stevinson et al. (23)	-	-	+	+	+
Labourey (20)	+/-	-	+	+	+
McNeely et al. (21)	+/-	+/-	+	+	+
Conn et al. (14)	-	-	+	+	+
Luktar-Flude et al. (2)	+/-	-	+	+	+
Stricker et al. (3)	-	+/-	+	+	+
Friedenreich et al. (18)	-	+/-	+	+	+
Courneya (16)	-	+/-	+	+	+
Courneya et al. (15)	-	+/-	+	+	+
Douglas (12)	-	+/-	+	+	+
Kirshenbaum (54)	-	+/-	+	+	+

Abbreviations: + = 'met'; +/- = 'unclear/partly met'; - = 'not met'

Systematic reviews of RCT/CCT and meta-analysis

Fatigue in treatment stage

By describing the results of analysis, four reviews (13;14;20;21) discern effect of exercise on fatigue in the treatment stage and post-treatment stage (table 15). One review (4) only illustrated the effect of this exercise on fatigue in the treatment stage. The conclusions of all individual reviews and meta-analyses are presented in table 16.

In the review of Schmitz et al. (13), which has an overall scientific quality with moderate limitations, less evidence was found regarding a consistent and positive effect of exercise on fatigue.

The review of Labourey (20), which has an overall scientific quality with major limitations, described one included primary study with a significant increase of fatigue in the control group, and a rather unchanged fatigue in the experimental group. In four other primary studies the effect of exercise was absent. However, these studies involved a small population. One publication investigates the effect of exercise on fatigue to individuals following a hormone therapy as medical treatment. The found significant effect does not hold for individuals confronted with chemotherapy.

In their meta analysis, Conn et al. (14), which has an overall scientific quality with moderate limitations, indicate a negligible effect of exercise on fatigue in the treatment stage (effect size -0.04).

The review of Brockow et al. (4), which has an overall scientific quality with minor limitations, showed inconsistent evidence concerning the effect of exercise on fatigue in the treatment stage (effect size -0.12).

Finally, the review of McNeeley et al. (21), which has an overall scientific quality with moderate limitations, pointed out that pooled data of four publications involved a non-significant small effect of exercise on fatigue in the treatment stage (effect size 0.28).

According to the GRADE principle (based on systematic reviews of RCT/CCT and meta-analyses), there is low-quality evidence for effect of exercise in the treatment stage on fatigue of adult cancer patients.

Physical functioning in treatment stage

Results of three reviews (13;14;19) make a distinction between the effect of exercise on physical functioning in the treatment stage and in the post-treatment stage (table 15). One review (4) discussed the effect of exercise on physical functioning in the treatment stage.

In one included primary study of the review of Knols et al. (19), which has an overall scientific quality with minor limitations, a statistical significant effect was described for exercise on functional capacity, muscular strength, and walking distance for individuals suffering from breast cancer. Regarding the effect of exercise on aerobe capacity, the same publication reported no significant differences between the intervention and control group. This review also showed positive effects of exercise on muscular strength and functional capacity concerning individuals confronted with a high quantity of chemical therapy in combination with bone marrow transplantation and periphery stem cell transplantation. With respect to a population with diverse tumours, the same review also showed positive effects of exercise on increased physically condition and aerobe capacity in the treatment stage. Exercise had no significant effect on muscular capacity.

Schmitz et al. (13) found in their review, which has an overall scientific quality with moderate limitations, a slightly significant effect of exercise on cardio respiratory condition (effect size 0.51). Furthermore, negligible evidence was illustrated for a consistent and positive effect of exercise on cardiorespiratory condition.

In the meta-analysis of Conn et al. (14), which has an overall scientific quality with moderate limitations, there is a significant but negligible effect of exercise on physical functioning (effect size 0.46).

Finally, in the review of Brockow et al. (4), which has an overall scientific quality with minor limitations, five included publications report a significant improvement of cardio respiratory condition in case of exercise. In addition, a moderate effect of exercise on cardio respiratory condition was found for adults breast cancer patients in the treatment stage (effect size 0.66).

According to the GRADE principle (based on systematic reviews of RCT/CCT and meta-analysis), there is high-quality evidence for effect of exercise on physical functioning with respect to adult cancer patients in the treatment stage.

Quality of life in treatment stage

Assessing the effect of exercise on QoL, two reviews made a distinction between treatment and post-treatment stage. (13;19) (table 15). Another review (4) discussed the effect of exercise on quality of life in the treatment stage.

The review of Knols et al. (19), which has an overall scientific quality with minor limitations, showed that one included publication described a statistical significant effect of exercise on quality of life for adults breast cancer patients. The same publication also illustrates that no statistical significant difference between the intervention and control group was found for the effect of exercise on self reported quality of life. In addition, positive findings were reported for exercise on self-reported QoL, within a population of different types of cancer. Regarding this population, no significant effect was found in relation to exercise on quality of life in the treatment stage.

In the review of Schmitz et al. (13), which has an overall scientific quality with moderate limitations, negligible qualitative evidence was considered with respect to a consistent positive effect of exercise on quality of life.

In their review, which has an overall scientific quality with minor limitations, Brockow et al. (4) discussed inconsistent evidence concerning the effect of exercise on specific quality of life for individuals with breast cancer (effect size 0.78). In addition, limited evidence was described regarding the effect of exercise on common health related quality of life for individuals with breast cancer in the treatment stage.

According to the GRADE principle (based on systematic reviews of RCT/CCT and meta-analysis), there is moderate-quality evidence for the positive effect of exercise on quality of life with respect to adults breast cancer patients in the treatment stage. Regarding other types of cancer, there is low-quality evidence for effect of exercise in the treatment stage.

Fatigue in post-treatment stage

Regarding the results on the effect of exercise on fatigue, five reviews (13;14;19-21) differentiated between the treatment and post-treatment stage (table 15).

The review of Schmitz et al. (13), which has an overall scientific quality with moderate limitations, indicated negligible qualitative evidence with respect to a consistent positive effect of exercise on fatigue.

In the review of Knols et al. (19), which has an overall scientific quality with minor limitations, a statistical significant effect was described in favour of the effect of exercise on self reported fatigue for individuals with breast cancer.

Labourey (20), discusses in his/her review, which has an overall scientific quality with major limitations, that one publication shows a significant decline of fatigue in the exercise arm. In this study the results between groups were negative. The review of Labourey (20) described

two primary studies with positive results of exercise on fatigue. However, in one study baseline characteristics differed between groups. In addition, one study addresses significance with respect to the control group. The the intervention groups of all these studies reported a decreased, fatigue .

The meta-analysis of Conn et al. (14), which has an overall scientific quality with moderate limitations, indicated a non-significant small effect of exercise on fatigue in the post-treatment stage (effect size 0.22).

Finally, McNeeley et al. (21), which has an overall scientific quality with moderate limitations, show two primary studies in their review with statistical significant improvement of fatigue by means of exercise in the post-treatment stage.

According to the GRADE principle (based on systematic reviews of RCT/CCT and meta-analysis), there is moderate-quality evidence for effect of exercise on fatigue with respect to adults cancer survivors in the post-treatment stage.

Physical functioning in the post-treatment stage

Concerning the results on the effect of exercise on physical functioning, three reviews (13;14;19) make a distinction between treatment and post-treatment stage (table 15).

The review of Knols et al. (19), which has an overall scientific quality with minor limitations, reported a the statistical significant effect of exercise by adults breast cancer survivors on aerobe capacity, strength and walking distance during the post-treatment stage. A significant effect of exercise on muscular strength and physical capacity is absent. However, positive effects of exercise by adults cancer survivors with diverse tumours were present regarding aerobe capacity and litheness.

Second, in the review of Schmitz et al. (13), which has an overall scientific quality with moderate limitations, moderate effect was found with respect to exercise on cardiorespiratory

condition (effect size 0.65). Besides, related to positive effect of exercise on cardio respiratory condition during the post-treatment stage, strong consistent qualitative evidence was found.

Finally, the meta analysis of Conn et al. (14), which has an overall scientific quality with moderate limitations, shows a moderate effect of exercise on physical functioning (effect size 0.44).

According to the GRADE principle (based on systematic reviews of RCT/CCT and meta-analysis), there is moderate-quality evidence for effect of exercise on physical functioning with respect to adults cancer survivors in the post-treatment stage.

Quality of life in post-treatment stage

In relation to the results on the effect of exercise on quality of life, three reviews (13;14;19) make a distinction between treatment and post-treatment stage (table 15). The review of Knols et al. (19), which has an overall scientific quality with minor limitations, stated a statistical significant effect of exercise on the self reported quality of life of individuals with breast cancer. Positive results were found concerning exercise on self reported quality of life of a population with diverse tumours. In addition, in the review of Schmitz et al. (13), which has an overall scientific quality with moderate limitations, a strong consistent qualitative effect of exercise on quality of life was found. Finally, in the meta-analysis of Conn et al. (14), which has an overall scientific quality with moderate limitations, a significant small effect was addressed concerning exercise on quality of life in the (effect size 0.22).

According to the GRADE principle (based on systematic reviews of RCT/CCT and meta-analysis), there is high-quality evidence for effect of exercise on quality of life with respect to adults cancer survivors in the post-treatment stage.

Fatigue in treatment/post-treatment stage

Related to the results on the effect of exercise on fatigue, two reviews (7;23) make a distinction between treatment and post-treatment stage (table 15).

In the review of Oldervoll et al. (7), which has an overall scientific quality with moderate limitations, three primary studies address the significant decline of fatigue after an exercise intervention. One primary study does not involve significant difference on fatigue between groups.

The review of Stevinson et al. (23), which has an overall scientific quality with moderate limitations, reported that seven primary studies stated a significant decrease of cancer related fatigue. In three studies, a non-significant diminish of cancer related fatigue was found. Six primary studies discussed an absence of difference between cancer related fatigue (1) following on the intervention, and (2) after several months. By pooling the data of twelve primary studies, a negligible effect of exercise on fatigue was shown (effect size -0.15). In this review, the effect of exercise per population varied. Based on this review, moderate evidence is involved concerning the impact of different types of cancer on the effect of exercise on fatigue (effect size 0.04). Individuals with breast cancer showed a slightly decrease of fatigue after participating in an exercise program (effect size -0.52).

According to the GRADE principle (based on systematic reviews of RCT/CCT and meta-analysis), there is low-quality evidence for effect of exercise on fatigue with respect to adult cancer patients and survivors in the treatment and post-treatment stage.

Physical functioning in treatment/post-treatment stage

With respect to the results on the effect of exercise on physical functioning, three reviews (3;7;21) do not make a distinction between treatment and post-treatment stage.

The review of Oldervoll et al. (7), which has an overall scientific quality with moderate limitations, reported that four primary studies show a significant increase of cardiovascular capacity. One study discusses the development of physical functioning. Another primary study observed no change in VO_{2max}, though by means of post-hoc analysis a significant positive variation was found. A third study shows the increasing effect of resistant exercise on the lower and upper extremity.

The review of Stevinson et al. (23), which has an overall scientific quality with moderate limitations, found a significant increase of physical functioning in the intervention group, compared to the control group (breast cancer) (effect size 0.96). The same observation holds for individuals with other types of cancer (effect size 0.55). It has to be noticed that the two largest publications do not set out the effect of exercise on physical functioning.

Finally, in the review of McNeeley et al. (21), which has an overall scientific quality with moderate limitations, three primary studies address the increase of peak oxygen consumption. Besides, pooled data of four studies suggest a significant incline of physical functioning and wellbeing in case of exercise (effect size 0.84). These data of three studies about peak oxygen consumption by symptom limited graded exercise, show an increase of 3,39 ml/kg per minute.

According to the GRADE principle (based on systematic reviews of RCT/CCT and meta-analysis), there is moderate-quality evidence for effect of exercise on physical functioning with respect to adult cancer patients and survivors in the treatment and post-treatment stage.

Quality of life in treatment/post-treatment stage

Concerning the results on the effect of exercise on quality of life, two reviews (7;21) do not distinguish between treatment and post-treatment stage.

In the review of Oldervoll et al (7), which has an overall scientific quality with moderate limitations, three primary studies report a significant increase of health related quality of life after exercise. One study does not describe this effect.

The review of McNeeley et al. (21), which has an overall scientific quality with moderate limitations, show pooled data of three studies which is likely to develop significant improvement of quality of life. An increase of four points or more on the FACT scale implies in that case that progression of quality of life is clinical relevant.

According to the GRADE principle (based on systematic reviews of RCT/CCT and meta-analysis), there is moderate-quality evidence for effect of exercise on quality of life with respect to adult cancer patients and survivors in the treatment and post-treatment stage.

Table 15; effectiveness of different outcomes in treatment and post-treatment stage based on systematic reviews of RCTs/CCTs and meta-analyses

	Treatment stage			**Post-treatment stage**		
	Fatigue	*Physical functioning*	*Quality of life*	*Fatigue*	*Physical functioning*	*Quality of life*
Brockow et al. (4)	+/-	+*	+/-			
Knols et al. (19)		+	+	+*	+	+
Schmitz et al. (13)	$+^{-}$	+*	$+^{-}$	$+^{-}$	+*	$+^{+}$
Labourey(20)	+/-			+		
McNeeley et al. (21)	+			+*		
Conn et al. (14)	-	+*		+	+*	+*

Abbreviations: + = positive results ; + = significant positive results; $+^{-}$ = weak evidence for positive results ; $+^{+}$= strong evidence for positive results; +/-= inconsistent evidences; - = no effect*

Table 16; conclusion per systematic review of RCTs/CCTs or meta-analyses

Article	Conclusion
Oldervoll et al.(7)	Patients suffering from cancer can benefit from exercise in case of sufficient rest periods.
Brockow et al. (4)	Exercise during treatment for breast cancer can be indicated as a self-support intervention, which can increase the capacity of activities of daily living.
Knols et al.(19)	Patients suffering from cancer potentially benefit from cancer in the treatment or post-treatment stage. The specific effects varies potentially from stage of illness, treatment and lifestyle.
Schmitz et al. (13)	Exercise increase cardiovascular fitness in the treatment and post-treatment stage, increase physiological effects and decrease symptoms in the treatment stage and increase strength and vitality in the post-treatment stage.
Stevinson et al. (23)	It appears that cancer patients can benefit from improved function without increases in fatigue associated with exercise. It is impossible to determine from current evidence whether exercise has direct effects on survival, recurrence or quality of life.
Labourey (20)	Physical activity seems to provide a means of combating cancer-related fatigue after treatment or even during treatment period itself.
McNeely et al. (21)	The evidence suggests that exercise is an effective intervention to improve quality of life, cardio respiratory fitness, physical functioning and symptoms of fatigue in breast cancer patients and survivors.
Conn et al. (14)	Exercise interventions resulted in small positive effect on health and well being outcomes among existing studies.

Systematic reviews of (quasi) experimental- en non-experimental studies

Fatigue in the treatment stage

Two reviews (16;54) describe the effect of exercise on fatigue in the treatment stage (table 17). The conclusions of all individual reviews are presented in table 18.

In the review of Courneya (16), which has an overall scientific quality with major limitations, it was concluded that exercise involves a positive effect on fatigue.

In another review, which has an overall scientific quality with moderate limitations, Kirshbaum (54) indicates that positive results were found regarding the effect of exercise on fatigue.

According to the GRADE principle (based on (quasi) experimental- and non-experimental studies), there is low-quality evidence for effect of exercise on fatigue with respect to adult cancer patients in the treatment stage.

Physical functioning in the treatment stage

Two reviews (16;54) described the effect of exercise on physical functioning in the treatment stage (table 17).

The review of Courneya (16), which has an overall scientific quality with major limitations, indicates that physical functioning in the treatment stage has a positive effect on functional capacity and muscular strength.

In addition, the review of Kirshbaum (54), which has an overall scientific quality with moderate limitations, describes the impact of exercise on the increase of functional capacity in the treatment stage.

According to the GRADE principle (based on (quasi) experimental- and non-experimental studies), there is low-quality evidence for effect of exercise on physical functioning with respect to adult cancer patients in the treatment stage.

Quality of life in the treatment stage

Two reviews (16;54) described the effect of exercise on quality of life in the treatment stage (table 17).

The review of Courneya (16), which has an overall scientific quality with major limitations, addresses the positive effect of exercise in the treatment stage on quality of life.

Kirshbaum (54) presents in the review, which has an overall scientific quality with moderate limitations, moderate evidence for the effect of exercise in the treatment stage on quality of life.

According to the GRADE principle (based on (quasi) experimental- and non-experimental studies), there is low-quality evidence for effect of exercise on quality of life with respect to adult cancer patients in the treatment stage.

Fatigue in the post-treatment stage

Two reviews (12;54) described the effect of exercise on fatigue in the post-treatment stage (table 17).

The review of Douglas (12), which has an overall scientific quality with major limitations, describes in his review exercise in the post-treatment stage has beneficial effect on fatigue.

The review of Kirshbaum (54), which has an overall scientific quality with moderate limitations, describes that exercise in the post-treatment stage increases fatigue.

According to the GRADE principle (based on (quasi) experimental- and non-experimental studies), there is low-quality evidence for effect of exercise on fatigue with respect to adults cancer survivors in the post-treatment stage.

Physical functioning in post-treatment stage

Two reviews (12;54) describe the effect of exercise on physical functioning in the post-treatment stage (table 17).

The review of Douglas (12), which has an overall scientific quality with major limitations, describes in his review that exercise in the post-treatment stage has beneficial effect on aerobic capacity, functional capacity, and muscle strength.

The review of Kirshbaum (54), which has an overall scientific quality with moderate limitations, indicates that exercise in the post-treatment stage has a beneficial effect on cardiopulmonary function and fitness.

According to the GRADE principle (based on (quasi) experimental- and non-experimental studies), there is low-quality evidence for effect of exercise on physical functioning with respect to adults cancer survivors in the post-treatment stage.

Quality of life in post-treatment stage

Two reviews (12;54) discuss the effect of exercise on physical functioning in the post-treatment stage (table 17).

In the review of Douglas (12), which has an overall scientific quality with major limitations, it is shown that exercise in the post-treatment stage has a positive effect on quality of life.

The review of Kirshbaum (54), which has an overall scientific quality with moderate limitations, present the same positive result of exercise on quality of life in the post-treatment stage.

According to the GRADE principle (based on (quasi) experimental- and non-experimental studies), there is low-quality evidence for effect of exercise on quality of life with respect to adults cancer survivors in the post-treatment stage.

Fatigue in treatment /post-treatment stage

Regarding the results on the effect of exercise on fatigue, three reviews (2;3;18) do not make a distinction in treatment and post-treatment stage (table 17).

The review of Luktar-Flude et al. (2), which has an overall scientific quality with moderate limitations, concluded the presence of evidence regarding the effect of (aerobe and resistant) exercise on the decline of fatigue by individuals with cancer in both the treatment and post-treatment stage.

The review of Stricker et al. (3), which has an overall scientific quality with major limitations, found strong evidence for the effectiveness of exercise linked to the treatment of cancer related fatigue.

Finally, the review of Friedenreich et al. (18), which has an overall scientific quality with major limitations, discussed that exercise (or not) has no influence in the perception of individuals regarding diminishing fatigue.

According to the GRADE principle (based on (quasi) experimental- and non-experimental studies), there is low-quality evidence for effect of exercise on fatigue with respect to adult cancer patients and survivors in both the treatment and post-treatment stage.

Physical functioning in treatment/post-treatment stage

Concerning the results on the effect of exercise on physical functioning, two reviews (2;18) do not make a distinction in treatment and post-treatment stage (table 17).

The review of Luktar-Flude et al. (2), which has an overall scientific quality with moderate limitations, concluded that exercise increases or slowly decreases physical functioning in the treatment and post-treatment stage.

Friedenreich et al. (18) observed in their review, which has an overall scientific quality with major limitations, an incline of functional capacity and decline of heart frequency.

According to the GRADE principle (based on (quasi) experimental- and non-experimental studies), there is low-quality evidence for effect of exercise on physical functioning with respect to adult cancer patients and survivors in both the treatment and post-treatment stage.

Quality of life in treatment/post-treatment stage

With respect to the results on the effect of exercise on quality of life, three reviews (2;15;18) do not make a distinction in treatment and post-treatment stage (table 17).

First, the review of Luktar-Flude et al. (2), which has an overall scientific quality with moderate limitations, indicates the positive effect (i.e. increase or moderate decrease) of exercise on quality of life in both the treatment and post-treatment stage.

Friedenreich et al. (18) show in their review, which has an overall scientific quality with major limitations, the increasing effect of exercise on quality of life.

The review of Courneya et al. (15), which has an overall scientific quality with major limitations, concluded a positive consistent effect of exercise on quality of life.

According to the GRADE principle (based on (quasi) experimental- and non-experimental studies), there is low-quality evidence for the positive effect of exercise on quality of life with respect to adult cancer patients and survivors in both the treatment and post-treatment stage.

Table 17; evidence for the effect of systematic reviews of (quasi) experimental- and non-experimental publications on diverse outcome measures in the treatment and post-treatment stage

	Treatment stage			**Post treatment stage**		
	Fatigue	*Physical functioning*	*Quality of life*	*Fatigue*	*Physical functioning*	*Quality of life*
Courneya (16)	+	+	+			
Douglas (12)				+	+	+
Kirshenbaum,(54)2006	+	+	$+^{-}$	+	+	+

Abbreviations: + = positive results ; + = significant positive results; $+^{-}$ = weak evidence for positive results ; $+^{+}$= strong evidence for positive results; +/-= inconsistent evidences; - = no effect*

Table 18; conclusions systematic reviews of (quasi) experimental- and non-experimental studies

Article	Conclusion
Luktar-Flude et al. (2)	The review provided evidence that exercise, both aerobic and strength exercise, may reduce fatigue in cancer patients during and after cancer treatment. The positive effect is consistent across various cancer sites, cancer stages, and cancer treatment modalities. Exercise is also associated with improvement or slower decline in physical functioning and quality of life in the studies reviewed.
Stricker et al. (3)	Despite the noted limitations in the research to date, the cumulative evidence is strong in support of exercise as an intervention to manage cancer related fatigue in selected patients.
Friedenreich et al. (18)	Some evidence exists that exercise has a beneficial effect on cancer patients' physologic and psychologic functioning.
Courneya (16)	Exercise during cancer treatment is likely to be beneficial to cancer patients.
Courneya et al. (15)	Exercise may improve quality of life following cancer diagnosis.
Douglas (12)	There is a growing body of evidence to justify the inclusion of exercise programmes in the rehabilitation of cancer patients returning to health after treatment: this evidence demonstrates both physical ad psychological benefits.
Kirshbaum (54)	There is evidence that aerobic exercise is an effective intervention in the treatment en post-treatment stage.

Discussion

As result of improved life expectations for individuals suffering from cancer, the past decade interest has risen in exercises in the prevention of symptoms like increased fatigue, decreased physical functioning and quality of life. Exercise is one of the interventions that can potentially prevent or diminish these symptoms or side effects. Especially the exercise during the treatment and post-treatment stage seems to be relevant. This systematic review had the objective to determine the effect of exercise by adult cancer patients and survivors, in the treatment stage or post-treatment stage, on fatigue, physical functioning and quality of life.

According to the best evidence synthesis can be concluded that high-quality evidence is present for the effect of exercise in adult cancer patients in the treatment stage, on physical functioning and quality of life (only breast cancer). However, low-quality evidence was found for the effect of exercise in the treatment stage on fatigue. Moderate-quality evidence, was found for the effect of exercise in the post-treatment stage on fatigue and physical functioning. High-quality evidence was found for the effect of exercise in the post-treatment stage on quality of life. With respect to reviews without distinction between the treatment and post-treatment stage, the effect of exercise on physical functioning and quality of life is nearly not proven. These reviews also suggest moderate effect of exercise on fatigue.

This conclusion is to a large extent consistent with the findings of Courneya et al. (10),. In their review, they indicated moderate positive effects of exercise on aerobe condition, physical functioning, muscularity, fatigue, and some dimension of quality of life. Contrary to the findings in current review, the overview of Courneya et al. (10) also reported moderate positive effect of exercise on fatigue in the treatment. Besides, their results in the treatment stage are less persuasive compared to the post-treatment stage, while this review showed that evidence for the effect of exercise on physical functioning and quality of life is stronger in

the post-treatment stage compared to treatment stage. The result is only likely to hold for fatigue.

Contrary to the overview article of Courneya et al. (10), the current review assessed methodological quality, This may involve similar (i.e. no difference in quality weight) interpretations of conclusions of each review. By applying the GRADE principle, this review can address the opposite: the review of a conclusion with more methodological quality potentially involves stronger evidence.

According to this GRADE principle, it can be concluded that exercise by adult cancer patients is effective in the treatment stage on physical functioning and quality of life. As a systematic review of systematic reviews is considered the most powerful design, it is unlikely that current findings concerning physical functioning and quality of life in the treatment stage will change in the future. However, future research could focus on fatigue in the treatment stage and physical functioning and fatigue in the post-treatment stage.

Based on the conclusion of this systematic review, offering exercise in the treatment stage is likely to be relevant for adult cancer patients in order to positively influence physical functioning and quality of life. Besides, recommending exercise to adults cancer survivors in the post-treatment stage seems also to involve encouraging effects on fatigue, physical functioning and quality of life.

One limitation of this review, as with every systematic review, is the influence of subjective reasoning by the researcher on the results. That is, identification and selection of literature may bias the outcome. The literature search was applied to limited databases. By searching with the same key words in other databases, more publications could be found. Assessment of methodological quality and clinical relevance by one researcher could decrease bias.

A disadvantage of a systematic review of systematic reviews and meta-analysis is the use of individually same publications in different reviews. In the fifteen included systematic

reviews, 112 different publications could be discerned. Of these publications, 52 publications were only discussed in one review, the others in more than one. In four reviews, only primary studies were included which were also included in other reviews. Consequently, the conclusion in each individual review could potentially be biased on the same publications. In the current review, there were no criteria formulated concerning type of cancer and treatment. This could influence the effect of exercise on fatigue, physical functioning and quality of life. Although, the review of Stevinson et al. (23) showed moderate evidence for no effect of exercise on fatigue (effect size 0.04).

With respect to inclusion criteria of this review, no direct requirements were addressed to the content of the intervention exercise. Noticeably, not all exercise programs in the included reviews and meta-analyses met the guideline of the American College of Sports Medicine's (ACSM). Accordingly the guideline of ACSM, for adults over age 65 or adults 50-64 year with chronic conditions, moderately intense aerobic exercise 30 minutes a day, five days a week is recommended or vigorously intense aerobic exercise 20 minutes a day, 3 days a week. Additionally, recommended the guideline of ACSM 8 to 10 strength exercises, 10-15 repetitions of each exercise twice to three times per week (164). As a consequence, the level of offered exercise is diversified. Accordingly, different exercises can not be compared. Instantly, it is not clear if the guideline of ACSM is sufficient for adult cancer patients and survivors. Further research is needed to develop the optimal type of exercise for each outcome (i.e. fatigue, exercise and quality of life) per pre-treatment, treatment, post-treatment and resumption stage. In that case, it had to be determined which frequency, intensity and duration of activity is needed to be most effective. In addition it is recommended to define control on the performance of exercise and determining the desired intensity.

More research is needed to clarify the level of exercise and the capacity to exercise by adult cancer patients and determining whether there is a period in de treatment stage that exercise is not recommended. Possibly, exercising in a specific period in the treatment stage has a negative effect on the health of adult cancer patients.

Many included publications had an overall scientific quality of moderate quality. Only two reviews have an overall scientific quality with minor limitations and six reviews has an overall quality of major limitations. The overview of criteria for judging the methodological quality, is one specific issue in the judgement of methodological quality that has been rated very low in different reviews. Only six out of 15 included reviews described the criteria on which the methodological quality were rated. It is difficult to assess the value of the found results. In order to create an overview of all the published reviews and meta-analyses with respect to exercise to the effect of exercise on fatigue, physical functioning and quality of life, the reviews and meta-analyses of low-quality evidence were also included in this review. In order to be able to publish reviews of good methodological quality related to the effect of exercise by individuals with cancer, consensus is necessary about quality assessment lists for each design: judgements on methodological quality of each review can then be compared.

With respect to the assessment of clinical relevance, not one review described the patients in detail, preventing the comparison of study participants and patients in daily life practice of a physical therapist. The interventions and treatment setting were also not described in one review, as a consequence, it is impossible to provide the same for patients in the setting of a physical therapist. For increasing the clinical relevance it is recommended to describe more detail the research population, treatment and treatment circumstance, to enable comparisons with daily practice.

Not all included reviews distinguished between treatment or post-treatment stage to determine the effect of exercise by adult cancer patients and survivors. Some reviews made

conclusions by summarizing treatment and post-treatment stage. For future research, it is recommended to use a theoretical model, for example a predefined organisational structure (PEACE (9) of PACC (11)) is elemental for publishing a review or research with an other design. In addition, agreement on outcome measures is needed to facilitate research focussed on interpretative and comparative analysis of results of different publications. The mentioned organisational structures is in that case crucial. An important aspect is the use of standardised measure methods: in order to compare and possibly pool the results. It has to be determined what type of measure tool dispose of psychometric attributes to evaluate the effect of exercise. Besides, it has to be determined at which level a change of outcome measure is clinical relevant. Moreover, identification of the exercise behaviour and history is required. That is, inactive individuals with cancer could need another type of optimal exercise compared to active individuals with cancer.

Conclusion

Regarding adult cancer patients during the treatment stage, analysis has high-quality evidence for the effect of exercise on physical functioning and quality of life (only breast cancer). However, in this stage low-quality evidence has been found for the effect of exercise on fatigue. In addition, during the post-treatment stage, moderate evidence argues for the effect of exercise on fatigue, physical functioning and high-quality evidence for quality of life. Based on this review, no recommendations can be made regarding the optimal type and dose (frequency, intensity or duration) of exercise by patients with cancer in the treatment and post-treatment stage.

Recommendations

- Research on the optimal level of exercise (in terms of frequency, intensity or duration) related to different outcomes (fatigue, exercise and quality of life) that is specified per pre-treatment, treatment, post-treatment and resumption stage.
- Describe control on the performance of exercise and determining the desired intensity.
- Consensus on use of assessment list for each specific design, in order to determine the methodological quality.
- A detailed description of the research population, treatment and treatment circumstance, to enable comparisons with daily practice.
- Use a specified structure (predefined organisational structure of PEACE or PACC) in research to the effect of exercise.
- Consensus on outcome measures in order facilitate interpretation and comparison of results in the different publications.
- Use of standardised measure methods, as to compare and possibly pool the results.
- Determine measurement instruments with the best psychometric properties to analyse the effect of exercise.
- Determine in which case a change in outcome measure relates to a clinical relevant change.
- Describe current exercise behaviour and history of an individual.
- Describe the level of exercise by individuals with cancer.
- Determine in which case (i.e. period) offering exercise is unwise.
- Determine potential negative effects of exercise in the treatment stage.

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Appendix 1: search strategy

(1) “Adults”(MeSH)	(46) “ Exercises, Isometric”(tw) or “ Exercises, Isometric”
(2) “Adult”(tw) or “Adult”	(47) “Graded Activity”(tw) or “Graded Activity”
(3) “Adults”(tw) or “Adults”	(48) “Graded Activities”(tw) or “Graded Activities”
(4) “Adult*”	(49) “Behavioural Graded Activity”(tw) or “Behavioural Graded Activity”
(5) Adult*	(50) “Graded Exercise”(tw) or “Graded Exercise”
(6) 1 or 2 or 3 or 4 or 5	(51) 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48 or 49 or 50
(7) “Neoplasms”(MeSH)	(52) “Quality of Life”(tw) or “Quality of Life”
(8) “Neoplasms”(tw) or “Neoplasms”	(53) “Qualities of Life”(tw) or “Qualities of Life”
(9) “Neoplasm”(tw) or “Neoplasm”	(54) “Life Quality”(tw) or “Life Quality”
(10) “Tumors”(tw) or “Tumors”	(55) “Life Qualities”(tw) or “Life Qualities”
(11) “Tumor”(tw) or “Tumor”	(56) “Fatigue”(tw) or “Fatigue”
(12) “Malign Neoplasms”(tw) or “Malign Neoplasms”	(57) “Lassitude”(tw) or “Lassitude”
(13) “Malign Neoplasm”(tw) or “Malign Neoplasm”	(58) “Physical Functioning”(tw) or “Physical Functioning”
(14) “Neoplasms, Malign”(tw) or “Neoplasms, Malign”	(59) “Muscle Strenght”(tw) or “Muscle Strenght”
(15) “Neoplasm, Malign”(tw) or “Neoplasm, Malign”	(60) “Strenght, Muscle”(tw) or “Strenght, Muscle”
(16) “Cancer”(tw) or “Cancer”	(61) “Physical Endurance”(tw) or “Physical Endurance”
(17) “Cancers”(tw) or “Cancers”	(62) “Endurance, Physical”(tw) or “Endurance, Physical”
(18) 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17	(63) 52 or 53 or 54 or 55 or 56 or 57 or 58 or 59 or 60 or 61 or 62
(19) 6 and 18	(64) 19 and 51 and 63
(20) “Motor Activity”(MeSH)	(65) “Systematic Review”(tw) or “Systematic Review”
(21) “Motor Activity”(tw) or “Motor Activity”	(66) “Systematic Reviews”(tw) or “Systematic Reviews”
(22) “Motor Activities”(tw) or “Motor Activities”	(67) “Review, Systematic”(tw) or “Review, Systematic”
(23) “Activity, Motor”(tw) or “Activity, Motor”	(68) “Reviews, Systematic”(tw) or “Reviews, Systematic”
(24) “Activities, Motor”(tw) or “Activities, Motor”	(69) “Literature Review”(tw) or “Literature Review”
(25) “Locomotor Activity”(tw) or “Locomotor Activity”	(70) “Literatures Review”(tw) or “Literatures Review”
(26) “Locomotor Activities”(tw) or “Locomotor Activities”	(71) “Review Literature”(tw) or “Review Literature”
(27) “Activity, Locomotor”(tw) or “Activity, Locomotor”	(72) “State-of-Art Review”(tw) or “State-of-Art Review”
(28) “Activities, Locomotor”(tw) or “Activities, Locomotor”	(73) “State-of-Art Reviews”(tw) or “State-of-Art Reviews”
(29) “Physical Activity”(tw) or “Physical Activity”	(74) “Review, State-of-Art”(tw) or “Review, State-of-Art”
(30) “Physical Activities”(tw) or “Physical Activities”	(75) “Reviews, State-of-Art”(tw) or “Reviews, State-of-Art”
(31) “Activity, Physical”(tw) or “Activity, Physical”	(76) “State of Art Review”(tw) or “State of Art Review”
(32) “Activities, Physical”(tw) or “Activities, Physical”	(77) “State of Art Reviews”(tw) or “State of Art Reviews”
(33) “Exercise”(tw) or “Exercise”	(78) “Review, State of Art”(tw) or “Review, State of Art”
(34) “Exercises”(tw) or “Exercises”	(79) “Reviews, State of Art”(tw) or “Reviews, State of Art”
(35) “Physical Exercise”(tw) or “Physical Exercise”	(80) “Literature Review”(tw) or “Literature Review”
(36) “Physical Exercises”(tw) or “Physical Exercises”	(81) “Literature Reviews”(tw) or “Literature Reviews”
(37) “ Exercise, Physical ”(tw) or “ Exercise, Physical”	(82) “Review, Literature”(tw) or “Review, Literature”
(38) “ Exercises, Physical ”(tw) or “ Exercises, Physical”	(83) “Reviews, Literature”(tw) or “Reviews, Literature”
(39) “Aerobic Exercise”(tw) or “Aerobic Exercise”	(84) 65 or 66 or 67 or 68 or 69 or 70 or 71 or 72 or 73 or 74 or 75 or 76 or 77 or 78 or 79 or 80 or 81 or 82 or 83
(40) “Aerobic Exercises”(tw) or “Aerobic Exercises”	(85) 64 and 84
(41) “Exercise, Aerobic”(tw) or “Exercise, Aerobic”	
(42) “Exercises, Aerobic”(tw) or “Exercises, Aerobic”	
(43) “Isometric Exercise”(tw) or “Isometric Exercise”	
(44) “Isometric Exercises”(tw) or “Isometric Exercises”	
(45) “Exercise, Isometric”(tw) or “Exercise, Isometric”	

Appendix 2: in- en exclusion criteria per review

Review	Inclusion criteria	Exclusion criteria
Oldervoll et al., 2004	- design: RCT - subject: exercise - intervention period: during and after treatment - language: English	- design: studies with multiple interventions and pilot studies
Brockow et al., 2007	- design: RCTs of CCTs - subject: exercise - intervention period: during treatment - medical treatment: radiotherapy, chemotherapy or hormone therapy - population: women with breast cancer (stage I, II or III) without metastases - intervention: aerobic exercise training and resistance exercise during 6 weeks at least - outcomes: physical fitness, physiological outcomes, pain, fatigue, quality of life, biological outcomes, psychological outcomes, body composition, exercise behaviour, harms.	- selection: group assignment based on self selection - intervention: exercise intervention which is a part of a complex intervention
Knols et al., 2005	- design: RCTs of CCTs - subject: exercise - intervention period: during and after treatment - medical treatment: surgery, chemotherapy, radiotherapy, hormone therapy - intervention: increase aerobic capacity or strength - setting: home based or at the practice - outcomes: VO2max, fatigue, body composition, exercise level, level of physical activities, walk distance, psychological distress, self-reported quality of life	- intervention: relaxation training
Schmitz et al., 2005	- design: control group - population: adults diagnosed with cancer - intervention: interventions to increase physical activity - language: English	- design: no control group
Stevinson et al., 2004	- design: prospective trials with a control arm. Control arm could comprise no intervention, alternative intervention or different exercise (published and unpublished) - population: patients with cancer - intervention period: during and after treatment - intervention: exercise as sole intervention or combined with other interventions - outcomes: no restriction	- population: healthy or historical control groups - intervention: trials of single exercise interventions - outcomes: effect of physical therapy

Review	Inclusion criteria	Exclusion criteria
McNeely et al., 2006	- design: RCTs comparing exercise with placebo, controlled comparison or standard care - populatie: patients with breast cancer (stage 0-III) - intervention: exercise - control intervention: placebo, gecontroleerde vergelijking of standaard zorg - primary outcomes: quality of life, cardio vascular fitness, physical functioning - secondary outcomes: fatigue or body composition	- population: cancers other than breast cancer - intervention: therapeutic exercise regimens addressing only specific impairments related to the shoulder, arm or both - publication: reports only available in abstract form
Conn et al., 2006	- design: pre-experimental, quasi experimental or experimental - language: English - population: aged 18 years or older - intervention period: during treatment or prior to the current research - size of trial: minimum of five treated subjects - intervention: interventions designed to increase resistance, flexibility or endurance exercise - outcomes: quality of life, physical function, mood, fatigue, body composition, exercise behaviour, symptoms - data: adequate data to calculate effect size - supervision: supervised and unsupervised	Not reported
Luktar-Flude et al., 2007	- population: aged 65 years or older - outcomes: fatigue and physical activity	Not reported
Stricker et al., 2004	- design: experimental and non-experimental studies - intervention: exercise - outcomes: fatigue	Not reported
Friedenreich et al., 1996	Not reported	Not reported
Courneya et al., (16)2001	- subject: effect of exercise during treatment	- design: descriptive studies - intervention period: after treatment - intervention: flexibility exercise and stretching exercise
Courneya et al., 1999	- intervention: exercise to increase cardiovascular fitness and strength	- intervention: flexibility exercise and stretching exercise - information: not enough information for a critical review
Douglas, 2005	Not reported	Not reported

Review	Inclusion criteria	Exclusion criteria
Kirshenbaum, 2006	- method: explicit described method - goals: goals must be relevant for the review - publication: in a peer reviewed journal	- language: every language except english - intervention: concerning lymphoedema - literature: grey literature
Labourey, 2007	- design: RCTs or meta-analyses - language: English or French - intervention period: during treatment - outcomes: benefits of physical activity	Not reported

Recommendations for exercise programs for adult cancer patients and survivors

A review of determinants of intentions and adherence, group cohesion, barriers, exercise preferences and intensity, frequency, duration of training

Journal: Psycho Oncology

Title: Recommendations for exercise programs for adult cancer patients and survivors; a review of determinants of intentions and adherence, group cohesion, barriers, exercise preferences and intensity, frequency, duration of training

Name author 1: P.Z.A. den Heijer, MSc, Physical Therapist, Health Scientist, Student Master of Science Physical Therapy Research, Utrecht University the Netherlands.

Name author 2: M.W.A. Jongert, MSc, Exercise Physiologist, Netherlands Organisation of Applied Scientific Research (TNO), Department Quality of Life, Leiden, the Netherlands

Name author 3: T. Takken, PhD, Medical Physiologist, Department of Pediatric Physical Therapy & Exercise Physiology, Wilhelmina Children's Hospital, University Medical Center Utrecht, the Netherlands

Corresponding author: P.Z.A. den Heijer, email: pdenheijer@gmail.com

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Background

Although exercise is becoming accepted as advantageous for adults suffering from cancer and cancer survivors, there is no uniform information with regard to training variables for adults suffering from cancer and cancer survivors. Generally, adults are becoming less physically active after being diagnosed with cancer. It is essential to know the underlying determinants of exercise behaviour to make it possible to create an useful intervention especially for this population.

Objectives

The first aim of this review was to determine the determinants of intention and adherence to exercise in adult cancer patients and survivors. The second purpose of this review was to identify exercise barriers and exercise preferences in adult cancer patients and survivors. The third objective was to determine the impact of group cohesion in a supervised exercise program for adult cancer patients and survivors. Finally, the fourth aim was identifying the reported recommendations for intensity, frequency, duration of aerobic and resistance training for adult cancer patients and survivors.

Methods

From January 1981 until April 2008, literature was searched in Pubmed, Cinahl, PSYCHinfo, Cochrane Library, PEDro databases. In order to include publications, four criteria were addressed: (1) the publication was written in Dutch, English, French or German, (2) the population concerns adults with cancer in the treatment stage or survivorship stage, (3) the intervention relates aerobic or resistance exercise, (4) one of the outcome measures exercise variables, determinants of intention, determinants of adherence, exercise barriers, exercise preferences, or group cohesion.

Results

In the different articles, the regression analysis indicate that attitude, subjective norm and PBC explained 23-68% (range) of the variance in exercise intention by adult cancer patients in the treatment stage. Additionally, intention explained 14-30% (range) of the variance of exercise behaviour in the treatment stage. Concerning exercise preferences, 33.6% (n=944) preferred starting exercise 3-6 months after treatment. Moreover, 60.2% (n=1064) preferred exercising with moderate intensity. Subsequently, 27.3% (n=1064) preferred low intensity exercise. Most adult cancer patients and survivors (32.6%) prefer to exercise alone. Relating to accompany, 25.2% (n=1123) have no preferences. Moreover, just 15.6% (n=1123) preferred exercising with other cancer survivors. Regarding the preferred type of exercise, 56.5% (n=1214) preferred walking.

Conclusions

According to this review, the three most frequent reported exercise barriers (n=1381) were fatigue (7.4%), lack of time (5.1%) and feeling sick (4.7%). Based on the exercise preferences of adult cancer patients and survivors, a tailored exercise programme must be an scheduled exercise programme (exercise type walking) with moderate intensity without accompany (alone) in the morning at home, 3-6 months after treatment. The reported recommendation is moderate to high intensity of aerobic exercise for adult cancer patients and survivors in general, with a frequency of 3-5 times a week and a duration of 10-60 minutes.

Keywords: *exercise variables, intention, adherence, exercise barriers, exercise preferences, group cohesion, exercise, cancer*

Introduction

Physical activity has multiple benefits. A previous review (1) found high-quality evidence for the effect of exercise by adults with cancer in the treatment stage, on physical functioning and quality of life (only breast cancer). However, low-quality evidence was found for the effect of exercise in the treatment stage on fatigue. Further, there was moderate-quality evidence found for the effect of exercise by adults with cancer in the survivorship stage, on fatigue, physical functioning and high-quality evidence on quality of life.

The conclusion of this review (1) is supported by the overview of Courneya et al. (2), based on diverse systematic reviews. In their review, Courneya et al. (2) indicate moderate positive effects of exercise on aerobic endurance capacity, physical functioning, strength, fatigue, and some dimension of quality of life.

Despite the reported benefits of exercise, a small number of cancer survivors perform habitual physical exercise, with exercise rates reducing considerably during treatment and remaining low even post-treatment (3-5). The literature proposed, that many adult cancer patients, who exercised previous the diagnosis cancer, do not maintain to exercise during the treatment or survivorship stage (6). Furthermore, adults cancer survivors, who did not exercise before being diagnosed, seldom take up exercise during or after treatment (6). The study of Vallance et al. (7) indicated that 34.3% (n=148) of non-Hodgkin's lymphoma survivors met the public health exercise guidelines during the pre-diagnosis stage. Respectively, 6.6% (n=23) and 23.9% (n=103) of the survivors met the exercise guidelines in the treatment stage and survivorship stage. Additionally, the study of Karvinen et al. (4) indicated that 30.6% (n=386) of the endometrial cancer survivors met the American College of Sports Medicine's (ACSM) exercise guidelines. Accordingly the guideline of ACSM, for adults over age 65 or adults 50-64 year with chronic conditions (33), recommended moderately intense aerobic exercise 30 minutes a day, five days a week or vigorously intense aerobic exercise 20 minutes a day, 3

days a week. Additionally, recommended the guideline of ACSM 8 to 10 strength exercises, 10-15 repetitions of each exercise twice to three times a week (33). The study of Jones et al. (3) reported 16% of the 295 participants, in the treatment stage, met the ACSM guideline . Remarkably, in that study only 32% reported at least one session of moderate or high intensity exercise per week during treatment.

Moreover, cancer survivors are unable to maintain habitual physical activities (an active lifestyle) (20). Approximately, half of those try to integrate an exercise program in to their daily activities go back to their previous activity levels within 3 to 6 months after starting to participate in the exercise program (34).

The benefits of exercise can only be realized through habitual exercise. Specifically, the efficacy of exercise depends largely on the motivation and adherence of the person (3). It is important to identify the determinants of exercise and the barriers to exercise in this group to maximize the adherence and the benefits of exercise (35;36). Additionally, it is important to develop strategies to help people suffering from cancer to adopt an active lifestyle and maintain long-term activities (20). A form of exercise is supervised group exercise. One mechanism in a group is group cohesion (37). Supposing, “cohesion is high, the group is motivated to perform well and is more able to coordinate activities for successful performance” (37). It might be an important mechanism for the motivation of adult cancer patients and survivors to participate in an exercise programme.

An other factor that possibly will influence exercise attitudes and motivation is whether an exercise program offered to adult cancer patients and survivors is consistent with their preferences (38). Tailoring exercise programs to the preferences of the participants can increase adoption and maintenance of the exercise program (38).

Theoretical framework

Numerous studies (36;39;40;49;50;59-63) have thoroughly studied exercise participation issues following cancer diagnosis using the Theory of Planned Behaviour (TpB). Accordingly, following these numerous studies, intention explain up to 35% of the physical activity variance (5). Consequently, intention appear to be the dominant predictor of exercise in cancer survivors (5). Sixty-eight percent of the intention variance can be explained by attitude toward exercise, perceived behaviour control and subject norm (5). However, the attribution of intention, attitude, perceived behaviour control and subjective norm varies across different studies (5). Therefore, research using other theoretical frameworks in cancer survivors would be useful (5). For this reason, this review exploited an adapted version of the Integrated Model for Explaining Motivational and Behavioural Change (I-CHANGE model). The I-CHANGE Model, is derived from the Attitude Social influence Self-Efficacy Model (ASE). However, the ASE-model is an integration of the TpB, Social Cognitive Theory (SCT), Trans Theoretical Model (TTM), Health Belief Model (HBM) and goal setting theories (64).

Following the I-CHANGE model, person's motivation or intention determine adult cancer patients and survivors' behaviour. Behaviour is the result of a persons' intentions and abilities. Intention can range from contemplation to preparation. The abilities of a person and actual behavioural skills increase the chance that intentions will be transferred into actions. On the other hand, barriers can lower the chance that intentions will be transferred into actions. The motivation of a person is determined by attitude, social influences and self-efficacy expectations. The I-CHANGE model supposes motivational factors are determined by various distal awareness factors, predisposing factors, psychological factors, biological factors, social and cultural factors, information factors (64).

According, to the assumed theoretical framework, the recommended exercise behaviour is trial and maintain. Following this theoretical framework there are additional factors, which determine the behaviour of a person with cancer (figure 1). Moreover, trial and maintain of the recommended exercise behaviour is influenced by the recommended type, frequency, volume, intensity of aerobic and resistance exercise. If the recommended exercise variables and other variables (e.g. variety of exercise) do not meet the exercise preferences of the adult cancer patients and survivors, these patients and survivors would not perform the desired exercise behaviour. Optionally, adult cancer patients and survivors can execute exercise behaviour in a supervised exercise group. Perhaps, group cohesion has an impact on the recommended exercise behaviour and indirect on quality of life, physical functioning and quality of life. Additionally, exercise has a direct effect on quality of life, physical functioning and fatigue.

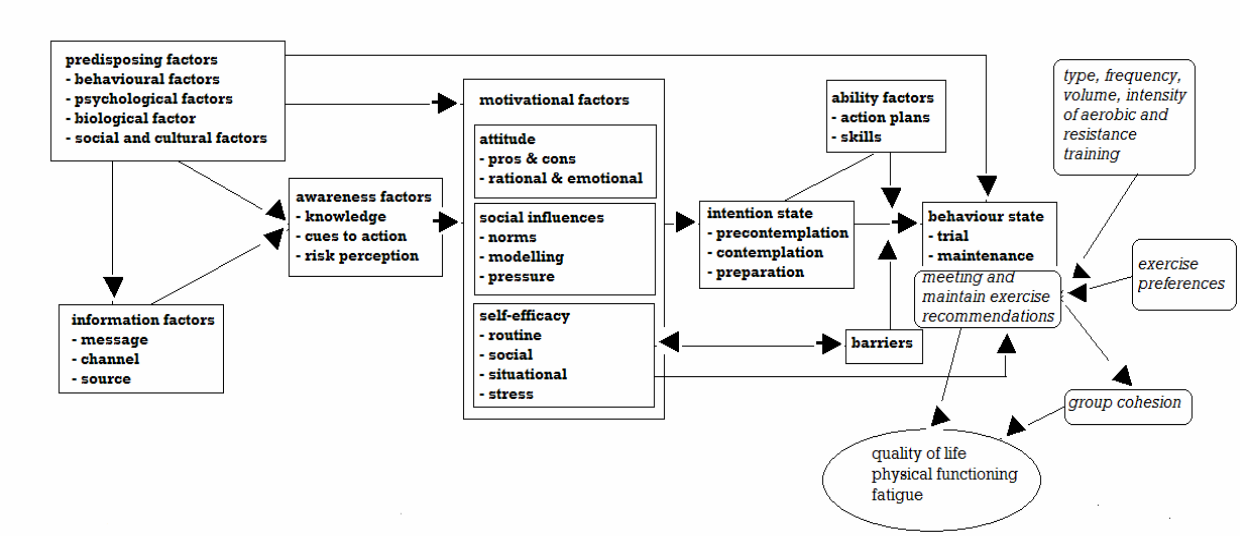

Figure 1: I-CHANGE model for exercise behaviour with additional explaining factors

PACC

In order to structure the organisation of research on the effect of exercise by adult cancer patients and survivors, Courneya et al. (65) created a conceptual framework called 'Physical Exercise Across the Cancer Experience' (PEACE). In 2003 an adapted framework is created. The 'Physical Activity and Cancer Control' (PACC) framework (2;66). This framework distinguishes two major stages (pre-diagnosis and post-diagnosis), which a person experience during cancer (figure 2). These major stages are divided into six time periods (pre-screening, screening, pre-treatment, treatment, survivorship, end of life) (table 1). For each time period, there are proposed cancer control targets: (I) pre-screening for prevention; (II) screening for detection; (III) pre-treatment for treatment preparation/coping; (IV) treatment for treatment effectiveness/coping; (V) survivorship for recovery/rehabilitation, disease prevention/promotion and survival; (VI) end of life for palliation (2).

This systematic review is focused on the treatment and survivorship stage. Following the overview article of Courneya et al. (2) the cancer control category "recovery" is important, "because over 50% of cancer survivors indicate a preference for beginning an exercise program immediately or soon after treatments rather than during treatments". In their overview article, Courneya et al. (2) provided general suggestions for future research efforts under the eight cancer control categories of the PACC framework. One of these suggestions in the survivorship stage is "what is the optimal type and dose of physical activity for rehabilitation or specific problems?". Additionally, the overview article of Courneya et al. (2) indicate the positive effects of exercise during treatment. This indicates the importance of a supervised exercise group in the treatment stage. Accordingly, it is import to answer the question of optimal type and dose of physical activity for the treatment stage.

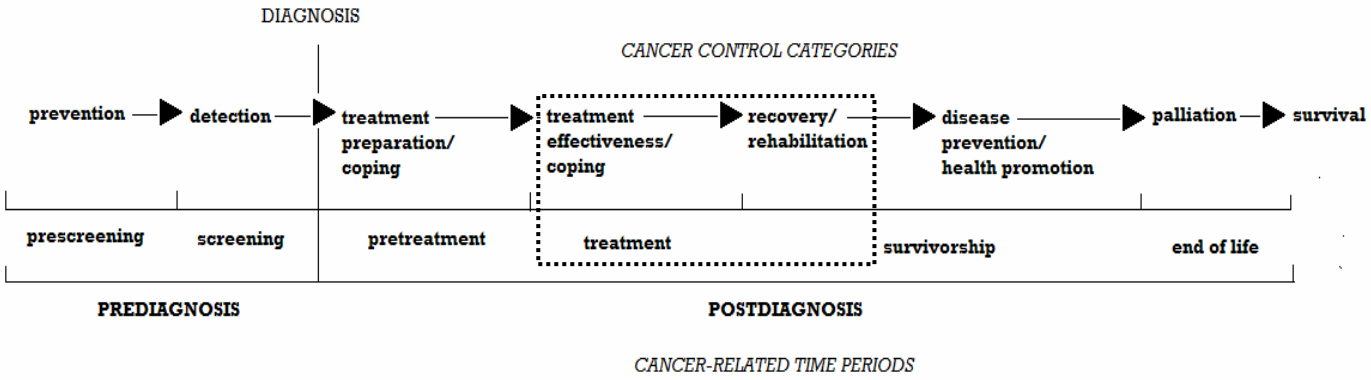

Figure 2; physical activity and cancer control framework (2;66)

Table 1; stage of the PACC framework (2)

Stage	Description
Pre-screening	Entire time period prior to cancer screening.
Screening	Time from the screening test until definitive result is known .
Pre-treatment	Time period after a definitive cancer diagnosis up until treatment is initiated and may also include the time between successive treatments.
Treatment	Time a person is actively being treated for cancer (primary cancer treatment).
Survivorship	Period following first diagnosis and treatment prior to the development of recurrence of cancer and death.
End of life	Deceased

Research considered

There is one review (67), which studied exercise barriers. This review included nine primary studies (60;68-75). None of these primary studies measured exercise barriers well; they did not report the specific barriers (67). Therefore, the review of Brawley et al. (67) did not report frequency of intensity of exercise barriers, but only mentioned implications.

The review of Van Weert et al. (26), with the aim to describe the development of a physical training programme for adult cancer patients and survivors, describe the content for an exercise programme for adult cancer patients with decreased aerobic capacity, decreased muscle strength, fatigue or physical functioning. The program developed by van Weert et al. (26) is a tailored physical self-management rehabilitation programme. Van Weert et al. (26) performed the aerobic exercise at an intensity determined by target heart rate of heart rate rest (RHR) + 30-50% (maximal heart rate (MHR)-(RHR)) over 20 minutes. Progressive resistance training started at 30% of the 1-repetition maximum (1-RM) with a 10-20 repetitions using three series of exercises.

Clinical relevance

Although exercise is becoming accepted as advantageous for adults suffering from cancer and cancer survivors, there is no well documented information with regard to specific training variables. It is important to determine the evidence of number of sets and repetitions, intensity of training, duration of rest between sets and exercise, frequency of training (48). Presently, there is no uniform information with regard to this training variables for adults suffering from cancer and cancer survivors.

Following the review of den Heijer et al. (1) there were no direct requirements addressed to the content of exercise intervention. According to no direct requirements, the contents of the exercise interventions were diversified. Accordingly, different exercise programmes were not

comparable. Therefore, it is needed to develop the optimal type of training for each outcome (i.e. fatigue, exercise and quality of life) for treatment and survivorship. In that case, it has to be determined which frequency, intensity and duration of activity is effective in reaching the desired goals.

Although, it is important to determine optimal exercise variables per stage, firstly it is also essential to determine the motive why adults do not exercise after being diagnosed with cancer. Generally, adults perform less exercise after being diagnosed with cancer (23). For that reason, it is essential to know the underlying determinants of (non) exercise behaviour. Detection of the underlying determinants makes it possible to design an useful intervention especially for the target population. This may maximize the chance of behaviour change and thus participation in an exercise program (57). Not only the determinants of exercise behaviour are important to know, also the underlying determinants of adherence of an exercise program are important. Exercise adherence rates in cancer survivors in the survivorship stage have ranged from 60 to 85% (66). Since exercise correlates and attitude differ for adult cancer patients and survivors compared with health individuals, research on determinants of adherence is important (23).

One factor, lowering adherence, is a patients' assignment to non preferred interventions. Patients assigned to their preferred intervention may have higher expectations of profit (76). Courneya et al. (76) concluded exercise preference moderated the effects of exercise in adults breast cancer patients receiving chemotherapy.

Research questions

- What are the determinants of intention and adherence to exercise for adult cancer patients and survivors?
- What are the exercise barriers and exercise preferences of adult cancer patients and survivors?
- What is the impact of group cohesion in a supervised exercise program for adult cancer patients and survivors?
- What are the reported recommendations for intensity, frequency, duration of aerobic and resistance training for adult cancer patients and survivors?

Method

Search strategy

A computer aided search of Pubmed, Cinahl, PSYCinfo, Cochrane Library and PEDro was performed by one researcher (PdH), from the period January 1981 until April 2008, to identify relevant systematic reviews and meta-analyses. The keywords and MESH-terms mentioned below, where used for the search in de electronic databases (Appendix 1). The following keywords where used in different combinations and plural forms: ‘adult’; ‘neoplasm’; ‘tumor’; ‘malign neoplasms’; ‘neoplasms, malign’; ‘malign neoplasm’; ‘neoplasm, malign’; ‘cancer’; ‘activity, motor’; locomotor activity’; ‘activity, locomotor’; ‘physical activity’; ‘activity, physical’; ‘exercise, physical’; ‘physical exercise’; ‘exercise, aerobic’; ‘aerobic exercise’; ‘exercise, isometric’; ‘isometric exercise’ ‘graded activity’; ‘behavioural graded activity’; ‘graded exercise’; ‘duration’; ‘intensity’; ‘sets’; ‘resistance’; ‘frequency’; ‘exercise variable’; ‘training variable’; ‘heart frequency’; ‘VO2max’; ‘VO2peak; ‘predictor’; ‘intention’; ‘motivation’; ‘barrier’; ‘adherence’; ‘compliance’; ‘patient compliance’; patient cooperation’; ‘user compliance’; ‘group cohesion’; ‘exercise preference’; ‘preference’; ‘exercise interest’.

Selection

All abstracts were studied by one researcher (PdH). If the abstract met the inclusion criteria (table 2), the article was printed. Full-text articles were retrieved for more detail by one researcher (PdH). After reading the full-text version the researcher decided whether the article was included in the review.

Table 2; inclusion criteria

Study: all designs written in Dutch, German, French or English language *Patients:* adults with cancer (all types) in the treatment or survivorship stage *Intervention:* exercise *Outcome:* exercise variables (intensity, frequency, duration) of aerobic and resistance training, determinants of intention, determinants of adherence, exercise barriers, exercise preferences, group cohesion.

Definitions

Cancer patients – persons suffering from cancer in the treatment stage.

Cancer survivors – persons suffering from cancer in the survivorship stage.

Exercise intention – motivation and plans

Exercise adherence – the degree to which a person fulfils a given exercise prescription.

Exercise barriers – actual barriers and perceived exercise barriers (67).

Actual exercise barriers – prevent persons from initiating exercise (67).

Perceived exercise barriers – tend to slow or halt completion of ongoing exercise behaviour (67).

Exercise preferences – patient's choice for interest in an exercise program, time of day to exercise, starting exercise, accompany and type of exercise.

Group cohesion – "a bonding force consisting of four factors, namely attraction to the group as whole and to individual members of the group, risk taking and instrumental value of the group"(37).

Exercise variables – training variables involving intensity, frequency, duration of aerobic and resistance training.

Data extraction

One researcher (PdH) extracted the relevant study characteristics. The same researcher performed the qualitative and quantitative data analyses.

Data analyses

Quantitative

The effects on the different outcomes in the included articles were compared. In case the effect size is reported, it is adopted as a measure to compare the effects of the different outcomes (table 5). The description of the quantitative results distinguished between treatment and survivorship stage. Concerning exercise preferences and barriers, absolute values from publications were applied. These values were grouped and cumulated. Accordingly, percentages were computed and displayed in histograms per item. Microsoft Excel was used to perform these steps.

Qualitative

Relevant study characteristics were extracted from the included reviews and presented in tables. The description of the qualitative results distinguish treatment and survivorship stage.

Results

Selection of articles

The search strategy in the different databases resulted in 1279 articles. Fifty five articles were potentially relevant (figure 3). Twelve articles (8-19) were excluded by abstract. Additionally, thirteen articles (5;20-32) were excluded by outcome. Ultimately, 30 articles (4;6;7;32;34-58) were included in this review.

Description of study characteristics

The descriptions (design, inclusion criteria, population, number of participants, method and measures) per article are presented in tables 3a-3f.

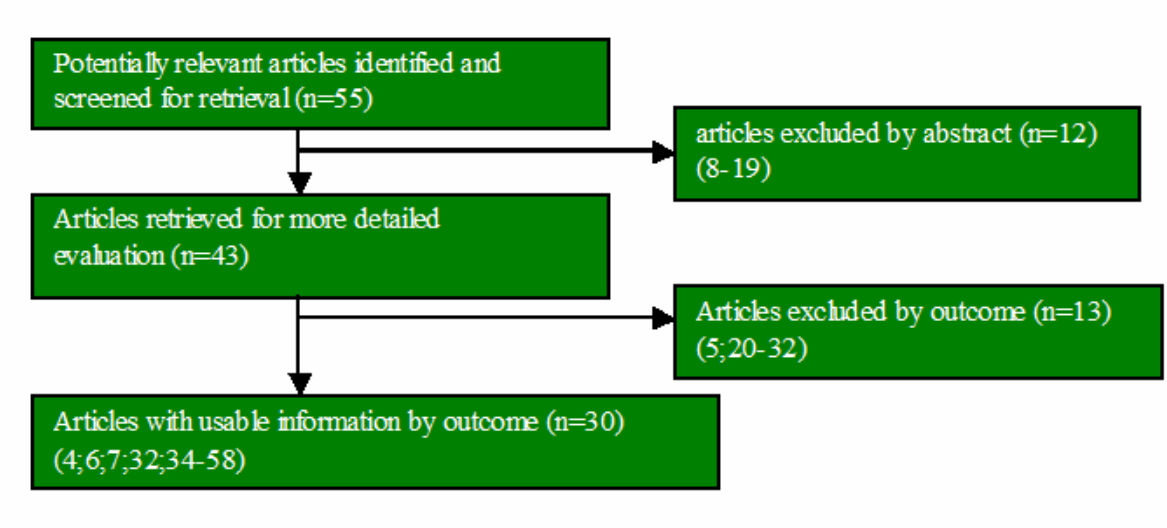

Figure 3; flow diagram included articles

Table 3a study characteristics articles of intention

ARTICLE	AIM	PACC	DESIGN	INCLUSION	POPULATION	NUMBER OF PARTICIPANTS	METHOD	MEASURES
Jones et al.(50)	Examine the demographic, medical and social cognitive determinants of exercise intentions in an institute-based cohort of primary brain tumor patients	Survivorship	Cross-sectional	- histologically confirmed primary brain cancer - >18 years - primary treating oncologist approval - ability to understand and provide written informed consent in English	Patients with primary brain tumor	100	Questionnaire	- demographic → self/reported measures - Intention → according guidelines of Ajez and prior research - Attitude → according guidelines of Ajez and prior research - Subjective norm → according guidelines of Ajez and prior research - Perceived behaviour control → according guidelines of Ajez and prior research - Exercise behaviour → Leisure Score Index from the Godin Leisure Time Exercise Questionnaire
Blanchard et al.(40)	Evaluate the theory of planned behaviour as a framework for understanding exercise intention and behaviour in survivors of breast and prostate cancer	Survivorship	Cross-sectional	Not reported	Survivors of breast or prostate cancer	129	Questionnaire	- demographic → self/reported measures - Intention → reported measures in prior studies - Attitude → reported measures prior studies - Subjective norm → reported measures in prior studies - Perceived behaviour control → reported measures of Ajez - Exercise behaviour → Leisure Score Index from the Godin Leisure Time Exercise Questionnaire
Jones et al.(49)	Examine the demographic, medical and social cognitive determinants of exercise intentions in an institute-based cohort of multiple myeloma cancer survivors	Survivorship	Cross-sectional	Not reported	Multiple myeloma cancer survivors	70	Questionnaire	- demographic → self/reported measures - Intention → reported measures in prior studies - Attitude → reported measures in prior studies - Subjective norm → reported measures in prior studies - Perceived behaviour control → reported measures in prior studies - Exercise behaviour → Leisure Score Index from the Godin Leisure Time Exercise Questionnaire
Andrykowski et al.(39)	Test of the utility of the TPB for understanding intentions to engage in a variety of positive physical and psychological health behaviours following cancer diagnosis	Treatment/ Survivorship	Cross-sectional	- > 18 years - history of cancer diagnosis and treatment - be able to read and write in English	Cancer patients and survivors	130	Questionnaire (per email)	- demographic → self/reported measures - Intention → measures reported in prior studies - Attitude → reported measures in prior studies - Subjective norm → reported measures in prior studies - Perceived behaviour control → reported measures in prior studies - Current performance of physical and psychosocial health behaviour → self/reported measures
Karvinen et al.(36)	Examine correlates of exercise intention and behaviour in endometrial cancer survivors	Survivorship	Cross-sectional	- > 18 years - English speaking - Approved for contact by a family of physician or primary oncologist - Histologically confirmed diagnosis of endometrial cancer	Endometrial cancer survivors	354	Questionnaire (per email)	- demographic → self measures - Intention → according recommendations of Ajez - Attitude → according recommendations of Ajez - Subjective norm → according recommendations of Ajez - Perceived behaviour control → according recommendations - exercise behaviour → modified version of Leisure Score Index from the Godin Leisure Time Exercise Questionnaire

Table 3b study characteristics articles of adherence

ARTICLE	AIM	PACC	DESIGN	INCLUSION	POPULATION	NUMBER OF PARTICIPANTS	METHOD	MEASURES
Coleman et al.(41)	Facilitating exercise adherence for patients with multiple myeloma and bone lesions	Treatment	Pilot study	- > 40 years not at risk for pathologic facture - currently not participating in an exercise programme	Patients with multiple myeloma	24	Assignment to exercise group or usual-care group. The prescribed exercise consisted of aerobic and strength home-based exercise.	Data collection of aerobic capacity, strength, fatigue, sleep, mood and anthroposophic measurements
Daley et al.(47)	Understanding the determinants of exercise after treatment for cancer	Survivorship	RCT	- sedentary women - aged 18-65 years - completed treatment for early stage breast cancer - no co-morbidities	Women treated for breast cancer	108	Group 1: Exercise therapy with one-to-one sessions of 50 minutes. Goal: attending 3 exercise sessions per week at 30 minutes of moderate intensity Group 2: Placebo-exercise group; 3 times a week during 8 weeks 50 minutes sessions. Every effort was made to keep HR less than 100 beats per minute Group 3: usual care group was encouraged to continue their life as normal	- Demographic information → self measures - Aerobic fitness → submaximal 8-minute single stage-walking test - Adherence → self measures
Pickett et al.(34)	Examine patterns of adherence to a brisk walking program in women receiving chemotherapy or radiotherapy	Treatment	RCT	- women treated for histologically confirmed stage I,II or IIIa breast cancer - scheduled to receive chemotherapy or radiotherapy	Breast cancer patients	52	Progressive walking prescription that was tailored to their current activity level and was accompanied by written instructions (ACSM-guidelines, when sedentary, 10-15 minutes a day, at least 5 days a week, 60-80% HRmax)	- Medical information → investigator-develop diary - Execise → daily dairy and activity level rating scale
Vallance et al.(32)	Examine long-term effects of pedometers and print materials on changes in physical activity and health related quality of life in breast cancer survivors who participated in a 3-month behaviour change intervention	Survivorship	RCT	- histologically confirmed stage I-IIIa breast cancer - physician approval - free chronic medical and orthopaedic conditions that would preclude physical activity - ability to read and understand English - completed adjuvant therapy except hormone therapy - no current breast cancer - interested in increasing physical activity	Breast cancer survivors	377	Group 1: Standard public health recommendation for physical activity Group 2: previously developed breast-cancer specific physical activity printed materials Group 3: step pedometer Group 4: combination of previously developed breast-cancer specific physical activity printed materials and step pedometer	- Demographic information → self measures - Exercise → Leisure Score Index from the Godin Leisure - Health related quality of life → Functional Assessment of Cancer Therapy-Breast (FACT-B)

Table 3b study characteristics articles of adherence (continued)

ARTICLE	AIM	PACC	DESIGN	INCLUSION	POPULATION	NUMBER OF PARTICIPANTS	METHOD	MEASURES
Courneya et al.(43)	Examine postprogram exercise motivation and adherence in cancer survivors	Treatment	RCT	Not reported	Cancer survivors	30	The intervention was a home-based personalized exercise programme. Individuals were prescribed walking ; 3-5 times a week, for 20-30 minutes, 65-75% of their estimate heart rate.	- Demographic and medical information → self measures - Perceived success → reported measures - Causal dimensions → revised causal dimension scale (CDSII) - Affective reactions → reported measures - Expected success → reported measures - Exercise → version of Leisure Score Index Godin Leisure
Kim et al.(52)	Investigate the effects of exercise on cardiopulmonary responses and adherence	Treatment	Pretest-posttest	- newly diagnosed breast cancer - no history of cancer - all stages of breast cancer - > 40 years - receiving cancer treatment	Newly diagnosed breast cancer patients	41	Exercise group participate in an 8-week moderate intensity supervised aerobic program 3 times a week. The control group received usual care.	Exercise → graded exercise test
Courneya et al.(42)	To apply the TpB to understand exercise motivation and behaviour in breast cancer survivors	Survivorship	Prospective design	Not reported	Breast cancer survivors	24	Two trainings sessions per week in the swimming pool. 10 minutes warming up,40 minutes cardiovascular training; core muscle group exercise with full range of motion and paddling in the pool.	- Demographic and medical information → self measures - Exercise → Leisure Score Index from the Godin Leisure - Intention → reported measures - Perceived behaviour control→ reported measures - Normative beliefs → self measures - Control beliefs → self measures - Exercise adherence → self measures
Courneya et al.(77)	Examine correlates of adherence and contamination in a RCT of exercise in cancer survivors using the theory of planned behaviour and the five factor model of personality	Treatment/ survivorship	RCT	- cancer diagnosis - voluntary participation in one of the group psychotherapy classes offered at the Cross Cancer Institute - the ability to understand English - passing the revised Physical Activity Readiness Questionnaire (rPAR-Q) - no contraindications to a moderate intensity exercise program	Cancer survivors	96	Participants in the exercise group received a fitness consultation lasting about 30 minutes, which included a personalized exercise prescription to follow for 10 weeks. Participants in the control group were asked not to start a structured exercise program and had no exercise prescription	- Past exercise, exercise adherence, exercise contamination → Leisure Score Index Godin Leisure Time Exercise Questionnaire - Attitude → according questions of Ajez - Perceived behaviour control → according questions of Ajez - Normative beliefs → reported measures - Control beliefs → reported measures - Personality → NEO five factor inventory (NEO-FFI) - Physical fitness → modified balke treadmill test - Demographic and medical information → self measures

Table 3b study characteristics articles of adherence (continued)

ARTICLE	AIM	PACC	DESIGN	INCLUSION	POPULATION	NUMBER OF PARTICIPANTS	METHOD	MEASURES
Courneya et al.(44)	Examine predictors of adherence in a RCT of resistance exercise training in prostate cancer survivors receiving androgen deprivation therapy	Treatment	RCT	- histologically confirmed prostate cancer - scheduled to receive androgen deprivation therapy for at least 3 months following recruitment - approval from the treating oncologist - no severe cardiac disease, uncontrolled hypertension, uncontrolled pain, unstable bone lesions, resided with 1 hour of fitness centre	Prostate cancer survivors	155	Participants in the exercise group receive resistance exercise training (2 sets, 8-12 repetitions, nine different exercises, 3 times a week, during 12 weeks). Resistance was increased by 5 pounds when the patient was able to complete more than 12 repetitions. Participants in the control maintain their current exercise level	- exercise behaviour → modified version of Leisure Score Index from the Godin Leisure Time Exercise Questionnaire - preprogram exercise → exercise stage of change measure based on TTM

Table 3c; characteristics articles of exercise barriers

ARTICLE	AIM	PACC	DESIGN	INCLUSION	POPULATION	NUMBER OF PARTICIPANTS	METHOD	MEASURES
Courneya et al., (46)	Reportt the barriers to supervised exercise in breast cancer patients participating in a RCT	Treatment	RCT	- > 18 years - stage I-IIIA breast cancer - adjuvant chemotherapy	Breast cancer patients	242	Patients were stratified by cancer centre, chemotherapy regime, randomly assigned to aerobic exercise training (3 times a week 60% VO2peak for 15 minutes, progressing 80% VO2peak for 45 minutes), resistance exercise training (3 times a week 2 sets 8-12 repetitions of 9 different exercise 60-70% 1RM) or usual care.	- Open ended question - If patient called for cancel, they were asked for a reason why.
Rogers et al.(55)	Determine physical activity correlates and barriers among head and neck cancer patients	Treatment/ survivorship	Cross-sectional	- history of head and neck cancer - > 21 years - English speaking	Head and neck cancer patients	59	Self-administrated survey during clinic visit	- demographic and medical information → survey and chart review - exercise behaviour → modified version of Leisure Score Index from the Godin Leisure Time Exercise Questionnaire - social cognitive theory constructs → self/reported measures
Rogers et al.(56)	Determine exercise barriers, outcome expectations, exercise stage of change and exercise preferences during breast cancer treatment	Treatment	cross-sectional	- female breast cancer patients - English speaking - Cognitively capable of answering survey questions accurately - Currently undergoing therapy - > 6 weeks post-surgical	Female breast cancer patients	23	Structured interview	- demographic information → self/reported measures - exercise barriers → questions derived from previous studies
Courneya et al.(35)	Report the weekly exercise barriers from the exercise group	Treatment/ survivorship	Longitu-dinal	- surgery for colorectal cancer within the past 3 months - recovered from surgery as indicated by their physician - were able to speak English - had no contraindications to exercise - passed the revised Physical Activity Readiness Questionnaire	Colorectal cancer survivors	69	Personalized exercise program based on their fitness results, past exercise, performance status, planned treatment protocol and exercise preferences. Participants were allowed to choose the aerobic exercise they preferred (goal 3-5 times per week, 20-30 min., 65-75% predicted HRmax).	- demographic information → reported measures - exercise behaviour → Leisure Score Index from the Godin Leisure Time Exercise Questionnaire - exercise barriers → telephone call - Physical Activity Readiness Questionnaire
Perna et al.(54)	Asses the relative frequency of barriers to exercise	Treatment/ survivorship	Cross-sectional	Not reported	Female breast cancer patients	176	questionnaire per mail and post	- exercise behaviour & barriers → questions derived from previous studies
Rogers et al.(57)	Determine the psychometric properties of scales to measure exercise barriers and task self-efficacy	Treatment	Cross-sectional	- 18-89 years - English speaking - Currently receiving treatment	Female breast cancer patients	90	Self-administrated survey	- demographic information → self/reported measures - exercise barriers → reported measures

Table 3d study characteristics articles of exercise preferences

ARTICLE	AIM	PACC	DESIGN	INCLUSION	POPULATION	NUMBER OF PARTICIPANTS	METHOD	MEASURES
Karvinen et al.(4)	Report the exercise programming and counselling preferences of a population-based sample of endomentrial cancer survivors	Treatment/ Survivorship	cross-sectional	- aged 18 years or older - able to provide written consent in English - had family physician or primary oncologist approval to contact - have had a confirmed diagnosis of endometrial cancer	endomentrial cancer survivors	386	questionnaire per mail and post	- demographic and medical information → Alberta Cancer Registry and a questionnaire - exercise behaviour → modified version of Leisure Score Index from the Godin Leisure Time Exercise Questionnaire - exercise preferences → questions derived from previous studies
Jones et al.(38)	Provide a comprehensive assessment of the exercise preferences of cancer survivors	Treatment/ Survivorship	cross-sectional	Not reported	Patients who had received diagnosis of prostate, breast, colorectal or lung cancer	307	questionnaire per mail and post	- exercise behaviour →Leisure Score Index from the Godin Leisure Time Exercise Questionnaire - exercise preferences → questions derived from previous studies
Jones et al.(51)	Examine interest and exercise preferences of an institution-based sample of brain tumor patients	Treatment	cross-sectional	- histological confirmed primary brain cancer - legal age - primary treating oncologist approval - able to understand and provide written informed consent in English	Patients diagnosed with primary brain cancer	106	questionnaire per mail and post	- demographic information → self/reported measures - exercise behaviour → Leisure Score Index from the Godin Leisure Time Exercise Questionnaire - exercise preferences → questions derived from previous studies
Vallance et al.(7)	Examine the exercise preferences of a population-based sample of non-hodgkin's lymphoma survivors	Survivorship	cross-sectional	Not reported	Patients diagnosed with non/Hodgkins´ lymphoma	431	questionnaire per mail and post	- demographic information → self/reported measures - exercise behaviour → Leisure Score Index from the Godin Leisure Time Exercise Questionnaire - exercise preferences → questions derived from previous studies
Rogers et al.(56)	Determine exercise barriers, outcome expectations, exercise stage of change and exercise preferences during breast cancer treatment	Treatment	cross-sectional	- female breast cancer patients - English speaking - Cognitively capable of answering survey questions accurately - Currently undergoing adjuvant therapy - At least 6 weeks post-surgical for breast cancer	Female breast cancer patients	23	Structured interview	- demographic information → self/reported measures - exercise preferences → questions derived from previous studies

Table 3e: study characteristics articles of group cohesion

ARTICLE	AIM	PACC	DESIGN	INCLUSION	POPULATION	NUMBER OF PARTICIPANTS	METHOD	MEASURES
May et al.(37)	Explore the relationship between group cohesion and intervention outcome	Survivorship	Subset of the sample in a prospective multicentre trial	- > 18 years - last cancer treatment completed at least three months before study entry - estimated life expectancy at least one year - referred for rehabilitation by medical specialist or general practitioner on the basis of at least three out of the following criteria: o physical complaints o reduced physical capacity o psychological problems o increased levels of fatigue o sleep disturbances o problems coping with reduced physical and psychosocial functioning	Cancer patient and survivors	132	Allocation randomly to physical training based on principles of self-management, physical training plus cognitive behavioural training	- demographic information → self-report questionnaire - group cohesion → Group Cohesion Questionnaire (GCQ-22) - global quality of life, physical functioning, fatigue → European Organization for Research and Treatment of Cancer Quality of Life-C30 (EORTC-QLQ-C30)
Midtgaard et al.(53)	Investigate group cohesion and changes in quality of life	Treatment	Exploratory and triangulated component design	- 18-65 years - diagnosis of cancer given at least one month prior the study - chemotherapy as treatment for advanced disease or as a part of adjuvant treatment - admission to the oncological or haematological clinic - at least one series of chemotherapy - performance stage 0-1 (WHO)	Cancer patients	55	Qualitative structured group interviews post-intervention	quality of life → European Organization for Research and Treatment of Cancer Quality of Life-C30 (EORTC-QLQ-C30) en Short Form 36 (SF-36)

Table 3f; characteristics articles of exercise variables

ARTICLE	AIM	PACC	DESIGN	INCLUSION	POPULATION	NUMBER OF PARTICIPANTS	METHOD	MEASURES
Strong et al.(58)	Estabilish an evidence-based exercise protocol for decreasing cancer related-fatigue and muscle wasting in patients with multiple myeloma	Treatment/ Survivorship	Systematic review	- Articles and books published between 1995-2005 - Sources must have reported: exercise interventions, fatigue, muscle wasting, physical performance outcomes - A sample that causes osteolytic bone lesions - Other cancers that have similarities to multiple myeloma in their disease process	Patients with multiple myeloma, haematological cancers, cancers that cause osteolytic lesions and cancer that affect older adults	510	Electronic database search in Pubmed, CINAHL, Ovid, EBSCOhost, CancerLit, Cochrane Library, Hooked on Evidence (American Physical Therapy Association), PEDro Search terms: multiple myeloma, cancer-related fatigue, exercise, physical therapy, cancer rehabilitation, bone lesions, fatigue, cancer, metastases, metastatic cancer, aerobic cancer, resistance exercise, muscle wasting, interventions	Breast Cancer Screening Committee of level of evidence classification
Humpel et al.(6)	Identify any existing guidelines or recommendations for exercise in cancer patients and survivors, to determine the focus of the identified guidelines and recommendations and determine the sources used to develop the guidelines and recommendations	Treatment/ Survivorship	Review	- Significant discussion about exercise/physical activity for cancer patients or survivors - Guideline or recommendation	Cancer patients and survivors	Not reported	Electronic database search in Medline, Cinahl, PsycInfo Search terms: cancer, malignancy, exercise, physical activity, resistance, guidelines, recommendations	Not reported
Galvao et al.(48)	Present an overview of exercise interventions in cancer patients during and after treatment and evaluate dose-training response considering type, frequency, volume, and intensity of training along with expected physiological outcomes	Treatment/ Survivorship	Review	Not reported	Cancer patients	Not reported	Electronic database search in Medline and scanning reference lists Search terms: exercise, cardiovascular training, resistance training, rehabilitation, cancer	Not reported

Exercise intention

Five studies (36;39;40;49;50) describe intention to exercise. All studies used the constructs of the TpB (figure 4). The TpB proposes that intention is the key determinant of behaviour. Intention is determined by three independent variables: attitude, subjective norm and perceived behaviour control (PBC) (40). Attitude is defined as "a learned disposition to respond in a consistently favourable or unfavourable manner with respect to a given object" (78). "Subjective norms consist of a person's beliefs about whether significant others think he/she should engage in the behaviour" (78). PBC is the "individual perception of the extent to which performance of the behaviour is easy or difficult (78). "Intention capture the motivational factors that influence a behaviour, how hard people are trying, how much effort they would extent to perform the behaviour" (78).

Moreover, following the TpB, a person intend to execute a behaviour when the person respond in a favourable manner to a given object. The person beliefs that others think he should engage the behaviour and the behaviour is easy to perform following the perception of the person.

Blanchard et al. (40) reported the standardized betas and explained variance for 5 theories of planned behaviour studies in cancer survivors (42;60;62;69;70). Table 6 describe these values and explained variance with additional betas and explained variance of the included studies (36;39;40;49;50) from the current review.

In the different articles (36;50;60;69;70), the regression analysis indicate that attitude, subjective norm and PBC explained 23-68% (range) of the variance in exercise intention by adult cancer patients in the treatment stage (table 4).

Additionally, intention explained 14-30% (range) of the variance of exercise behaviour in the treatment stage (36;50;60;69;70).

Moreover, in the survivorship stage, the regression analysis indicate that attitude, subjective norm and PBC explained 36-49% (range) of the variance in exercise intention by adult cancer patients in the treatment stage (40;42;49). Regarding the explanation of the variance of exercise behaviour in the survivorship stage, intention explained 30-36% (range) of this variance (40;42;49).

One study (39) makes no distinction between treatment stage and survivorship stage. In this study the regression analysis indicate that attitude, subjective norm and PBC explained 42% of the variance in exercise intention by adult cancer patients and cancer survivors.

In the study of Jones et al.(50) with a population of patients with brain tumors, affective attitude and PBC are the most important predictors of exercise intentions. However, the relationship between instrumental attitude and intention was influenced by gender and body mass index (BMI). Particularly, male and overweight patients regard health benefits of exercise as more important than female and normal weight patients (50). In the study of Jones et al.(49), with a population of multiple myeloma, there was a significant association between higher intentions, instrumental attitude and medical variables, not having received radiation therapy or stem cell transplantation.

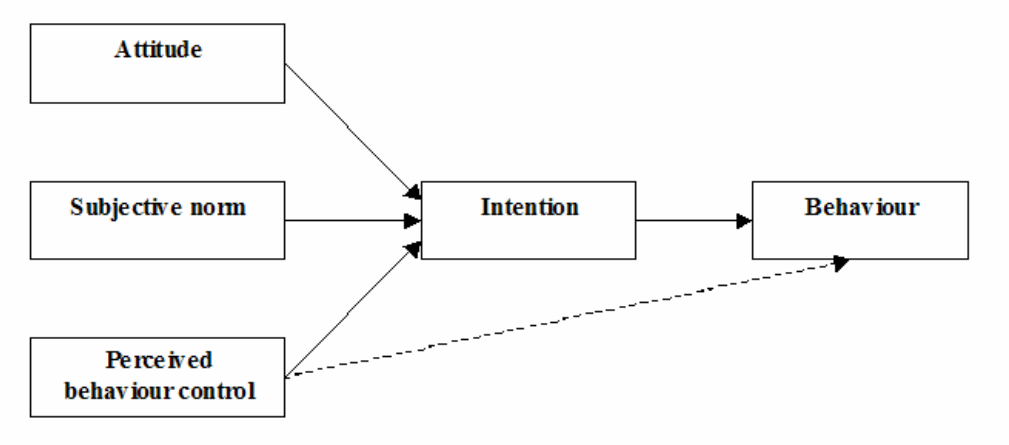

Figure 4; Theory of Planned Behaviour

Table 4; regression of intention on the theory of planned behaviour

		EXERCISE BEHAVIOUR			EXERCISE INTENTION			
	Type of cancer	*Intention*	*PBC*	R^2	*Attitude*	*SN*	*PBC*	R^2
Courneya et al.(69)	Colectoral cancer (treatment)	0.29*	0.28*	0.22	0.45*	0.15	0.00	0.31
Courneya et al.(70)	Colecteral cancer (treatment)	0.45**	0.21***	0.30	0.43**	ns	ns	0.23
Courneya et al.(60)	Breast cancer (treatment)	0.26**	0.22**	0.14	0.29**	0.30**	-0.04	0.23
Courneya et al.(62)	Mixed cancer (treatment)	0.29**	0.11	0.14	0.49**	0.05	0.42**	0.68
Jones et al.(50)	Primairy brain cancer (treatment)	nr	nr	nr	(a) 0.24** (i) 0.15	-0.05	0.36**	0.32
Karvinen et al.(36)	Endometrial cancer (treatment)	0.38**	0.11 (SE) 0.18*	0.31	(a) 0.30** (i) 0.06	0.02	-0.02 (SE) 0.36**	0.38
Courneya et al.(42)	Breast cancer (survivorship)	0.64*	-0.10	0.35	-0.33	0.58*	0.33***	0.49
Blanchard et al.(40)	Breast cancer (survivorship)	0.47*	0.15	0.30	0.27*	0.20**	0.36***	0.45
Jones et al.(49)	Multiple myeloma (survivorship)	nr	nr	nr	(a) 0.06 (i) 0.42**	0.07	0.23	0.43
Blanchard et al.(40)	Prostate cancer (survivorship)	0.50**	0.15	0.36	-0.05	0.08	0.59***	0.36
Andrykowski et al.(39)	Cancer (treatment/ survivorship)	nr	nr	nr	0.54**	0.16*	0.19*	0.42

*Abbreviations: * p<0,05; ** p<0,01; *** p<0,10; PBC = perceived behavioural control; SN = subjective norm; ns = not significant; (a) = affective attitude; (i) = instrumental attitude; (SE); self-efficacy*

Exercise adherence

Nine studies (32;34;41-45;47;52;77) described adherence. "Adherence refers to the level of participation achieved in a behavioural regimen once the individual has agreed undertake it" (34). Exercise adherence can also be defined as "the degree to which a person fulfils a given exercise prescription" (77). According to Courneya et al. (44), pre-program overall exercise stage, intention, age, quality of life, fatigue, subjective norm, leg-press test and PBC predicted exercise behaviour in the treatment stage by prostate cancer patients. Pre-program overall exercise stage was the strongest predictor of exercise adherence. According to this exercise stage, exercise adherence was hard for adult cancer patients in the precontemplation and contemplation stage (44). Regarding age, aged 75 years or older was a negative predictor for exercise adherence (44). Additionally, higher disease stage predicted lower levels of adherence (44). Following the study of Courneya et al. (77), past exercise is an important predictor of exercise adherence, although it was not an independent predictor. Moreover, it was the strongest independent predictor for exercise contamination ("the extent to which the control condition has adopted the intervention") (77). Furthermore, gender (men) was an significant predictor of exercise adherence (77). Remarkably, intention was not a predictor of exercise adherence, but is was a predictor for contamination (77). More specifically, according to the study of Courneya et al. (77), gender, extraversion, normative beliefs are main predictors of exercise adherence in cancer survivors. Contrary to the results of Courneya et al. (77), in the study of Courneya et al. (42) intention was the only determinant of exercise adherence. Daley et al. (47) focussed their analysis of determinants of adherence on socio-demographic factors, health-related factors and treatment factor by women treated for breast cancer. Outstandingly, none of these determinants was, in their study, a significant determinant of exercise adherence. Regarding the study of Courneya et al. (43) expected success and affective reactions after the exercise programme are predictors of post-program

exercise. Perceived success was the strongest correlation of expected success, positive affect, negative affect (43). Perceived success also predicted post-program exercise independent of expected success, affective reactions and programme exercise (43). According to this result, Courneya et al. (43) suggested that perceived success might be an important variable in comprehending continued motivation and adherence after a structured exercise programme. Following Kim et al. (52) improved control for the symptoms of nausea, vomiting and fatigue may help adult cancer patients adherence to exercise in the treatment stage. According to the study of Vallance et al. (32) the utilization of easy to use self-monitoring methods, such as the pedometer and theoretical based exercise may improve exercise maintenance. Concerning theory-based behavioural interventions, these interventions may increase exercise rates concerning women with breast cancer in the treatment stage (34). According to the study of Pickett et al. (34), a structured exercise program of moderate-intensity that includes information and support related to exercise adherence strategies may be beneficial for sedentary women breast cancer patients in the treatment stage. Coleman et al. (41) reported important factors and suggestions to consider to facilitate exercise adherence for multiple myeloma patients in the treatment stage. These factors are presented in table 5.

Table 5; important factors and suggestions for exercise adherence (41)

IMPORTANT FACTORS	SUGGESTIONS
Patient selection	Patients need to undergo a assessment for risk factors before participation.
Exercise support from a family member or friend	Try to include a family member or friend who will be a positive support for encouraging exercise. If there is not a person for supporting, suggest participation in a group exercise program available in the community.
Exercise equipment	Identifying if patients will be able to perform exercises at any location and that the equipment is a facilitator to exercising, not a barrier.
Motivation	Health care providers should have plans for motivational contacts with patients when prescribing exercise.
Modifying exercises	Help patients to feel successful in their exercise programme regardless the intensity.

Exercise barriers

Concerning the exercise barriers, six studies (35;46;54-57) describe these barriers. Three major themes of barriers can be distincted between the exercise barriers; (I) disease/treatment-related barriers, (II) life-related barriers and (III) motivation related barriers (46). Disease/treatment-related barriers are those barriers related to the disease or treatment. According to Courneya et al. (46), "life-related barriers are those not related to the disease or treatments but appear to be legitimate barriers that do not primarily reflect motivation". Motivational barriers are those barriers primarily reflecting motivation. Disease/treatment related barriers are most frequent reported (42.9%) (figure 5). The most frequent reported barriers concerning disease/treatment-related barriers (n=582) are fatigue (17.5%), feeling sick (11.2%), nausea/vomiting (8.2%), pain (6.2%) and chemotherapy day (5.7%) (35;46;55;56) (figure 6a). Other reported disease/treatment-related barriers were shoulder weakness/-pain, diarrhoea, infection, chemotherapy line inserted, surgical complications, doctors appointment, dizziness, medical complications, weakness, low blood count, depression, tachycardia, doctors'order, headache, metastatic disease, radiation markings, blisters, vertigo, coincidental medical condition, blood clot (35;46;55;56). Additionally, Perna et al. (54) reported also fatigue as an exercise barrier, but they did not note absolute measures of barrier frequency or intensity. According to the barriers regarding the life-related (n=382) barriers, lack of time (18.3%), flu/cold (12.0%), vacation (9.9%), holiday closure (8.6%), bad weather (8.4%) and out of town (8.1%) are the most frequent reported barriers (35;46;55;56) (figure 6b). Other reported life-related barriers are personal issues, injury, visitors, enough activity elsewhere, joint pain/tendonitis, not feeling well, lack of child care, social responsibilities, back problems, car injury, leg problems, confusion, fever, family death, urinary tract infection, bad hip, broken rib and shingles (35;46;55;56). The most frequent reported barriers on the subject of motivation related barriers (n=407) are loss of

interest (9.8%), exercise not a priority (9.1%), procrastination (8.4%) and lack of self-discipline (8.4%) (35;46;55;56) (figure 6c). Other reported motivation related barriers are lack of knowledgeable exercise staff, fear of injury, fear of making condition worse, progressing toward exercise, lack of skills, discouragement, miscommunication, exercise too strenuous, fear of infection and forgetting (35;46;55;56). Overall, the three most frequent reported exercise barriers (n=1381) are fatigue (7.4%), lack of time (5.1%) and feeling sick (4.7%) (35;46;55;56) (figure 6d). In order to determine the psychometric properties of an exercise barrier self-efficacy scale, Rogers et al. (57) additionally determine the level of exercise barriers. The exercise barrier self-efficacy scale distinct nine items (reported with mean and stand deviation per exercise barrier) (n=86); lack of discipline to exercise (50.9±27.6), nausea (22.8±29.0), not a priority (46.1±26.8), bad weather (44.2±30.3), fatigue (34.6±26.6), no interested (39.2±27.6), lack of time (37.8±28.6) enjoyment (39.3±27.4) and nobody for encouragement (47.4±28.3).

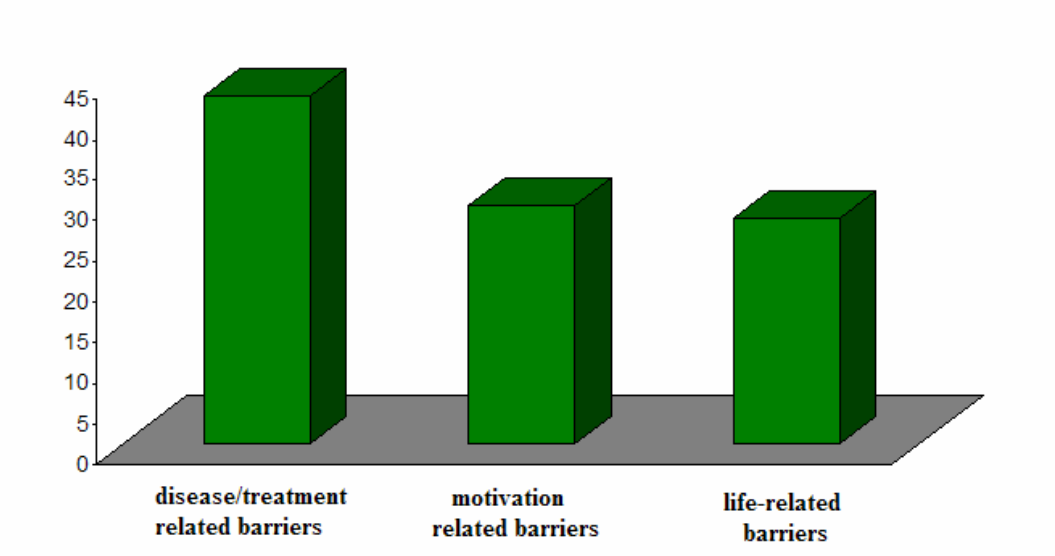

Figure 5.; distinction between exercise barriers (n=1381)

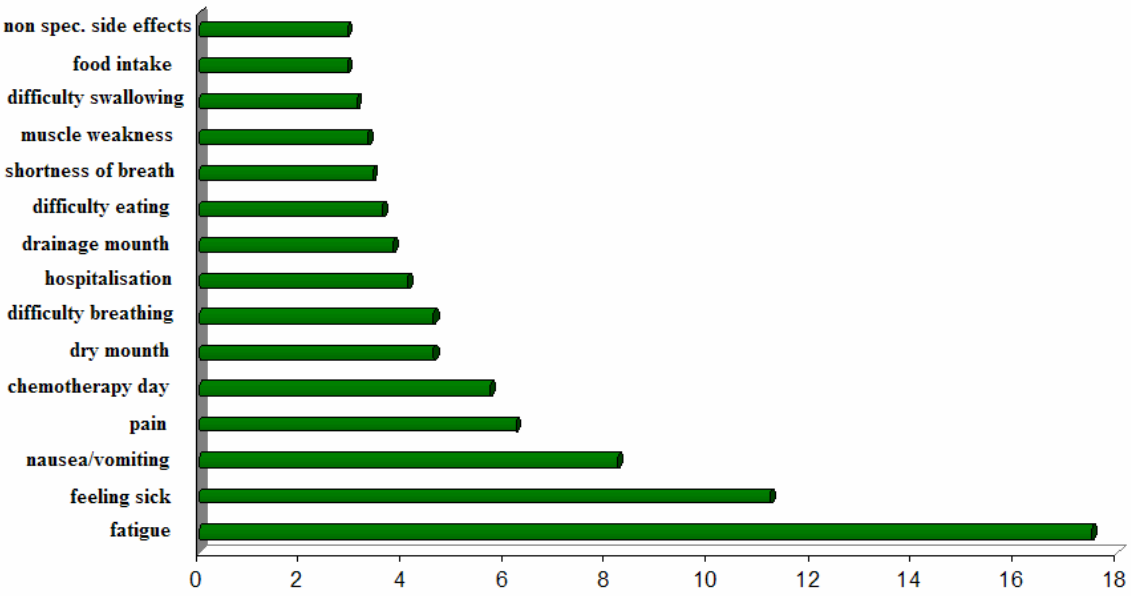

Figure 6a; most frequent reported disease/treatment-related barriers (%) (n=582) (35;46;55;56)

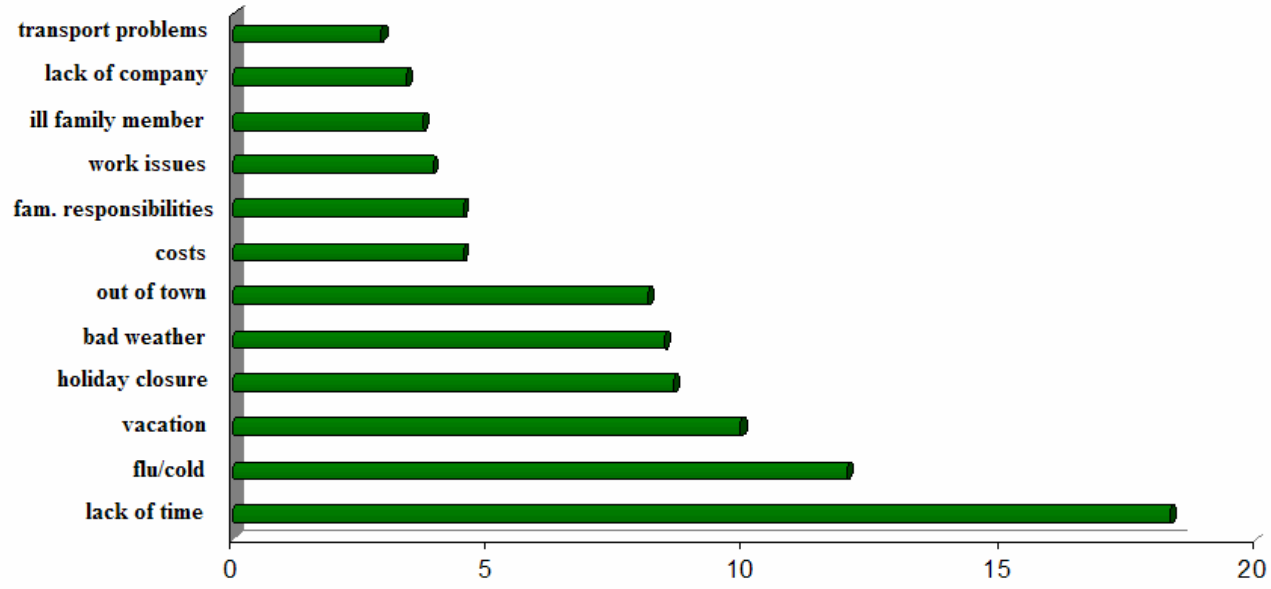

Figure 6b; life-related barriers (%) (n=382) (35;46;55;56)

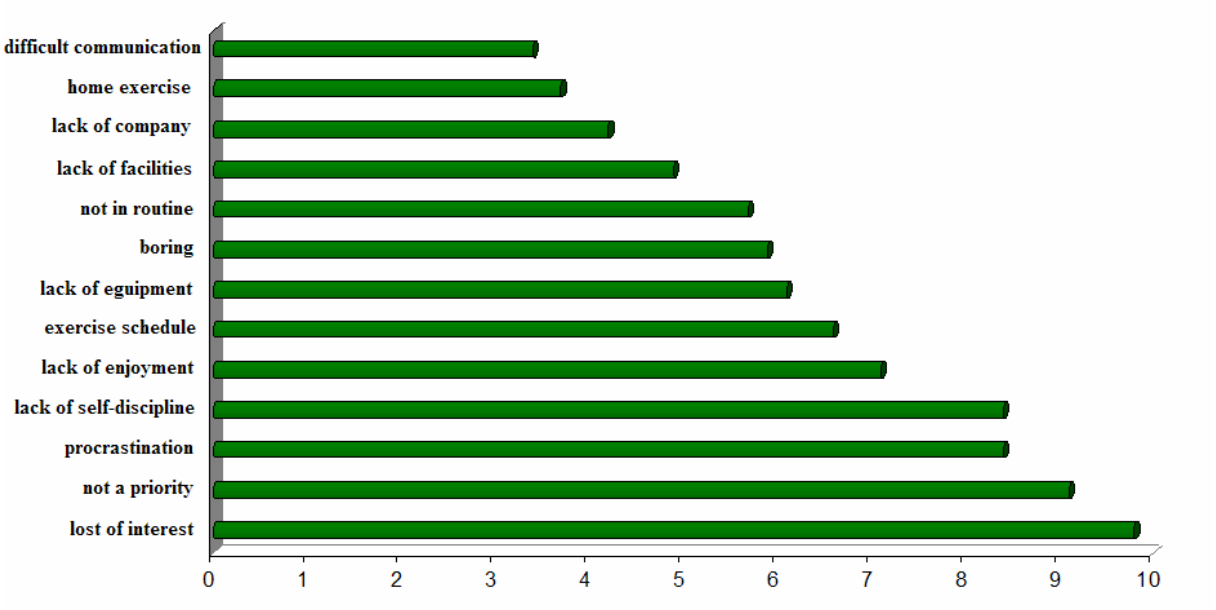

Figure 6c; motivation related barriers (%) (n=407) (35;46;55;56)

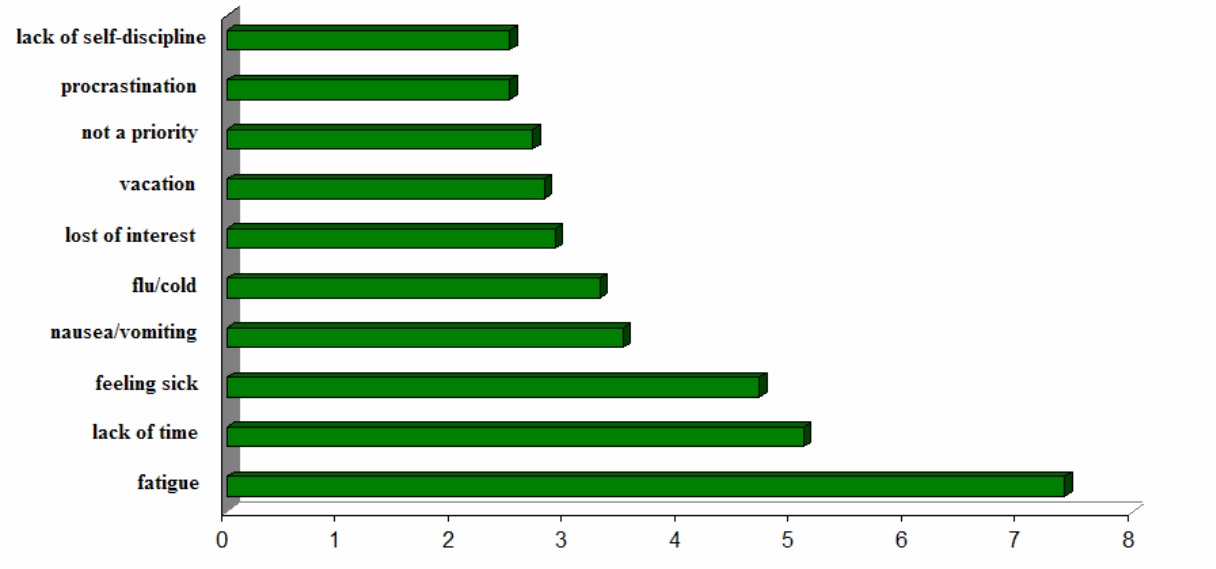

Figure 6d; most frequently reported barriers (%) (n=1381) (35;46;55;56)

Exercise preferences

Five studies (4;7;38;51;56) describe exercise preferences. Only one study (51) made a distinction between treatment stage and survivorship stage (table 6). In all studies, adult cancer patients and survivors have interest in an exercise program and prefer to exercise at home. In two studies (4;38), the primary preferred person the receive exercise counselling from is an exercise specialist from a cancer centre. The secondary preferred person is the oncologist. In three studies (4;7;38), the morning is the most preferred time of day to exercise and exercising in the early evening or at night is preferred in one study (56). In three studies (4;7;38) adult cancer patients and survivors prefer, scheduled exercise, to structure their exercise. In three studies (7;38;56) adult cancer patients and survivors prefer unsupervised exercise and one study (4) reported preferences for supervised exercise.

Furthermore, 33.6% (n=944) preferred starting exercise 3-6 months after treatment (4;7;38;56) (figure 7a). Secondly, 26.4% (n=944) preferred starting exercise before treatment (4;7;38;56). Additionally, 60.2% (n=1064) preferred exercising with moderate intensity (4;7;38;56) (figure 7b). Subsequently, 27.3% (n=1064) preferred low intensity exercise (4;7;38;56). Most adult cancer patients and survivors (32.6%) prefer exercising alone (4;7;38;51;56) (figure 7c). Relating to accompany, 25.2% (n=1123) have no preferences (4;7;38;51;56). Moreover, 15.6% (n=1123) preferred exercising with other cancer survivors (4;7;38;51;56).

Regarding the preferred type of exercise, 56.5% (n=1214) preferred walking) (4;7;38;56) (figure 7d). Secondly, 7.2% (n=1214) preferred cycling (4;7;38;56). Thirdly, 6.8% (n=1214) preferred gardening as type of exercise (4;7;38;56).

Table 6; exercise preference per stage (51)

	Treatment stage	Survivorship stage
Receiving information	No	Yes
Ability to participate	No	Yes
Accompanied	No preference	Family
Place	At home	At home
Exercise time	20-30 minutes	Over 30 minutes
Interest in attending	Three times a week	Three times a week

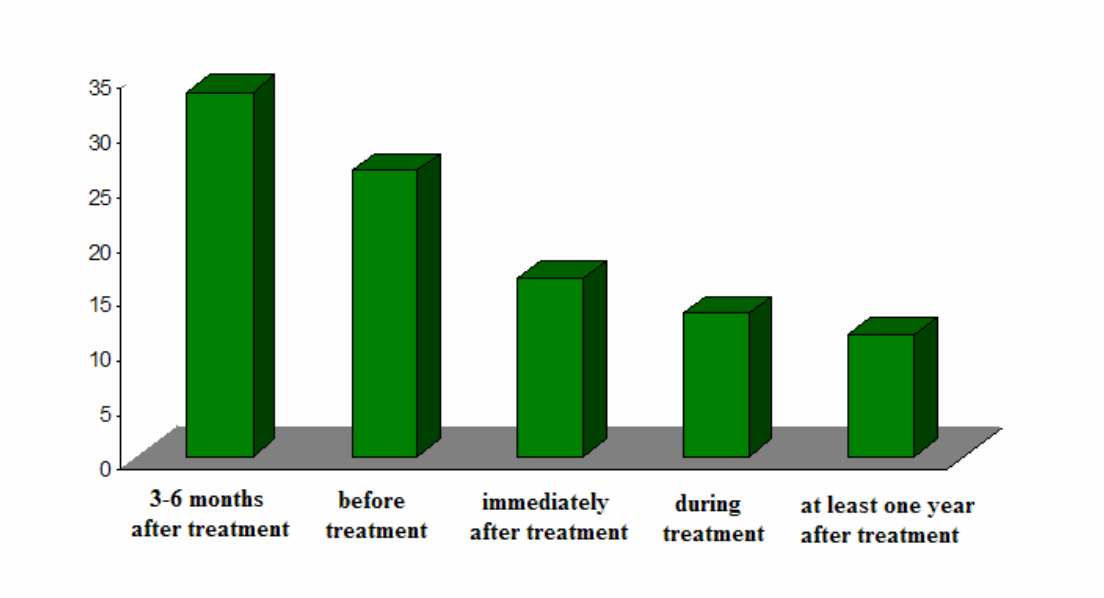

Figure 7a; preferences concerning starting exercise (%) (n=944) (4;7;38;56)

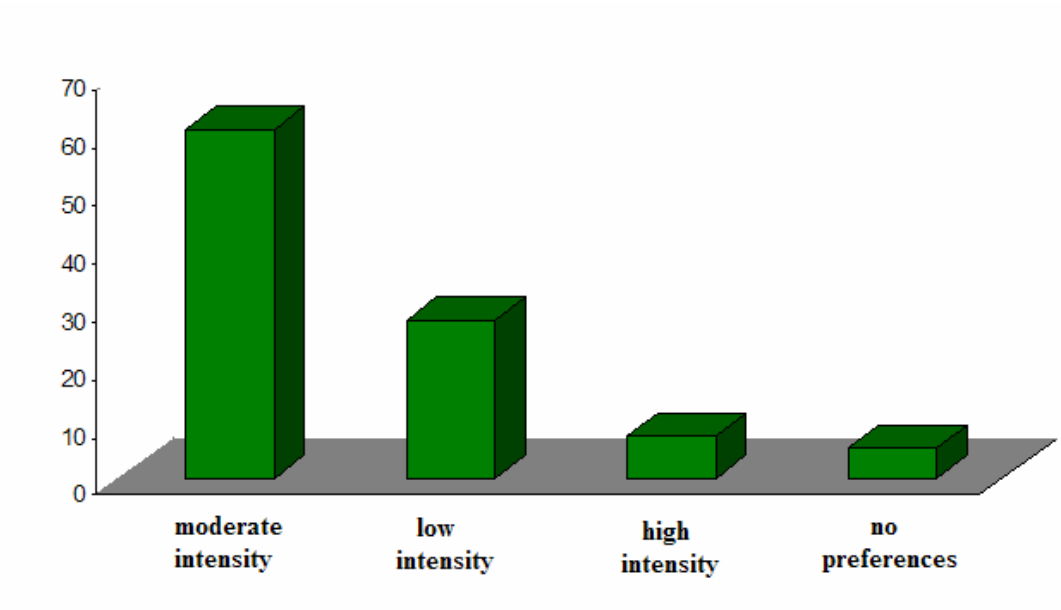

Figure 7b; preferences concerning intensity (%)(n=1064) (4;7;38;56)

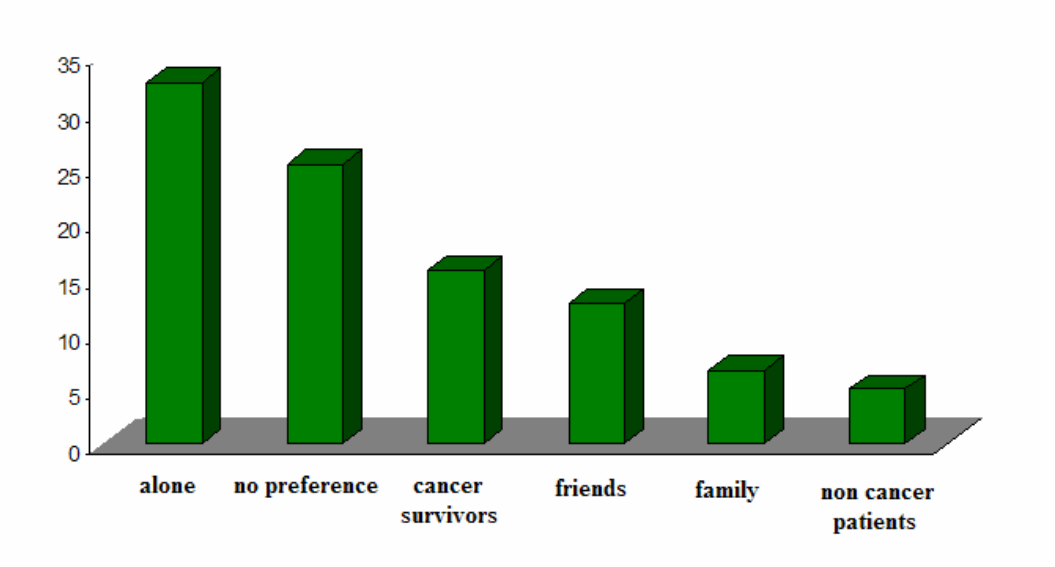

Figure 7c; preferences concerning accompany (%)(n=1123) (4;7;38;51;56)

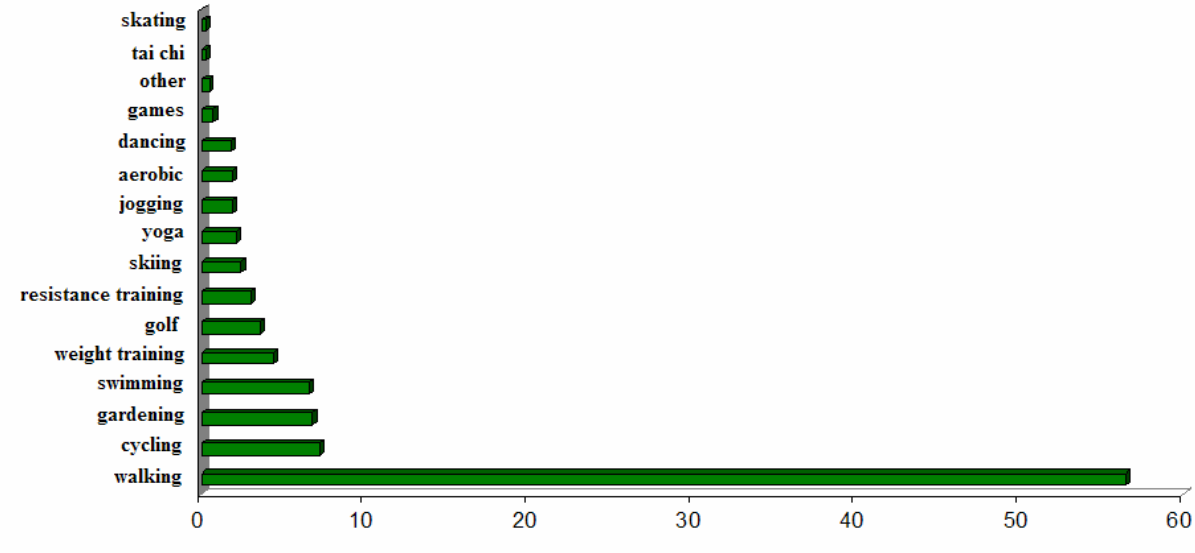

Figure 7d; preferences concerning type of exercise (%)(n=1214) (4;7;38;56)

Group cohesion

Two studies (37;53) describe group cohesion. In the study of May et al. (37) group cohesion was assessed with the Group Cohesion Questionnaire-22 (GCQ-22). This questionnaire distinguished four scales: Bond Group, Bond Member, Cooperation and Instrumental Value (37). The Bond Group is defined as "the bond with the group as total" (37). Bond Member is defined as "the bond with other members of the group" (37). Moreover, Cooperation is defined as "involvement" and Instrumental Value is defined as "support of the group". The study of May et al. (37) demonstrate that Cooperation within the group was associated to better outcome. Concerning this Cooperation, a higher Cooperation predicted higher post-intervention quality of life, physical functioning and lower fatigue in men and higher quality of life and physical functioning in women (37). Dissimilarity, a higher Bond Member is negatively associated with better outcome. Women who describe a stronger Bond Member demonstrate lower post-intervention quality of life (37).

Midtgaard et al. (53) group cohesion was assessed with group interviews. The group interview was divided into three domains: motivation, group integration, group norm. Moreover, they (53) defined motivation as "individuals attraction to the group". Group integration is defined as "the influence of having cancer" (53). Furthermore, group norm is defined as "the nature of the group and the level of group development" (53). Concerning motivation, the study of Midtgaard et al. (53) showed that group setting stimulated adult cancer patients and survivors trying activities despite their physical limitations. Regarding group integration, they (53) described that most adult cancer patients experienced during the exercise period in the group a decreased physical condition, caused by treatment side effects. During the period of decreased physical condition, the participants used each other as role model (53). On the subject of group norm, there were more reasons than having cancer for the interaction and integration in the group. Exercise provide adult cancer patients and

survivors a chance to approach each other for other reasons that their illness. Following the study of Midtgaard et al. (53), the investigation of group cohesion, make clear that adult cancer patients in the treatment stage participating in a group exercise programme can build up a form of team spirit.

Exercise variables

Regarding exercise variables, three reviews (6;48;58) reported recommendations for intensity, frequency, duration of aerobic and resistance training. In this review, 36 unique primary publications (79-114) could be distinguished. The review of Strong et al. (58) included also the review of Galvao & Newton (48). Only three primary publications (82;84;85) were reported in two reviews (48;58).

The goal population of two reviews (6;48) was patients with cancer in general (table 7). Dissimilarity, the review of Strong et al. (58) distinguished the goal population in adult cancer patients and survivors with solid tumors and haematological cancers, older cancer survivors and adult cancer patients related fatigue. For these different goal populations, different forms of intensity, frequency and duration are recommended. The intensity of aerobic exercise for adult cancer patients in general, is suggested to range between 55-90% maximum heart rate (MHR), 50-85% maximum heart rate reserve (MHRR) or 40-75% heart rate reserve (HRR) (6;48). The suggested frequency of aerobic exercise, for adult cancer patients in general, is 3-5 times a week (6;48). Moreover, the duration of aerobic exercise, for this goal population, is recommended to be 10-60 minutes (6;48). Especially, aerobic exercise with an intensity of 40-60% HRR or 60-80% MHR and frequency of 4 times a week during 35 minutes, is recommended for patients with solid tumors and haematological cancer (58). Particular recommendations for older cancer survivors of aerobic exercise are an intensity of 60-70% MHR, frequency of 7 times a week during more than 30 minutes (58). Specially for patients with cancer-related fatigue, aerobic exercise with an intensity of 50-70% MHR or ratings of perceived exertion (RPE) of 11-13 on the Borg Rating of Perceived Exertion Scale and frequency of 3-5 times a week during 15-30 minutes, is recommended (58). Concerning resistance exercise for adult cancer patients in general, Galvao and Newton (48) suggested an intensity of 50-80% 1-repitition maximum (1-RM) or 6-12 RM with 1-4 sets per muscle

group 1-3 times a week. Regarding resistance exercise in older cancer survivors, Strong et al. (58) recommended 1 set of 8-10 exercises of 10-15 repetitions for all major muscle groups during 20-30 minutes, two times a week.

Table 7; recommended exercise variables according to the included reviews

		Goal population	Intensity	Frequency (per week)	Duration (volume)	Cancer relevant expected outcomes
Aerobic	Strong et al.(58)	Patients with solid tumors and hematological cancers	40-60% HRR 60-80% MHR	4	35 minutes	-
		Older cancer survivors	50-70% MHR	7	> 30 minutes	-
		Patients with cancer-related fatigue	55-70% MHR RPE = 11-13 on Borg scale	3-5	15-30 minutes	-
	Galvao and Newton.(48)	Adult cancer patients and survivors	55-90% MHR 40-85% MHRR	3-5	20-60 minutes	↑cardiopulmonary function ↑ insulin sensitvity ↑ HDL ↓ LDL ↓ fatt mass ↓ fatigue
	Humpel et al.(6)	Adult cancer patients and survivors	40-75% HRR 55-85% MHR	3-5	10-60 minutes	
Resistance	Strong et al.(58)	Older cancer survivors	1 set of 8-10 exercises of 10-15 repetitions for all major muscle groups	2	20-30 minutes	-
	Galvao and Newton (48)	Adult cancer patients and survivors	50-80% 1-RM 6-12RM	1-3	1-4 sets per muscle group	↑ muscle mass ↑ muscle strength ↑ muscle power ↑ muscle endurance ↑ BMD ↑ functional performance ↓ fatigue ↑ resting metabolic rate ↓ fatt mass
	Humpel et al.(6)	-	-	-	-	-
Flexibility	Strong et al.(58)	Older cancer survivors	Slow,static stretches held for 10-30 seconds	2-3	-	-
	Galvao and Newton (48)	Adult cancer patients and survivors	10-30 seconds	2-3	2-4 sets per muscle group	↑ or no change in range of motion
	Humpel et al.(6)	-	-	-	-	-

Abbreviations: HRR = Heart Rate Reserve; MHRR= maximum heat rate reserve; MHR = maximal heart rate; RPE = ratings of perceived exertion; RM= repetition maximum; HDL = high-density lipoprotein; LDL= low-density lipoprotein; BMD= bone mineral density; - = not reported

Discussion

Although exercise is becoming accepted as advantageous for adults suffering from cancer and cancer survivors, there is no uniform information with regard to exercise variables for adults suffering from cancer and cancer survivors. In general, adults exercise less after being diagnosed with cancer. For that reason, it is essential to know the underlying determinants of exercise behaviour. Detection of the underlying determinants makes it possible to make an useful intervention especially for this population.

The first aim of this review was to determine the determinants of intention and adherence to exercise in adult cancer patients and survivors. The second objective was to identify the exercise barriers and exercise preferences of adult cancer patients and survivors. The third purpose of this review to establish the impact of group cohesion in a supervised exercise program for adult cancer patients and survivors. Finally, the fourth aim was to identify the reported recommendations for intensity, frequency, duration of aerobic and resistance training for adult cancer patients and survivors.

Regarding to the first aim, the determinants of intention, in adults with cancer, are instrumental attitude, affective attitude, subjective norm, PBC (self-efficacy), medical variables, not having received therapy or stem cell transplantation, gender, body weight. The explained variance for these variables distinct between de treatment and survivorship stage.

Affective attitude is a determinant of intention, this suggest that aspects of an exercise program must focus on pleasant or amusing aspects of exercise. Enjoyment makes attitudes more positive, which may influence a persons' exercise intentions. Additionally, the exercise program must focus attention on health benefits of exercise participation and encouragement. Consideration is needed for gender and body weight by designing an exercise program. Given the different determinants, it might be desirable for physiotherapists or exercise researchers to execute theoretically based determinant analysis. According to the included

articles, TpB appears to be a useful framework for understanding intention and behaviour. Although, it must be recognized that attitude, subjective norm and PBC are not the only determinants of intention and behaviour in adult cancer patients and survivors. Additionally, other variables should be considered. The I-CHANGE model may be a more complete model for understanding intention, behaviour and maintenance of exercise in adult cancer patients and survivors. Further research should examine the usefulness of the I-CHANGE model or other models, like TransTheoretical Model (TTM), Health Belief Model (HBM) or Common Sense Self-Regulation Model (CS-SRM).

Following Courneya et al. (115), it is suggested that frequency, intensity and duration of exercise differs by determinant. According to this suggestion, research is recommended for investigating, which exercise variables are required per determinant of intention (e.g. attitude, subjective norm and PBC).

In addition, the determinants of adherence in the treatment stage are pre-program overall exercise stage, intention, age, quality of life, fatigue, subjective norm, leg-press test, PBC, past exercise behaviour, gender (men), extraversion, normative beliefs, expected success and affective reactions after the exercise programme. Improved control for the symptoms of nausea, vomiting and fatigue may help persons' adherence to exercise in the treatment stage. The utilization of easy to use self-monitoring methods, such as the pedometer and theoretical based exercise may improve exercise maintenance.

In order to increase the adherence, adult cancer patients and survivors must be screened for motivation, including intention, subjective norm, PBC. Additionally, screening for exercise beliefs and personality is indicated. One strategy for increasing motivation is motivational interviewing (MI). MI is "a client-centered counselling procedure designed to help clients discover and overcome their own barriers to changing a health behaviour" (20). In a RCT of Bennett et al. (20) in a sample of long-term cancer survivors, the participants in the MI group

were, at the beginning, more inactive with a mean of 900 kcal per week less activity than the control group. Finally, at the end of study, the participants in the MI group were 230 kcal per week more active than the control group (20).

Regarding to the second objective, exercise barriers, there was no distinction made between the treatment or survivorship stage. The main barriers are fatigue, lack of time, feeling sick, nausea/vomiting, flu, loss of interest, vacation, exercise not a priority, procrastination, lack of self discipline. Most exercise barriers are disease/treatment or life-relate.

Furthermore, concerning exercise preferences, in the treatment or survivorship stage, adult cancer patients and survivors prefer unsupervised scheduled exercise (exercise type walking) with moderate intensity without accompany (alone) in the morning at home, 3-6 months after treatment. They preferred exercise counselling from an exercise specialist from cancer centre.

Given the exercise preferences, physiotherapist should offer individual and group exercise programs. This is essential for maximizing exercise adherence. Overall the knowledge of exercise preferences of adult cancer patients and survivors develop adherence. Although the influence of exercise preferences on adherence need to be investigated. Moreover, the exercise preferences should be taken in to account by designing exercise programs. Additionally, paying attention to the exercise preferences may increase the benefits of exercise. Taking into account the exercise preferences of adult cancer patients and survivors, different exercise programs must be designed with different structures, types of supervision, start moments, accompany, intensity and type of exercise. The best option is a tailored exercise programme as a results of the exercise preference; break up exercises throughout the day, tailored prescription to the ability of the person and keep the person involved and performing some type of prescripted exercise (41).

Although, the oncologist is the second preferred person to receive counselling from, it seems to be the most logical option, while oncologists have direct contact with adult cancer patients

and survivors. The study of Jones et al. (15), shows that a large portion of oncologist felt exercise important, beneficial and safe in the treatment stage. Forty-three percent tried to recommended exercise and 28% recommended exercise in the past month (15). This is a low percentage, given the beneficial effects of exercise. The study of Jones et al. (16), implicate that oncologist's recommendation have a modest effect on exercise behaviour in adults breast cancer patients and survivors. Therefore, it is recommended to implemented exercise prescription by an oncologist.

Regarding the third aim, the impact of group cohesion in a supervised exercise program in the treatment stage is that the group can build up a form of team spirit. There is an indication that group cohesion has an impact on quality of life, physical functioning and fatigue.

Not all included articles make a distinction between treatment or survivorship stage. Some articles make an overall conclusions of the treatment and survivorship stage. Regarding future research, it is recommended to apply more structure to the research. Making a distinction between treatment or survivorship stage (by using a predefined organisational structure e.g. PEACE (65) or PACC (2;66)) is fundamental for publishing an valuable article.

According to the last aim, there was no distinction in description of exercise variables in the treatment or survivorship stage. The reported recommendations for intensity of aerobic exercise for adult cancer patients in general, range between moderate to high (55-90% MHR, 50-85% MHRR or 40-75% HRR). The reported recommendations for frequency of aerobic exercise, for adult cancer patients in general, is 3-5 times a week. Moreover in the reported recommendations, the duration of aerobic exercise, for this goal population, is 10-60 minutes. Especially, aerobic exercise with an moderate to high intensity (40-60% HRR or 60-80% MHR) and frequency of 4 times a week during 35 minutes, is reported as a recommendation for patients with solid tumors and haematological cancer. Particular reported recommendations for older cancer survivors of aerobic exercise are an intensity of moderate

to high (60-70% MHR), frequency of 7 times a week during more than 30 minutes. Specially for patients with cancer-related fatigue, aerobic exercise with an intensity of 50-70% MHR or RPE of 11-13 on the Borg Perceived Exertion Scale and frequency of 3-5 times a week during 15-30 minutes, are reported recommendations. Concerning resistance exercise for adult cancer patients in general, an intensity of 50-80% 1-RM or 6-12 RM with 1-4 sets per muscle group 1-3 times a week are reported recommendations. Regarding resistance exercise in older cancer survivors, 1 set of 8-10 exercises of 10-15 repetitions for all major muscle groups during 20-30 minutes, two times a week is reported as a recommended.

Concerning these exercise variables it is recommended to investigate, in a study which included many types of cancer, these specific intensity, frequency and duration in the treatment and survivorship stage in order to compare the response of various types of cancer to the same exercise stimuli. There is an indication that different types of cancer, cancer stages, type of treatment and age of patient are responsible for a different response to the same training variables, but this must be investigated. Furthermore, investigation should give the extent to prescript sufficient exercise to adult cancer patients and survivors according to type of cancer, cancer stage, type of treatment or age in the context of evidence-based practice. Although, it may not be realistic to expect that general evidence based exercise guidelines for adult cancer patients and survivors can be developed, while there are numerous types of cancer and great discrepancy in treatment. In the included studies there were no recommendations mentioned concerning rest periods. The sufficient time for the rest period need to be investigated for both aerobic and resistance exercise.

Possibly, a restriction of this review, as with every systematic review, is the influence of subjective analysis by the researcher on the results. That is, identification and selection of literature may bias the outcomes. Additionally, literature search was applied to limited databases. By searching with the same key words in other databases, more publications could

be found. Another restriction may be the judgement of methodological quality and clinical relevance, which is only limited to one researcher. As a result, the quality of publications could be biased. Since data-synthesis and interpretation has been exported by only one researcher.

Generally, the literature reported an intensity of aerobic exercise for adult cancer patients in general, between 55-90% MHR, 50-85% MHRR or 40-75% HRR with a frequency of 3-5 times a week and a duration of 10-60 minutes. Moreover, an exercise program must centre attention on health benefits of exercise participation and encouragement. Furthermore, consideration is needed for gender en body weight by designing an exercise program. Beside, physiotherapist or exercise researchers need to execute theoretically based determinant analysis before designing a exercise programme. In order to increase motivation and overcome barriers to participate in an exercise programme, the strategy of MI is recommended. Given the exercise preferences, physiotherapist should offer individual and group exercise programs. The best option is a tailored exercise programme as a results of the exercise preference. According to this review, the tailored exercise programme must be scheduled exercise programme (exercise type walking) with moderate intensity without accompany (alone) in the morning at home, 3-6 months after treatment. Given the second (no preferences) and third (exercise with other adult cancer patients and survivors) preferences, it is recommended to offer an tailored individual (unsupervised) exercise programme and an group exercise programme. Additionally, the physiotherapist must stimulate group cohesion in the form of building up a sense of team spirit.

Conclusion

The determinants of intention, in adult cancer patients and survivors, are instrumental attitude, affective attitude, subjective norm, PBC (self-efficacy), medical variables, not having received therapy or stem cell transplantation, gender, body weight. Moreover, the determinants of adherence in the treatment stage are pre-program overall exercise stage, intention, age, quality of life, fatigue, subjective norm, leg-press test, PBC, past exercise behaviour, gender (men), extraversion, normative beliefs, expected success and affective reactions after the exercise programme. The main barriers are fatigue, lack of time, feeling sick, nausea/vomiting, flu, loss of interest, vacation, exercise not a priority, procrastination, lack of self discipline. Concerning exercise preferences, in the treatment or survivorship stage, adult cancer patients and survivors prefer scheduled exercise (exercise type walking) with moderate intensity without accompany (alone) in the morning at home, 3-6 months after treatment. According to the impact of group cohesion in a supervised exercise program in the treatment stage, is that the group can build up a form of team spirit. There is an indication that group cohesion has an impact on quality of life, physical functioning and fatigue. Regarding the intensity of aerobic exercise for adult cancer patients in general in the treatment or survivorship stage, the reported recommendations of intensity range between 55-90% MHR, 50-85% MHRR or 40-75% HRR. The reported recommendation of frequency of aerobic exercise is 3-5 times a week. Further, the duration of aerobic exercise, for this goal population, in the reported recommendations is 10-60 minutes.

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Appendix 1: search strategy

(1) “Adults”(MeSH)	(46) “ Exercises, Isometric”(tw) or “ Exercises, Isometric”
(2) “Adult”(tw) or “Adult”	(47) “Aerobic Training”(tw) or “Aerobic Training”
(3) “Adults”(tw) or “Adults”	(48) “Resistance Training”(tw) or “Resistance Training”
(4) “Adult*”	(49) 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46 or 47 or 48
(5) Adult*	
(6) 1 or 2 or 3 or 4 or 5	
(7) “Neoplasms”(MeSH)	(50) “Duration”(tw) or “Duration”
(8) “Neoplasms”(tw) or “Neoplasms”	(51) “Sets”(tw) or “Sets”
(9) “Neoplasm”(tw) or “Neoplasm”	(52) “Intensity”(tw) or “Intensity”
(10) “Tumors”(tw) or “Tumors”	(53) “Resistance”(tw) or “Resistance”
(11) “Tumor”(tw) or “Tumor”	(54) “Frequency”(tw) or “Frequency”
(12) “Malign Neoplasms”(tw) or “Malign Neoplasms”	(55) “Heart Frequency”(tw) or “Heart Frequency”
(13) “Malign Neoplasm”(tw) or “Malign Neoplasm”	(56) “VO2max”(tw) or “VO2max”
(14) “Neoplasms, Malign”(tw) or “Neoplasms, Malign”	(57) “VO2peak”(tw) or “VO2peak”
(15) “Neoplasm, Malign”(tw) or “Neoplasm, Malign”	(58) “Predictor”(tw) or “Predictor”
(16) “Cancer”(tw) or “Cancer”	(59) “Predictors”(tw) or “Predictors”
(17) “Cancers”(tw) or “Cancers”	(60) “Intention”(tw) or “Intention”
(18) 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17	(61) “Intentions”(tw) or “Intentions”
(19) 6 and 18	(62) “Motivation”(tw) or “Motivation”
(20) “Motor Activity”(MeSH)	(63) “Motivations”(tw) or “Motivations”
(21) “Motor Activity”(tw) or “Motor Activity”	(64) “Barriers”(tw) or “Barriers”
(22) “Motor Activities”(tw) or “Motor Activities”	(65) “Adherence”(tw) or “Adherence”
(23) “Activity, Motor”(tw) or “Activity, Motor”	(66) “Compliance, Patient”(tw) or “Compliance, Patient”
(24) “Activities, Motor”(tw) or “Activities, Motor”	(67) “Patient Cooperation”(tw) or “Patient Cooperation”
(25) “Locomotor Activity”(tw) or “Locomotor Activity”	(68) “Cooperation, Patient”(tw) or “Cooperation, Patient”
(26) “Locomotor Activities”(tw) or “Locomotor Activities”	(69) “User Compliance”(tw) or “User Compliance”

(27) “Activity, Locomotor”(tw) or “Activity, Locomotor” (28) “Activities, Locomotor”(tw) or “Activities, Locomotor” (29) “Physical Activity”(tw) or “Physical Activity” (30) “Physical Activities”(tw) or “Physical Activities” (31) “Activity, Physical”(tw) or “Activity, Physical” (32) “Activities, Physical”(tw) or “Activities, Physical” (33) “Exercise”(tw) or “Exercise” (34) “Exercises”(tw) or “Exercises” (35) “Physical Exercise”(tw) or “Physical Exercise” (36) “Physical Exercises”(tw) or “Physical Exercises” (37) “ Exercise, Physical ”(tw) or “ Exercise, Physical” (38) “ Exercises, Physical ”(tw) or “ Exercises, Physical” (39) “Aerobic Exercise”(tw) or “Aerobic Exercise” (40) “Aerobic Exercises”(tw) or “Aerobic Exercises” (41) “Exercise, Aerobic”(tw) or “Exercise, Aerobic” (42) “Exercises, Aerobic”(tw) or “Exercises, Aerobic” (43) “Isometric Exercise”(tw) or “Isometric Exercise” (44) “Isometric Exercises”(tw) or “Isometric Exercises” (45) “Exercise, Isometric”(tw) or “Exercise, Isometric”	(70) “Compliance, User”(tw) or “Compliance, User” (71) “Group Cohesion”(tw) or “Group Cohesion” (72) “Groups Cohesion”(tw) or “Groups Cohesion” (73) “Group Cohesions”(tw) or “Group Cohesions” (74) “Exercise Preference”(tw) or “Exercise Preference” (75) “Exercise Preferences”(tw) or “Exercise Preferences” (76) “Preference”(tw) or “Preference” (77) “Preferences”(tw) or “Preferences” (78) “Exercise Interest”(tw) or “Exercise Interest” (79) “Exercise Interests”(tw) or “Exercise Interests” (80) “Exercise Variable”(tw) or “Exercise Variable” (81) “Exercise Variables”(tw) or “Exercise Variables” (82) “Training Variable”(tw) or “Training Variable” (83) “Training Variables”(tw) or “Training Variables” (84) 50 or51 or 52 or 53 or 54 or 55 or 56 or 57 or 58 or 59 or 60 or 61 or 62 or 63 or 64 or 65 or 66 or 67 or 68 or 69 or 70 or 71 or 72 or 73 or 74 or 75 or 76 or 77 or 78 or 79 or 80 or 81 or 82 or 83 (85) 19 and 48 and 84