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Risk of obesity and elevated blood pressure in relation to the type of milk consumed by children and adolescents: The CASPIAN- IV study

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K E Y W O R D S: child, adolescent, milk, obesity, overweight, hypertension, pasteurization, non-communicable disease

ABSTRACT: Controversies exist on the association of dairy fat content with cardio-metabolic status. We aimed to explore the relationship of the type of consumed milk with body mass index (BMI) and blood pressure (BP) in a nationally representative sample of Iranian children and adolescents. This study was conducted on 14880 students, aged 6-18 years, selected by multistage random cluster sampling from 30 provinces of Iran. In addition to completing questionnaires on demographic characteristics and lifestyle habits, physical examination was conducted. The type of milk used by participants was categorized by two ways: i. as non-pasteurized milk (NPM), low-fat pasteurized and high-fat pasteurized milks (LFPM, HFPM) and ii. As high fat milk (HFM, which consisted of NPM+HFPM) and low fat milk (LFM).Three models of binary logistic regression test were applied. The study had a participation rate of 90.6%; 13,486 students (75.6% urban, 50.8% boys) with mean age (SD) of 12.47 (3.36) years completed the study. After adjusting for confounders, we found statistically significant decrease in the risk of overweight/obesity in consumers of NPM and HFPM in comparison to LFPM users and in HFM consumers in comparison to LFM users. We found increase in the risk of diastolic hypertension (HTN) only in HFPM consumers in comparison to LFPM users, respectively. However HFM showed non-significant relation to blood pressure status compared to LFM. Our findings propose that in relation to cardio-metabolic risk, the quality of fat in milk (intact natural or un-intact) might be more important than the amount of fat.

Introduction

Dairy foods are valuable and healthy sources of nutrients including proteins, fat, calcium, vitamin D, potassium, and magnesium. (Drouin-Chartier et al. 2014) A considerable body of evidence suggests that higher consumption of dairy foods might be related to better protection against obesity, hypertension (HTN) and diabetes.(Crichton et al. 2014, Warensjo et al. 2010, McGrane et al. 2011, Yuan et al. 2013, Grantham et al. 2013).The protective effect against obesity is documented regardless of the nutrient density provided by dairies (O'Sullivan et al. 2014) or the physical activity level.(Abreu et al. 2014) Most previous studies underscored the benefits of low fat dairy products.(McGrane et al. 2011, Soedamah-Muthu et al. 2012, Ralston et al. 2012) Consuming low-fat and no-fat dairy is also recommended as healthier choices in the dietary guidelines for Americans 2010 and its 2015 draft.(Dietary Guidelines for Americans 2010, Dietary Guidelines for Americans 2015) However some other researchers proposed that the suggested harmful effects of high fat content of dairies in relation to cardio-metabolic status need to be reassessed. A review of evidence did not confirm the association between intake of dairy products with increased risk of unfavorable cardiovascular events, regardless of the milk fat content.(Huth et al. 2012) Similarly, another study did not document the suggested unhealthy effects of saturated fat content of dairy products.(Astrup et al. 2014) Moreover some observational evidence suggests that high-fat dairy consumption is inversely associated with the risk of generalized (Kartz et al. 2013) and central obesity .(Holmberg et al. 2013)Most of these studies have been conducted in adult population, and limited experience exists in the pediatric age group. The current study aims to assess this relationship of the type of the consumed milk with excess weight and elevated blood pressure (BP) in a large national sample of Iranian children and adolescents.

Methods and materials

Methods

This nationwide study was conducted as part of a national surveillance program entitled Childhood and Adolescence Surveillance and PreventIon of Adult Non-communicable diseases (CASPIAN-IV) study. Detailed methodology is published (Kelishadi et al. 2013), and here we report the items related to the current study. It was performed in 2011-2012 in urban and rural areas of 30 provinces in Iran on a nationally- representative sample of 14880 students aged 6-18 years. They were selected by multistage random cluster sampling. Equal clusters sampling (480 in each province) with respect to gender (boy/girl), school grade (elementary/middle/high schools), and residence area (urban/rural) was done.

After obtaining informed consent from parents and verbal assent from students, demographic, physical activity (PA) level, screen time (ST), family, medical and infancy history and dietary data were gathered through a validated questionnaire by trained staff. The questionnaire was compiled with some modifications on the World Health Organization- Global School-based student Health Survey (WHO-GSHS) questionnaire. It was filled out by students under the supervision of staff and the presence of at least one parent. (Fallah et al. 2014)

Physical measurements

Trained health professionals measured anthropometric indexes according to standard protocols, using calibrated instruments. Anthropometric measures included height and weight, as well as circumferences of hip, waist and wrist. Then the waist- to- hip ratio (WHR) and waist- to- height ratio (WHtR), and body mass index (BMI) were calculated. BP was measured according to standard protocol (NHLBI Guideline 2004) using calibrated instruments. After enough rest, BP readings were taken twice from each person with 5 minutes interval. The readings at the first Korotkoff sound were considered as the systolic BP (SBP) and at the fifth sound as diastolic BP (DBP). The average of two measurements was recorded.

A supervisor and a team of external evaluators monitored performance, and checked and calibrated equipment according to standardized protocols.

Definitions

Hypertension (HTN) and obesity/overweight were defined according to the latest pediatric cut-points based on age-and gender-specific percentiles. Elevated BP was categorized as pre-HTN and HTN according to the Fourth Report of the working group on Blood Pressure Control in Children, commissioned by the National Heart, Lung and Blood Institute of the US National Institutes of Health. Pre-HTN was considered as either BP equal or greater than the age- and gender-specific 90^{th} percentile after adjusting for weight and height or as BP equal or more than 120/80 mmHg. When BP was equal or greater than the age- and gender-specific 95^{th} percentile value, it was considered as HTN. (NHLBI Guideline 2004)

BMI status was categorized according to the WHO reference curves, i.e. BMI between 85^{th} and 95^{th}percentile was considered as overweight, and levels equal or greater than 95^{th} percentiles obesity. (WHO 2006)

The types of cow milk with different fat content that are usually consumed by Iranian families were asked in the questionnaire. Milk types were categorized as low-fat and high-fat pasteurized milks (LFPM, HFPM), containing un-intact dairy fat, as well as non-pasteurized milk (NPM) type, containing whole natural dairy fat, which was used after boiling at home.

Irrespective of being pasteurized or not, the milk type was also categorized as low fat milk (LFM) and high fat milk (HFM) consisting of NPM and HFPM.

Ethical considerations

Relevant regulatory organizations and institutional review boards approved the study. After clear explanation about the study objectives and methods, written informed consent was obtained from parents and verbal assent from students. Data were handled confidentially and questionnaires were completed anonymously. Each subject could withdraw his/her consent at any time.

Statistical analysis

Dependent variables were elevated BP (consisting of pre-HTN and HTN) and elevated BMI (consisting of overweight and obesity). Binary logistic regression test was applied in three models. Model I: unadjusted univariate analysis, Model II: adjusted for confounder variables (gender, age, physical activity level, screen time, BMI for BP analysis, birth weight, milk type in infancy, family history of HTN, and frequency of other food groups consumed), and Model III: further adjusted for the frequency of dairy consumption. Statistical analyses were done using SPSS software (version 20:00, Chicago, IL, USA); $P<0.05$ was set as significance level.

Results

The study had a participation rate of 90.6% and 13,486 students (75.6% urban) completed the study. They consisted of 6846 boys and 6640 girls with mean (SD) age of 12.47 (3.36) years. Overall, 80.8% of participants used HFM

and 19.2% used LFM; 26.7%, 19.2% and 54.1% used NPM, LFPM and HFPM, respectively. Baseline characteristics of participants are presented in Table 1.

Findings according to consuming NPM and HFPM vs. LFPM

SBP showed no significant relationship with these type of milks (P=0.50). After adjusting for confounders, odds ratios (OR) resulted from logistic regression test revealed statistically significant decrease in the risk of overweight/obesity in consumers of NPM and HFPM in comparison to LFPM users: 0.29 decrease for NPM (OR=0.71[95% CI:0.62-0.81, P<0.001) and 0.18 for HFPM (OR=0.82[0.73-0.92],P<0.001). Girls consuming NPM had 0.32 decrease (OR=0.67[0.56-0.82], P=0.001) and those using HFPM had0.22 (OR=0.77[0.66-0.91], P=0.003) decreased risk of overweight/obesity. Only boys who consumed NPM revealed 0.25 (OR=0.74[0.61-0.90], P=0.002) decrease in this risk.

As presented in Table2, we found 0.40 (OR=1.39 [1.03, 1.87], P=0.03) and a borderline significant increase 0.30 (OR=1.30 [0.99, 1.71], P=0.05) in the risk of diastolic HTN and diastolic and/or systolic HTN only in HFPM consumers in comparison to LFPM users, respectively.

Findings according to consuming HFM vs. LFM

Adjusted Ors showed statistically significant decrease in the risk of overweight/obesity in users of HFM in comparison to LFM consumers: HFM showed 0.22 (OR=0.78[0.70, 0.87], P<0.001) decrease in this risk after adjusting for confounders. The decrease in this risk was greater in girls than in boys (25% (OR=0.74[0.63, 0.87], P<0.001) versus 17% (OR=0.82[0.70, 0.96], P=0.01)). HFM milk consumption showed no significant relation to SBP or DBP (Table 3).

Discussion

Our study revealed that consumption of HFM (pasteurized or non-pasteurized) had a protective effect against overweight/obesity with greater effect in girls. Meanwhile HFPM (and not NPM) increased the risk of diastolic HTN.

The favorable effects of dairy consumption on health are documented in many previous studies. (Lee 2014 et al. , Dror et al. 2014, Gopinath et al. 2014) In adult Koreans, high consumption of dairy products was associated with a lower prevalence of obesity.(Lee et al. 2014) In a systematic review and meta-analysis a neutral effect of dairy intake is shown on adiposity during early and middle childhood and a modestly protective effect in adolescence.(Dror et al. 2014) In Australia, it is shown that consumption of dairy products, particularly cheese, could have beneficial effects on BP of adolescents especially in girls.(Gopinath et al. 2014) In a study among Iranian adults, inverse association is reported between the frequency of dairy consumption and the prevalence of metabolic syndrome .(Azadbakht et al. 2005) However, such a protective effect was not seen in adolescents of the same population (Ghotboddin Mohammadi et al. 2015) and some other studies. In a 9- year- follow up study , dairy products intake was not associated with changes in BP among African Americans over time, though in whites higher intake of LFM was associated with lesser increases in BP.(Alonso 2009)A study among Azorean Portuguese adolescents found a protective association of dairy product intake with abdominal obesity only in boys .(Abreu et al. 2012)A systematic review on cohort studies concluded that the protective effect of dairy consumption on risk of overweight and obesity is suggestive but not consistent.(Louie et al. 2011) In a birth cohort in Hong Kong, no association was found between consumption of milk and other dairy products with adiposity. (Lin et al. 2012)

In addition most of the studies have focused on the use of low fat dairies. In a young non-hypertensive population in Spain, dietary supplementation with whole-fat dairy products, compared to low-fat dairy, was associated with weight gain and no effect was observed for levels of BP. (Alonso 2009) Our findings are almost contrary to this study, but they are consistent with the results of a study In Luxembourg, which showed that higher consumption of whole fat dairy foods may have the potential to lower the prevalence of global and abdominal obesity. (Crichton et al. 2014) Our findings are also in line with a trial in the Netherlands, which found low-fat dairy might have BP lowering effects. (van Meijl et al. 2011)

Such differences may originate from differences in the age group and sex of the participants, design of the studies, as well as the type of dairy consumed. For instance, a study in Iran suggested that the favorable effect of high- fat dairy depends on its type (fermented or non-fermented, fluid or solid).(Wang et al. 2011) Other researchers have emphasized on the types of dairy foods regarding their effects and focused on the synergy provided by the food matrix, rather than simply the component parts of the food. (Warensjo et al. 2010) Others have assessed the effect of chemicals of dairy fat and attributed the protective effects of dairy to some of its fatty acids. (Mirmiran et al. 2015) It seems that the association of cardio-metabolic status and quality/quantity of dairy fat, and its other components, deserves detailed research. The structure of fat may be affected by pasteurization as it is shown by some researchers about whey protein of milk.(Phoebe et al. 2015) Regarding the association of milk intake with cardio-metabolic risk, the quality of fat in milk (intact natural, un-intact) maybe more important than the amount of it.

In Conclusion, Our study on a large population-based sample, suggests protective effect for HFM (NPM plus HFPM) against obesity in the pediatric age group. Further analysis showed that this protection is more powerful for non-pasteurized whole fat milk than HFPM. Also the intake of HFPM increased the risk of diastolic HTN, whereas NPM showed greater protection against obesity, without significant effect on HTN. These new findings deserve more attention in the future studies.

Table1. Comparison of baseline characteristics of study participants according to the type of consumed milk: The CASPIAN-IV Study

		LFM(n=2589)	HFM(n=10897)		Total(n=13486)	P value of difference
		LFPM(n=2589)	HFPM(n=7566)	NPM(n=3601)		
Age (y)		12.54 (3.26)	12.62 (3.37)	12.15 (3.39)	12.48 (3.36)	<0.001
BMI (kg/m^2)		19.25 (4.59)	18.92 (4.40)	18.45 (4.29)	18.86 (4.41)	<0.001
SBP(mmHg)		102.26 (13.70)	101.84 (13.37)	100.35 (13.42)	101.52 (13.47)	<0.001
DBP (mmHg)		64.90 (11.16)	65.38 (11.51)	63.79 (11.36)	64.86 (11.42)	<0.001
Physical activity (score)		0.01 (1.00)	0.024 (1.00)	0.06 (0.98)	0.001 (1.00)	<0.001
Screen time (h)		1.47 (0.79)	1.46 (0.80)	1.32 (0.78)	1.42 (0.79)	<0.001
Age (y)	6-10	782 (18.2%)	2216 (51.6%)	1297 (30.2%)	4295(100.0%)	<0.001
	11-14	959 (20.6%)	2469 (53.1%)	1219 (26.2%)	4647(100.0%)	
	15-19	825 (18.6%)	2551 (57.7%)	1048 (23.7%)	4424(100.0%)	
	Total	2566 (19.2%)	7236 (54.1%)	3564 (26.7%)	13366(100.0%)	
Sex	Boy	1221 (18.0%)	3662 (54.1%)	1886 (27.9%)	6769 (100.0%)	<0.001
	Girl	1345 (20.4%)	3574 (54.2%)	1678 (25.4%)	6597 (100.0%)	
	Total	2566 (19.2%)	7236 (54.1%)	3564 (26.7%)	13366(100.0%)	
BMI category	Underweight	288 (18.0%)	897 (56.0%)	417 (26.0%)	1602 (100.0%)	<0.001
	Healthy weight	1603 (18.3%)	4723 (53.8%)	2446 (27.9%)	8772 (100.0%)	
	Overweight and obese	648 (22.8%)	1539 (54.1%)	658 (23.1%)	2845 (100.0%)	
	Total	2539 (19.2%)	7159 (54.2%)	3521 (26.6%)	13219(100.0%)	
SBP category	Normal	2515 (19.1%)	7112 (54.1%)	3514 (26.7%)	13141(100.0%)	0.674
	Pre-HTN and HTN	27 (22.1%)	65 (53.3%)	30 (24.6%)	122 (100.0%)	
	Total	2542 (19.2%)	7177 (54.1%)	3544 (26.7%)	13263(100.0%)	
DBP category	Normal	2470 (19.2%)	6900 (53.8%)	3465 (27.0%)	12835(100.0%)	<0.001
	Pre-HTN and HTN	67 (16.3%)	267 (65.0%)	77 (18.7%)	411 (100.0%)	
	Total	2537 (19.2%)	7167 (54.1%)	3542 (26.7%)	13246(100.0%)	
SBP and/or DBP category	Normal	2452 (19.2%)	6856 (53.8%)	3440 (27.0%)	12748(100.0%)	<0.001
	Pre-HTN and HTN	85 (17.0%)	312 (62.5%)	102 (20.4%)	499 (100.0%)	
	Total	2537 (19.2%)	7168 (54.1%)	3542 (26.7%)	13247(100.0%)	
Physical Activity level	Mild	877 (19.4%)	2524 (55.9%)	1113 (24.7%)	4514 (100.0%)	0.001
	moderate	941 (19.3%)	2610 (53.6%)	1320 (27.1%)	4871 (100.0%)	
	severe	725 (18.8%)	2032 (52.6%)	1107 (28.6%)	3864 (100.0%)	
	Total	2543 (19.2%)	7166 (54.1%)	3540 (26.7%)	13249(100.0%)	
screen time category	<=2hours	2033 (18.8%)	5776 (53.4%)	3004 (27.8%)	10813(100.0%)	<0.001
	>2 hours	522 (21.0%)	1411 (56.8%)	549 (22.1%)	2482 (100.0%)	
	Total	2555 (19.2%)	7187 (54.1%)	3553 (26.7%)	13295(100.0%)	
Infancy milk type	Breast milk	2059 (18.8%)	5905 (53.9%)	2986 (27.3%)	10950(100.0%)	0.001
	Any Milk other than breast milk	437 (21.3%)	1141 (55.6%)	474 (23.1%)	2052 (100.0%)	
	combined	51 (16.9%)	162 (53.8%)	88 (29.2%)	301 (100.0%)	
	Total	2547 (19.1%)	7208 (54.2%)	3548 (26.7%)	13303(100.0%)	
Milk consumption frequency	Seldom/never	492 (17.8%)	1512 (54.8%)	756 (27.4%)	2760 (100.0%)	0.02
	Weekly	840 (19.1%)	2341 (53.2%)	1222 (27.8%)	4403 (100.0%)	
	Daily	1220 (19.9%)	3336 (54.5%)	1563 (25.5%)	6119 (100.0%)	
	Total	2552 (19.2%)	7189 (54.1%)	3541 (26.7%)	13282(100.0%)	

*Values are expressed as mean (SD) for quantitative variables and frequencies (percent) for qualitative variables.

*BMI: Body Mass Index, SBP: Systolic Blood pressure, DBP: Diastolic Blood Pressure, HFM: high fat milk, LFM: low fat milk, LFPM: Low-Fat Pasteurized Milk, HFPM: High-fat pasteurized Milk, HTN: hypertension

Table 2. Univariate odds ratios and 95% confidence intervals for body mass index and blood pressure according to the three consumed milk types: The CASPIAN-IV Study

Sex	BMI / BP* status	Milk type*	P	Odds ratio Model I	P	Odds ratio Model II	P	Odds ratio Model III
Total	Overweight and obesity[1]	NPM	<0.0001	0.66 (0.58, 0.75)	<0.0001.	0.71 (0.62, 0.81)	<0.0001.	0.71 (0.62, 0.81)
		HFPM	<0.0001.	0.80 (0.72,0.89)	0.001	0.82 (0.73,0 .92)	0.001	0.82 (0.73, 0.92)
		LFPM	.	.	.	.	.	.
	Systolic Pre-HTN* and HTN[2]	NPM	0.39	0.79 (0.47, 1.34)	0.62	0.86 (0.48, 1.54)	0.62	0.86 (0.48, 1.54)
		HFPM	0.48	0.85 (0.54, 1.33)	0.50	0.84 (0.51, 1.38)	0.50	0.84 (0.51, 1.38)
		LFPM	.	.	.	.	.	.
	Diastolic Pre-HTN and HTN[3]	NPM	0.23	0.81 (0.58, 1.14)	0.40	0.85 (0.59, 1.23)	0.40	0.85 (0.59, 1.23)
		HFPM	0.01	1.42 (1.08, 1.87)	0.03	1.39 (1.03,1.87)	0.03	1.39 (1.03,1.87)
		LFPM	.	.	.	.	.	.
	Sys. and/or dias. Pre-HTN and HTN[4]	NPM	0.29	0.85 (0.63, 1.14)	0.43	0.88 (0.63, 1.21)	0.43	0.88 (0.63, 1.21)
		HFPM	0.02	1.31 (1.02, 1.67)	0.05	1.30 (0.99, 1.71)	0.05	1.30 (.99, 1.71)
		LFPM	.	.	.	.	.	.
Boys	Overweight and obesity[1]	NPM	<0.0001.	0.60 (0.55, 0.78)	0.00	0.74 (0.61, 0.90)	0.002	0.74 (0.61, 0.90)
		HFPM	0.01	0.82 (0.70, 0.95)	0.08	0.86 (0.73, 1.02)	0.08	0.86 (0.73, 1.02)
		LFPM						
	Systolic Pre-HTN and HTN[2]	NPM	0.72	0.88 (0.46, 1.69)	0.808	1.09 (0.53,0 .23)	0.80	1.09 (0.53, 2.23)
		HFPM	0.94	0.97 (0.55, 1.73)	0.736	0.89 (0.47, 1.69)	0.73	0.89 (0.47, 1.69)
		LFPM	.	.	.	.	.	.
	Diastolic Pre-HTN and HTN[3]	NPM	0.15	0.72 (0.46, 1.12)	0.17	0.70 (0.43, 1.16)	0.13	1.35 (0.91, 2.01)
		HFPM	0.03	1.47 (1.03, 2.11)	0.13	1.35 (0.91, 2.01)	0.17	0.70 (0.43, 1.16)
		LFPM	.	.	.	.	.	.
	Sys. and/or dias. Pre-HTN and HTN[4]	NPM	0.29	0.81 (0.55,1.19)	0.315	0.80 (0.52, 1.23)	0.31	0.80 (0.52, 1.23)
		HFPM	0.04	1.39 (1.01,1.92)	0.129	1.31 (0.92, 1.88)	0.12	1.31 (0.92, 1.88)
		LFPM	.	.	.	.	.	.
Girls	Overweight and obesity[1]	NPM	<0.0001.	0.65 (0.54,0.78)	<0.0001.	0.67 (0.56,0.82)	<0.0001.	0.67 (0.56,0.82)
		HFPM	0.001	0.781 (0.67,0 .90)	0.003	0.77 (0.66,0 .91)	0.003	0.79 (0.66,0.91)
		LFPM	.	.	.	.	.	.
	Systolic Pre-HTN and HTN[2]	NPM	0.23	0.57 (0.23, 1.43)	0.27	0.55 (0.19, 1.58)	0.27	0.55 (0.19, 1.58)
		HFPM	0.20	0.61 (0.28, 1.30)	0.45	0.72 (0.32, 1.65)	0.45	0.72 (0.32,1.65)
		LFPM	.	.	.	.	.	.
	Diastolic Pre-HTN	NPM	0.78	0.93 (0.56, 1.53)	0.31	1.82 (0.56, 5.86)	0.91	1.03 (0.60, 1.76)

and HTN[3]	HFPM	0.19	1.31	(0.86, 2.00)	0.75	1.21 (0.35, 4.15)	0.20	1.35 (0.85, 2.13)
	LFPM	.	.		.	.	.	.
Sys. and/or dias. Pre-HTN and HTN[4]	NPM	0.57	0.87	(0.50, 1.37)	0.90	0.97 (0.59, 1.58)	0.90	0.97 (0.59, 1.58)
	HFPM	0.43	1.16	(0.79, 1.69)	0.34	1.22 (080, 1.85)	0.34	1.22 (0.80, 1.85)
	LFPM	.	.		.	.	.	.

1: Normal BMI is reference group; 2: normal systolic blood pressure is reference group;3: normal diastolic blood pressure is reference group; 4: normal systolic and/or diastolic blood pressure is reference group

Model I: Crude model(unadjusted model)

Model II: Odds ratios are adjusted for age, sex, birth weight, screen viewing, physical activity, infant milk type, history of family blood pressure, food consumed(vegetable, bread and grain group, saturated fat, protein, full-fat dairy, free fat dairy ,and nuts)

ModelIII: Odds ratios are additionally adjusted for amount of Milk consumed* BMI: Body Mass Index, BP: Blood pressure, LFPM: Low-fat pasteurized milk, HFPM: High-fat pasteurized Milk, NPM: Nopasteurized milk, HTN: hypertension

Table 3. Univariate odds ratios and 95% confidence intervals for body mass index and blood pressure according to the two consumed milk t

IV Study

Sex	BMI /BP* status	Milk type*	P	Odds ratios Model I	P	Odds ratios Model II	P
Total	Overweight and obesity[1]	HFM	<0.0001.	0.75 (0.68, 0.84)	<0.0001.	0.78 (0.70, 0.87)	<0.0001.
		LFM	.	.	.	.	.
	Systolic Pre-HTN* and HTN[2]	HFM	0.40	0.83 (0.5, 1.28)	0.51	0.85 (0.53, 1.37)	0.50
		LFM	.	.	.	.	.
	Diastolic Pre-HTN and HTN[3]	HFM	0.13	1.22 (0.93, 1.59)	0.20	1.21 (0.90, 1.62)	0.18
		LFM	.	.	.	.	.
	Sys. and/or dias. Pre-HTN and HTN[4]	HFM	0.22	1.16 (0.91, 1.47)	0.25	1.16 (0.89, 1.51)	0.24
		LFM	.	.	.	.	.
Boys	Overweight and obesity[1]	HFM	<0.0001.	0.76 (0.66, 0.88)	0.01	0.82 (0.70, 0.96)	0.01
		LFM	.	.	.	.	.
	Systolic Pre-HTN and HTN[2]	HFM	0.84	0.94 (0.54, 1.63)	0.89	0.95 (0.52, 1.75)	0.88
		LFM	.	.	.	.	.
	Diastolic Pre-HTN and HTN[3]	HFM	0.27	1.21 (0.85, 1.72)	0.51	1.13 (0.77, 1.68)	0.491
		LFM	.	.	.	.	.
	Sys. and/or dias. Pre-HTN and HTN[4]	HFM	0.27	1.19 (0.87, 1.63)	0.44	1.147 (0.80, 1.62)	0.42
		LFM	.	.	.	.	.
Girls	Overweight and obesity[1]	HFM	<0.0001.	0.74 (0.64, 0.85)	<0.0001.	0.74 (0.64, 0.87)	<0.0001.
		LFM	.	.	.	.	.
	Systolic Pre-HTN and HTN[2]	HFM	0.15	0.60 (0.29, 1.22)	0.34	0.68 (0.31, 1.50)	0.32
		LFM	.	.	.	.	.
	Diastolic Pre-HTN and HTN[3]	HFM	0.39	1.19 (0.79, 1.79)	0.34	1.24 (0.79, 1.93)	0.33
		LFM	.	.	.	.	.
	Sys. and/or dias. Pre-HTN and HTN[4]	HFM	0.71	1.07 (0.74, 1.54)	0.52	1.13 (0.76, 1.70)	0.52
		LFM	.	.	.	.	.

1: Normal BMI is reference group; 2: normal systolic blood pressure is reference group;3: normal diastolic blood pressure is reference grou and/or diastolic blood pressure is reference group

Model1: crude model(unadjusted model)

Model2: odds ratios are adjusted for sex, age, PA level, Screen Time, BMI for Hypertension analysis, birth weight, infancy milk type, famil frequency of other food consumed such as vegetables, bread and grain group, fats, proteins, nuts

Model3: odds ratios are additionally adjusted for frequency of milk consumption.

* BMI: Body Mass Index, BP: Blood pressure, HFM: high fat milk, LFM: low fat milk, HTN: hypertension

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