Journal of Pediatric Advance Research

ATHENAEUM SCIENTIFIC PUBLISHERS

Research Article

Metabolic Syndrome in Childhood Cancer Survivors

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Citation: Salman HH, et al. Metabolic Syndrome in Childhood Cancer Survivors. J Pediatric Adv Res. 2024;3(3):1-10.

http://dx.doi.org/10.46889/JPAR.2024.33049

Received Date: 09-12-2024

Accepted Date: 23-12-2024

Published Date: 30-12-2024

Abstract

Background: Cancer is the second leading cause of death in Iraq and the remarkable improvements in pediatric cancer treatment protocols in the last few decades resulted in increase the number of childhood cancer survivors. Unfortunately, these improvements were associated with the incidence of metabolic syndrome in Childhood cancer survivors.

Method: A case control study was carried out in Basra children specialty hospital/oncology center to detect the frequency of metabolic syndrome in Childhood cancer survivors. A total of 50 (26 male and 24 female) cancer survivor subjects and 50 (26 male and 24 female) as control were included in the study. The mean of age of test group was 10.8 ± 6.4 year and the control group was 10.6 ± 6.3 year. A special designed questionnaire was used for the purpose of the study. Measurements in terms of height, weight, body mass index, blood pressure were recorded. The biochemical investigations included in the study were fasting blood sugar, serum insulin like growth factor 1, serum cholesterol, triglycerides, low density lipoprotein and high-density lipoprotein. Both hematological and solid tumors with their treatment modality and off therapy time were included.

Result: The results showed that the lipid profile of cancer survivors are significantly differ from control group specially for Hodgkin Lymphoma and Non Hodgkin Lymphoma (p-value 0.0 for cholesterol, LDL, HDL in HL and for cholesterol and HDL in NHL, p-value is 0.02 for TG in HL). Fasting blood sugar was significantly different only in Acute Lymphoblastic Leukemia compare to control group (p-value is 0.0). Whereas mean Insulin like Growth Factor was higher than control in Ewing group (p-value 0.0). All 50 control subjects had normal FBS and 11 cancer survivors showed prediabtic value. The mean of body mass index did not show any differences of all cancer types included in this study compare to control group (P >0.05). Almost 70% of cancer and control groups had normal body weight and 10% were under-weight. One of the control and 2 of Acute Lymphoblastic Leukemia subjects were obese while 3 Acute lymphoblastic leukemia and 4 Hodgkin lymphoma were overweight. Systolic and diastolic blood pressure of all cancer types were comparable with the control subjects (P > 0.05). The higher systolic pressure (110 ± 11) and diastolic pressure (73 ± 11) was in Acute lymphoblastic leukemia group. About 10 % of control and cancer survivors were pre-hypertensive one of control, Acute Lymphoblastic leukemia, NHL and 3 of HL were hypertensive. Additionally, the comparison of control group with different types of treatment protocols had significant impact on Cholesterol, Low density Lipoprotein and High density Lipoprotein values. Whereas serum Triglyceride greatly affected (P=0.018) in the group treated by chemotherapy, radiotherapy and surgery. The Fasting blood sugar was significantly higher in all types of treatment group compare with control, while Insulin like Growth Factor affected only (P = 0.002) in the group treated by chemotherapy, radiotherapy and surgery. Body Mass Index and blood pressure did not show any correlation among the different types of treatment (p-value >0.05). Conclusion: Accordingly, childhood cancer survivors are at more risk of late developing one or more component of metabolic syndrome. The late effect of chemotherapy and radiotherapy need to be considered seriously for all cancer survivors. The results also suggest a future research for each cancer type separately to elucidate the exact mechanism behind developing the metabolic syndrome.

Keywords: Hyperlipidemia; Metabolic Syndrome; BMI; Childhood Cancer

Introduction

The remarkable improvements in pediatric cancer treatment protocols in the last few decades resulted in increase the number of Childhood Cancer Survivors (CCS) [1]. Unfortunately, the new therapies are intensive and administered during the growing phase of children, so they found to be associated with various late effects such as cardiac dysfunction, pulmonary problems, endocrinopathies, fertility disorder, osteoporosis, obesity and even second malignancy [2,3]. Furthermore, Haddy, et al., studied the incidence of hypertension, prehypertension and obesity in childhood and adolescent cancers survivors [4]. In addition, high level of fasting serum insulin, impaired glucose tolerance test, dyslipidemia had been reported with those survivors [5]. These signs and symptoms collectively called metabolic syndrome or syndrome X. Metabolic syndrome in other words a group of symptoms include: (i) insulin resistance (with glucose intolerance and hyperinsulinemia), (ii) dyslipidemia (high serum Triglycerides (TG), Cholesterol (CH) and Low Density Lipoproteins (LDL) levels and decreased High Density Lipoproteins (HDL) concentration), (iii) hypertension (with or without other cardiac diseases) and (iv) obesity [6].

Material and Methods

A case control study was carried out in Basra children specialty hospital/oncology center. The study group was 50 cases of subjects who were survived from cancer and completed their treatment at least 1 year and their current age range 4-30 years (inclusion criteria). Patients with relapsed disease or treated for relapse are excluded from the study (exclusion criteria), the patients classified into hematological and solid malignancies. The subjects who have meet the inclusion criteria for the study were contacted by telephone and asked to come fasting overnight to the center of pediatric oncology. Control group 50 healthy individuals equivalent in terms of sex and age to the above cases were selected from children and adolescents who visit or work in Al-Basrah hospital for maternity and children. Data collection by using a special designed questionnaire for the purpose of the study and the following information were taken: name, date of birth, all cases and survivors were classified as specific age groups in years (4-12years, 12-18 years,18-30 years) sex (male or female), address, age at diagnosis, body weight (kg), height (CM), BMI, family history of DM, cardiovascular diseases and hypercholesrtolemia. Type of malignancy (hematological or solid), type of treatment, duration of the treatment and off time therapy. Investigations in form of (fasting blood sugar, CH, HDL, LDL, TG and SIGF). Anthropometric measures: The body weight (Kg) of test subjects was measured using an electronic weigh scale. The height (CM) of all participants was measured using Stadiometer. BMI (Kg/m^2). According to CDC charts (2-20 years), BMI was classified according to age and sex [7]. The subject was considered underweight if their BMI was lower than 5th percentile. The normal body weight accounted for subject their BMI ranging 5th- 85th percentile. If BMI from 85th to 95th percentile, the subject at risk of overweight. Obesity was considered when BMI is larger than 95th percentile [7]. For individuals older than 20 years, underweight for BMI lower than 18, normal body weight for BMI range from 18 to 25, overweight for BMI from 25 to 30 and obese for BMI higher than 30. Regarding of blood pressure: was conducted in sitting position for the right arm using sphygmomanometer of appropriate cuff size. For children and adolescent hypertension was considered when systolic blood pressure and /or diastolic BP >95^{th} percentile for height, sex and age on three or more occasions. Prehypertension mean as systolic and /or diastolic BP between 90^{th} and 95^{th} percentile, prehypertension in adolescents stating at 12 years is defined as BP from 120/80 mmHg to 95^{th} percentile [8]. For adolescent more than 12 years blood pressure higher than 140/90 mmHg defined as hypertension and more than 120/80 mmHg as prehypertension. Biochemical investigations: (CH, TG, LDL, HDL and FBS) was measured by withdrawing a venous blood sample from 12 hour fasting subjects at early morning. The investigation was measured by calorimetric – enzymatic process using the bichromatic end point techniques [9]. IGF.1 Sample were analyzed using DRG IGF-1 600 ELISA Kit. The Test principle based on competitive binding in which subject samples, standards and controls were acidified and neutralized prior to the assay procedure the pre-treated sample was incubated at room temperature with conjugate (biotinylated IGF-1) which compete with patient sample for monoclonal antibody directed a towards an antigenic site on the IGF-1 molecule coated on microtiter wells. The wells were washed and then incubated with Enzyme Complex (Streptavidin-HRP-Complex). After addition of the substrate solution, the intensity of colour developed was reverse proportional to the concentration of IGF-1 in the patient sample.

Data Analysis

Statistical Package for Social Sciences (SPSS) was used to perform statistical analysis. Data were presented either as mean (standard deviation) or as median (range) as described in each parameters. Categorical variables compared by Cross tabulation with Chi square test. One way a nova was used to compare continuous variables of test and control groups.

Results

A total of 50 (26 male and 24 female) cancer survivor subjects and 50 (26 male and 24 female) as control were included in the study (Table 1).

Variables		Cases		Control		P-value
		No.	%	No.	%	
Age (years)	4-12	37	74	38	76	0.942
	12-18	4	8	4	8	
	18-30	9	18	8	16	
Sex	Male	26	52	26	52	1
	Female	24	48	24	48	
Mean age (SD)		10.8 (6.4)		10.6 (6.3)		0.831

Table 1: Age and sex distribution of the cases and control.

Cases and control were matched for both sex and age, the mean of age of survivors was 10.8(6.4) and for control group was 10.6(6.3) and the p-value for mean comparison was 0.83.

Diagnosis	No of subjects (m, f)	Age year (range) *	Therapy duration year (range) *	Offset time year (range)*
ALL	**15** (6, 9)	**15** (6-29)	**3** (2.5-3.3)	**5** (1-17)
AML	**3** (1, 2)	**9** (6-16)	**0.6** (0.6-3)	**1** (1-1)
HL	**12** (8, 4)	**8.5** (5-23)	**0.5** (0.3-3)	**1.4** (1-11)
NHL	**9** (5, 4)	**6** (4-19)	**0.5** (0.5-0.7)	**1.5** (1-5)
WILM	**4** (2, 2)	**5** (4-15)	**1** (0.4-1.5)	**1** (1-2)
NB	**3** (2, 1)	**6** (5-8)	**1** (0.4-3)	**1** (1-2)
GCT	**2** (1, 1)	**11.5** (3-20)	**1.5** (2-1)	**4** (1-7)
EWG	**2** (1, 1)	**10** (4-16)	**1** (1-1)	**1** (1-1)
Total	**50** (26, 24)			
* Data presented as median (minimum, maximum)				

Table 2: Distribution of age and sex according to duration of therapy and off time from therapy. Different types of cancer were classified according to the duration of therapy and off time from therapy.

Solid tumor was presenting in 11 subjects while 39 were hematological malignancies. The cancer was one of the following types: Acute Lymphocytic Leukemia (ALL), Acute Myelocytic Leukemia (AML), Hodgkin Lymphoma (HL), non-Hodgkin lymphoma (NHL), WILM, Neuroblastoma (NB), GCT and EWG. The duration of therapy was ranging from 6 months to 3 years depending on the cancer type. Follow up time was from 1 year to 17 years.

Lipid Profile

The data of lipid profile in terms of serum cholesterol, serum triglycerides, low density lipoproteins and high density lipoproteins are represented in Table 3,4.

Diagnosis	CH mg/dl		P-value	TG mg/dl		P-value	LDL mg/dl		P-value	HDL mg/dl		P-value
	< 200	> 200		< 110	> 110		< 130	> 130		<35 in male and <40 in female	>35 in male and >40 in female	
Control	50 (100)	0 (0)	-	50 (100)	0 (0)	-	50 (100)	0 (0)	-	2 (4)	48 (96)	-
Cancer Survivors	48 (96)	2 (4)	0.495	49 (98)	1 (2)	1	46 (92)	4 (8)	0.177	**19 (38)**	**31 (62)**	**0.004**
ALL	15 (100)	0 (0)	1	15 (100)	0 (0)	1	15 (100)	0 (0)	1	**8 (53)**	**7 (47)**	**0.001**
AML	3 (100)	0 (0)	1	3 (100)	0 (0)	1	3 (100)	0 (0)	1	1 (33)	2 (67)	0.163
HL	**10 (83)**	**2 (17)**	**0.035**	11 (92)	1 (8)	0.194	**9 (75)**	**3 (25)**	**0.005**	**6 (50)**	**6 (50)**	**0.001**
NHL	9 (100)	0 (0)	1	9 (100)	0 (0)	1	8 (89)	1 (11)	0.153	**3 (33)**	**6 (67)**	**0.02**
WILM	4 (100)	0 (0)	1	4 (100)	0 (0)	1	4 (100)	0 (0)	1	0 (0)	4 (100)	1
NB	3 (100)	0 (0)	1	3 (100)	0 (0)	1	3 (100)	0 (0)	1	0 (0)	3 (100)	1
GCT	2 (100)	0 (0)	1	2 (100)	0 (0)	1	2 (100)	0 (0)	1	1 (50)	1 (50)	0.113
EWG	2 (100)	0 (0)	1	2 (100)	0 (0)	1	2 (100)	0 (0)	1	0 (0)	2 (100)	1
Total	98 (98)	2 (2)	-	99 (99)	1 (1)	-	96 (96)	4 (4)	-	21 (21)	79 (79)	-

Table 3: Categorical classification of lipid profile in the survivors and control data presented as No. (%).

Diagnosis	Mean CH (SD)	P-value	Mean TG (SD)	P-value	Mean LDL (SD)	P-value	Mean HDL (SD)	P-value
Control	112.3 (12.3)	-	76.5 (16.3)	-	41 (13.4)	-	55.8 (9)	-
Cancer Survivors	148.5 (26.3)	0.0*	88.9 (18.8)	1	85.7 (29.1)	0.0*	43.1 (9)	0.0*
ALL	141.9 (21.6)	0.0*	85.3 (27.6)	1	81.7 (28.3)	0.0*	43 (20.3)	0.01*
AML	135.1 (39.1)	1	64.8 (13.4)	1	74.3 (40)	0.7	48.6 (19.7)	1
HL	156.4 (37.7)	0.0*	99.5 (29)	0.02*	99.9 (36)	0.0*	38.2 (11.6)	0.0*
NHL	149.7 (34.3)	0.0*	85.7 (19.5)	1	88.6 (34.3)	0.0*	43.9 (10.4)	0.2
WILM	133.9 (8.1)	0.9	87 (19.6)	1	73 (7.4)	0.4	41.7 (2.3)	0.9
NB	171.1 (29.8)	0.0*	92.3 (17.5)	1	64 (50.2)	1	54.4 (4.2)	1
GCT	147.7 (13.1)	0.0*	88.5 (4.9)	1	87.4 (13.6)	0.3	40.6 (2.3)	1
EWG	161.1 (26.8)	0.04*	104 (19)	1	90.5 (21.9)	0.2	48 (1.4)	1
Total	130.4 (28.8)	-	82.7 (21.7)	-	63 (33)	-	49.4 (13.4)	-
* Significant differences against control at P < 0.05								

Table 4: Lipid profile characteristics of the study.

Compare to control group serum cholesterol was significantly higher in ALL, HL, NHL, NB, GCT and EWG patients. Whereas serum triglycerides were higher than control only in NHL patients. The serum low density lipoproteins of ALL, HL and NHL were significantly greater than that of control subjects. The mean of serum high density lipoproteins of ALL and HL was significantly lower than the control group. AML and WILM patients showed comparable lipid profile to control.

Although there were some significant differences in lipid profile compare to control group, the result from Table 3 clearly showed 2 cases of HL had hypercholesrtolemia, only 1 triglyceridemia, 3 high LDL and 6 low HDL. One patient of NHL had high LDL and 3 showed low HDL. Additionally, low HDL was presented in 2 of the control, 8 of ALL, 1 of AML and 1 GCT. All other subjects had normal lipid profile.

Blood Sugar, Serum Insulin and BMI

The findings of blood sugar, insulin and BMI are illustrated in Table 5.

Diagnosis	Mean FBS (SD)	P-value	Mean IGF (SD)	P-value	Mean BMI (SD)	P-value
Control	73.6 (7.6)	-	75 (36)	-	19.2 (3.7)	-
Cancer Survivors	92.9 (18)	0.1	121.9 (119.9)	0.0*	18.8 (4.1)	1
ALL	101 (41)	0.0*	141 (190)	1	21.8 (5.4)	1
AML	95 (15.3)	1	23 (13)	1	20.1 (7.3)	1
HL	90.6 (10.6)	0.1	101 (58)	1	18.9 (5.8)	1
NHL	88.4 (9.8)	1	80 (47)	1	16.4 (2.2)	1
WILM	82.6 (14)	1	83 (27)	1	15.7 (3.6)	1
NB	83.3 (11.5)	1	139 (47)	1	15.2 (1.1)	1
GCT	95 (7.1)	1	132 (15)	1	19.9 (2.9)	1
EWG	97.2 (35.7)	1	484 (562)	0.0*	15.6 (4.6)	1
Total	83.2 (20.7)	-	98 (116)	-	19 (4.5)	-
* Significant differences against control at P < 0.05						

Table 5: Distribution of cases and control according to FBS, IGF and BMI.

Fasting blood sugar was significantly different only in ALL compare to control group (p-value 0.0). Whereas mean IGF was higher than control in EWG group (p-value 0.0). The mean of body mass index did not show any differences of all cancer types included in this study compare to control group (P > 0.05).

Cancer Type	FBS mg/dl						P-value
	< 99		100-125		> 125		
	No	%	No	%	No	%	
Control	50	100	0	0	0	0	-
Cancer survivors	38	76	11	22	1	2	0.001
ALL	10	67	4	27	1	7	0.003
AML	2	67	1	33	0	0	0.056
HL	9	75	3	25	0	0	0.006
NHL	8	89	1	11	0	0	0.152
WILM	4	100	0	0	0	0	1
NB	3	100	0	0	0	0	1

GCT	1	50	1	50	0	0	0.038
EWG	1	50	1	50	0	0	0.038

Table 6: Distribution of fasting blood sugar in the study.

Cancer survivors and control were classified into three groups: normal, prediabetic and diabetic (less than 99 mg/dl, from 100 - 125 mg/dl and more than 125 mg/dl; respectively) as shown in Table 6.

From Table 6, only one patient of ALL had a diabetic value of FBS. All 50 control subjects had normal FBS and 11 cancer patients showed prediabtic value. Those are divided between ALL, AML, HL, NHL, GCT and EWG.

Furthermore, according to body mass index percentile the study subjects were sub-classified into four groups under-weight, normal body weight, over weight and obese (less than 5% percentile or less than 18 BMI score, 5%-85% or 19-25, 85% - 95% or more than 25 more than 95% or more than 30; respectively) as shown in Table 7.

Cancer Type	BMI percentile								P-value
	<5% or < 18		5%-85% or 19-25		85%-95% or < 25		> 95% or > 30		
	No	%	No	%	No	%	No	%	
Control	4	8	35	70	10	20	1	2	-
Cancer survivors	5	10	35	70	8	16	2	4	0.901
ALL	0	0	10	67	3	20	2	13	0.013
AML	0	0	3	100	0	0	0	0	0.361
HL	1	8	7	58	4	33	0	0	0.731
NHL	2	22	7	78	0	0	0	0	0.269
WILM	1	25	3	75	0	0	0	0	0.499
NB	0	0	3	100	0	0	0	0	0.999
GCT	0	0	1	50	1	50	0	0	0.524
EWG	1	50	1	50	0	0	0	0	0.253

Table 7: Distribution of cancer survivors and control according to BMI.

Almost 70% of cancer and control groups had normal body weight and 10% were under-weight according to their age. One of the control and 2 of ALL subjects were obese. The remaining 18 subjects were overweight. From the 15 ALL, 3 were overweight whereas from 12 HL, 4 were overweight.

Blood Pressure

According to blood pressure percentile mentioned previously the study group divided into three subgroups: normotensive, pre-hypertensive and hypertensive (Table 8).

Cancer Type	BP percentile						P-value
	Hypertensive		Pre-hypertensive		Normotensive		
	No	%	No	%	No	%	
Control	1	2	5	10	44	88	-
Cancer survivors	5	10	6	12	39	78	0.271

ALL	0	0	3	20	12	80	0.521
AML	1	33	0	0	2	67	0.131
HL	3	25	1	8	8	67	**0.038**
NHL	1	11	1	11	7	78	0.315
WILM	0	0	1	25	3	75	0.436
NB	0	0	0	0	3	100	0.999
GCT	0	0	0	0	2	100	0.999
EWG	0	0	0	0	2	100	0.999

Table 8: Categorical classification of cancer survivors and control according to blood pressure percentile.

About 10 % of control and cancer survivors were pre-hypertensive. 1 of control, ALL, NHL and 3 of HL were hypertensive. Moreover, the mean systolic pressure and diastolic pressure (Table 9) of the control group was (102 ± 13) and (66 ± 10); respectively.

Diagnosis	SysBP (SD)	P-value	DiasBP (SD)	P-value
Control	102 (13)	-	66 (10)	-
Cancer survivors	104 (12)	1	66 (9)	1
ALL	110 (11)	0.48	73 (11)	0.54
AML	108 (8)	1	65 (13)	1
HL	107 (13)	1	66 (10)	1
NHL	102 (10)	1	65 (8)	1
WILM	95 (13)	1	60 (12)	1
NB	92 (7)	1	56 (6)	1
GCT	98 (24)	1	62 (17)	1
EWG	95 (7)	1	60 (1)	1
Total	103 (12)	-	66 (10)	-

Table 9: Distribution of cancer survivor and control according to Systolic and diastolic blood pressure.

Systolic and diastolic blood pressure of all cancer types were comparable (P > 0.05) with the control subjects. The higher systolic pressure (110 ± 11) p- value was (0.48) and diastolic pressure (73 ± 11) was in ALL group. The lowest systolic pressure (92 ± 7) and diastolic pressure (56 ± 6) was in NB group.

Treatment Modality

Three treatment modalities were included in the current study: chemotherapy alone, chemotherapy+surgery and chemotherapy+ radiotherapy and surgery. The results of investigation of lipid profile against protocol of treatment are listed in Table 10.

		N	Mean (SD)	P-value
CHmgldl	Control	50	112.3 (12.3)	-
	chemotherapy alone	24	146.3 (27.4)	**.000**
	chemo+radio+surg.	8	139.1 (33.1)	**.013**
	chemo+surg.	18	155.7 (30.3)	**.000**
	Total	100	130.4 (28.8)	-
HDLmgldl	Control	50	55.8 (9)	-
	chemotherapy alone	24	43.3 (17.6)	**.000**
	chemo+radio+surg.	8	40.8 (12.2)	**.009**
	chemo+surg.	18	43.8 (9.7)	**.002**

	Total	100	49.4 (13.5)	-
LDLmgldl	Control	50	41 (13.5)	-
	chemotherapy alone	24	86 (29.5)	**.000**
	chemo+radio+surg.	8	80 (31.9)	**.000**
	chemo+surg.	18	87.5 (35.8)	**.000**
	Total	100	63.4 (33)	-
TGmgldl	Control	50	76.5 (16.3)	-
	chemotherapy alone	24	83.4 (25.2)	1.000
	chemo+radio+surg.	8	100.5 (34)	**.018**
	chemo+surg.	18	91.4 (17.4)	.059
	Total	100	82.8 (21.7)	-

Table 10: Treatment modalities used in Childhood cancer survivors against lipid profile in the current study.

The results showed that the comparison of control group with different types of treatment protocols had significant impact on the serum cholesterol, LDL and HDL values (p-value <005). Whereas serum TG greatly affected (P=0.018) in the group treated by chemotherapy + radiotherapy + surgery (Table 11).

		N	**Mean (SD)**	**P-value**
FBSmgldl	Control	50	73.6 (7.6)	-
	chemotherapy alone	24	95.4 (33.6)	**.000**
	chemo+radio+surg	8	95 (17.1)	**.018**
	chemo+surg.	18	88.8 (10)	**.021**
	Total	100	83.3 (20.7)	-
IGFmgldl	Control	50	75.1 (34.5)	-
	chemotherapy alone	24	108 (156)	1.000
	chemo+radio+surg	8	228.9 (266)	**.002**
	chemo+surg.	18	94 (48)	1.000
	Total	100	98.7 (116)	-
BMI	Control	50	19.2 (3.6)	-
	chemotherapy alone	24	20.5 (5.4)	1.000
	chemo+radio+surg	8	17.8 (5.7)	1.000
	chemo+surg.	18	17.1 (3.9)	.497
	Total	100	19 (4.4)	-

Table 11: Treatment modalities used in CCS against FBS, IGF and BMI in the current study cancer survivors distributed according to the modality of treatment against FBS,IGF and BMI.

The FBS was significantly higher in all types of treatment group compare with control (p-value <0.05), while IGF affected only (P = 0.002) in the group treated by chemotherapy + radiotherapy + surgery. BMI did not show any correlation among the different types of treatment (p-value >0.05).

		N	**Mean (SD)**	**P-value**
	Control	50	102 (13)	-
	chemotherapy alone	24	109 (11)	0.127

SysBP	chemo+radio+surg.	8	103 (9)	1
	chemo+surg.	18	99 (15)	1
	Total	100	103 (13)	-
DiasBP	Control	50	66 (10)	-
	chemotherapy alone	24	70 (11)	0.613
	chemo+radio+surg.	8	65 (9)	1
	chemo+surg.	18	63 (10)	1
	Total	100	66 (10)	-

Table 12: Treatment modalities used in Childhood cancer survivors against Blood pressure in the current study. In this table we found no correlation between different types of modality.

Discussion

In this study there was significant difference in lipid profiles between cases and control group (p-value < 0.05),in comparison with control group serum cholesterol was significantly higher in ALL, HL, NHL, NB, GCT and EWG survivors ,whereas serum triglycerides were higher than control only in NHL survivors, the serum low desity lipoprotein of ALL, HL and NHL were significantly greater than survivors except in AML and Wilms tumor where the results were comparable to the control group(p-value >0.05). These results were in accordance with a study carried out by S. Morphata, et al., 2016 on survivors of ALL except they found STG also significantly raised in survivors and explained that by obesity and increase fatty tissue among survivors, in our study BMI between cases and control was nearly comparable, for that reason S.TG shows no significant difference [9].

Regarding blood sugar, we found significant increase in blood sugar among ALL patients in comparison with control group, FBS was normal in all subjects of control group, where 11 of cancer patients were prediabetic, those are divided between ALL, AML, HL, NHL, GCT and Ewing sarcoma. In similar to study carried out by S. Morphata, et al., 2016 who studied 76 ALL survivors and this was explained by the chemotherapeutic drugs that used in ALL which include L- asparginase and corticosteroids that interact with the metabolism of glucose and cause decrease in the secretion of insulin and insulin resistance, respectively [9].

In this study there were no significant difference in BMI between cases and control groups, 70% of cases and control groups were have normal BMI; 10% of both groups were underweight; and only one of control and 2 of survivors of ALL were obese. The result was in similar with that of a study carried out by M Van Waas, 2010. They investigated 500 cancer survivors and they found that BMI did not changed significantly compared to control group [10]. In contrast to this study, a review article carried out by M Van was 2010 on survivors of cancer who are more than 18 years' age. They found significant increase in BMI among ALL survivors especially those treated with cranial radiotherapy and this was explained by deficiency of growth hormones which result from hypothalamic pituitary axis damage [1]]. A possible explanation for this difference is that BMI does not represent exactly the distribution of body fat, so we should measure the abdominal obesity by measurement of waist circumference for more accurate identification of abdominal obesity.

Regarding blood pressure, we found no significant difference in systolic and diastolic blood pressure between cases and control groups (P-value >0.05), most of them were within normal value, 10% of both groups were prehypertensive and one case from control, ALL, NHL and 3 of HL were hypertensive. Susanna 2012, compared the blood pressure of 68 ALL survivors with an equivalent control group. In contrast to our study, they found significant increase in systolic and diastolic blood pressure among survivors of ALL and this was explained by high BMI among patients treated with cranial radiotherapy [12]. Similar results obtained by Gunn, et al., 2016 who found that hypertension and obesity were common in 276 cancer survivors [13]. In our study the result of blood pressure can be explained by the normal result of BMI.

Conclusion

Number of cancer survivors are increasing as a result of earlier detection and more effective and intensive treatment strategies. Childhood cancer survivors are at more risk of late development of one or more component of metabolic syndrome. The late effect of chemotherapy and radiotherapy need to be considered seriously for all cancer survivors. These late effects might include:

defect in hormone synthesis, hormone resistance, altering lipid profile, endothelial damage, cardiovascular effect and increase body weight. Considering the important role of the liver in carbohydrate, lipid and insulin metabolism one should speculate that the evolution of metabolic syndrome may be partly related to the hepatotoxic effect of the chemotherapy used to treat childhood malignancies.

Conflict of Interests

The authors have no conflict of interest to declare.

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