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Universal screening program for lipid disorders in 2–10 years old Lebanese children: A new approach

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ABSTRACT

Introduction: Dyslipidemia has been recognized as a risk factor for cardiovascular diseases. Studies have showed that the development of atherosclerotic lesions begins in childhood and progresses throughout life. While the prevalence of dyslipidemia in adults has been reported to be 10 times higher in Lebanon compared to Western countries, data on the prevalence of dyslipidemic children in Lebanon is lacking.
Objectives: This study was conducted to assess the benefit of a protocol for universal screening for lipid disorders in Lebanese children aged between two and ten years old.
Materials and methods: A total of four hundred children aged 2–10 years old (51.5% boys) were included in the study. The subjects were recruited from private pediatric clinics after parental consent. Fasting total cholesterol (TC), triglycerides (TG), low density lipoprotein (LDL), high density lipoprotein (HDL) levels were measured and non-HDL cholesterol was calculated. The values were categorized according to 2011 Expert Panel on Integrated Guidelines for Cardiovascular Health and Risk Reduction in Children and Adolescents.
Results: The overall prevalence of high TC (≥200 mg/dL), high non-HDL-C (≥145 mg/dL), high LDL (≥130 mg/dL), high TG (≥100 mg/dL) and low HDL (<40 mg/dL) was respectively 19.5%, 23%, 19%, 31.8% and 20%. The overall frequency of dyslipidemia was 51.7%. In a bivariate analysis, dyslipidemia in children was associated with a BMI ≥95th percentile and parents having TC > 240 mg/dL with a P value respectively of .006 and .0001. Furthermore, high TG was independently associated with a BMI ≥95th percentile ($P = .0001$). Children with parents having TC > 240 mg/dL was significantly correlated with high TC, high non-HDL-C and high LDL ($P = .0001$ for all variables). Finally, according to the Pediatric Dyslipidemia Screening Guidelines from the 2011 Expert Panel, 62.3% of dyslipidemic children had at least 1 risk factor that qualified them for screening while 37.7% of them didn't have any risk factor.
Conclusions: It is preferable to review the latest pediatric dyslipidemia screening guidelines by performing a universal screening program since a third of our dyslipidemic Lebanese children will be missed.

1. Introduction

Elevated total cholesterol (TC), elevated low-density lipoprotein cholesterol (LDL-C), elevated non-high-density lipoprotein cholesterol (non-HDL-C), high triglycerides (TG) and low high-density lipoprotein cholesterol (HDL-C) are all suggesting of dyslipidemia that are lipid metabolism disorder [1,2]. Lipid serum levels abnormalities, including overproduction or deficiency, have been recognized as an independent risk factor in the progression of cardiovascular disease (CVD) [3]. Nearly all of the clinical impacts of cardiovascular disease take place in middle aged persons. Yet, studies in the previous four decades have more and more indicated that the development of atherosclerotic lesions begins in childhood

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and progresses all over the lifetime [1,3,4].

High plasma concentrations of lipids, particularly cholesterol, are associated with a causal relationship to the pathogenesis of atherosclerosis, the process responsible for most cardiovascular diseases that include coronary, peripheral cerebrovascular and vascular diseases. Cardiovascular diseases are the leading cause of death in France and the United Kingdom: about one quarter of deaths (more in women than in men) are attributable to coronary heart disease [5]. Most affected subjects are under 60 years of age. Effective management of hypercholesterolemia and other risk factors has demonstrated all its benefits in reducing cardiovascular mortality [2,6,7].

According to the World Health Organization (WHO), the leading cause of death worldwide is ischemic heart disease followed by stroke. They announced that in 2015, 8.75 million deaths were due to heart disease and 6.24 million deaths were due to stroke. That's why dyslipidemia in children is a very important subject to deal with.

1.1. Epidemiology

There are no available data on the prevalence of dyslipidemic children in Lebanon [8].The predictable prevalence of familial hypercholesterolemia (FH) differs significantly among studies [9].We estimated around 20% of worldwide children who have lipid disorders and the majority of them are not diagnosed [10].

According to the National Health and Nutrition Examination Surveys (NHANES) study who included 36 949 subjects, the estimated prevalence of FH in US adults was 0.40%, or a prevalence of 1 in 250 while the reported prevalence was 1 in 500 persons [9,11]. The NHANES study also reported that 50% of those with familial hypercholesterolemia had a personal or family history of early cardio vascular event and 80% of them were under pharmacological management [11,12].

1.2. Atherosclerosis in the pediatric population

Lipid disorders usually start in infancy and teenage years and remain until adult life [1]. While the clinical symptoms of atherosclerosis manifest in adulthood, some studies such as the Bogalusa Heart study and the Pathobiological Determinants of Atherosclerosis in Youth (PDAY) study, showed that fatty streaks are present in the aorta from the first decade and in the coronary arteries by the second decade [13]. So hyperlipidemia in children is associated to early atherosclerosis, and eventually to early CVD [1,13].

Some studies demonstrate that the process of atherosclerosis initiate in early life like the autopsy studies proving the presence of atherosclerotic lesions in the pediatric population and some other indirect studies [4,13]. The relationship among adult cardiovascular risk factors and early atherosclerosis was also revealed by these studies [13].

1.2.1. The Bogalusa Heart study

The investigators made autopsies on 204 young people aged between 2 and 39 years old who have died from non-cardiac causes, especially traumatic etiologies, to evaluate the presence of atherosclerotic lesion in asymptomatic young people [4,13–15]. They confirmed the presence of fatty streaks in 50% of people aged between two and fifteen years old and in 85% of cases aged 21–39 years old [15]. So the degree of arterial wall surface covered with fatty streak increased with age [4,14].

1.2.2. The PDAY study

The investigators made autopsies on 2876 people, aged between 15 and 34 years old, who died mainly from trauma or suicide. [4,13,16,17]They studied the association between CVD risk factors measured at the time of autopsy and the degree of fatty streaks and fibrous plaques in the aortic artery and the right coronary artery in adolescents and young adults, and establish an association between the severity of atherosclerotic lesions and the elevated number of conventional risk factors [16,17].

1.2.3. The muscatine study

It is a noninvasive, indirect study made on 725 adults aged between 33 and 42 years old who correspond to a group followed from the time when they were children [18]. The investigators evaluated Carotid Intimal Medial Thickness (CIMT) using ultrasonography. The carotid intimal medial thickness has been validated as a marker of the atherosclerotic progression in adult [4,18].

1.3. Lipid profile indications in children

It is documented that we could neglect up to 36% of children who are dyslipidemic if we only screen subject with a positive family history, so we needed a precise guideline on how to screen these children [1,3]. The United State National Heart Lung and Blood institute (NHLBI) set up guidelines that suggested screening for kids for lipid disorders according to their ages [1]. In this study, we will focus on specific ages for the screening.

-Between 2 and 8 years old: we should only do a selective screening for children with risk factors for early cardiovascular disease. A fasting lipid profile (FLP) is the ideal primary screening test.

According to the data from NHANES the difference between nonfasting and fasting lipid measurements is minimal so the screening test could be done with a non FLP but the decision upon starting treatment with a lowering agent must be based on a FLP [11].

2. The study

There is a significant correlation between CVD predisposing factors and high level of TC, LDL, TG and low level of HDL-C. While the prevalence of dyslipidemia in adults has been reported to be 10 times higher in Lebanon compared to Western countries, data on the prevalence of dyslipidemic children in Lebanon is lacking [3,8]. After reviewing previous research, the United State National Heart Lung, and Blood institute (NHLBI) expert panel established guidelines that recommend selective screening for children between two and ten years old for lipid disorders in only those with a positive history of some risk factors [19].

2.1. Objectives

This study was conducted to assess the benefit of a protocol for universal screening for lipid disorders in Lebanese children aged between two and ten years old.

2.2. Methods and materials

This study is a descriptive study including several variable such as age, sex, BMI≥95th percentile, passive smoking, child with known dyslipidemia, parents with TC > 240 mg/dL, first or/and second degree parents with premature coronary artery disease or equivalent, parents with diabetes mellitus, parents with hypertension.

The study was conducted from August 2015 to December 2017 after approval from the hospital's ethics committee.

2.3. Data acquisition

A total of four hundred children aged 2–10 years old were

included in the study. These subjects were recruited from private pediatric clinics after parental consent during regular visit. Pediatricians were asked to fill a questionnaire for consenting parents. Weight and height were measured and BMI was calculated using the calculator provided by the Centers for Disease Control and Prevention (CDC) that provided the BMI-for age percentile on a CDC BMI-for-age growth chart. A 12 h fasting total cholesterol, triglycerides, LDL, HDL levels were measured using enzymatic photometric test or enzymatic color test and non-HDL cholesterol was calculated. The values were categorized according to "2011 Expert on Integrated Guidelines for Cardiovascular Health and Risk Reduction in Children and Adolescents" [1]; the levels of lipid were categorized into three groups, the high risk group was defined having a TC ≥ 200 mg/dL, TG ≥ 100 mg/dL for 2–9 years old and ≥130 mg/dL for the age of 10, LDL ≥130 mg/dL, non HDL-C ≥145 mg/dL, HDL <40 mg/dL, the borderline group was defined having TC between 170 and 199 mg/dL, TG 75–99 mg/dL for 2–9 years old and 90–129 mg/dL for the age of 10, LDL 110–129 mg/dL, non HDL-C 120–144 mg/dL, HDL 40–45 mg/dL, and the acceptable group was defined having TC < 170 mg/dL, TG < 75 mg/dL for 2–9 years old and <90 mg/dL for the age of 10, LDL <110 mg/dL, non HDL-C <120 mg/dL and HDL >45 mg/dL.

2.4. Statistical analysis

With a 95% confidence interval and a margin of error of 5%, the data were analyzed using Statistical Package for Social Science (SPSS) software version 22. The qualitative variables are expressed as a percentage and the quantitative variables values are expressed as an average ± Standard deviation. A value of $P < 0.05$ is considered significant. The descriptive statistics as well as the bivariate analysis of the study were calculated using the Student's test and the chi-square tests: Pearson Chi Square for parametric tests and Fisher Exact Test for nonparametric tests and for the analysis of risk factors for dyslipidemia in children.

3. Results

3.1. Descriptive study

The study recruited 400 children including 206 males (51.5%) and 194 females (48.5%). From this sample, 78 child were exposed to second hand smoking (19.5%), 45 had a BMI≥ 95th Percentile (11.3%), 21 with known dyslipidemia (5.3%), 77 having parents with TC > 240 mg/dL (19.3%),9 having a first degree parents with premature coronary artery disease or equivalent (2.3%), 21 having a second degree parents with premature coronary artery disease or equivalent (5.3%),29 having a first or/and second degree parents with premature coronary artery disease or equivalent (7.2%), 24 having parents with diabetes mellitus (6%), 15 having parents with hypertension (3.8%) and 201 Children with criteria that qualify them for screening (50.2%).

The overall prevalence of high TC, high non-HDL-C, high LDL, high TG and low HDL was respectively 19.5%, 23%, 19%, 31.8% and 20%. The overall prevalence of borderline-high TC, non-HDL-C, LDL, TG and low HDL was respectively 47%, 44.8%, 36%, 53.3% and 37%.

3.2. Distribution of dyslipidemia according to age groups

In the borderline high risk group, the overall frequency of dyslipidemia was 77.3% and the highest frequency of dyslipidemia was found at 10 years old (17.8%) while in the high risk group overall frequency of dyslipidemia was 51.7% and the highest frequency of dyslipidemia was found at the age of 6 (15.9%) (Figs. 1–2).

3.3. The bivariate analysis in the borderline high risk group

In a bivariate analysis of the borderline high risk group, dyslipidemia in children was associated with a BMI ≥95th percentile, with female gender and with parents having TC > 240 mg/dL with a *P* value respectively of .006, .029 and .0001 (Table 1).

Furthermore, according to the Pediatric Dyslipidemia Screening Guidelines from the 2011 Expert Panel, in the borderline high risk group 57.6% of dyslipidemic children had at least 1 risk factor that qualified them for screening while 42.4% of them didn't have any risk factor and was significant with a *P* value of .0001. Children qualified for screening has higher frequency of dyslipidemia compared to those not qualified for screening and this is a big percentage of missed children (Table 2).

Additionally, in the borderline high risk group, high TG was independently associated with a BMI ≥ 95th percentile ($P = .0001$) (Table 3).Children with parents having TC > 240 mg/dL was significantly correlated with high TC, high non-HDL-C and high LDL ($P = 0.0001$ for all variables) (Table 4). There was a significant gender difference and females had a more significantly elevated TC ($P = 0.049$) and elevated non-HDL-C ($P = 0.040$). (Table 5).

In the borderline high risk group, children not qualified for screening had a significant correlation with an elevated TC, high non-HDL-C, high TG with a P value of .0001 and with high LDL with a *P* value of .002 (Table 6).

3.4. The bivariate analysis in the high risk group

In a bivariate analysis of the high risk group, dyslipidemia in children was associated with a BMI ≥95th percentile and with parents having TC > 240 mg/dL with a P value respectively of .006 and .0001 (Table 7).

Furthermore, according to the Pediatric Dyslipidemia Screening Guidelines from the 2011 Expert Panel, in the high risk group 62.3% of dyslipidemic children had at least 1 risk factor that qualified them for screening while 37.7% of them didn't have any risk factor and was significant with a *P* value of .0001. Also in the high risk group, children qualified for screening had higher frequency of dyslipidemia compared to those not qualified for screening and this is percentage of is a big percentage of missed children (Table 8).

Additionally, in the high risk group, high TG was independently associated with a BMI ≥ 95th percentile ($P = .0001$) (Table 9).Children with parents having TC > 240 mg/dL was significantly correlated with high TC, high non-HDL-C and high LDL ($P = .0001$ for all variables) (Table 10).

In the high risk group, children not qualified for screening had a significant correlation with an elevated TC, high non-HDL-C, high TG high LDL with a P value of .0001 for all variables (Table 11).

4. Discussion

According to a systemic review made by Don P. Wilson published on May 2015 on universal cholesterol screening during youth, supplementary approaches are needed to improve screening quality and especially because of the association between high lipid level and the prevalence of premature coronary artery disease [20]. In this study the overall prevalence of borderline high dyslipidemia was 77.3% which is significantly higher compared to Mexican children (54.3%) [21]. We reported in the high risk group in our study, 51.7% of dyslipidemic children and this percentage were significantly higher compared to the United State of America (USA) children (20% of children belong to high risk group in USA) [1].

Furthermore the prevalence of particular lipid abnormality in the borderline high risk group in our study was, 47% for TC, 44.8% for non-HDL-C, 36% for LDL, 53.3% for TG and 37% for HDL. While

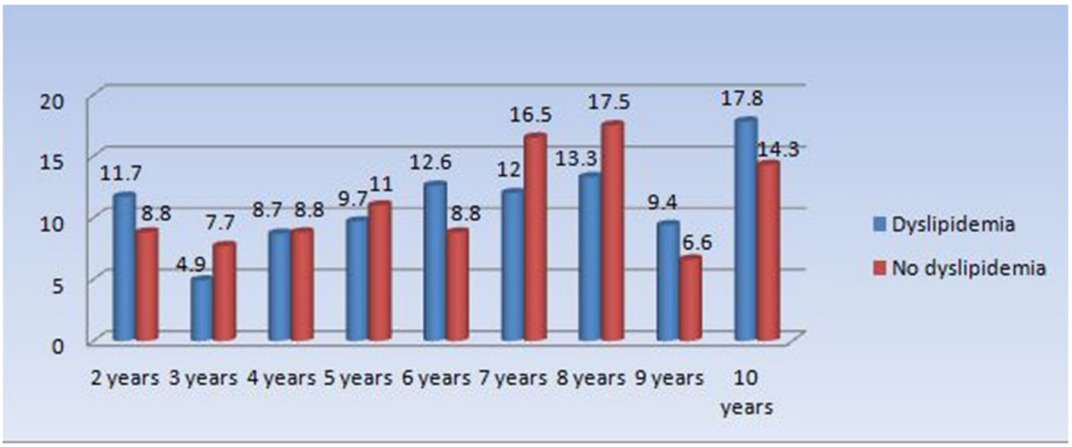

Fig. 1. Percentage of dyslipidemic and non-dyslipidemic children by age groups in the borderline high risk group.

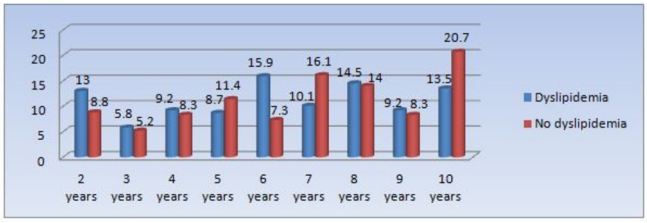

Fig. 2. Percentage of dyslipidemic and non-dyslipidemic children by age groups in the high risk group.

While the prevalence in USA children were reported as follow, 8% for TC, 12% for non-HDL-C, 7% for LDL, 12% for TG and 15% for HDL [1]. We can find that in Lebanon we have higher prevalence of all lipids, which might be due to genetic predisposition and to bad dietary.

In the borderline high risk group and the high risk group, BMI≥95th percentile and parents having TC > 240 mg/dL were significantly associated to dyslipidemia with a *P* value respectively of .006 and .0001. BMI≥95th percentile was significantly correlated to abnormal level of TG in both groups with a P value of .0001 similar to the study made by Marie-Hélène Gannagé-Yared on 2016 that confirmed the association between obesity and high level of TG [8]. Children with parents having TC > 240 mg/dL was significantly correlated with high TC, high non-HDL-C and high LDL (*P* = .0001 for all variables) in both groups, this confirms the genetic predisposition to dyslipidemia in the Lebanese population.

In addition, according to the Pediatric Dyslipidemia Screening Guidelines from the 2011 Expert Panel, in the borderline high risk group and in the high risk group, respectively 42.4% and 37.7% of dyslipidemic children didn't have any risk factor that qualify them

Table 1
Bivariate analysis of the variables included in the study (according to the borderline high risk group.

Independents variables		Dyslipidemia *Percentage (numbers)*	No dyslipidemia *Percentage (numbers)*	*P* value
Genre	Male	48.5 (150)	61.5 (56)	.029*
	Female	51.5 (159)	38.5 (35)	
Passive smoking	Yes	20.4 (63)	16.5 (15)	.409
	No	79.6 (246)	83.5 (76)	
BMI≥ 95th percentile	Yes	13.6 (42)	3.3 (3)	.006*
	No	86.4 (267)	96.7 (88)	
Parents having TC > 240 mg/dL	Yes	22.7 (70)	7.7 (7)	.001*
	No	77.3 (239)	92.3 (84)	
First degree parents with premature coronary artery disease or equivalent	Yes	2.3 (7)	2.2 (2)	.97
	No	97.7 (302)	97.8 (89)	
Second degree parents with premature coronary artery disease or equivalent	Yes	6.1 (19)	2.2 (2)	.137
	No	93.9 (290)	97.8 (89)	
First or/and second degree parents with premature coronary artery disease or equivalent	Yes	8.1 (25)	4.4 (4)	.232
	No	91.9 (284)	95.6 (87)	
Parents with diabetes	Yes	5.8 (18)	6.6 (6)	.786
	No	94.2 (291)	93.4 (85)	
Parents with hypertension	Yes	3.6 (11)	4.4 (4)	.712
	No	96.4 (298)	95.6 (87)	

Qualitative variables are expressed as a percentage and quantitative variables in (brackets) as average ± Standard deviation.
* Indicates a significant difference between the two groups with a value of $P < 0.05$.

the prevalence in Mexican children were reported as follow, 43.5% for TC, 44.1% for non-HDL-C, 29.9% for LDL, 63% for TG and 46.3% for HDL [21]. In Lebanon we have higher TC, higher non HDL-C and higher LDL but lesser TG. Additionally the prevalence of particular lipid abnormality in the high risk group in our study was, 19.5% for TC, 23% for non-HDL-C, 19% for LDL, 31.8% for TG and 20% for HDL.

Table 2
Bivariate analysis of children qualified for screening in the borderline high risk group.

Independents variables		Dyslipidemia *Percentage (numbers)*	No dyslipidemia *Percentage (numbers)*	*P* value
children qualified for screening	Yes	57.6 (178)	25.3 (23)	.0001*
	No	42.4 (131)	74.7 (68)	

* Indicates a significant difference between the two groups with a value of $P < .05$.

Table 3
Bivariate analysis of BMI in the borderline high risk group.

Independents variables		BMI ≥95th percentile *Percentage (numbers)*	BMI < 95th percentile *Percentage (numbers)*	*P* value
Total cholesterol *(mg/dL)*	<170	48.9 (22)	53.5 (190)	.558
	≥170	51.1 (23)	46.5 (165)	
HDL *(mg/dL)*	<40	26.7 (12)	19.2 (68)	.235
	≥40	73.3 (33)	80.8 (287)	
Non-HDL-C *(mg/dL)*	<120	44.4 (20)	56.6 (201)	.122
	≥120	55.6 (25)	43.4 (154)	
LDL *(mg/dL)*	<110	71.1 (32)	63.1 (224)	.291
	≥110	28.9 (13)	36.9 (131)	
TG *(mg/dL)*	<75	15.6 (7)	50.7 (180	.0001*
	≥75	84.4 (38)	49.3 (175)	

* Indicates a significant difference between the two groups with a value of $P < .05$.

Table 4
Bivariate analysis of parents high TC in the borderline high risk group.

Independents variables		Parents with TC > 240 *Percentage (numbers)*	Parents with TC ≤ 240 *Percentage (numbers)*	*P* Value
Total Cholesterol *(mg/dL)*	<170	31.5 (25)	57.9 (187)	.0001*
	≥170	67.5 (52)	41.1 (136)	
HDL *(mg/dL)*	<40	24.7 (19)	18.9 (61)	.254
	≥40	75.3 (58)	81.1 (262)	
Non-HDL-C *(mg/dL)*	<120	31.2 (24)	61 (197)	.0001*
	≥120	68.8 (53)	39 (126)	
LDL *(mg/dL)*	<110	41.6 (32)	69.3 (224)	.0001*
	≥110	58.4 (45)	30.7 (99)	
TG *(mg/dL)*	<75	39 (30)	48.6 (157)	.127
	≥75	61 (47)	51.4 (166)	

* Indicates a significant difference between the two groups with a value of $P < .05$.

Table 5
Bivariate analysis of gender in the borderline high risk group.

Variables independents		Male *Percentage (numbers)*	Female *Percentage (numbers)*	*P* value
Total Cholesterol *(mg/dL)*	<170	57.8 (119)	47.9 (93)	.049*
	≥170	42.2 (87)	52.1 (101)	
HDL *(mg/dL)*	<40	18 (37)	22.2 (43)	.294
	≥40	82 (169)	77.8 (151)	
Non-HDL-C *(mg/dL)*	<120	60.2 (124)	97 (50)	.040*
	≥120	39.8 (82)	97 (50)	
LDL *(mg/dL)*	<110	67 (138)	60.8 (118)	.199
	≥110	68 (33)	39.2 (76)	
TG *(mg/dL)*	<75	49.5 (102)	43.8 (85)	.253
	≥75	50.5 (104)	56.2 (109)	

* Indicates a significant difference between the two groups with a value of $P < .05$.

for screening. This means that we are missing above a third of our dyslipidemic Lebanese children (Fig. 3).

Finally because the highest frequency of dyslipidemic children was found at the age of 10 in the borderline high risk group and at the age of 6 in the high risk group, it is advised to repeat the screening of our previously screened non dyslipidemic children at 6 and at 10 years old.

4.1. Limitations of the study

Our study was limited by the small sample size and also by the small age of children's parents so the manifestations of atherosclerosis did not became clinically evident and we considered them not having premature coronary artery disease or equivalent while they might have it in the future.

Table 6
Bivariate analysis of children qualified for screening in the borderline high risk group.

Independents variables		Qualified for screening *Percentage (numbers)*	Not qualified for screening *Percentage (numbers)*	*P* value
Total cholesterol *(mg/dL)*	<170	40.8 (82)	65.3 (130)	.0001*
	≥170	59.2 (119)	34.7 (69)	
HDL *(mg/dL)*	<40	23.9 (48)	16.1 (32)	.051
	≥40	76.1 (153)	83.9 (167)	
Non HDL *(mg/dL)*	<120	44.3 (89)	66.3 (132)	.0001*
	≥120	55.7 (112)	33.7 (67)	
LDL *(mg/dL)*	<110	56.7 (114)	71.4 (142)	.002*
	≥110	43.3 (87)	28.6 (57)	
TG *(mg/dL)*	<75	36.3 (73)	57.3 (114)	.0001*
	≥75	63.7 (128)	42.7 (85)	

* Indicates a significant difference between the two groups with a value of $P < .05$.

Table 7
Bivariate analysis of the variables included in the study (according to the high risk group).

Independents variables		Dyslipidemia *Percentage (numbers)*	No dyslipidemia *Percentage (numbers)*	*P* value
Genre	Male	48.3 (100)	54.9 (106)	.186
	Female	51.7 (107)	45.1 (87)	
Passive smoking	Yes	17.9 (37)	21.2 (41)	.395
	No	82.1 (170)	78.8 (152)	
BMI≥ 95th percentile	Yes	15.5 (32)	6.7 (13)	.006*
	No	84.5 (175)	93.3 (180)	
Parents with TC > 240 mg/dL	Yes	27.1 (56)	10.9 (21)	.0001*
	No	72.9(151)	89.1 (172)	
First degree parents with premature coronary artery disease or equivalent	Yes	2.4 (5)	2.1 (4)	.817
	No	97.6 (202)	97.9 (189)	
Second degree parents with premature coronary artery disease or equivalent	Ye	6.3 (13)	4.1 (8)	.339
	No	93.7 (194)	95.9 (185)	
First or/and second degree parents with premature coronary artery disease or equivalent	Yes	8.7 (18)	5.7 (11)	.248
	Non	91.3 (189)	94.3 (182)	
Parents with diabetes	Yes	5.8 (12)	6.2 (12)	.86
	Non	94.2 (195)	93.8 (181)	
Parents with hypertension	Yes	3.9 (8)	3.6 (7)	.9
	Non	96.1 (199)	96.4 (186)	

* Indicates a significant difference between the two groups with a value of $P < .05$.

Table 8
Bivariate analysis of children qualified for screening in the high risk group.

Independents variables		Dyslipidemia *Percentage (numbers)*	No dyslipidemia *Percentage (numbers)*	*P* value
Children qualified for screening	Yes	62.3 (129)	37.3 (72)	.0001*
	No	37.7 (78)	62.7 (121)	

* Indicates a significant difference between the two groups with a value of $P < .05$.

Table 9
Bivariate analysis of BMI in the high risk group.

Independents variables		BMI ≥95th percentile *Percentage (numbers)*	BMI < 95th percentile *Percentage (numbers)*	*P* value
Total cholesterol *(mg/dL)*	<170	48.9 (22)	53.5 (190)	.815
	170–199	31.1 (14)	27(96)	
	≥200	20 (9)	19.4 (69)	
HDL *(mg/dL)*	<40	26.7 (12)	19.2 (68)	.215
	40–45	22.2 (10)	16.3 (58)	
	≥45	51.1 (23)	64.5 (229)	
Non HDL *(mg/dL)*	<120	44.4 (20)	56.6 (201)	.27
	120–144	28.9 (13)	20.8 (74)	
	≥145	26.7 (12)	22.5 (80)	
LDL *(mg/dL)*	<110	71.1 (32)	63.1 (224)	.183
	110–129	20 (9)	16.6 (59)	
	≥130	8.9 (4)	20.3 (72)	
TG *(mg/dL)*	<75	15.6 (7)	50.7 (180	.0001*
	75–99	24.4 (11)	21.1 (75)	
	≥100	60(27)	28.2(100)	

* Indicates a significant difference between the two groups with a value of $P < .05$.

Table 10
Bivariate analysis of parents high TC in the high risk group.

Independents variables		Parents with TC > 240 mg/dL *Percentage numbers)*	Parents with TC ≤ 240 mg/dL *Percentage (numbers)*	*P*value
Total cholesterol *(mg/dL)*	<170	31.5 (25)	57.9(187)	.0001*
	170–199	27.3 (21)	27.6 (89)	
	≥200	40.3 (31)	14.6 (47)	
HDL *(mg/dL)*	<40	24.7 (19)	18.9 (61)	.469
	40–45	14.3 (11)	17.6 (57)	
	≥45	61 (47)	63.5 (205	
Non HDL *(mg/dL)*	<120	31.2 (24)	61 (197)	.0001*
	120–144	24.7 (19)	21.1 (68)	
	≥145	44.2 (34)	18 (58)	
LDL *(mg/dL)*	<110	41.6 (32)	69.3 (224)	.0001*
	110–129	16.9 (13)	17 (55)	
	≥130	41.6 (32)	13.6 (44)	
TG *(mg/dL)*	<75	39 (30)	48.6 (157)	.245
	75–99	22.1 (17)	21.4 (69)	
	≥100	39 (30)	30 (97)	

* Indicates a significant difference between the two groups with a value of $P < .05$.

Table 11
Bivariate analysis of children qualified for screening in the high risk group.

Independentsvariables		Qualified for screening *Percentage (numbers)*	Not qualified for screening *Percentage (numbers)*	*P* value
Total cholesterol *(mg/dL)*	<170	40.8 (82)	65.3 (130)	.0001*
	170–199	30.8 (62)	24.1 (48)	
	≥200	28.4 (57)	10.6 (21)	
HDL *(mg/dL)*	<40	23.9 (48)	16.1 (32)	.07
	40–45	18.4 (37)	15.6 (31)	
	≥45	57.7 (116)	68.3 (136)	
Non HDL *(mg/dL)*	<120	44.3 (89)	66.3 (132)	.0001*
	120–144	22.4 (45)	21.1 (42)	
	≥145	33.3 (67)	12.6 (25)	
LDL *(mg/dL)*	<110	56.7 (114)	71.4 (142)	.0001*
	110–129	16.4 (33)	17.6 (35)	
	≥130	26.9 (54)	11.1 (22)	
TG *(mg/dL)*	<75	36.3 (73)	57.3 (114)	.0001*
	75–99	23.4 (47)	19.6 (39)	
	≥100	40.3 (81)	23.1 (46)	

* Indicates a significant difference between the two groups with a value of $P < .05$.

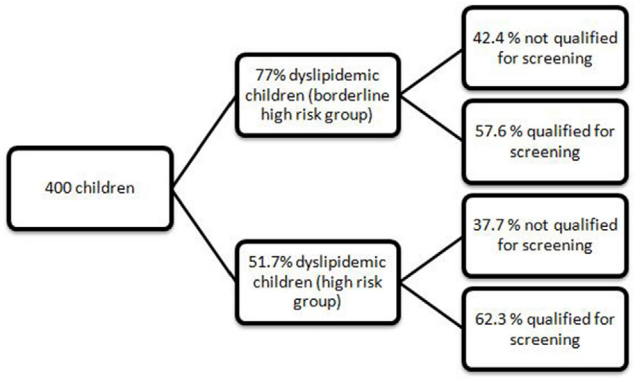

Fig. 3. Study flow diagram.

5. Conclusion

Because of the high prevalence of dyslipidemia in Lebanese children according to this study compared to other studies, it is preferable to review the latest pediatric dyslipidemia screening guidelines by performing a universal screening program since above third of our dyslipidemic Lebanese children will be missed. Dyslipidemia in this study was significantly associated to BMI≥95th percentile so it is advised to consider a healthier diet modification to decrease the progression of cardiovascular disease and the emergence of premature coronary artery disease in our population. It is estimated that increasing the sample size could lead to more significant results so it might be essential to increase our sample size in order to get a better estimation on the population.

Ethical statement

The study was conducted from August 2015 to December 2017 after approval of the hospital's ethics committee.

Author agreement

All authors have accepted the content of the manuscript.

Conflicts of interest

No conflict of interest is declared by all authors.

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