

Table 1. Summary of 38 studies included in present review

Author, year, country	Study design	Number of articles	Participants	Survivors/ Controls	Age	Type of Ca	Outcome measures
Gülnerman et al., 2021, Turkey (25)	CC	-	75	35/40	7-12	ALL	<p>Significant difference in motor performance between CCSs <math>\leq 49</math> and <math>&gt;49</math> months after therapy (<math>P &lt; 0.001</math>)</p> <p>History of radiation therapy associated with lower activity (<math>P = 0.010</math>)</p> <p>85 % referred preference to a structure exercise program with no cost</p> <p>50 % preferred to exercise in afternoons/evenings</p> <p>47 % would be willing to participate in exercise session 3 times/week</p> <p>88 % would be willing to participate in 60 min exercise session</p>
Rokitka et al., 2021, USA (42)	Qualitative & Quantitative data	-	20	-	21-52	Leukemia, lymphoma, Sarcoma, CNS et al.	<p>76 % reported no preference for independent or group session</p> <p>94 % preferred both aerobic and resistance training</p> <p>80 % mentioned as barriers lack of time and scheduling problems</p> <p>3/11 said that current health problems barriered their participation in exercise</p> <p>95 % reported that nutritious diet in combination with physical activity would be useful</p> <p>30 % mentioned as motivators the exercise's benefits to physical and mental health</p> <p>19/28 parents reported their lack of time as barrier for their children's exercise</p>
Cheung et al., 2020, China (41)	Qualitative	-	28 parents of CCSs	-	35-48	Leukemia, lymphoma, brain tumor et al.	<p>16/28 reported busy schoolwork as barrier for physical activity</p> <p>Exercise tolerance was significantly better among survivors without CAD (<math>24.4 \pm 8.1</math> vs. <math>21.1 \pm 10.1</math> mL/kg/min, <math>P &lt; 0.001</math>)</p>
Christoffersen et al., 2020, USA (20)	Cohort Study	-	663	338/325	Mean age $\sim 28.5$	ALL	<p>Significant improvement in physical functioning were found in Ankle DF-ROM [flexed (<math>P = 0.018</math>)] and Ankle DF – Strength (<math>P = 0.021</math>)</p>
Däggelmann et al., 2020, Germany (18)	Pilot Clinical trial	-	11	-	6-21	Leukemia, lymphoma, CNS tumor et al.	<p>6MWT showed statistical</p>
Lanfranconi	Prospective	-	159	141/18	3-18	ALL, AML	

et al., 2020, Italy (21)	longitudinal cohort study					Hodgkin lymphoma et al.	difference before and after training ( $P= 0.0007$ ) CCSs referred as barriers: 52 % feeling tired/ being fatigue 39 % preferring to watch TV 34 % lack of time 20 % unsure about what to do 19 % felt pain
Mizrahi et al., 2020, Australia (32)	Cross-sectional	-	102	-	8-18	ALL, Lymphoma, Wilms tumor et al.	CCSs referred as most common enablers to physical activity: 99 % health improvement 96 % important for health 88 % feeling stronger muscles 81 % satisfaction/fun 97 % motivation from parents 81 % exercise with friends 72 % positive feedback from friends
Morales et al., 2020, Spain (7)	Meta-analysis	27	697	669/28	5-38	ALL, lymphoma, brain tumor, solid tumor et al.	9/12 found no significant improvement in VO <sub>2</sub> peak ( MD = 1.97 ml·kg <sup>-1</sup> ·min <sup>-1</sup> , 95%CI=0.12–4.06P=0.065)
Nani et al., 2020, Greece (43)	Observational qualitative study	-	3	-	5-6	AML, retinoblastoma	CCSs reported improved physical function, mental health and social life
Antwi et al., 2019, USA (8)	Meta-analysis	16	2628	1413/1215	<18	ALL, Leukemia, non-Hodgkin Lymphoma, CNS, et al.	8 meta-analyzed studies showed physical activity was lower in CCS than non-cancer controls (g = - 0.889; 95% confidence interval [CI] = - 1.648 - 0.130; P=0.022)
Kelada et al., 2019, USA (9)	Systematic review	19	3261 CCS & 77 families of CCS	2205/1056	<19	ALL, lymphoma, brain tumor et al.	CCSs reported: Improvement in social life and psychological functioning, reduction of sedentary life, increased physical activity. Parents of CCSs mentioned family reconnection and social support CCSs self-report: 7 -12 after 12 months follow up, mean 86.39 ± 13.56 (P<0.05)
Van Dijk – Lokkart et al., 2019, The Netherlands (13)	Randomized controlled clinical trial	-	53(follow up 12 months)	-	7-18	Hematologic malignancy, brain tumor, solid tumor	Parents report 7 -12(children) after 12 months follow up, 69.64 ± 23.82 (P<0.01)
Manchola-González et al., 2019, Spain (12)	Randomized controlled clinical trial	-	19	12/7	7-17	ALL	After training founded significant group – time interaction + 6.7 (95% CI=0.6-12.8 ml/kg/min; η <sub>2</sub> partial = 0.046, P = 0.035)
Papalia et al., 2019, France (26)	CC	-	20	10/10	Survivors 12±4.3 Controls 12.5±4.4	Brain tumor	Significant higher VO <sub>2</sub> peak in the control group than Brain Tumor survivors (43.3 ± 11.9 and 32.4 ± 10.2 mL/kg/min, respectively, P = 0.04)
Schindera et	Cross-	-	766	-	5-15	Leukemia,	Lower physical activity in

al., 2019, Sweden (33)	sectional					lymphoma, CNS tumor et al.	CSSs with musculoskeletal/neurological condition (OR 0.7; 95% CI 0.5-0.9, $P=0.017$ ) and in relapsed CCSs (OR 0.5; 95%CI 0.4-1.0, $P=0.030$ )
Tonorezos et al., 2019, USA (35)	Cohort study	-	6199	-	22-54	Leukemia, Hodgkin lymphoma, CNS tumor et al.	Vigorous exercise was associated with a lower prevalence of: depression ( $P_{trend}=0.003$ ), somatization ( $P_{trend}=0.005$ )
Alford et al., 2018, Australia (27)	Prospective Cross-sectional	-	148	74/74	Mean age $\pm$ SD 15.0 $\pm$ 4.5	Leukemia, lymphoma, CNS tumor et al.	Malnourished CCSs had significant lower PAL (1.39 $\pm$ 0.19) than well-nourished CCSs (1.57 $\pm$ 0.32) ( $P=0.01$ ) Physical activity levels were significantly negatively associated with fatigue in children ( $\beta=-0.68$ , $P<0.01$ ) and adolescents ( $\beta=-0.62$ , $P<0.01$ ) survivors
Ho et al., 2018, China (34)	Cross-sectional	-	400	-	7-18	Leukemia, lymphoma, brain tumor et al.	No statistical difference for mean change between min in the intervention group (4.7 [SD 119.9]) and in the control group (-24.3 [SD 89,7]) in weekly MVPA after 24 weeks ( $P=0.30$ )
Howell et al, 2018, USA (14)	Randomized controlled trial	-	78	53/25	11-15	ALL, CNS tumor retinoblastoma et al.	Significant improvement in intervention's group fitness measures (hand grip strength, $P=0.01$ ; number of sit-ups, $P=0.002$ ; pushups, $P=0.0008$ )
Kabak et al., 2018, Turkey & Belgium (10)	Systematic review	49	14146	9553/4593	1-60	ALL, lymphoma brain tumor et al.	Three studies showed lower fitness level in ALL survivors ( $P<0.05$ ) After 12 months intervention group showed statistically significantly: lower levels of cancer related fatigue ( $P<0.001$ ); higher levels of self-efficacy ( $P<0.001$ ) and physical activity ( $P<0.001$ ); better quality of life ( $P<0.01$ )
Li et al., 2018, China (15)	Prospective randomized controlled trial	-	222	117/105	9-16	Leukemia, lymphoma, bone tumor et al.	Increase exercise over 8 years associated with a 40% reduction in risk of death of any cause (RR, 0.60; 95% CI 0.44-0.82, $P=0.001$ )
Scott et al., 2018, USA (22)	Cohort study	-	From 15450, 5689 included in final change analysis	-	Mean=25.9	Leukemia, lymphoma, CNS tumor et al.	6-MET-h/wk increase in vigorous exercise was associated with 13% reduction of death from any cause
Tanner et al., 2018, USA (19)	Quasi – experimental study	-	30	15/15	5-18	ALL	The SLP intervention group had better scale scores for: bilateral coordination ( $P=0.05$ ); running speed/agility ( $P<0.01$ ); strength

							( <i>P</i> =0.01) The SLP intervention group (Md=78) reported higher level of activity than control group (Md=56), ( <i>P</i> =0.033) Four studies with distance delivered intervention programs reported that participant's physical activity did not change significantly [Hedges' <i>g</i> = 0.423, SE = 0.25, 95% C.I. (-0.069, 0.916), <i>P</i> = 0.092] Significant differences in activity with the fracture group reporting more somewhat active hours -typified by walking- (mean 6.0 vs. 4.1, <i>F</i> =5.58, <i>P</i> <0.02) and combined active and somewhat active hours (mean 8.8 vs. 6.9, <i>F</i> =6.14, <i>P</i> <0.01) on a typical weekend day Founded medium effect size ( <i>r</i> =0.55) between moderate-to-vigorous physical activity (MVPA) and total self-efficacy scores and medium effect size ( <i>r</i> =0.62) about subscale for adequacy Survivors reported physical inactivity due to concern about: academic performance (41.4%), fatigue and low physical strength (35.2%) Children reported headaches and fatigue as barriers for physical activity CCSs with better physical function exercised more often ( <i>r</i> =0.22, <i>P</i> =0.01); more general fatigue ( <i>r</i> =0.18, <i>P</i> =0.04) and cognitive fatigue ( <i>r</i> =0.23, <i>P</i> =0.01) was associated with less exercise; CCSs reported "very" or "extremely" interested about: weight control programs (75%), learning to eat more nutritiously (84%), getting in shape (87%) Female survivors had lower mean VO <sub>2</sub> max than healthy siblings ( <i>P</i> =0.03) Statistically significant differences in: bilateral Coordination ( <i>P</i> =0.021, 95% CI, -0.78 to -0.07), balance ( <i>P</i> <0.001, 95% CI, -
Mizrahi et al., 2017, Australia (11)	Systematic review & meta-analysis	13	270	-	0-41	Leukemia, lymphoma, brain tumor et al.	
Nayiager et al., 2017, Canada (40)	Cross-sectional cohort study	-	75	-	13-38	ALL	
Ruble et al., 2016, USA (16)	Randomized controlled trial	-	19	9/10	8-12	ALL, lymphoma, osteosarcoma et al.	
Chung et al., 2014, China (36)	Cross-sectional study	-	128	-	9-16	Leukemia, lymphoma, kidney tumor et al.	
Macartney et al., 2014, Canada (44)	Qualitative	-	12	-	9-18	Brain tumor	
Badr et al., 2013, USA (38)	Cross-sectional	-	170	-	3-29	CNS tumor, leukemia, lymphoma et al.	
Miller et al., 2013, USA (28)	Cross-sectional	-	104	72/32	8-46	Leukemia, lymphoma, embryonal tumor et al.	
Piscione et al., 2013, Canada (37)	Cross-sectional	-	30	-	4-18	Posterior fossa brain tumor	

Rueegg et al., 2012, Sweden (29)	CC	-	1572	1038/534	≥16	Leukemia, lymphoma, CNS tumor et al.	<p>1.66 to -0.97), running speed/agility (<math>P=0.005</math>, 95% CI, -1.04 to -0.20);</p> <p>In the strength and agility analyses: participants who had received chemotherapy (<math>P=0.018</math>, 95% CI, 0.19–1.93) or radiotherapy (<math>P=0.008</math>, 95% CI, 0.35–2.18] demonstrated significantly lower scores</p> <p>Survivors ≥40 years were more likely to have limitations in sports (OR 2.7, 95%CI, 1.02-7.16);</p> <p>Survivors reported musculoskeletal (n=43; 95%CI 3.2 – 5.7) and neurological (n=27; 95%CI 1.8 – 3.9)) limitations</p> <p>CCSs referred:</p> <p>Pain and fatigue syndromes (n=7; 95%CI 0.3-1.4), psychological problems (n=2; 95%CI 0.1-0.8), limitations in sports if they had been diagnosed with CNS tumor (OR 7.1; 95%CI, 3.7-13.8), retinoblastoma (OR 5.6; 95%CI, 1.7-18.7), bone tumor (OR 12.3; 95%CI, 5.4-28.2) and soft tissue sarcoma (OR 3.5; 95%CI, 1.4-8.9)</p> <p>CCSs reported physical inactivity due to: Lack of time (44%), “do not like it” (27%), laziness (19%); Male’s most frequent physical activities: soccer (42%), swimming (19%); Female’s most frequent physical activity: dancing (33%), swimming (30%);</p> <p>61% of males and 18.5% of females preferred participating in competitive sports (<math>P&lt;0.005</math>)</p> <p>Correlation between social withdraw (OR 1.7, 95%CI, 1.2-2.5, <math>P=0.01</math>) and use of antidepressants (OR 3.2, 95%CI, 1.1-1.7, <math>P=0.02</math>) with physical inactivity in adulthood</p> <p>LTPA significantly associated with improved physical function in adult CCSs (<math>P&lt;0.01</math>); in adolescent LTPA was associated with improved overall health related quality of life, social and cognitive</p>
Bertorello et al., 2011, Italy (23)	Cohort study	-	102	-	10-30	ALL	<p>CCSs reported physical inactivity due to: Lack of time (44%), “do not like it” (27%), laziness (19%); Male’s most frequent physical activities: soccer (42%), swimming (19%); Female’s most frequent physical activity: dancing (33%), swimming (30%);</p> <p>61% of males and 18.5% of females preferred participating in competitive sports (<math>P&lt;0.005</math>)</p> <p>Correlation between social withdraw (OR 1.7, 95%CI, 1.2-2.5, <math>P=0.01</math>) and use of antidepressants (OR 3.2, 95%CI, 1.1-1.7, <math>P=0.02</math>) with physical inactivity in adulthood</p> <p>LTPA significantly associated with improved physical function in adult CCSs (<math>P&lt;0.01</math>); in adolescent LTPA was associated with improved overall health related quality of life, social and cognitive</p>
Krull et al., 2010, USA (30)	Cohort study	-	2058	1652/406	12 - 17	Leukemia, CNS tumor et al.	<p>CCSs reported physical inactivity due to: Lack of time (44%), “do not like it” (27%), laziness (19%); Male’s most frequent physical activities: soccer (42%), swimming (19%); Female’s most frequent physical activity: dancing (33%), swimming (30%);</p> <p>61% of males and 18.5% of females preferred participating in competitive sports (<math>P&lt;0.005</math>)</p> <p>Correlation between social withdraw (OR 1.7, 95%CI, 1.2-2.5, <math>P=0.01</math>) and use of antidepressants (OR 3.2, 95%CI, 1.1-1.7, <math>P=0.02</math>) with physical inactivity in adulthood</p> <p>LTPA significantly associated with improved physical function in adult CCSs (<math>P&lt;0.01</math>); in adolescent LTPA was associated with improved overall health related quality of life, social and cognitive</p>
Paxton et al., 2010, USA (39)	Cross-sectional	-	215	-	11-33	CNS tumor, leukemia, lymphoma et al.	<p>CCSs reported physical inactivity due to: Lack of time (44%), “do not like it” (27%), laziness (19%); Male’s most frequent physical activities: soccer (42%), swimming (19%); Female’s most frequent physical activity: dancing (33%), swimming (30%);</p> <p>61% of males and 18.5% of females preferred participating in competitive sports (<math>P&lt;0.005</math>)</p> <p>Correlation between social withdraw (OR 1.7, 95%CI, 1.2-2.5, <math>P=0.01</math>) and use of antidepressants (OR 3.2, 95%CI, 1.1-1.7, <math>P=0.02</math>) with physical inactivity in adulthood</p> <p>LTPA significantly associated with improved physical function in adult CCSs (<math>P&lt;0.01</math>); in adolescent LTPA was associated with improved overall health related quality of life, social and cognitive</p>

Tercyak et al., 2006, USA (17)	Randomized controlled trial	-	75	-	11-21	Leukemia et al.	<p>function, cancer worry (all <math>P</math>'s&lt;0.01)</p> <p>Depressive symptoms coexisting with conflicts with parents constituted risk factor for physical inactivity (<math>\beta=0.005</math>, <math>P&lt;0.05</math>)</p> <p>Older aged CCSs had higher behavioral risk factor (<math>P= 0.01</math>)</p> <p>Survivors had higher risk to mention performance limitations (RR, 1.8; 95%CI, 1.7-2.0)</p> <p>CCSs with musculoskeletal (RR, 1.9; 95%CI, 1.7-2.0), neurologic (RR, 2.0; 95%CI, 1.9-2.2), cardiac impairments ((RR, 2.0; 95%CI, 1.8-2.2) had highest risk for developing a performance limitation; survivors of bone cancer were 2.9 times (95%CI, 2.6-3.3 times) as likely, survivors of brain cancer were 2.5 times (95%CI, 2.2-2.8 times) as likely, and survivors of Hodgkin lymphoma were 1.8 times (95%CI, 1.6-2.0 times) as likely to report a physical performance limitation;</p> <p>Survivors who received radiation were more likely to report limitations in physical performance when compared with survivors who received only surgery (RR, 1.4 [CI, 1.1 to 1.7])</p> <p>CCSs had significantly lower weekly activity score than controls (<math>P&lt; 0.05</math>)</p>
Ness et al., 2005, USA (24)	Cohort study	-	15320	11481/3839	0-47	Leukemia, brain cancer, Hodgkin lymphoma et al.	<p>Survivors who received radiation were more likely to report limitations in physical performance when compared with survivors who received only surgery (RR, 1.4 [CI, 1.1 to 1.7])</p> <p>CCSs had significantly lower weekly activity score than controls (<math>P&lt; 0.05</math>)</p>
Tillmann et al., 2002, UK (31)	CC	-	56	28/28	5-15	ALL	<p>Survivors who received radiation were more likely to report limitations in physical performance when compared with survivors who received only surgery (RR, 1.4 [CI, 1.1 to 1.7])</p> <p>CCSs had significantly lower weekly activity score than controls (<math>P&lt; 0.05</math>)</p>