



Acute Lymphoblastic Leukemia (ALL): A Literature Review on Pediatric Population



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Submission: March 14, 2024; Published: April 15, 2024

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Abstract

Leukemia is a cancer of the bone marrow, which mainly affects the production and development of leukocytes, and each type of Leukemia can be divided into different subtypes. It is also the type of cancer that most affects children, more specifically, Acute Lymphoblastic Leukemia (ALL). This literature review aims to understand the impacts of this cancer, both on the individual and those around them, based on scientific evidence published between 2003 and 2023. A search of scientific articles and other relevant sources on the topic was carried out, free access, totaling 50 documents. According to the analysis, many studies talk about these impacts, especially the impacts on these people's families. However, more needs to be done regarding environmental sustainability and Leukemia.

Conclusion: The results of our study may have implications for utilization of adaptive RT strategies, however, there is still need for further studies focusing on this critical issue.

Keywords: Leukemia; Children; Families; Quality of life; Environmental sustainability; Large Granular Lymphocyte Leukemia

Abbreviations: ALL: Acute Lymphoblastic Leukemia; AML: Acute Myeloid Leukemia; CML: Chronic Myeloid Leukemia; CLL: Chronic Lymphoblastic Leukemia; WHO: World Health Organization; PLL: Prolymphocytic Leukemia; LGL: Large Granular Lymphocyte Leukemia; HCL: Hairy Cell Leukemia; RAM: Autonomous Region of Madeira; PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses; QoL: Quality of Life; SDGs: Sustainable Development Goals

Introduction

Leukemia, also known as blood cancer, is a neoplasm of the bone marrow characterized by abnormal production of blasts, that is, leukocytes that are in an immature phase of their development, ending up preventing the production of normal cells, such as red blood cells, platelets and other white blood cells [1]. Consequently, this formation of abnormal cells leads to anemia due to decreased red blood cells, infections and bleeding, such as nosebleeds and bruises, which must be treated as quickly as possible. As blood cells are produced in the bone marrow, they are expected to circulate throughout the body, not concentrating in a single region and spreading, for example, to the spleen and liver [1]. There are, therefore, several types of Leukemia, each characterized by the type of cell that is affected, that is, myeloid or lymphoid cells, and by the rapidity of its development and worsening, which can be chronic if it worsens slowly, or acute if it worsens. Gets worse more quickly. The four main subtypes of Leukemia are Acute Myeloid Leukemia (AML), Chronic Myeloid Leukemia (CML), Acute Lymphoblastic Leukemia (ALL) and Chronic Lymphoblastic Leukemia (CLL) [2,3].

Regarding Acute Myeloid Leukemia (AML), unlike most other cancers, it is not characterized by stages. In 2016, the World Health Organization (WHO) updated the classification system for AML subtypes, considering the factors currently known to affect the prognosis, aiming to improve the classification of this subtype. Therefore, the WHO classifies AML into several groups, including AML with specific genetic abnormalities (gene or chromosome changes), AML with changes related to myelodysplasia, AML related to previous chemotherapy or radiation, AML not otherwise specified, Sarcoma myeloid (also known as granulocytic Sarcoma or chloroma) and Down syndrome-related myeloid proliferation [4]. This subtype of Leukemia affects adults over 65 and children, although at a lower rate [3]. Therefore, understanding the subtype of AML can be crucial, as it can occasionally affect a patient's prognosis and the most effective course of treatment [5]. Acute Lymphoblastic Leukemia (ALL) is a type of Leukemia that mainly affects children, with its first peak in incidence between two and five years of age, and males are the most affected [1]. We can state that ALL is more prevalent between early childhood (birth

to 3 years) and second childhood (3 to 5 years of age; Papalia & Feldman [6]). However, it may appear throughout childhood (up to 10 years) and adolescence (over ten years of age; National Cancer Institute [7]).

It is, therefore, essential to note that from cells known as lymphoblasts, lymphocytes mature and become mature cells that fight the immune system, T lymphocytes and B lymphocytes. Initially, ALL originates from lymphocyte precursors, i.e., it may begin in T cells at a different stage of maturation or in early B cells, giving rise to two subtypes of ALL: T-ALL and B-ALL [8]. This Leukemia arises from genetic changes in these lymphocytes and will influence the next cell lineage [3], multiplying uncontrollably and reducing the number of normal cells [9]. Chronic Myeloid Leukemia (CML), also known as chronic myelogenous Leukemia, is a subtype of Leukemia that begins in developing myeloid cells, which produce red blood cells, platelets, and most types of white blood cells (except lymphocytes), presenting a genetic alteration, more specifically in the BCR-ABL gene. Initially, CML is a relatively slow-growing leukemia. However, it can transform into acute Leukemia, proliferating and becoming more challenging to treat. This subtype of Leukemia mainly affects adults [4].

Finally, Chronic Lymphoblastic Leukemia (CLL) is the subtype of Leukemia that most frequently affects adults over 55. As it is chronic, its leukemic cells multiply slowly, and it may occur that many people do not show symptoms for several years [10]. There are two distinct types of CLL: one is characterized by slow growth, taking time to manifest symptoms until the patient needs medical care; the second is the most dangerous because it grows faster. Although leukemic cells of these two types look similar, laboratory tests can distinguish them. The assays look for the proteins ZAP-70 and CD38 [10]. B lymphocytes are the origin of the standard form of CLL. However, some uncommon forms of Leukemia resemble CLL in specific ways: Prolymphocytic Leukemia (PLL), Large Granular Lymphocyte Leukemia (LGL), and Hairy Cell Leukemia (HCL) [10]. There is no specific cause for the onset of Leukemia. However, some risk factors may be associated with its development. Genetic predispositions are one of these factors where; for example, in the case of children who have multiple genetic syndromes, such as Down syndrome, Li-Fraumeni Syndrome and neurofibromatosis, they are more likely to develop Acute Lymphoblastic Leukemia and Acute Myeloid Leukemia [11]-associated with genetics, family history and the probability that siblings of children with cancer will develop it later [9]. Environmental factors also influence the onset of Leukemia, such as exposure to ionizing radiation, exposure to pesticides and chemotherapy (Cancer et al. (PDQ)-Patient Version) - [11,12]. Finally, another risk factor is lifestyle-related factors, such as smoking, alcohol, diet, and physical activity (Cancer et al. (PDQ)-Patient Version - [12]).

It is, therefore, essential to classify the type of Leukemia to enable the best treatment and a better response [1] based on clinical examinations and information collection. Firstly, collecting family and medical history is crucial in order to understand

whether there has been any case of cancer in the family and whether there has been any significant illness, as well as a physical examination (palpation of the lymph nodes). Furthermore, it is essential to carry out blood tests, namely blood counts, which are the first to provide suspicion of the disease [13]. If the suspicion is confirmed, a myelogram is performed, that is a bone marrow examination, where a sample of the marrow is removed from the pelvis using a syringe and a fine needle so that it is possible to specify which type of leukemia present [7]. If there is a small number of cells, it is not possible to correctly confirm a diagnosis, so it is essential to collect more samples later in time [1]. This last exam allows other equally essential tests to be carried out that support a better characterization of the disease: cytology, which counts the number of cells and evaluates their appearance; immunophenotyping, which determines, in the case of ALL, whether B or T lymphocytes are affected, and also the cytogenetic study, which evaluates mutations in chromosomes and genes [11]. After the diagnosis, performing a Lumbar Puncture may also be helpful. This examination aims to collect a sample of the cerebrospinal fluid and analyze whether the leukemic cells have spread through the spine and to the brain, and also an X, in order to check whether leukemic cells have accumulated in the breast [7,13].

Each patient has a specific protocol for treatment according to their clinical condition and characteristics, such as the patient's age, cytogenetic and molecular results, and coexisting diseases [11]. Several types of treatments can be used. Generally, the primary treatment administered consists of cycles of chemotherapy, with intervals between them so that the body recovers, which can be administered in pills, liquid intake or by intravenous, intramuscular, subcutaneous injection or lumbar puncture [9]. Other possible treatments are targeted therapy, immunotherapy, radiotherapy, or stem cell transplantation [11]. Most patients receive maintenance therapy for up to two to three years after the initial diagnosis in order to avoid relapses, following an initial phase of intensive induction that aims to achieve complete remission. Through this therapy, most individuals can regularly carry out their daily activities during the relatively stable maintenance phase [14].

The treatment helps fight cancer. However, it causes a series of side effects, such as hair loss, poor appetite, diarrhea, nausea, increasing risk of fever/infections, the appearance of bruises and even fatigue [9,14]. It is important to note that throughout the treatment, not only physical effects appear but also psychological effects associated with psychological comorbidities. Children may experience procedure anxiety due to invasive procedures, such as blood tests and myelograms [15] and fears, such as fear of needles, fear of removing adhesive tape, fear of taking pills, fear of physical changes that ALL may cause and the fear of dying [16]. Children with ALL may present problems related to sociability, bad mood, irritability, crying spells [15] and sleep problems, such as insomnia and sleep anxiety [14]. They rarely present self-

injurious behaviors. However, they may become temperamental and direct their anger and aggression toward their caregivers [15]. From a cancer survival perspective, survivors manifest psychological symptoms such as anxiety, despair, anguish and even suicide, and this risk remains for a considerable period [17]. Other aspects related to psychological health also arise, such as sleep problems, fatigue and concerns about body image, intimacy, and return to school and work, all of which should be evaluated and monitored as part of a comprehensive care plan [17].

Data obtained in 2020, states that in Portugal, there was a prevalence of 41.5 per 100,000 inhabitants, with males being the most prevalent, with a total of 2300 cases of Leukemia recorded. Portugal also presented an age-standardized incidence rate of 7.4 per 100,000 inhabitants; that is, 1547 cases were identified in 2020 in both sexes and at all ages, with a higher incidence in sex males with 838 cases [18]. Thus, that same year, Portugal recorded that 3.5% of cancer cases corresponded to Leukemia [19]. From a pediatric point of view, between 2010 and 2019, around 2685

new cases of cancer were diagnosed in Portugal, including the islands, in children under the age of 15, with Leukemia being the type of cancer with the highest percentage (26.7%). The male gender stood out with a higher incidence rate of 52.8 per 100,000 inhabitants [7]. Furthermore, the leukemia group had an overall 5-year survival rate of 83.2% between 2010 and 2019 [7]. As for the Autonomous Region of Madeira (RAM) in Portugal, Myeloid Leukemias had a crude incidence rate of 5.11 per 100,000 inhabitants. And Lymphoblastic Leukemias with a crude incidence rate of 4.72 per 100,000 inhabitants [19]. Taking into account that Leukemia can appear at any age in children (early childhood, i.e. from birth to 3 years of age; second childhood, between 3 and 6 years of age; and throughout third childhood, between 6 and 11 years of age; and in adolescence, from 11 to 20 years of age, Papalia & Feldman [6]) and, adults aged 55 or over, we can consider that they correspond to the current Alpha Generation (individuals born to from 2010) and the Baby Boomers Generation, individuals born between 1940 and 1960 (currently aged 60 to 80) [20].

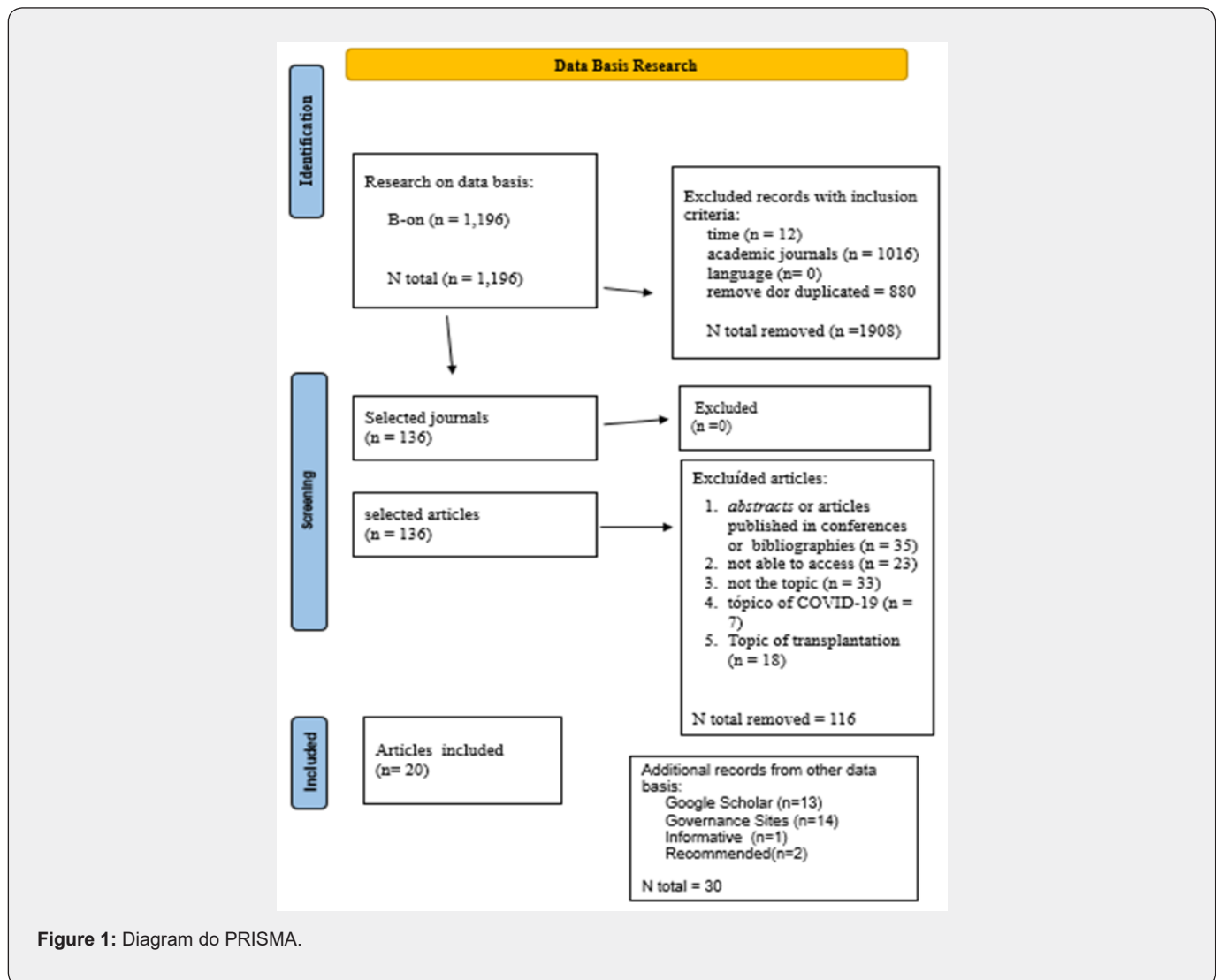


Figure 1: Diagram do PRISMA.

Methodology

To carry out this literature review, we used the principles of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) principles to research the existing literature on Leukemia between 2003 and 2023. The main objective was to research scientific articles on Leukemia, its impacts, and potential interventions, with a greater focus on the pediatric population. The search was then done using the B-on, PubMed, Google, Google Scholar, ScienceDirect, and Springer databases. The research carried out at B-On had the following research protocol: (“Leukemia” AND “blood cancer”) AND (Symptoms AND treatment AND diagnosis AND “psychology* effects”) AND (children OR youth OR adults) AND (“family* impact” OR well-being). The Boolean Operators “AND” were used to ensure that the four topics were included in the search and “OR” to increase the chances of obtaining more results within the same topics. About truncators, the symbol “*” was used to guarantee the inclusion of words with the exact origin, and the “symbol was used to guarantee

that the concepts of two words were searched together and not separately. The investigation was carried out between September and December 2023. Initially, the search result was 1,196 articles (Figure 1). The inclusion criteria were scientific articles related to Leukemia and its impacts and websites of relevant organizations on the topic, written in English and Portuguese and with free access. The exclusion criteria were scientific articles published before 2003, with paid access, Abstracts or articles published in conferences, articles that did not address the topic and articles that talked explicitly about stem cell transplants. After careful selection, 20 articles were included for analysis, and 116 were excluded. Thirty additional articles and organization websites were used to supplement the research.

Results

In Table 1 [21-50], we can see in detail each of the documents analyzed for the presentation of results that follow. The results were categorized into Impact on families, Quality of Life, Psycho-oncology and environmental sustainability.

Table 1: Authors, Year of publication, keywords, database.

Artigos Incluídos			
Authors & Year	Title	Keywords	Database
Ahmadi [21]	Music as a method of coping with cancer: A qualitative study among cancer patients in Sweden	“coping,” “cancer,” “music of nature,” “religious music,” “hard and heavy music,” “cheerful music.”	B-on
Berkman et al., [17]	A review of psychological symptoms and post-traumatic growth among adolescent and young adult survivors of childhood cancer.	“adolescence,” “cancer,” “children,” “distress,” “outcomes”	B-on
Carlsson et al., [22]	Psychological distress in parents of children treated for cancer: An explorative study.	----	B-on
Chan et al. [23]	A systematic review of adventure therapy for child, adolescent, and young adult cancer patients.	“Adventure therapy,” “Cancer,” “Children,” “Young adults,” “Systematic review,” “Health-related quality of life”	B-on
Gerhardt et al., [24]	Supporting Siblings as a Standard of Care in Pediatric Oncology.	“Adjustment,” “cancer,” “intervention,” “pediatric,” “sibling”	B-on
Harman et al. [25]	Early intervention for infants and toddlers: Applications for pediatric oncology.	“childhood cancer,” “early childhood development,” “early intervention,” “infants and toddlers”	B-on
Karayağmurlu et al., [26]	The assessment of quality of life, depression and anxiety in siblings of children with cancer: A case-control study.	“Anxiety”; “depression”; “pediatric cancer”; “siblings”; “quality of life”	B-on
Kaul et al. [27]	Mental distress and health care use among survivors of adolescent and young adult cancer: A cross-sectional analysis of the National Health Interview Survey.	“adolescent and young adult cancer,” “mental distress,” “mental health care access,” “Kessler’s distress scale”	B-on
Kazak et al. [28]	Screening for psychosocial risk in pediatric cancer.	“family adjustment,” “pediatric oncology,” “psychology,” “psychosocial,” “screening”	B-on
Koumarianou et al., [29]	A review of psychosocial interventions targeting families of children with cancer.	“children with cancer,” “family empowerment,” “interventions,” “mental health”	B-on
Kuehn et al., [30]	Physical Activity as a Treatment for Cancer-Related Fatigue in Children, Adolescents and Young Adults: A Systematic Review.	“cancer-related fatigue”; “childhood cancer”; “physical activity”; “exercise”; “systematic review”	B-on
Ljungman et al., [31]	Long-Term Positive and Negative Psychological Late Effects for Parents of Childhood Cancer Survivors: A Systematic Review.	----	B-on

Melguizo-Garín et al., [32]	Importance of Social Support of Parents of Children with Cancer: A Multicomponent Model Using Partial Least Squares-Path Modelling.	“social support received”; “social support provided”; “adjustment of parents”; “stress”; “life satisfaction”; “parents of children with cancer”; “PLS-SEM”; “structural equation modelling”	B-on
Rensen et al., [33]	Parental functioning during maintenance treatment for childhood acute lymphoblastic leukemia: Effects of treatment intensity and dexamethasone pulses.	“ALL,” “dexamethasone,” “parents,” “psychosocial,” “quality of life,” “sleep”	B-on
Rost & Mihailov [34]	In the name of the family? Against parents’ refusal to disclose prognostic information to children.	“Pediatric oncology,” “Family unit,” “Prognostic disclosure,” “Systemic thinking,” “Decision-making”	B-on
Satapathy et al., [35]	Non-pharmacological Interventions for Pediatric Cancer Patients: A Comparative Review and Emerging Needs in India.	“Counseling,” “Pediatric Oncology,” “Psychological interventions”	B-on
Scarponi et al., [36]	Emotional, Behavioral, and Physical Health Consequences in Caregivers of Children with Cancer: A Network Analysis Differentiation in Mothers’ and Fathers’ Reactivity.	“parental distress”; “oncopediatric patients”; “graph theory”; “gender differences”; “anxiety”; “depression”; “somatization”; “hostility”; “risk factors”; “phenotype”; “behavior”	B-on
Sidhu et al., [37]	The effectiveness of a peer support camp for siblings of children with cancer.	“camp,” “childhood cancer,” “interventions,” “siblings”	B-on
Steur et al. [14]	The Impact of maintenance therapy on sleep-wake rhythms and cancer-related fatigue in pediatric acute lymphoblastic Leukemia.	“Sleep,” “Cancer-related fatigue,” “Acute lymphoblastic leukemia,” “Pediatric,” “Actigraphy,” “Dexamethasone.”	B-on
Wayant et al., [38]	Identification of evidence for critical positive psychological constructs in pediatric and adolescent/young adult patients with cancer: a scoping review.	“adolescent,” “young adult,” “oncology,” “psychology,” “psychosocial,” “well-being”	B-on
Additional articles and governance sites			
Almeida & Souza [39]	A importância do brincar para crianças hospitalizadas: um estudo de caso	“brincar,” “hospitalização,” “câncer,” “criança”	Google acadêmico
American Cancer Society [8]	What is acute lymphocytic leukemia (ALL)?	----	Google
American Cancer Society [9].	What Is Childhood Leukemia?	----	Google
American Cancer Society [4].	What Is Chronic Myeloid Leukemia?	----	Google
American Cancer Society [5].	Acute Myeloid Leukemia (AML) Subtypes and Prognostic Factors.	----	Google
American Cancer Society [10].	What Is Chronic Lymphocytic Leukemia?	----	Google
Bonfiglio et al., [40]	The Impact of environmental pollution on cancer: Risk mitigation strategies to consider.	“Cancer”; “The impact of environmental pollution on cancer”; “Heavy metals”; “Asbestos”; “United Nations’ Sustainable Development Goals (SDGs) by 2030”	Google acadêmico
Cabral [41]	Obesity in Childhood and Adolescence: A Review.	“Childhood Obesity”; “Adolescent Obesity”; “Overweight”; “Risk Factors”; “Cognitive-Behavioral Theory”	Recomendação da docente
Casarotto, C. [20]	Dossiê das gerações: como comunicar com os Millennials, GenZ e Alphas	----	Google
National Cancer Institute [12]	Cancer Prevention Overview (PDQ®)-Patient Version	----	Google
Cardoso [13]	Câncer Infantil: Aspetos Emocionais E Atuação Do Psicólogo.	----	Google acadêmico
National Cancer Institute [7]	Childhood Acute Lymphoblastic Leukemia Treatment - NCI.	----	Google
Datta et al., [15]	Psico-Oncologia Pediátrica	----	Google acadêmico

Davis et al. [11].	Leukemia: an overview for primary care	---	Google acadêmico
De Lima Avelino et al., [42]	Fatores de riscos ambientais para o câncer pediátrico	"riscos ambientais", "incidência", "saúde da criança", "neoplasias"	Google acadêmico
Dionne-Odom et al., [43]	Supporting Family Caregivers of Adult and Pediatric Persons with Leukemia	"cancer", "family", "caregiver", "leukemia", "palliative care", "pediatric cancer"	Google acadêmico
Portugal Clinical Trials [19]	Epidemiologia	----	Google
Registo Oncológico Nacional [44]	Folha Informativa Pediatria	----	Google
Leibring & Anderzén-Carlsson [16]	Fear and Coping in Children 5-9 years old Treated for Acute Lymphoblastic Leukemia - A Longitudinal Interview	"Acute lymphoblastic leukemia"; "Coping strategies"; "Fear"; "Qualitative method"; "Young children"	Google acadêmico
Liga Portuguesa Contra o Cancro [2]	Tipos - Leucemia	----	Google
Liga Portuguesa Contra o Cancro [45]	Aspetos Psicológicos	----	Google
Liga Portuguesa Contra o Cancro [46]	Nutrição e Atividade Física	----	Google
Long et al., [47].	Psychosocial functioning and risk factors among siblings of children with cancer: An updated systematic review.	"family"; "oncology"; "pediatric cancer"; "psychosocial adjustment"; "sibling".	Google acadêmico
Monsell et al., [48]	What mental health professionals and organizations should do to address climate change.	"sustainability", "climate change," "mental health," "psychiatry2", "carbon footprint"	Google acadêmico
Musarezaie et al., [49]	Factors affecting quality of life and fatigue in patients with Leukemia under chemotherapy.	"Chemotherapy," "fatigue," "leukemia," "quality of life"	Google acadêmico
Nações Unidas [50]	Objetivos de Desenvolvimento Sustentável	----	Google
Diane Papalia & Ruth Duskin Feldman [6]	Desenvolvimento Humano	----	Recomendação da docente
J.P. Pereira [3]	Farmacogenética na Terapêutica das Leucemias	"Leucemia", "farmacogenética", "SNP", "imatinib"	Google acadêmico
Silva et al., [1]		"Características biológicas da leucemia", "fatores psicossociais associados", "intervenção psicológica".	Google acadêmico
World Health Organization [18]	Cancer Today	-----	Google

Impact on families

When diagnosed with cancer in a child, such as ALL, it affects not only the child but also the family. The ability of family members to provide voluntary assistance is crucial for nearly all adults and children with Leukemia to effectively navigate demanding treatment plans and intricate medication regimens and preserve their day-to-day quality of life [43]. Parents play a fundamental role in providing care to their children, as they are directly involved in that new reality [36], having to adjust their roles and routines to meet the child's immediate needs. [29], In addition, they may face various challenges and problems, such as stress [32], which puts them in the difficult position of accompanying and supporting their child during the entire process. After the diagnosis, an unstable situation and lack of concentration arise to keep the child safe while they receive treatment [22].

This responsibility triggers a wide range of emotional reactions that can cause significant psychological suffering [36]. All these emotional reactions are understandable, such as feeling scared, anxious and in shock, leading to feelings of denial and anger, as no one expects something of this magnitude to happen to their child. Furthermore, feelings of guilt are often one of the main reactions, with recurring thoughts that they did something wrong or because they had not noticed their child's symptoms sooner [13]. Throughout treatment, parents face several challenges, one of which is communication. Studies state that persistence is essential for a concrete diagnosis. However, those with younger children had to trust their intuition and careful observation of behavioral signs since children do not know very well verbalize what they feel, unlike parents of older children, who could be explicit about their symptoms [51]. Furthermore, parents find it difficult to return to their previous lives upon

learning of the diagnosis and dealing with the emotional scars and fears associated with their child's cancer after the end of treatment [22].

According to Long et al. [47], siblings of children with cancer also suffer from the new reality felt in the family nucleus. Logically, a severe illness in one of the siblings dramatically affects the others due to the siblings' significant influence on each other's identities [26,37]. The effects of cancer on a "healthy" sibling can influence their life trajectory if the sibling has difficulties in adapting and regulating in several areas and may present a variety of adversities at an emotional/behavioral and educational level, as well as manifesting behaviors of risk and stress-related medical conditions [37,47]. In fact, of all the feelings and emotions experienced, intense and generalized negative emotions, such as worry, uncertainty about the future, loss of normality and family changes, such as decreased attention from parents, in which feelings of abandonment, disruption of family life and increased domestic responsibilities are the most reported in the literature [47].

The social life of these siblings is greatly influenced, as they spend less time with friends and participate in fewer social activities. Although friends are a source of distraction and emotional support, and in agreement with Long et al. [47], many of these siblings reported that their experiences related to cancer were often not understood by their friends [47]. In the case of children with cancer requiring a stem cell transplant, siblings are often the prominent donors, which can harm the health of these siblings, leading to moments of distress and low self-esteem, often neglecting the necessary psychological support (Evans et al., 2021). Therefore, to reduce levels of worry and uncertainty, siblings should be given regular updates and developmentally appropriate information about their sick sibling's illness and treatment, encouraging hospital visits [24]. These siblings are, in fact, a psychosocial risk group and must receive appropriate support [24].

Quality of life

Young adults and children diagnosed with Leukemia are an especially vulnerable group who can suffer a range of late effects, including depression and fatigue, which can compromise their long-term mental, physical, spiritual and emotional well-being [38]. The main focus of treatment is to increase the survival rate and alleviate underlying symptoms, with ensuring the quality of life (QoL) being the fundamental criterion for evaluating response to treatment [49]. Thus, Musarezaie and collaborators (2014) state that an individual's QoL is directly related to all factors related to cancer, that is, exhaustion, emotional and psychological problems, denial of the disease and altered mental images, which arose from modifications in bodily functions and the duration of the disease [1,49]. Furthermore, the authors argue that QoL depends significantly on the characteristics of each individual,

such as age, gender, educational qualifications, financial conditions, and physical health, which makes it extremely necessary for the medical team to have these demographic data in mind in order to promote their quality of life [1,49]. Indeed, one of the most prevalent and disturbing side effects of Leukemia and its treatments is fatigue, which can negatively affect the quality of life of these individuals and lead to a series of other problems [49]. While older individuals may have problems finding a job and stress related to their work, younger individuals may have difficulties with school performance or when they start attending college, which can lead to stress. It is possible to capture the variety of issues that may affect the increase in distress and fatigue in the 15 to 39 age group at diagnosis [27].

Cancer patients must take additional care in their daily lives, with physical exercise and a healthy and balanced diet being the main ones to consider [45]. Regarding physical exercise, interventions involving physical activity have a significant impact on fatigue in adult cancer patients, making it possible to reduce fatigue in children, adolescents and young adults affected by cancer [30]. Various physical methods, including aerobics, yoga, and adapted physical exercise, can help with psychological issues such as anxiety, sleep, cognitive fatigue and quality of life [35]. Walking, dancing, cycling on an exercise bike, meditation, and stretching, among others, are some techniques used and defended in these studies as applicable to help improve fatigue [35]. Therefore, exercising not only helps prevent the onset of cancer and increase the survival rate but also helps throughout treatment, improving quality of life, satisfaction, vitality, self-esteem, acceptance, and anxiety, and also helps with muscle strengthening and body composition [38,45].

However, not only does the quality of life of these individuals decrease, but also that of those around them, such as siblings of children with cancer. A study by Karayağmurlu and collaborators [26] indicates that these siblings have a low quality of life and low self-esteem, which justifies that an increase in the age difference between healthy siblings and sick siblings will be associated with a reduced quality of life. This result may be related to unmet needs and more responsibilities to which these siblings are subject [26].

Psycho-Oncology

Psycho-oncology studies the psychological and behavioral variables present in the disease and treatment process and the psychological interventions that occur throughout this process. Techniques have been developed and refined to enhance the effects of medical treatments, allowing each cancer patient to focus their mental resources to reinforce the effects of their medications (Carvalho, 2010). Psychologists can mediate in providing care to patients and their families. They also frequently assist interdisciplinary cancer treatment teams and contribute to research, policy design and practical guidance [36]. Pediatric Psycho-Oncology has a strong focus on the emotional and

behavioral aspects of children to transform the traumatic effects of the entire disease process into positive experiences, with resources for acquiring healthy strategies to deal with adverse and complicated situations. Furthermore, the psychologist can help the child deconstruct meanings regarding the hospital environment so that the experience is less problematic [13].

The intervention and the psychological assessment must be appropriate to the children's age [13] and carried out as early as possible [25]. It can be carried out individually and in groups. One of the approaches suggested by the literature as being very effective is using music as a coping mechanism [13]. According to Chan et al. [23], Adventure Therapy, despite still being developed, appears to benefit both children and adolescents [23], as they are encouraged to reflect on their experiences to change the way they interpret challenges and consider different approaches to overcoming them, adopting the strategies learned to deal with similar challenges in their everyday lives [23]. This therapeutic approach should consider differences in age, culture, level of physical fitness and physical condition [23]. Additionally, Wayant et al. [38] also indicate that art can be used as therapy in these cases, as it increases well-being, improves the attribution of meanings and induces happiness [38].

It is important to note that the psychologist, in this area of activity, must recognize the patient as a whole, not just look at the disease, and help the patient [2]:

- i. Deal with the disease and its treatments and promote greater therapeutic adherence.
- ii. Prevent difficulties in family functioning.
- iii. Amplify, activate and reinforce possible support networks to reduce feelings of isolation, helplessness and abandonment.
- iv. Clarify erroneous perceptions and information, promoting knowledge about the disease and its treatments.
- v. Promote the emotional well-being of family members.
- vi. Facilitate communication between the patient and healthcare professionals.

According to Harman et al. [25], children are strong and resilient and can participate in developmental activities and therapeutic play even when sick and hospitalized. Although there may be some medical contraindications, even brief periods of play that stimulate development are appropriate, manageable, and effective. During hospitalization, play is a resource for children to express themselves and elaborate on their experiences. It can, therefore, be used to maintain the personality development process, promote less traumatic affective states and preserve sociability [39]. The literature argues that playing helps not only

in coping with illness and hospitalization but also in treatment. Furthermore, playing integrated into therapy can promote better adherence to treatment, better interaction with the hospital team, and minimize pain due to the leisure time and fun provided. Therefore, playing in the hospital is extremely valuable and essential in facilitating coping with the disease, the invasive procedures experienced throughout the disease process, and its contribution to child development [39].

Regarding the families of these patients, the literature suggests that they should also be monitored, as they also suffer from the disease, albeit indirectly. Unlike other cancer care providers, people caring for patients with Leukemia are required to stay in the hospital for more extended periods and deal with the side effects of treatments over a more extended period [43]. Regarding parents of children with cancer, these parents go through tremendous suffering on a physical, psychological, and social level [22,36] and sleep problems [33,36], having its resilience put to the test [36], in the short and long term [31].

According to Scarponi et al., [36], despite somatic disorders, adverse effects on disability and quality of life [32], parental distress has received little attention in research. Often, these parents find themselves in such an emotionally unstable state during treatment that they tend to ignore their own psychological needs in favor of caring for and safeguarding their child [22]. In this complex scenario, psychologists will be able to provide timely and effective interventions to improve the quality of life of parents of children diagnosed with cancer to respond to their psychological needs [33,36], with the aim is to create flexible adaptation mechanisms during your child's treatment so that the process of adaptation to the disease and the child's general well-being are effective in the long term [29,36]. Cognitive Behavioral Therapy and Problem-Solving Training are good examples of possible interventions, as they promote coping measures and psychological adjustment. The literature suggests that psychosocial interventions are practical and beneficial for parents and siblings. It is essential to implement protocols that include these families [29].

Furthermore, Melguizo-Garín et al. [32] state that social support is critical. The ability of parents to lean on their network and receive support has a positive impact on their well-being and quality of life, and stress can be effectively reduced as well as an increase in satisfaction with their life can be perceived by the social support that is given [32]. Psychologists have the role of helping pediatric patients and their families to better deal with the disease, to live better, to feel less distress and to deal with cognitive issues, with the aim of improving their quality of life [35]. It is essential to identify the specific psychosocial needs of these children and their families in order to facilitate the provision of appropriate care to respond to their concerns and screening for psychosocial risks [28,52].

Environmental sustainability

We are witnessing climate change's Impact on our society and its consequences, which include damage to physical and mental health. Therefore, paying attention to health issues is essential, focusing on more fragile cancer patients [49]. Start by recognizing the harmful effects of environmental pollution and taking coordinated action to reduce its Impact on human health while combating rising cancer rates [40]. To this ecological emergency, society must act and adapt, adopting more sustainable practices [40]. For example, they should become aware of the activities currently used in healthcare contexts, such as the treatments and materials used, and opt for choices with a lower environmental impact to reduce carbon emissions [49]. Environmental risk factors are one of the main factors contributing to Leukemia's onset (Cancer et al. (PDQ)-Patient Version) [11,12], especially in children. Benzene, which can be found in gasoline, air pollution, and nail polish removers, among other products in our daily lives; legal and illicit drugs, such as tobacco, alcohol, and cannabis, when exposed during pregnancy, are examples of factors that could influence the development of Leukemia [42]. Furthermore, the authors (2021) state that radiation exposure allows mutations to occur in the genome, facilitating changes in Leukemia's development.

Therefore, it is imperative to prioritize prevention above all else, as it increases social capital and significantly decreases associated carbon emissions [49]. The agenda for 2030, made up of 17 Sustainable Development Goals (SDGs), aims to address various dimensions of sustainable development (socio, economic, environmental), promoting peace, justice and effective institutions (United Nations, 2023). The third objective, designated as ensuring access to quality healthcare and promoting well-being for all, at all ages, aims, by 2030, to reduce the mortality rate from non-communicable diseases through prevention and treatment, also promoting mental health and well-being, eradicate preventable deaths of newborns and children under five years of age; strengthen the prevention and treatment of substance abuse, including drug abuse and harmful use of alcohol, and substantially reduce the number of deaths and illnesses due to dangerous chemicals, contamination and pollution of air, water and soil (Nations Unidas, 2023). Therefore, the main focus should be educating communities about the possible health risks associated with environmental pollution, promoting health by changing habits, meeting environmental sustainability objectives, and introducing positive and significant behavioral changes, which include stopping smoking, limiting exposure to pollutants, and adopting a balanced diet rich in fruits and vegetables [40,53,54].

Final Considerations

Leukemia as a whole and in the pediatric population has a significant impact on the child or adolescent themselves and their families [22,36,43,51]. Parents often ask that the medical team

not share their child's prognosis with their child, avoiding family arguments, and, at the same time, professionals feel that family cohesion and structure will be seriously affected if they inform the child about the prognosis. Against the parents' wishes [34]. It is worth highlighting the need to abandon the notion that a child's well-being involves keeping them safe from bad news [34,55], as they deserve to know what is happening in order to ensure better adherence to treatment and find some meaning in what they are going through.

The psychologist has a central role in the area of Psycho-Oncology, particularly in understanding the disease in light of the biopsychosocial model, i.e., not only focusing on the cancer patient but on all aspects around them, with the primary objective being to provide a better quality of life to the patient, through a psychosocial approach [13,56-59]. It is recommended that more studies should be promoted that focus on this topic related to the pediatric population and the impacts on their families, integrating a more holistic approach taking into account physical and mental health.

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DOI: [10.19080/CTOIJ.2024.25.556189](https://doi.org/10.19080/CTOIJ.2024.25.556189)

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