



# Subclinical Cardiac Dysfunction in Childhood Cancer Survivors: Insights from Global Longitudinal Strain and Risk Factor Profiling

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## Abstract

**Objective** To evaluate subclinical cardiac dysfunction and its association with treatment exposure and metabolic risk factors in a cohort of asymptomatic childhood cancer survivors (CCS).

**Methods** In this cross-sectional, observational, single-centre study, pediatric and young adult CCS were evaluated. Eligible participants were diagnosed before 18 years of age and had completed cancer therapy at least two years prior to enrolment. Data on cancer history, treatment exposures, and comorbidities were extracted from electronic medical records. Cardiovascular evaluation included history, physical examination, electrocardiogram, and comprehensive 2D-echocardiography with global longitudinal strain (GLS) analysis. Cumulative anthracycline-equivalent doses (CAE) and radiation exposure to the heart were documented.

**Results** Out of 456 CCS, anthracycline exposure was noted in 88% [mean (SD) CAE dose: 178.1 (123.2) mg/m<sup>2</sup>], and 6.3% had received cardiac radiation. The median (Q1, Q3) age at evaluation was 15 (10, 19) years, with a median (Q1, Q3) follow-up of 6.5 (4.9, 9.3) years. Left ventricular ejection fraction was reduced in 2.8%, while abnormal GLS was detected in 41.4%. On multivariable logistic regression, abnormal GLS was independently associated with CAE dose > 250 mg/m<sup>2</sup> ( $P=0.012$ ), obesity ( $P=0.004$ ) and hypertriglyceridemia ( $P=0.05$ ).

**Conclusion** Abnormal GLS was prevalent in over 40% of asymptomatic CCS. Higher anthracycline exposure and presence of obesity and dyslipidemia were linked with subclinical cardiac dysfunction. These findings underscore the need for routine cardiac surveillance using strain imaging and aggressive management of modifiable risk factors to mitigate long-term cardiovascular morbidity in CCS.

**Keywords** Anthracycline · Chemotherapy · Echocardiography · GLS · Survivor

## Introduction

Advances in cancer therapy have significantly improved survival in childhood cancer, shifting attention toward long-term health outcomes and late effects, particularly cardiotoxicity. Cardiac complications are a leading cause of morbidity and mortality among childhood cancer survivors (CCS), especially those treated with anthracyclines and chest radiotherapy. Large cohort studies, including the Childhood Cancer Survivor Study (CCSS) and the Dutch LATER cohort, report cumulative heart failure incidence of 4.8–10.6% by mid-adulthood [1, 2]. CCS are over ten times more likely to develop ischemic heart disease or stroke and up to seven times more likely to die from heart failure compared to their siblings [1, 3, 4].

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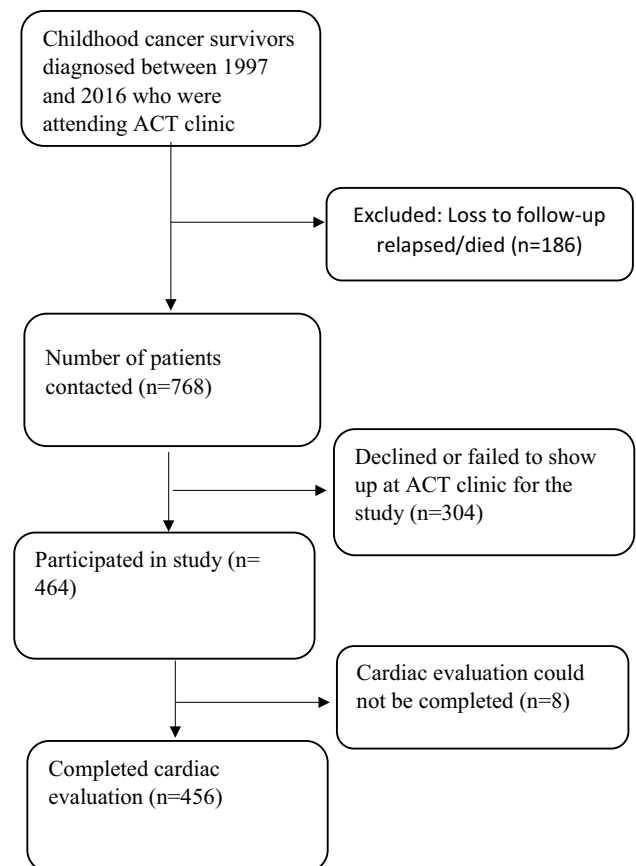
The burden of cardiotoxicity increases with age and is compounded by modifiable cardiovascular (CV) risk factors such as hypertension, dyslipidemia, obesity, and diabetes [5, 6]. Survivors with one or more chronic health conditions face nearly a twofold increased risk of late mortality, underscoring the need for targeted preventive strategies [5, 6]. Importantly, symptomatic cardiac dysfunction often manifests after a prolonged latent period, offering a critical window for early detection and intervention. International guidelines recommend long-term cardiac surveillance for CCS to detect preclinical dysfunction and guide preventive care [7]. Traditional echocardiographic indices like ejection fraction (EF) and fractional shortening (FS) are limited by their insensitivity to early myocardial damage. Advanced imaging parameters such as global longitudinal strain (GLS) and diastolic function markers offer greater sensitivity and are now endorsed by the American Society of Echocardiography and the European Association of Cardiovascular Imaging for routine monitoring during and after cancer therapy [8, 9]. There is also growing interest in developing risk prediction models to individualize prevention and surveillance [10].

Despite these advances, data from low- and middle-income countries (LMICs), including India, remain limited. This is particularly concerning given the high background prevalence of CV risk factors in the Indian population, as reported by the ICMR-INDIAB study [11]. This study aims to evaluate the prevalence of both overt and subclinical cardiac dysfunction in asymptomatic CCS and examine its association with treatment exposures and conventional CV risk factors.

## Methods

This cross-sectional, observational study was conducted in the pediatric oncology department of a tertiary care cancer centre in Northern India from December 2017 to December 2019. CCS who were diagnosed before the age of 18 years, were in complete remission, and had completed therapy at least two years prior to enrollment were eligible for inclusion. Patients were identified through the electronic database of the pediatric oncology department's "After Completion of Therapy (ACT)" clinic (Web Fig. 1). The study was approved by the hospital ethics committee and written informed consent was obtained from all participants or their guardians, as appropriate.

All participants underwent a detailed evaluation including medical history (including prior diagnosis of cardiac conditions, hypertension, diabetes mellitus, medication use, history of smoking), and complete physical examination including anthropometric assessment and estimation of resting blood pressure. Fasting blood samples were obtained



**Fig. 1** Flowchart showing eligible participants in the study ACT after completion of therapy

to assess the renal, liver, and thyroid functions, fasting blood glucose, and lipid profile.

Demographic, socioeconomic, cancer-related, and treatment-related data were abstracted from electronic medical records. Chemotherapy exposure was categorized by drug class (anthracyclines, alkylating agents, antimetabolites, and platinum compounds). Cumulative anthracycline dose was calculated using standard conversion factors (doxorubicin = 1, daunorubicin = 0.6, mitoxantrone = 10.5) [12]. For patients who received radiotherapy, treatment planning records and dose-volume histograms were reviewed. The mean heart radiation dose, percentage volume of the heart receiving  $\geq 5$  Gy (V5), and  $\geq 20$  Gy (V20) were documented. V5 and V20 were markers of low-dose and high-dose radiation exposure, respectively. No patients had received prophylactic cardioprotective agents.

All participants underwent a 12-lead electrocardiogram (ECG) and a comprehensive two-dimensional (2D) echocardiographic evaluation including strain analysis, performed by a dedicated cardiologist blinded to clinical data. Examinations were performed using a Philips Affiniti 70 ultrasound system, following protocols established by the



Intersocietal Commission for the Accreditation of Echocardiography Laboratories (ICAEL) [13].

Left ventricular (LV) structure and function were assessed using parasternal and apical views. LV volumes, mass, ejection fraction (EF), and shortening fraction were calculated as per American Society of Echocardiography (ASE) guidelines and categorized as normal, mildly, moderately, or severely abnormal [14]. Right ventricular (RV) function was evaluated using tricuspid annular plane systolic excursion (TAPSE), with age-appropriate cutoffs.

Diastolic function was assessed using mitral inflow velocities (E, A), E/A ratio, deceleration time, tissue Doppler imaging (medial and lateral annular velocities), E/e' ratio, left atrial (LA) volume, pulmonary venous flow, and estimated right ventricular systolic pressure, following ASE/European Association of Cardiovascular Imaging guidelines [15].

Global longitudinal strain (GLS) was evaluated in apical 4-, 3-, and 2-chamber views using speckle-tracking echocardiography on a Philips IE33 system (1–5 MHz probe) with Automated Cardiac Motion Quantifications Software. GLS analysis was deemed feasible only when all myocardial segments were tracked adequately. Age-specific GLS reference cut-offs were applied for pediatric and adult survivors [16, 17]. Additional cardiac parameters, including pulmonary artery pressures, valvular lesions, pericardial abnormalities, and aortic pathology (e.g., calcification, dilation), were also documented. Predicted individual risks for heart failure, ischemic heart disease, and stroke were calculated using the Childhood Cancer Survivor Study (CCSS) Cardiac Risk Calculator, which incorporates demographic and cancer treatment characteristics [18].

Assuming a prevalence of reduction in GLS of about 10% among patients exposed to cumulative anthracycline equivalent dose (CAE) of more than  $> 250 \text{ mg/m}^2$  compared to those exposed to lower doses ( $< 250 \text{ mg/m}^2$ )—based on published literature [7], and using a power of 80% with a two-sided significance level of 5%, a sample size of 291 patients was required to detect a statistically significant difference. Accounting for a 10% dropout rate due to various reasons, a minimum of 320 patients were planned to be screened.

**Statistical analysis:** Data were analyzed using SPSS version 25.0 (IBM Corp., Chicago, IL, USA). Descriptive statistics were used to summarize demographic and clinical variables. Continuous variables were expressed as mean (SD) or median (Q1, Q3). Chi-square or Fisher's exact tests were used for categorical variables, and Mann–Whitney U or Kruskal–Wallis tests for continuous variables. Participants were categorized depending upon the age at diagnosis (0–5, 6–10, and  $> 10$  years), age at evaluation: ( $< 18$  and  $\geq 18$  years), CAE dose ( $< 250 \text{ mg/m}^2$  and  $\geq 250 \text{ mg/m}^2$ ) for analysis. Threshold of  $250 \text{ mg/m}^2$  has been chosen based on recommendation of by International Guidelines

Harmonization Group (IGHG) to ensure consistency with internationally accepted risk stratification criteria [19]. Univariate and multivariable logistic regression analyses were performed to assess association between demographic and cancer-related characteristics, treatment exposures (chemotherapy, CAE dose, cardiac radiation), and metabolic syndrome components [obesity, hypertension, hypertriglyceridemia, low high-density lipoprotein (HDL), and raised fasting blood glucose] with abnormal GLS. Results were reported as odds ratios (ORs) with 95% confidence intervals (CIs). A two-sided  $P$  value  $< 0.05$  was considered statistically significant.

## Results

The study included 456 CCS with a mean (SD) CAE dose of  $178.1 (123.2) \text{ mg/m}^2$  (Table 1). Age at diagnosis ( $> 10$  years), age at evaluation ( $> 18$  years), and follow-up duration  $< 5$  years were significantly associated with higher CAE. Anthracycline exposure varied significantly by primary diagnosis, with the highest doses observed in bone sarcoma. Older children were more likely to have bone sarcoma and relatively shorter follow-up. There were no statistically significant differences in CAE across categories of obesity, hypertension, low HDL, hypertriglyceridemia, or abnormal fasting blood sugar.

Among 149 survivors treated with radiotherapy, 29 had exposure to the heart. The volumetric analysis revealed that whole and partial volume of the heart was in the radiation field in 4 and 13 patients, respectively, and 12 patients received unintentional radiation to the heart, due to proximity to the planned radiation field. The mean RT dose to the heart (D-mean) ranged between 0.46 and 13.6 Gy and included those receiving low ( $< 10$  Gy,  $n = 19$ ) and moderate (10–20 Gy,  $n = 10$ ) doses. Volumetric analysis revealed that low dose (V5) radiation to large volume ( $\geq 50\%$ ) of the heart occurred in 10/29 patients, the rest (19/29) had low volume exposures. All 29 patients received high dose radiation (V20) to small cardiac volumes ( $< 30\%$ ). Of these 22/29 patients were exposed to both anthracycline and RT to the heart.

Overt LV systolic dysfunction with abnormal ejection fraction seen in only 2.4% and reduced fractional shortening in 1.9%. All these patients had abnormal GLS. Right ventricle systolic function and pulmonary artery pressures were normal in nearly all patients. Of note, subclinical LV dysfunction, indicated by abnormal GLS, was present in 41.4% patients (Table 2). The mean chamber dimensions among patients with normal and low GLS were similar indicating GLS can detect subclinical LV dysfunction which may not be identified by conventional parameters



**Table 1** Demographic, cancer and treatment characteristics by cumulative anthracycline equivalent dose in 456 childhood cancer survivors

Variables	Total n (%)	CAE (mg/m <sup>2</sup> ) Mean (SD)	P value <sup>a</sup>
<b>Age at Diagnosis (years)<sup>b</sup></b>	7 (1–18)		
0–5	174 (38.2)	124.3 (89.4)	0.001
6–10	124 (27.2)	96.0 (121.0)	
> 10	158 (34.6)	223.1 (135.1)	
<b>Age at evaluation (years)<sup>b</sup></b>	15 (5–36)		
< 10	97 (21.2)	127.6 (99.1)	< 0.001
10–18	220 (48.2)	184.3 (123.8)	
> 18	139 (30.4)	203.3(128.3)	
<b>Follow up duration (years)<sup>b</sup></b>	6.4 (4.9–9.3)		
< 5	125 (27.4)	208.3 (148.3)	0.004
≥ 5	331 (72.5)	166.6 (110.5)	
<i>Gender</i>			
Female	99 (21.71)	147.9 (124.1)	0.001
Male	357 (78.2)	186.4 (121.9)	
<i>Primary diagnosis</i>			
Leukemia	225 (49.3)	147.0 (94.8)	< 0.001
Lymphoma	109 (23.9)	232 (67.2)	
Bone sarcoma	54 (11.8)	363.3 (72.5)	
Embryonal malignancy	47 (10.3)	67.4 (104.7)	
Others	21 (4.6)	0	
<i>Exposure</i>			
Anthracycline	405 (88.8)	200.4 (112.3)	< 0.001
Alkylating	424 (93)	174.9 (117.8)	
Antimetabolite	279 (61.1)	164.7 (103.2)	
Platinum	46 (10)	145.17 (193.7)	
Radiation to heart	29 (6.3)	189.9 (137.8)	
<b>CAE (mg/m<sup>2</sup>)<sup>b</sup></b>	178.06 (123.2)		
< 100	99 (21.7)	38.0 (41.3)	–
100–< 250	229 (50.2)	148.4 (33.7)	–
≥ 250	128 (28.1)	339.3 (89.6)	–
<i>Components of metabolic syndrome</i>			
Obese (BMI)	138 (30.3)	170.4 (118.9)	0.339
Hypertension	52 (11.4)	190.0 (106.1)	
Low HDL	267 (58.6)	183.2 (118.9)	
Hypertriglyceridemia	40 (8.8)	160.1 (92.7)	
FBS abnormal	19 (4.2)	169.4 (144.0)	

CAE cumulative anthracycline equivalent, BMI body mass index, HDL high density lipoprotein, FBS fasting blood sugar

<sup>a</sup>P value indicate difference in CAE across composite groups

<sup>b</sup>Values expressed as median (range)

like LV ejection fraction, fractional shortening or chamber enlargement (Web Table 1).

Application of the CCSS cardiac risk calculator revealed that 93% of our survivors were at moderate (71%; 2–4.9%) or high risk (22%; ≥ 5%) of heart failure by the age of 50 years. The risk of ischemic heart disease and stroke was low (< 2%) in the majority (68.4% and 67.7% respectively) of the cases (Web Table 2).

Univariate analysis revealed that odds of abnormal GLS were higher among older survivors at diagnosis, and at evaluation, had a primary diagnosis of leukemia or bone sarcoma and were exposed to higher doses of anthracycline > 250 mg/m<sup>2</sup> (Table 3). On multivariable regression analysis, CAE dose > 250 mg/m<sup>2</sup> was the main independent risk factor for reduced GLS after adjusting for demographic and treatment factors (Table 4). Obesity and



**Table 2** Echocardiographic parameters of 456 childhood cancer survivors

Parameter	Normal n (%)	Abnormal n (%)
<i>LV systolic function</i>		
Ejection fraction <sup>a</sup>	445 (97.6)	11 (2.4)
Fractional shortening <sup>b</sup>	448 (98.1)	8 (1.9)
<i>RV systolic function</i>		
TAPSE	456 (100)	0
<i>LV diastolic function</i>		
LV diastolic dysfunction <sup>c</sup>	440 (96.7)	13 (2.8)
<i>Subclinical LV dysfunction</i>		
Global longitudinal strain	267 (58.6)	189 (41.4)
High PA pressure	449 (99.1)	4 (0.9)
<i>Valvular lesions</i>		
MR	421 (92.3)	35 (7.7)

LV left ventricle, MR mitral regurgitation, PA pulmonary artery, RV right ventricle, TAPSE tricuspid annular plane systolic excursion

<sup>a</sup>All abnormal values of reduced EF were mild;

<sup>b</sup>3/448 survivors had borderline SF, which were taken as normal

<sup>c</sup>Left ventricular diastolic dysfunction 3/456 values were indeterminate

hypertriglyceridemia were significantly associated with abnormal GLS.

## Discussion

We conducted a comprehensive 2-D echocardiographic evaluation in a large cohort of asymptomatic pediatric and young adult survivors of childhood cancer, the majority (88%) of whom had received anthracyclines. Only a small subset (6.3%) was exposed to cardiotoxic radiotherapy. Notably, a significant proportion of survivors exhibited subclinical cardiac dysfunction as detected by GLS, independently associated with exposure to CAE dose > 250 mg/m<sup>2</sup> and cardio-metabolic risk factors (obesity, and hypertriglyceridemia). These findings at a median age of 15 years and median follow-up of 6.5 years are clinically significant given the progressive nature of therapy-induced cardiac dysfunction.

Previous studies report varying prevalence of cardiac dysfunction, influenced by differences in treatment exposure, imaging techniques, diagnostic thresholds, age at evaluation, and follow-up duration. In the current study, left ventricular ejection fraction (LVEF) was abnormal in 2.5% at a median follow-up of 6.5 years. This is somewhat lesser compared to findings from the St. Jude Lifetime Cohort (5.8% abnormal LVEF at 23 years) and the Dutch CCS cohort (7.7% at 7.9 years) [20, 21]. The higher prevalence in these studies is likely attributable to longer follow-up durations, differences in LVEF thresholds, and greater exposure to chest

radiotherapy. Contrary to prior studies suggesting younger age and female sex as risk factors, we did not observe such associations likely due to limited sample sizes in these subgroups and lower treatment exposures in younger children [22].

Abnormal GLS was observed in 41.4% CCS in the current study which is much higher than previous values ranging from 18 to 28% [20, 21]. It is plausible that prolonged surveillance will reveal further LVEF decline in this subset, emphasizing the importance of early detection. Longitudinal assessment of this cohort will clarify the trajectory of cardiac function with aging. Strain imaging is increasingly recognized for its value in detecting early myocardial changes. While LVEF remains the conventional standard, it is limited by inter-observer variability, dependence on loading conditions, and geometric assumptions. GLS offers better reproducibility and is more sensitive to early dysfunction. Studies show that GLS abnormalities precede changes in LVEF and are better predictors of adverse cardiovascular outcomes. For CCS, GLS may be a preferred screening tool over LVEF, as supported by recent literature [8, 9].

Strikingly, over half of the survivors exposed to chest radiotherapy had abnormal GLS, though sample size precluded statistical analysis. This suggests a need for further research into the combined cardiotoxic effects of radiation and anthracyclines. Additionally, metabolic syndrome components, particularly obesity and hypertriglyceridemia, emerged as significant risk factors for subclinical dysfunction independent of treatment exposures. These findings align with the CCSS study, which showed decreased mortality with healthier metabolic profiles [1, 3, 4]. Given India's high burden of cardio-metabolic disease including earlier onset and more aggressive progression of diabetes among Asian Indians, these associations are particularly concerning [23]. In a recent cohort of 500 Indian CCS, prevalence rates of metabolic syndrome (12.2%), central obesity (33%), and dyslipidemia (61.8%) were alarmingly high [24]. Lifestyle interventions must therefore be integral to survivorship care models in our country.

The current study suggests that the CCSS cardiac risk calculator would classify 93% of CCS as moderate or high risk of heart failure by age 50. This highlights the importance of initiating early interventions, especially as the median age of the study cohort was 15 years. According to expert consensus, a relative GLS reduction of > 15% from baseline is clinically significant and should prompt closer follow-up [25].

The strengths of this study include its large cohort from a single center in a low- to middle-income country, detailed treatment exposure data, and use of comprehensive echocardiographic parameters including GLS. Limitations include the cross-sectional design, relatively short follow-up, absence of baseline and serial measurements



**Table 3** Logistic regression analysis of risk factors for abnormal global longitudinal strain

Variables	Total (n=456)	GLS abnormal (n=189)	Univariate OR (95% CI)	P value
<b>Age at diagnosis<sup>a</sup></b>	7 (4–12)	9 (5–13)	1.0 (1.0–1.1)	<0.001
0–5 years <sup>b</sup>	174 (38.2)	54 (31)	1	
6–10 years <sup>b</sup>	124 (27.2)	56 (45.2)	1.8 (1.1–2.9)	0.013
≥ 10 years <sup>b</sup>	158 (34.6)	79 (50)	2.2 (1.4–3.4)	<0.001
<b>Age at evaluation<sup>a</sup></b>	15 (10–19)	16 (13–19)	1.0 (1.0–1.1)	0.008
< 10 years <sup>b</sup>	97 (21.3)	21 (21.6)	1	
10–18 years <sup>b</sup>	220 (48.2)	115 (52.3)	0.4 (0.2–0.8)	0.008
≥ 18 years <sup>b</sup>	139 (30.5)	53 (38.1)	1.7 (1.1–2.7)	0.009
<b>Follow-up duration<sup>a</sup></b>	6.5 (4.9–9.3)		0.9 (0.9–1.0)	0.950
< 5 years <sup>b</sup>	125 (27.4)	54 (43.2)	1	
≥ 5 years <sup>b</sup>	331 (72.6)	135 (40.8)	0.9(0.5–1.3)	0.641
<i>Gender</i>				
Female <sup>b</sup>	99 (21.7)	37 (37.4)	1	
Male <sup>b</sup>	357 (78.3)	152 (42.6)	1.2 (0.7–1.9)	0.353
<i>Primary diagnosis</i>				
Leukemia <sup>b</sup>	226 (49.6)	80 (35.4)	0.6 (0.4–0.8)	0.010
Lymphoma <sup>b</sup>	108 (23.6)	46 (42.6)	1.0 (0.6–1.6)	0.855
Bone sarcoma <sup>b</sup>	54 (11.8)	36 (66.7)	3.2 (1.7–5.9)	<0.001
Embryonal malignancy <sup>b</sup>	47 (10.3)	15 (34)	0.6 (0.3–1.2)	0.164
Others <sup>b</sup>	21 (46.1)	12 (57.1)	1.9 (0.8–4.7)	0.141
<i>Exposure</i>				
Anthracycline <sup>b</sup>	405 (88.8)	167 (41.2)	0.9 (0.5–1.6)	0.795
Alkylating <sup>b</sup>	424 (93)	175 (41.2)	0.9 (0.4–1.8)	0.784
Antimetabolite <sup>b</sup>	279 (61.1)	102 (36.5)	1.6 (1.1–2.3)	0.013
Platinum <sup>b</sup>	46 (10)	27 (58.6)	0.4 (0.2–0.8)	0.014
Radiation to heart <sup>b</sup>	29 (6.3)	13 (44.8)	0.8 (0.4–1.8)	0.703
<b>CAE<sup>c</sup></b>	178.1 (123.2)	200.2 (134.6)	1.0 (1.0–1.0)	0.002
≥ 250 mg/m <sup>2b</sup>	128 (28.1)	72 (38.1)	2.3 (1.5–3.5)	<0.001
<i>Metabolic Syndrome</i>				
Obese (BMI) <sup>b</sup>	138 (30.2)	73 (52.9)	0.5 (0.3–0.7)	0.001
Hypertension <sup>b</sup>	52 (11.4)	28 (53.8)	0.5 (0.3–1.0)	0.056
Low HDL <sup>b</sup>	153 (57.3)	114 (42.7)	1.1 (0.7–1.6)	0.520
Hypertriglyceridemia <sup>b</sup>	40 (8.8)	25 (62.5)	2.5 (1.3–5.0)	0.006
FBS raised <sup>b</sup>	19 (4.2)	10 (52.6)	1.6 (0.6–4.0)	0.316

Values reported as <sup>a</sup>median (range) or <sup>b</sup>n (%) or <sup>c</sup>mean (SD)

*BMI* body mass index, *CAE* cumulative anthracycline equivalent, *FBS* fasting blood sugar, *HDL* high density lipoprotein, *GLS* global longitudinal strain

and lack of a control group. Selection bias may have occurred, as only CCS attending follow-up or responding to outreach were included.

In conclusion, we report a high prevalence of sub-clinical cardiac dysfunction among asymptomatic CCS. High-dose anthracycline exposure, obesity, and hypertriglyceridemia are associated with abnormal GLS which highlights the need for longitudinal monitoring and lifestyle interventions in survivorship care.

### What this Study Adds?

- 41% of the childhood cancer survivors with a median age of 15 years showed abnormal GLS despite normal LVEF
- Obesity and hypertriglyceridemia emerged as novel independent risk factors for cardiotoxicity.



**Table 4** Multivariable logistic regression analysis of risk factors for abnormal global longitudinal strain

Variables	RR (95% CI)	P value
Age at diagnosis	1.0 (0.9–1.0)	0.121
Age at evaluation	0.9 (0.9–1.0)	0.789
Sex (Female)	0.9 (0.8–1.2)	0.789
CAE		0.012
> 250 mg/m <sup>2</sup>	2.1 (1.1–3.8)	
<i>Metabolic syndrome</i>		
Obese (BMI)	0.9 (0.7–1.1)	0.004
Hypertension	0.9 (0.7–1.3)	0.886
Low HDL	0.9 (0.6–1.4)	0.684
Hypertriglyceridemia	0.9 (0.7–1.2)	0.050
FBS raised	0.9 (0.6–1.5)	0.947

*BMI* body mass index, *CAE* cumulative anthracycline equivalent, *CI* confidence interval, *FBS* fasting blood sugar, *HDL* high density lipoprotein

**Supplementary Information** The online version contains supplementary material available at <https://doi.org/10.1007/s13312-025-00250-y>.

**Author Contributions** SJ and GK conceptualized and designed the study and analyzed the data. NA performed all the 2-D echocardiograms and interpreted their results. NA, PM, AP and SG were involved with data collection, statistical analysis and interpretation. All authors have contributed to the writing of the manuscript.

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**Data Sharing** De-identified data is available on request on request from corresponding author.

**Conflict of interest** None.

**Ethics Approval** Institutional Review Board Ref No: RGCIRC/IRB/49/2017, dated August 16, 2017.

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