IJHS

Review Article

Level of physical activity and sedentary behavior in children and adolescents diagnosed with cancer: A systematic review

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WEBSITE: ijhs.org.sa
ISSN: 1658-3639
PUBLISHER: Qassim University

ABSTRACT

Objective: The objective of the study was to examine already published evidence on the level of physical activity and sedentary behavior in children during and after treatment for cancer. And, thusly to verify if patients are following the recommendations of the World Health Organization, United States Centers for Disease Control and Prevention and American College of Sports Medicine.

Methods: The platforms for searches were EBSCO, Web of Science and PubMed. The keywords used were physical activity, sedentary behavior, children or adolescents with cancer.

Results: Found 4572 articles. 16 satisfied the eligibility criteria. The most children of whom had a low level of physical activity and a high level of sedentary behavior.

Conclusions: We conclude that this population showed an increase in sedentary behavior. And, it was also observed that does not have specific recommendations for this population. Already, the recommendations used for the healthy children and for chronic patients are not ideal for this population. Therefore, it is demonstrated that specific recommendations must be created for this population.

Keywords: Neoplasms, oncology, pediatrics, physiotherapy, sedentary lifestyle

Introduction

Childhood cancer corresponds to around 1–3% of all new cases of neoplasms diagnosed in Brazil.[1] Despite its low incidence, this disease represents the leading death cause by disease among children, being the first most incident in developed countries and the second in developing countries.[2,3] The Brazilian National Cancer Institute estimated 420,000 new cases of cancer in 2018/2019 for each year, 12,500 of them involving children and adolescents.[1] This pathology has a wide range of malignancies such as leukemias, epithelial tumors, lymphomas, and tumors of the central nervous system, the main neoplasms for this age group.[1]

Usually, the oncological treatment leads to traumatic physical and psychological impact.[4,5] In this sense, physical exercise has been serving as a form of additional treatment, both in hospitals as at home, playing an important motivational role to children and their families.[6-10] Children hospitalized during treatment can safely perform several types of exercises, both aerobic and resistance exercises.

Physical activity contributes to the patient's clinical condition at aerobic and physical fitness level, muscular strength, and flexibility, and it helps decrease in treatment-related side effects, such as fatigue, arthralgia, cachexia, anxiety, and depression.[9,11-13] Its benefits are also of emotional and behavioral character, and may facilitate the child's adherence to the treatment.[8,14]

The World Health Organization (WHO) and the American College of Sports Medicine (ACSM) recommend that the ideal for a healthy child is the daily practice of 60 min of moderate-intensity physical activity.[15,16] The WHO stated that it is extremely important for children with higher risk of developing osteoporosis, hypertension, non-insulin dependent diabetes, and cardiovascular disease to follow these recommendations, as they prevent such diseases.[15]

The United States Centers for Disease Control and Prevention (CDC) suggest 60 min of moderate intensity physical activity, from 5 or more days a week, and 20 min of high intensity, from 3 or more days a week.[17] Similarly, to the WHO, it explained the importance of physical activity among children due to decreased muscle mass, strength, balance, and postural control caused by low levels of physical activity in this population.[17]

In contexts like these, exercise would improve cardiorespiratory, muscular conditions, bone health, biomarkers of cardiovascular and metabolic health.[18-21] There are still no specific designations on the suitable level of physical activity for children with cancer, as found for adults in the WHO and ACSM.[15,16,22] The existing guidance says that, whenever possible, children and young people with any disability must follow the giving recommendations by undergoing the evaluation and quantification of the appropriate type and intensity of physical activity depending on their medical conditions with their doctor and multi-professional team.[15,16]

This way, there is need for further studies on the importance to achieve the level of physical activity recommended for these children, both in the treatment and post-treatment periods. In addition, as the survival and the importance of healthy habits already have the literature's recognition, it is also important to investigate the change that occurs in the lifestyle of these patients, usually associated with sedentary behavior.[18,23-25]

The aim of this systematic review was to examine already published evidence investigating the level of physical activity and sedentary behavior in children during and after ontological treatment and thus assess whether these patients have been following the recommendations of the WHO, and of CDC and ACSM.

Methods

This systematic review followed the recommendations by Preferred Reporting Items for Systematic Review and Meta-analyses.[26]

Eligibility criteria

We included cohort, cross-sectional, and case–control studies on sedentary behavior and the level of physical activity among children with cancer, regardless of whether they considered it as an exposure or outcome variable. The considered age group was from 0 to 19 years. The articles were published in Portuguese, English or Spanish. Systematic reviews, clinical trials, case studies, dissertations, theses, book chapters, cross-reference articles, studies published out of the deadline and in not previously established languages were not included in the study. This study is registered in the Prospero platform by ID: CRD42018077199.

Research strategy

Electronic searches were carried out in EBSCO, Web of Science and PubMed databases using the MeSH Terms/MeSH Heading controlled descriptors and its proper entry terms, in addition to the Health Sciences Descriptors. The search was conducted in March 2018 and was updated in June 2021.

Selection of studies and data collection

For the selection of studies and data collection, researchers followed the acronym Population, Intervention, Comparators, Outcomes, and Study.[27] The search was carried out by a main researcher and two independent reviewers who searched for and reviewed all potentially relevant articles. Then, they conducted the reading of titles and abstracts. After the first selection, they managed the complete reading of the articles, excluding those that did not meet the inclusion and exclusion criteria. In cases in which there was no consensus, a fourth evaluator was consulted to decide on the eligibility of the study [Figure 1]. Articles identified by the manual search of references of articles included in the study were also incorporated.

Methodological evaluation

The evaluation methodology adopted was the Level of Scientific Evidence of the Oxford Centre for Evidence-Based Medicine that evaluates the quality of the found articles and their respective levels of recommendation.[28] This classification is specifically performed in health care, being categorized in levels divided into four groups (A, B, C, and D). The groups are defined in: A – Experimental or observational studies of high coherence; B – Experimental or observational studies of little

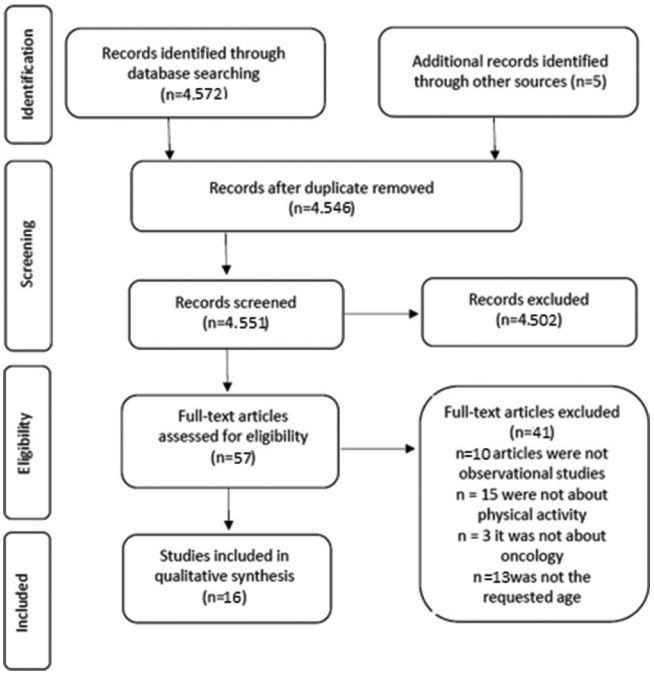

Figure 1: Flowchart of the studies included in the systematic review

coherence; C – Reports of uncontrolled case; and D – Study of little coherence with low critical evaluation. Therefore, study scores are given according to each group. Within a certain group there is a quality subdivision within evidence levels considering the Group A has subdivisions 1A, 1B, and 1C; the Group B has subdivisions 2A, 2B, 2C, 2A, and 3B; while Group C has subdivision 4; and Group D subdivision 5.

Methodological quality analysis and statistical description

The PEDro database is used by physical therapists in more than 80 countries, accounting for more than 3,900 searches a day. Among these countries, we highlight Australia, United States and Brazil, 10% of all accesses on the PEDro database being performed by physiotherapists. For a randomized controlled trial, be indexed on the PEDro database, it must satisfy five predetermined criteria:

1. The study must compare at least two interventions, that is, must compare an intervention to a group that has not undergone interventions or a placebo or to another intervention
2. At least one of the interventions must be part of physiotherapy practice
3. Interventions must have been applied to humans who represent the patients of physiotherapeutic practice
4. The distribution of subjects to treatment groups must be random or intentionally random and
5. The study must be fully published in a journal and must have been reviewed by peers.[29]

The PEDro scale, which evaluates the methodological quality and statistical description of randomized controlled trials, contains 11 criteria, accounting for score from 0 to 10, implying that the higher the score, the better the methodological quality and statistical description of the study according to the following criteria: (1) Eligibility and origin of participants; (2) random distribution of participants; (3) secret allocation; (4) similarity to the starting point of the study; (5) blinding of subjects; (6) blinding of therapists; (7) blinding of the evaluators; (8) analysis by treatment intention; (9) intergroup statistical analysis; and (10) measures of accuracy and variability.

The total score is generated by summing criteria 2 and 11. Criterion 1 on eligibility and the origin of participants is not considered in the final score as it is associated with the external validity of the study.[29] Article evaluation only considers what is reported in the manuscript and when the evaluators are unsure when scoring a criterion, this criterion gets a no.[29] The concept of evidence-based practice arouses in France during the 19th century; however, the use of evidence to guide clinical practice only gained prominence when the knowledge generated from the increase in scientific production could be organized and made available in electronic databases. The PBE ensures the individual care provided to patients is conscious and thoughtful, based on high-quality clinical research.[30,31]

Results

Initially, we identified 4572 articles. Next, we excluded duplicate studies (a total of 26 articles) and then held the triage phase of titles and abstracts. We excluded a total of 4502 articles, reaching a sample of 52 articles. After manually evaluating the bibliographical references of these articles, we added 5 more articles to the sample, thus totaling 57 for complete reading. Among these, 16 fulfilled the eligibility criteria to undergo qualitative evaluation [Table 1].

As for the obtained scores Level of Scientific Evidence of the Oxford Centre for Evidence-Based Medicine, the articles obtained a classification between 1B and 2B, considering the best rating was 1A. Among the methodological criteria that failed the most, there were: the non-description of some of the individuals' characteristics, such as studies that did not differ the found types of neoplasms and not identified the difference between sexes. Some studies did not report the therapeutic modality used to treat patients, not even the total number of subjects in the sample. In some articles, the authors reported the number of children with cancer, but did not report the number of children in the control sample.

Another significant flaw we found in some articles was the lack of definition of the basis of the results, as there were no details on screen time and physical inactivity, as well as on the result of any test reported in the methodology section. We also observed that some studies failed at achieving some of the proposed objectives. Studies with better evaluation obtained 1B classification.[21,32,33,45-48] While studies with worse ratings got 2B.[34-41,49] The methodological evaluation shows that no article has reached its maximum values, making it clear that there were methodological flaws in the execution. However, none of them qualified with a low degree of recommendation, which can characterize the study sample as "recommended."

We carried out the qualitative methodological analysis and statistical description of studies from the nine items and CONSORT statement recommendations considered relevant to do so and to conduct the objective and reproducible extraction.[47] Hence, we considered the methodological evaluation performed by the evaluators and classified based on the study. As described in Table 2, all the studies met at least one of the eligibility criteria, and the lowest assigned grade being.[44] The other ones remained above the expected average. And we also observed how reproducible are the evaluated techniques, in a way it would be possible to reproduce them in clinical practice, despite the authors suggesting a better evidence-based practice evaluation for this study.

This review comprised 16 articles published in English between 1998 and 2019. However, it was only by 2013 and 2019 that it obtained the highest number of publications, totaling three articles in those years. The main characteristics of the studies included in the systematic review are in Table 1.

Table 1: Main features of the studies included in the systematic review

Serial number	References	Study location	Sample	Sex (female/male)	Journal	Study type
1	Van Dijk-Lokkart *et al*., 2019	Holanda	68	32/36	Pediatric Blood and Cancer	Quasi-experimental clinical trial
2	Schindera *et al*., 2019	Swiss	766	338/428	Pediatric Blood and Cancer	Cohort
3	Grimshaw *et al*., 2019	Australia	20	9/11	Pediatric Blood and Cancer	Qualitative study
4	Murphy-Alford *et al*., 2018	Australia	74	35/39	Clinical Nutrition	Cohort
5	Devine *et al*., 2018	United States	303	183/120	Psycho-Oncology	Cohort
6	Withycombe *et al*., 2018	United States	23	15/8	Journal of Adolescent and Young Adult Oncology	Cohort
7	Marcoux *et al*., 2017	Canada	246	124/122	Pediatric Blood and Cancer	Cohort
8	Braam *et al*., 2016	Netherlands	60	25/35	Supportive Care in Cancer	Cohort
9	Gotte *et al*., 2014	Germany	130	79/51	Pediatric Blood and Cancer	Cross-sectional
10	Badr *et al*., 2013	United States	170	82/88	Journal of Cancer Survivorship	Cohort
11	Fuemmeler *et al*., 2013	United States	15/15	14/16	Journal of Pediatric Hematology/Oncology	Control case
12	Tan *et al*., 2013	Malaysia	38/38	NI	Leukemia Research	Cohort
13	Cox *et al*., 2009	Canada and United States	838	366/256	Cancer	Cohort
14	Winter *et al*., 2009	Germany	80/80	NI	Pediatric Blood and Cancer	Cohort
15	Keats *et al*., 2006	Canada	97	42/55	Journal of Pediatric Oncology Nursing	Cross-sectional
16	Reilly *et al*., 1998	United Kingdom	20	11/9	Pediatric Research	Cohort

Caption: NI: Not informed

The total sample of this review comprised 2854 participants, and most of them showed a low level of physical activity and a high level of sedentary behavior when compared to the WHO'S recommendations. Concerning the evaluation phase of this population, we observed patients during and after cancer treatment. None of the individuals in remission returned to the basal level of physical activity. The description of the main objectives of the selected studies, as well as its main results and the classification of the methodological evaluation are in Table 3.

When it comes to the tools used to evaluate children with cancer on their physical fitness, physical activity level, psychological parameters, pain, among others, there was a lack of consensus on their use and the difficulty to find tools and specific questionnaires to this population. Most studies employed them to verify the level of physical activity, the accelerometer[48] and the scale in METs.[37-39] Some of the selected references for review also created questionnaires to evaluate patients' sedentary behavior and physical fitness and some used other measures, such as gait cycles and tests to evaluate cardiorespiratory capacity, strength, and flexibility in separate.[20,21,32,35,39-42]

For this same evaluation, the articles also used other tests such as leisure Godin's Leisure Time Exercise Questionnaire,[39,46] a modified version of Germany's physical activity questionnaire created by Health Interview and Examination Survey for Children and Adolescents of the Robert Koch Institute,[45] gait cycles (GCS) measured with the StepWatch 3TM Activity Monitor,[35] ergometric test,[21,44] physical activity and recreation questionnaire of Minnesota and self-administered occupational physical activity questionnaire by Tecumseh to estimate daily physical activity and energy metabolism in addition to more general questions on sedentary activities,[40] progressive exercise testing with gas exchange, impedance cardiograph during exercise, 6 min walk test,[40] cycle ergometer using Godfrey Protocol and the peak VO_2.[21,35] One should note that some of these studies also use questionnaires especially designed for this analysis.[49,50]

In addition of what is mentioned previously, tests and questionnaires, it was found out that some studies used the Movement ABC to evaluate motor skills in pediatric cancer patients.[44] This physical activity questionnaire evaluates leisure time and the difficulty to perform manual movements

Table 2: Description of the PEDro scale by study and evaluation criterium

Criteria	Article 1	Article 2	Article 4	Article 5	Article 6	Article 7	Article 8	Article 9	Article 10	Article 11	Article 12	Article 13	Article 14	Article 15	Article 16
Eligibility and origin of participants	s	s	s	s	s	s	s	s	s	s	s	s	s	s	s
Random distribution	s	n	s	s	s	s	s	s	s	s	s	s	s	s	s
Secret allocation	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
Comparison of starting point	s	n	s	s	s	s	s	s	s	s	s	s	s	s	s
Blinding OS subjects	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
Blinding of therapists	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
Blindness OS the evaluators	n	n	n	n	n	n	n	n	n	n	n	n	n	n	n
Proper monitoring	s	n	s	s	s	s	n	s	n	s	s	s	s	s	s
Intent to treat	s	n	s	s	s	s	s	s	n	s	s	s	s	s	s
Intergroup statistics	n	s	n	s	s	n	n	s	n	s	s	s	s	s	s
Measures of precision and variaility	s	s	s	s	s	s	s	s	n	s	s	s	s	s	s
Score PEDro overall	6	3	6	7	7	6	5	7	3	8	6	6	7	7	7

QV: STUDY: study/selected article, s: yes, n: no, Article 3 PEDro evaluation was not carried out due to being a qualitative study

Table 3: Study goals, main results, and evaluation of the oxford level of evidence

Reference	Goal	Main results	NE
Van Dijk-Lokkart, *et al*., 2019	To assess cancer-related fatigue in children with cancer during the final stages of treatment and the first period after cessation of therapy, and its association with physical activity over a 1 year period	Most PEDSQL-MFS scores in both age groups increased over time, reflecting an improvement in cancer-related fatigue over treatment. Minutes of the day of sedentary behavior decreased slightly, and activity levels increased slightly during the one-year follow-up. Also, it has been shown that over a one-year period, the most physically active children experience less cancer-related fatigue	1B
Schindera *et al*., 2019	To investigate the behavior of physical activity time and screen time of childhood cancer survivors aged 5–15 years to assess how physical activity time and screen compare with international recommendations, and examination of demographic, socioeconomic, lifestyle and clinical factors associated with physical activity and screen time	More than half of the surviving children from cancer had sufficient physical activity according to WHO recommendations and the median time devoted to BP was 7.3 h/week. An average screen time was found to be 82 min/day, and 68% of children had acceptable screen time according to recommendations. A decrease in physical activity was found for some regions and it was also smaller for those who had a relapse or suffered from musculoskeletal/neurological conditions	2B
Grimshaw *et al*., 2019	Understand parental perspectives on physical activity for children during acute cancer treatment and explore strategies to overcome physical inactivity	A study presents a spiral of consequences for the decline of physical activity, which is present since the beginning of the treatment, such as the treatment itself, the hospital environment, movement restrictions, loss of independence, isolation, and low motivation. Demonstrating then the complexity of the reasons and how they are multifactorial. And, in this study, it is shown that for parents and children to be able to improve, it is necessary that support for changes comes from the entire oncology team	-
Murphy-Alford, *et al*., 2018	To define body composition, physical activity, and food consumption of childhood cancer survivors, examining the effect of this lifestyle and the clinical factors in body composition	Survivors of childhood cancer tend to have an increase in fat mass and decreased lean body mass, as well as poor health behaviors, an inactive lifestyle and excess of time of inactivity	1B
Devine *et al*., 2018	To identify factors associated with physical activity in childhood cancer survivors and examine longitudinal associations between psychosocial factors, family involvement and behavior	It observed inadequate levels of physical activity for 46% of adolescents by identifying predictors such as sex, the parents' educational level, and cranial radiation associated with adolescents at greater risk of low physical activity	1B
Withycombe *et al*., 2017	To verify, beyond the feasibility of a larger study, the amount of steps/day of patients, increase in PA and fatigue during camping activities	The PA among patients in camping was high when compared to children without follow-up. The number of patients' steps was also higher among those experiencing camping when compared what is recommended in the literature	2B
Marcoux *et al*., 2017	To characterize the effects of cancer treatment-related disabilities in a population of survivors of child acute lymphoblastic leukemia	Prevalence of metabolic syndrome components compared to treatment and nutritional issues. The authors observed cardiotoxicity in treatment. The physical activity of this population was not enough according to the performed questionnaires and tests	2B
Braam *et al*., 2016	It assesses cardiorespiratory fitness, the level of physical activity and sedentary behavior in patients after cancer treatment	Physical activity level lower than the recommended in the literature	1B
Gotte *et al*., 2014	To evaluate the current need for exercise interventions in children and adolescents during the treatment of acute cancer. It compares the levels of physical activity before and during cancer diagnosis according to self-administered reports. It provides information on specific risk factors for inactivity	Before cancer treatment, children showed normal levels of physical activity, with moderate intensity activity indicators. In some categories, the patients showed higher levels of activity when compared to the reference population. A total of 91% showed decreased physical activity during treatment and a reduction of 74% in home stays	1B
Badr *et al*., 2013	To characterize the association between weight and lifestyle behaviors (diet and level of physical activity) among children who survived cancer and determine whether the differences in weight and lifestyle behaviors depend on the characteristics of the group level and lifestyle behaviors	Most survivors did not follow the national recommendation for fiber intake and physical activity level. It presented the summary scores for lower quality of life and greater cognitive and general fatigue considering healthy population standards. The individuals who presented more concern with cancer were significantly more likely to meet the recommendations on the level of physical activity	2B
Fuemmeler *et al*., 2013	It evaluates changes in body mass, diet, physical activity, and body composition among children undergoing cancer treatment for leukemias and lymphomas	During the 6–12 months after the diagnosis, cancer patients showed a lower level of moderate physical activity/vigorous when compared to the control samples. The case groups remained inactive during the year when compared to controls	2B

(Contd...)

Table 3: *(Continued)*

Reference	Goal	Main results	NE
Tan *et al*., 2013	To evaluate the level of physical activity and the standards for patients with acute leukemia undergoing induction or consolidation chemotherapy in hospitals when compared to healthy controls	Patients with leukemia have significantly lower levels of physical activity, spend significantly more time engaged in sedentary behavior, being less involved in activities from light to moderate intensity. None of the patients participated in physical activities of vigorous intensity	2B
Cox *et al*., 2009	To describe modifiable influences on physical activity participation in pediatric cancer survivors	Approximately 25% of the interviewed in the total sample did not report physical activity in leisure time. Women were more active, men showed less fatigue than women	2B
Winter *et al*., 2009	To define the average reduced level of physical activity in patients with pediatric cancer when compared to a healthy control sample. To differentiate home and hospital stays regarding the level of physical activity. To verify whether cancer type and its corresponding treatment influences the physical activity level and whether there is any predisposition to inactivity associated with some type of cancer	The authors found significant differences for high intensity level physical activity, as cancer patients were 69% less active than the control group. During hospitalization patients were 60% less active when compared to patients who experienced home stay. Bone tumors, when compared to leukemia and lymphoma patients, showed lower level of physical activity	2B
Keats *et al*., 2006	It assesses the impact of a cancer diagnosis on the level of physical activity among adolescents, and their behavior while experiencing cancer	There were significant differences at all 3 levels of intensity (light, moderate, and vigorous). It presented a statistically important reduction in the total leisure score during treatment. Patients did not recover prediagnostic levels of physical activity after treatment completion. Vigorous and moderate frequencies remained reduced after treatment	1B
Reilly *et al*., 1998	To determine the cause behind overweight children after cancer treatment, testing the hypothesis that the reduced energy expenditure is due to reduced levels of physical activity	Total energy expenditure was significantly higher in the control group than in patients. Resting energy expenditure is higher in the control group than in the patient group. The energy spent in physical activity was significantly higher among patients than among control patients, showing a lower level of physical activity	2B

QOL: Quality of life, PA: Practice of physical activity, NE: Oxford's level of scientific evidence, WHO: World Health Organization, PEDSQL-MFS: Pediatric Quality of Life Multidimensional Fatigue Scale

with a ball and static and dynamic balance.[44] One of the studies used the Child Health and Illness Profile--Adolescent Edition to evaluate medical, psychological, family, and behavioral predictors and the physical activity levels of children and adolescents.[32]

In muscular strength evaluations, it evaluated energy levels by using a Ground Reaction Force Lionel Engine Platform (Novotec Medical GmbH, Pforzheim, Germany) and an electronic hand dynamometer Medup Linear (Marcoux *et al*., 2016). Considering all these measures for quality-of-life assessment, we observed the most used tools were the Pediatric Quality of Life (PedsQL 4.0),[40,41] SF-36[36] and for fatigue the PedsQL Multidimensional Fatigue Scale Acute Version.[50]

Discussion

In this study, we observed that children undergoing cancer treatment have low level of physical activity, not following what is recommended by ACSM, 2010, WHO, 2011 and CDC, 2018,[21,34-36,38-40,45,46,48-50] being possible to consider the creation of physical activity programs for this population during and after treatment.[33,39,45] We presented the important benefits for this patients and a degree of interest for physical activity programs focused on this disease.[34-40]

We observed the selected studies have different characteristics, goals, and designs. The most common goals comprised data collection on the physical activity level of these children and physical activity-related behavior. Regarding the evaluation phase of this population, we observed subjects who were still undergoing treatment, and others at the post-treatment and remission stage of the disease. In the literature, some studies state that individuals present increased sedentary behavior at the moment of the diagnosis, when beginning treatment, and also at the remission stage of the disease, not retaking pre-treatment physical activity levels.[42-46]

In a study, Badr *et al*. (2013) and collaborators aimed at knowing if children and adolescents were following the guidelines for diet and the level of physical activity or not, by associating it with Body Mass Index (BMI) and pointing out that most of the survivors did not meet the Brazilian national recommendation for fiber intake and physical activity level. Just 55.6% of survivors presented a normal BMI. The remaining survivors were underweight (11.7%), overweight (19.1%), or obese (13.6%). In the same line of the study, Murphy-Alford *et al*. (2018) aimed at observing body composition and food consumption of these patients, suggesting that children and adolescents who survived cancer tend to have increased mass fat and decreased lean body mass, in addition to a little active lifestyle and excess inactivity time.

Corroborating with the previous idea Reilly *et al*. (1998) noted a reduced energy metabolism due to decreases in physical activity levels. And Fuemmeler *et al*. (2013) report that these children either heavily gain or lose weight during treatment

and have difficulties to recover their normal weight after this period. It is worth to highlight that with inactivity patients take the risk of developing obesity, cardiovascular diseases, reduced muscle strength, reduced bone mineral density and of reducing health-related quality of life.[38]

In addition, Marcoux *et al*. (2017) wanted to characterize the effects of disabilities in survivors of acute Lymphoblastic Leukemia. These researchers observed the prevalence of metabolic syndrome components (obesity, insulin resistance, hypertension, and dyslipidemia), big bone morbidity, neurocognitive effects, and cardiotoxicity. Considering all of these findings are treatment-related features, one could understand them as side effects from treatment, from the reduction in physical activity level and increased sedentary behavior.[40]

While Devine *et al*. (2018) and collaborators aimed at identifying factors associated with physical activity in adolescents who survived childhood cancer and, therefore, at investigating longitudinal associations between elements such as psychosocial factors, family involvement, and behavior, and their future prospects of engaging in physical activity in young and adult life. In its findings, there were inadequate levels of physical activity for 46% of adolescents, with identification predictors such as: Sex, parents' educational level, and cranial radiation associated with adolescents with greater risk of developing insufficient physical activity. In the study by Winter *et al*. (2009), the authors found a difference between home and hospital stays, as children who experienced hospital stay showed increased sedentary behavior and children with bone cancer compared to LLA that also featured lower levels of physical activity.

As for the probability of them performing physical activity in adult life, 40% of adolescents reported that they have not undertaken physical activities at adequate levels.[32] Furthermore, there was a greater chance of non-adherence to physical activity recommendations among female patients and patients who did not follow a healthy diet.[32]

According to Braam *et al*. (2016), children have a lower physical activity level than what we see recommended in the literature, increased sedentary behavior, which leads to changes in cardiorespiratory and physical fitness. Corroborating with this statement, Gotte *et al*. (2014) found that during treatment and hospitalizations, the level of physical activity among children decreased 91% while during home stays it decreased in around 74%, also reporting an increase in sedentary behavior.[45] It can be mentioned that the researchers' assumptions on this systematic review understands that the treatment of this disease would change active behavior and the characteristics of these children.

Corroborating with the above-mentioned studies, Keats *et al*. (2006) found a decrease in the index of total leisure during cancer treatment. It showed that patients could not recover pre-diagnostic physical activity levels after treatment and that during treatment levels of vigorous and moderate physical activity dropped.[46] The percentage of children that achieved the recommended level of physical activity in pre-treatment was of 84.6%, only leaving 26% of the total during treatment, and 73.6% for the total in the post-treatment period.[46]

The most current articles such as Grimshaw, *et al*. (2019) were looking for ways to overcome the barriers of physical inactivity during the acute treatment of childhood cancer, explaining as important factors shown by parents: loss of independence, isolation, and low motivation.[50] It was also presented that the reasons for the physical activity to be reduced are complex and multifactorial.[50] And the study addresses the need that this family has the support of the oncology team, being important to have changes in the environment in which these patients are inserted. Of services and policies for the promotion of physical activity, facing them as assistance to the patient.[50]

Corroborating the finding of changes in the environment in which children are included, in the study by Schindera, *et al*. (2019), it was observed that survivors of childhood cancer had a recommended degree of physical activity in 55% of cases and that the factor important for this, it was due to the fact that the active way of going to school (walking or cycling) and the mandatory sport at school, demonstrate that this factor contributed a lot to the hours of physical activity.[49] Already related to fatigue, in the study by Van Dijk-Lokkart, *et al*. (2019), an important fact is reaffirmed, that more physically active children experience less cancer-related fatigue.[48]

Therefore, this study observed that every change that occurs in the lives of these children since the moment of diagnosis is totally unfavorable to physical activity. The psychological and physical impact of treatment and motor changes affect these children, leading to the decrease in the level of physical activity an increase in sedentary behavior. The hospital environment, the acute and chronic side effects, the lack of incentives and the fear of exercising under these conditions also influence sedentary behavior due to the lack of activities focused on this population. Not to mention any great risk of bias found in the studies.

The limitations of this study range from the difficulty of finding studies on the topic, studies that address the same variables and the quality of the studies. With this in mind, we believe there is a need for further studies aimed at encouraging physical activity within this population since the moment of diagnosis, promoting active habits to achieve the recommended level of physical activity and that can hopefully last for the rest of their lives. There is also need for specific recommendations for children with cancer, considering only general recommendations aimed at adults are not enough, especially in situations that require thoughtful care in certain periods of the treatment protocol.

Conclusions

When conducting this review, we observed the predominance of studies on sedentary behavior and on level of physical activity, highlighting that this population do not remain active during and after treatment, even after a long remission period of the disease. We concluded that this population showed an increase in sedentary behavior, a decrease in the level of physical activity and that there are no specific recommendations for this population by WHO, ACSM and CDC.

However, the main critique of the paper is that participants did not follow WHO, ACSM and CDC guidelines. There is no way to know from the studies that the guidelines were not followed, all you can state is that the participants did not meet the levels of activity recommended by these organizations.

Moreover, there were found studies with methodological deficits, demonstrating the need for further quality studies in the area. There are difficulties to find tools focused on this population and a specific way of measuring how sedentary these children are. There were also noticed that the recommendations given to healthy children do not apply to those with chronic illness such as cancer, as this is a disease with a range of differentiated malignancies with late and acute treatment side effects that alter motor performance, cardiorespiratory capacity, and the general health condition of the patient.

Authors' Declaration Statements

Ethics approval and consent to participate

This study does not need an ethics committee.

Conflict of interest

The authors have no conflicts of interest to declare.

Funding statement

No funding was received to produce this paper.

Authors' Contributions

All authors contributed to the study conception and design. Material preparation, data collection, analysis and manuscript drafting were performed by all authors. All authors read and approved the final manuscript.

Acknowledgment

We would like to thank our team who gave me a golden opportunity to work on this project. We had also like to express our gratitude to laboratory of research who gave us such an opportunity to explore this subject.

Disclaimer

There is no source of funding, as the authors were responsible for all expenses involved in the study. The opinions expressed in the submitted article are specific to the institution or financier. The manuscript has been read and approved by all authors, that the authorship requirements mentioned earlier in this document have been met and that each author believes that the manuscript represents an honest work, if this information is not provided in another journal.

Conflict of Interest

All authors declare that they have no conflict of interest.

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