Association Between Dairy and Ischemic Heart Disease Among Chinese Adult: A Prospective Study in Qingdao

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Abstract

Background

Previous studies linking dairy consumption with ischemic heart disease (IHD) are almost from western countries, few from China. The present study was to explore the relationship between dairy consumption and IHD among Chinese adults.

Methods

The data for the present study was from the prospective cohort study of China Kadoorie Biobank (CKB) in Qingdao, a total of 33,355 participants in the present study. An interviewer-administered laptop-based questionnaire was used to collect information on the consumption frequency of dairy, incident IHD cases were identified through Disease Surveillance Point System (DSPs) and the new national health insurance databases. Cox regression analyses were performed to estimate adjusted hazard ratios (HRs) and confidence interval (CI) for the relationship between the incidence of IHD and dairy consumption.

Results

The baseline survey reported that 32.4% of males and 34.6% of females consumed dairy regularly (i.e. ≥ 4 days/week). Over an average of 9.2 years follow-up, 2,712 new-onset IHD were documented. Compared with participants who never or rarely consume dairy, the hazard ratio (HR) of consumed dairy regularly was 0.85(0.73-0.98) for males ($P < 0.05$), while no significant benefits were identified for females.

Conclusions

In Chinese adults, regular dairy consumption had an inverse association to the onset of IHD only for males, while no similar association for females.

Introduction

IHD is the leading cause of death worldwide[1]. The number of death caused by IHD reached 9.14 million and the number of disability-adjusted life years (DALYs) reached 182.03 million in 2019[2]. In 2016, the IHD mortality rate ranked first, accounting for 40% of mortality in Chinese adults[3], which has become a serious public health issue[4]. IHD hospitalization rates annually increased 5.4% among the China Kadoorie Biobank(CKB) cohort study[5].

Most western countries dietary guidelines recommended intake low-fat milk in place of full-fat dairy (i.e. milk fat $> 3\%$)[6], while WHO recommended an intake of whole milk or dairy products (e.g. cheese) of 250g/day[7]. Dairy contains more saturated than unsaturated fat. Previous studies linked intake of full-fat dairy with increasing the risk of IHD[8]. It seems that low-fat dairy foods might be beneficial to high-fat dairy foods for health, but almost all the fat in the milk (i.e. butter or cream) remains in the human food supply. It has been reported that saturated fatty acids in dairy will increase the risk of IHD by affecting the content of low-density lipoproteins (LDL) or blood pressure [9-11], while saturated fatty acids in dairy do not adversely affect cholesterol levels[12, 13], which mainly came from western countries. However, Chinese adults consumed few dairy products (e.g. butter, cheese), the average intake of dairy products was 24.7 g/d in 2012[14], owing to lactose intolerance. The association between dairy and IHD risk has rarely been investigated among Chinese adults. The present study was to investigate the association between dairy consumption and the risk of IHD.

Materials And Methods

Study population

The participants of the present study came from the prospective survey of China Kadoorie Biobank (CKB) in Qingdao. Details of the study have been previously reported[15-17]. A total of 35,508 residents, aged 30-79 (born in 1930-1970), completed the baseline survey in 2004-2008. Participants that self-reported IHD (n=1827), stroke (n=238), cancer (n=162) at baseline survey was excluded, the final analysis included 33,355 participants.

The ethics board of the University of Oxford, and the National, Shandong Provincial and the Qingdao Centers for Disease Control and Prevention in China all approved this study. All the participants in the survey had signed written informed consent.

Data collection

The laptop-based questionnaire was completed by trained health works, including sociodemographic information (age, education, occupation, household income, marital status), lifestyle (alcohol consumption, smoking status), family history, dairy products, and other diet frequency (rice, wheat, other staple foods, red meat, poultry, fish, eggs, fresh fruit, fresh vegetables, soybean, and preserved vegetables) in last 12 months. The date on the frequency of dairy (e.g. milk, yogurt) consumption included 5 groups (never/rarely, 1-3 d/month, 1-3 d/week, 4-6 d/week, daily).

Physiological measurements include body weight, height, waist circumference (WC), blood pressure, random glucose, etc. Body mass index (BMI) was calculated as weight (kg) divided by height squared (m^2). For each individual, blood pressure was measured twice and taken as the average. A third measure was required if the blood pressure difference was more than 10 mm Hg between the first two measures, and take the average of the last two blood pressure values recorded. Random blood glucose levels were measured immediately following sample collection using the SureStep Plus System (Johnson & Johnson, New Brunswick, NJ, USA).

Follow-up for IHD and MCE

The primary outcome was the IHD (International Classification of Diseases-10 I20–I25) and MCE(major coronary event) incident, and IHD mortality. Which was ascertained through the Disease Surveillance Point System(DSPs) and the new national health insurance databases[18]. Participants were followed up from baseline until the date of IHD or MCE incidence, IHD mortality, loss to follow-up, or December 31, 2015, whichever came first.

Statistical Analysis

The series of characteristics of the participants were described with frequency (N) and percentages (%) according to categories of dairy consumption, using Student t-test for continuous variables and Chi-square test for categorical variables.

Multivariable Cox proportional hazards model was used to estimate the hazard ratio (HR) and 95% confidence interval (CI) of dairy consumption and IHD risk, which were adjusted for gender (male or female), age (continuous variable), education (below high school, high school and above), occupation, marital status, household income (<20,000 yuan or $\geq$ 20,000 yuan), diet frequency (egg, fresh vegetables, red meat, fresh fruit, poultry, soybean), smoking status (non-current smoking or current smoking), alcohol consumption (non-current drinking or current drinking), metabolic equivalent of task (MET), body mass index (BMI), systolic blood pressure (SBP), diastolic blood pressure (DBP), and random glucose (continuous variable), family history of myocardial infarction (MI).

All p values were two-sided, $p < 0.05$ was considered to be statistically significant. All analyses were performed using SPSS (version 25.0). All graphs were plotted using R 4.0.5 (<https://www.R-project.org/>).

Results

Characteristics of participants

Among the 33,355 participants, the mean (SD) age at baseline was 50.7 (10.0) years. 32.4% of male and 34.6% of female participants consumed dairy daily (Table 1). Participants that consumed dairy more frequently were female, more likely with higher education level, higher MET, lower blood pressure and lower BMI ($P < 0.05$) (Additional file 1:Supplementary Table S1).

Table 1
Baseline characteristics of participants by frequency of dairy consumption

Characteristics	Dairy consumption					Overall
	Never	Monthly	1-3 day/week	4-6 day/week	Daily	
Number of participants	10395	3555	6757	1446	11202	33355
Women (%)	55.6	52.3	53.7	56.6	56.8	55.3
Mean age (years)	51.8(9.6)	51.2(10.0)	49.5(9.6)	47.7(9.8)	50.6(10.5)	50.7(10.0)
High school and above (%)	26.1	35.8	41.2	49.8	41.6	36.4
Factory/Professional/sales (%)	50.4	55.4	61.2	69.8	58.7	56.7
Married (%)	92.0	92.5	94.6	94.9	92.7	92.9
Household income $\geq$ 20,000 (yuan) (%)	51.6	62.1	67.4	70.2	63.8	60.8
Regular food Consumption ^a (%)						
Eggs	47.5	43.2	41.2	40.0	66.0	51.7
Fresh fruit	47.5	41.3	50.4	50.1	67.3	54.2
Fresh vegetables	98.8	98.0	96.5	94.9	98.9	98.1
Soybean	6.8	4.9	4.6	6.4	9.9	7.2
Red meat	61.0	62.0	54.0	53.8	68.5	61.9
Poultry	1.3	1.7	3.9	2.1	1.9	2.1
Current drinking in men ^b (%)	53.7	45.4	43.7	47.0	48.8	48.8
Current smoking in men ^b (%)	65.6	58.6	54.2	54.1	57.2	59.2
MET (MET-hr/day)	15.2(10.1)	15.4(10.6)	17.0(10.9)	19.9(11.4)	17.6(10.1)	16.6(10.4)
BMI (Kg/m ²)	26.3(3.7)	25.9(3.7)	25.5(3.4)	25.0(3.4)	25.4(3.6)	25.7(3.6)
SBP (mmHg)	132.3(22.5)	130.4(21.5)	128.9(21.5)	126.3(19.8)	128.2(20.9)	129.7(21.6)
DBP (mmHg)	78.9(10.9)	77.8(11.1)	77.6(10.8)	76.5(10.5)	77.6(10.5)	77.6(10.8)
Random glucose ^c (mmol/L)	6.4(2.4)	6.4(2.9)	6.2(2.4)	6.0(2.1)	6.4(2.8)	6.3(2.6)

MET: exercise metabolic equivalent; BMI: Body Mass Index; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; MI: myocardial infarction; Values are either percentage or mean (SD)

^a Regular food consumption means consuming food products daily

^b In women, only 1.5% current drinking and 1.0% current smoking

^c 422 participants had missing values for random glucose

Characteristics	Dairy consumption					Overall
	Never	Monthly	1-3 day/week	4-6 day/week	Daily	
Family history of MI (%)	5.2	5.0	4.7	5.5	6.5	5.5
MET: exercise metabolic equivalent; BMI: Body Mass Index; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; MI: myocardial infarction; Values are either percentage or mean (SD)						
^a Regular food consumption means consuming food products daily						
^b In women, only 1.5% current drinking and 1.0% current smoking						
^c 422 participants had missing values for random glucose						

Association Between Dairy Consumption And Ihd (Dup: Abstract ?)

During an average of 9.2 years follow-up (305,655.5 person-years), a total of 2,712 incident IHD cases (1,075 males and 1,637 females) and 420 incident MCE cases (271 males and 149 females) were documented (Table 2), with an incidence of 887.3 (713.8 for male, and 892.0 for female) per 100,000 person-years. Multi-factor Cox regression was used to analyze the relationship between dairy consumption and the onset of IHD. After adjusting for major covariates, compared with participants who never or rarely consumed dairy, higher dairy intake had a natural effect on the incidence of IHD, MCE, and IHD mortality (Table 3, 4, and Additional file 1: Supplementary Table S2). While the inverse association was stronger in males than in females, and no statistically significant association was found between dairy consumption and IHD in females.

Table 2
IHD incident characteristics of participants according to age

Baseline age(y)	Incident age(y)	PYs	IHD incident	
			Cases	Cases/PYs(/100,000)
30~	49.5±3.2	113289.5	236	208.3
45~	59.0±3.1	110338.7	865	784.0
55~	67.7±3.4	52303.6	860	1644.2
65~79	77.3±3.7	29723.7	751	2526.6
All	63.6±9.2	305655.5	2712	887.3
HR: indicates hazard ratio; CI, confidence interval; PYs: Pearson years				

For males, dairy consumption <4 days/week was inversely associated with risk of IHD with an HR(95%CI) of 0.85 (0.73-1.00) and 0.85 (0.73-0.98) in dairy consumption ≥4 days/week. Additionally adjusted for BMI, blood pressure, and random glucose, HR attenuated to 0.84 (0.72-0.99) and 0.86 (0.75-0.99), respectively.

Table 3
Risk of IHD, MCE and IHD mortality associated with consumption of dairy

Characteristics	Dairy consumption		
	Never	<4 day/week	≥4 day/ week
IHD			
Cases	903	734	1075
PYs	92,292.98	88,778.41	114,812.61
Cases/PYs (/100,000)	978.41	826.78	936.31
Modle1	1.00	0.98(0.89-1.08)	0.93(0.85-1.01)
Modle2	1.00	0.97(0.88-1.07)	0.95(0.87-1.04)
Modle3	1.00	0.97(0.88-1.08)	0.99(0.90-1.09)
MCE			
Cases	142	108	170
PYs	95,075.64	90,932.75	118,238.13
Cases/PYs (/100,000)	149.35	118.77	143.78
Modle1	1.00	0.90(0.70-1.16)	0.89(0.70-1.11)
Modle2	1.00	0.90(0.70-1.17)	0.89(0.71-1.12)
Modle3	1.00	0.92(0.71-1.19)	0.94(0.74-1.18)
IHD mortality			
Cases	89	73	100
PYs	95,513.82	91,318.09	118,823.54
Cases/PYs (/100,000)	93.18	79.94	84.16
Modle1	1.00	1.04(0.76-1.42)	0.80(0.60-1.06)
Modle2	1.00	1.08(0.79-1.49)	0.84(0.63-1.13)
Modle3	1.00	1.08(0.78-1.48)	0.86(0.64-1.16)
For further statistical analysis, individuals of dairy product consumption were combined into three groups (never/rarely, <4 days/week, ≥4 days/week).			
Model 1: stratified by age-at-risk, gender (only in total population)			
Model 2: as for model 1, additionally adjusted for education, occupation, marital status, household income, and food consumption (eggs, fresh fruit, fresh vegetables, soybean, red meat, poultry), alcohol consumption, smoking status, MET, family history of MI			
Model 3: as for model 2, additionally adjusted for BMI, SBP, DBP, random glucose			

Subgroup Analyses

Subgroup analysis was done to investigate the relationship between dairy consumption and risk of IHD, according to baseline characteristics (Figure.1). The association between dairy and IHD was differed by education (p-values for interaction: 0.017 for males, and 0.014 for females), household income (p-values for interaction: 0.048 for males, and 0.032 for females). Stronger inverse associations among males who non-current smoking (p-values for interaction: 0.036), males who non-current drink, although the interaction test was not statistically significant for the latter one. No similar associations were observed across subgroups stratified according to age, occupation, marital status, alcohol consumption, MET, BMI, SBP and family history of MI (all p values for interaction >0.05).

Table 4
Risk of IHD associated with dairy among 14,908 male and 18,447 female participants

Characteristics	Dairy consumption		
	Never	<4 day/week	≥4 day/ week
male			
Cases	359	280	436
Modle1	1.00	0.88(0.75-1.02)	0.87(0.75-1.00)
Modle2	1.00	0.85(0.73-1.00)	0.85(0.73-0.98)
Modle3	1.00	0.84(0.72-0.99)	0.86(0.75-0.99)
female			
Cases	544	454	639
Modle1	1.00	1.05(0.93-1.19)	0.97(0.86-1.08)
Modle2	1.00	1.07(0.94-1.21)	1.04(0.93-1.18)
Modle3	1.00	1.08(0.95-1.23)	1.10(0.97-1.24)
For further statistical analysis, individuals of dairy product consumption were combined into three groups (never/rarely, <4 days/week, ≥4 days/week).			
Model 1: stratified by age-at-risk, gender (only in total population)			
Model 2: as for model 1, additionally adjusted for education, occupation, marital status, household income, and food consumption (eggs, fresh fruit, fresh vegetables, soybean, red meat, poultry), alcohol consumption, smoking status, MET, family history of MI			
Model 3: as for model 2, additionally adjusted for BMI, SBP, DBP, random glucose			

In addition, stronger positive associations were also observed among females with age >50y (p-value for interaction: 0.929), although the interaction test was not statistically significant.

Discussion

This large prospective study showed that intake of dairy regularly is not related to the onset of IHD, in line with previous studies[19, 20]. However, the association between dairy and IHD varies depending on gender. For males, compared with those who never or rarely intake dairy, who intake dairy ≥4 days/week exerted a significant protective effect on the IHD onset, while no similar association was observed in females.

Comparison with other studies

Dairy is rich in nutrients (e.g. amino acid, calcium, vitamins), was an ideal food for healthy people of all age groups. *The Chinese dietary Guideline (2016)* recommended that adults intake dairy 300g/day (e.g. milk, yogurt)[21]. The overall level of dairy intake still did not meet the dietary reference values. The Korean Genome Epidemiology Study (KoGES), consisting of 7354 healthy Korean adults aged 40-69, supported those who intake higher milk, or dairy products had a protective association on the cardiovascular system[22]. The Guangzhou Biobank Cohort Study (GBCS) reported that full-fat dairy has a protective association on cardiovascular[23].

Nutrient content and bioactive ingredients in dairy vary greatly[24]. This indicates that it was whole food rather than single nutrients that should be focused on. Full-fat dairy may be related to lowering levels of homocysteine, hypolipidemic and protecting individuals from hypertension[25, 26], thus may reduce the risk for IHD. It has been reported intake of full-fat dairy was in neutral or inverse association with the onset of IHD[27, 28].

Association between dairy consumption and IHD

The relationship between dairy consumption and IHD risk was more pronounced in males with higher education, household income ≥20,000 yuan, and non-current smoking. That is because smoking is an important risk factor for central obesity and is associated with DNA methylation and oxidative stress[29, 30], heavy smoking tended to have multiple other health-related risk factors, weakening the protection of dairy products. In addition, higher consumption of dairy was related to a lower risk of metabolic syndrome [31], reducing the risk of IHD, which may be contributed to the large amount of calcium contained in dairy [32-34]. The association was more pronounced in males than in females [35, 36].

For females, who aged >50 years and with lower education level (below high school), higher dairy consumption would increase the risk of IHD, but the risk was more likely to attribute to physiological effects. This may be because the body hormone levels of females modified after menopause, which would increase the risk of IHD[37]. And higher education was associated with a later age at natural menopause through effects on lifestyle behaviors[38].

Strengths and limitations of this study

The present study had several strengths, including large sample size, a relatively long follow-up, and comprehensive evaluation of various factors on the relationship between dairy consumption and IHD onset among Chinese adults. A few limitations need to be considered. The dietary questionnaire design was relatively simple, did not distinguish between milk and yogurt, date reported the average intake of dairy was 21.8kg/year in Shandong Province, mainly milk (65.7%) and yogurt (26%)[39]. Food frequency was self-reported, which possibly cannot eliminate residual confounding

Conclusion

In summary, dairy consumption had a protective association for the onset of IHD for males, particularly in males with high-level education and non-current smoking. While dairy consumption had a positive association for females who are old and with lower education. Therefore, the different populations should be given different dietary commend of dairy for preventing IHD.

Abbreviations

CKB: China Kadoorie Biobank; IHD: Ischemic heart disease; MCE: Incident major coronary event; HR: Hazard ratio; CI: Confidence interval; WC: Waist circumference; DSPs: Disease Surveillance Point System; MET: Exercise metabolic

equivalent; BMI: Body Mass Index; SBP: Systolic blood pressure; DBP: Diastolic blood pressure; MI: Myocardial infarction; PYs: Pearson years; KoGES: Korean Genome Epidemiology Study cohort; GBCS: Guangzhou Biobank Cohort Study.

Declarations

Ethics approval and consent to participate

The CKB study was approved by the Ethical Review Committee of the Chinese Center for Disease Control and Prevention and the Oxford Tropical Research Ethics Committee, University of Oxford. All participants provided informed written consent prior to participation in the study.

Consent for publication

Not applicable.

Availability of data and materials

Details of how to access China Kadoorie Biobank data and details of the data release schedule are available from www.ckbiobank.org/site/Data+Access.

Competing interests

The authors have declared that no competing interests exist.

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Authors' contributions

JS, CP and FL collected and analyzed the data, drafted and edited the manuscript. YG, PP, SW, ZP, ZC and LL collected the data. XT, RG designed the study, and reviewed the manuscript. All the authors have read and approved the final manuscript.

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References

1. Chen ZF, Young L, Yu CH, Shiao SPK: A Meta-Prediction of Methylenetetrahydrofolate-Reductase Polymorphisms and Air Pollution Increased the Risk of Ischemic Heart Diseases Worldwide. *Int J Environ Res Public Health* 2018; 15.
2. Wang W, Hu M, Liu H, Zhang X, Li H, Zhou F, Liu YM, Lei F, Qin JJ, Zhao YC, et al: Global Burden of Disease Study 2019 suggests that metabolic risk factors are the leading drivers of the burden of ischemic heart disease. *Cell Metab* 2021.

3. Shengshou HU, Runlin GAO, Lisheng LIU, Manlu ZHU, Wen W, Yongjun W, Zhaosu WU, Huijun LI, Dongfeng GU, Yuejin Y, et al: Summary of the 2018 Report on Cardiovascular Diseases in China. *Chinese Circulation Journal*. 2019; 34:209-220.
4. Vos T, Lim SS, Abbafati C, Abbas KM, Abbasi M, Abbasifard M, Abbasi-Kangevari M, Abbastabar H, Abd-Allah F, Abdelalim A, et al: Global burden of 369 diseases and injuries in 204 countries and territories, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. *The Lancet* 2020; 396:1204-1222.
5. Levy M, Chen Y, Clarke R, Bennett D, Tan Y, Guo Y, Bian Z, Lv J, Yu C, Li L, et al: Socioeconomic differences in health-care use and outcomes for stroke and ischaemic heart disease in China during 2009–16: a prospective cohort study of 0.5 million adults. *The Lancet Global Health* 2020; 8:e591-e602.
6. Astrup A, Bradley BHR, Brenna JT, Delplanque B, Ferry M, Torres-Gonzalez M: Regular-Fat Dairy and Human Health: A Synopsis of Symposia Presented in Europe and North America (2014-2015). *Nutrients* 2016; 8.
7. Willett W, Rockström J, Loken B, Springmann M, Lang T, Vermeulen S, Garnett T, Tilman D, DeClerck F, Wood A, et al: Food in the Anthropocene: the EAT-Lancet Commission on healthy diets from sustainable food systems. *Lancet* (London, England) 2019; 393:447-492.
8. Harcombe Z: US dietary guidelines: is saturated fat a nutrient of concern? *Br J Sports Med* 2019; 53:1393-1396.
9. Buziau AM, Soedamah-Muthu SS, Geleijnse JM, Mishra GD: Total Fermented Dairy Food Intake Is Inversely Associated with Cardiovascular Disease Risk in Women. *J Nutr* 2019; 149:1797-1804.
10. Teren A, Vogel A, Beutner F, Gielen S, Burkhardt R, Scholz M, Thiery J, Ceglarek U: Relationship between fermented dairy consumption, circulating short-chain acylcarnitines and angiographic severity of coronary artery disease. *Nutr Metab Cardiovasc Dis* 2020; 30:1662-1672.
11. Siri-Tarino PW, Chiu S, Bergeron N, Krauss RM: Saturated Fats Versus Polyunsaturated Fats Versus Carbohydrates for Cardiovascular Disease Prevention and Treatment. *Annu Rev Nutr* 2015; 35:517-543.
12. Lovegrove JA, Givens DI: Dairy food products: good or bad for cardiometabolic disease? *Nutr Res Rev* 2016; 29:249-267.
13. Huth PJ, Park KM: Influence of dairy product and milk fat consumption on cardiovascular disease risk: a review of the evidence. *Adv Nutr* 2012; 3:266-285.
14. He YN, Yang XG, Xia J, Zhao LY, Yang YX: Consumption of meat and dairy products in China: a review. *Proceedings of the Nutrition Society* 2016; 75:385-391.
15. Chen Z, Lee L, Chen J, Collins R, Wu F, Guo Y, Linksted P, Peto R: Cohort profile: the Kadoorie Study of Chronic Disease in China (KSCDC). *Int J Epidemiol* 2005; 34:1243-1249.
16. Chen Z, Chen J, Collins R, Guo Y, Peto R, Wu F, Li L, China Kadoorie Biobank collaborative g: China Kadoorie Biobank of 0.5 million people: survey methods, baseline characteristics and long-term follow-up. *Int J Epidemiol* 2011; 40:1652-1666.
17. Li-ming LI, Jun LV, Yu GUO, Rory C, Jun-shi C, Richard P, Fan WU, Zheng-ming C: The China Kadoorie Biobank: related methodology and baseline characteristics of the participants. *Chinese Journal of Epidemiology*. 2012; 33:249-255.
18. Yang G, Hu J, Rao KQ, Ma J, Rao C, Lopez AD: Mortality registration and surveillance in China: History, current situation and challenges. *Popul Health Metr* 2005; 3:3.
19. Dehghan M, Mente A, Rangarajan S, Sheridan P, Mohan V, Iqbal R, Gupta R, Lear S, Wentzel-Viljoen E, Avezum A, et al: Association of dairy intake with cardiovascular disease and mortality in 21 countries from five continents (PURE): a prospective cohort study. *Lancet* 2018; 392:2288-2297.
20. Guo J, Astrup A, Lovegrove JA, Gijsbers L, Givens DI, Soedamah-Muthu SS: Milk and dairy consumption and risk of cardiovascular diseases and all-cause mortality: dose-response meta-analysis of prospective cohort studies. *Eur J Epidemiol* 2017; 32:269-287.

21. Yuexin Y, Huanmei Z: Introduction of Dietary Guidelines for Chinese Residents (2016) *J Acta Nutrimenta Sinica*. 2016; 38:209-217.
22. Lee HA, An H, Lee E: Dietary patterns related to cardiovascular disease based on reduced rank regression analysis of healthy middle-aged Koreans: data from the community-based Korean Genome and Epidemiology Study (KoGES) cohort. *Am J Clin Nutr* 2020; 111:1159-1169.
23. Sun Y, Jiang C, Cheng KK, Zhang W, Leung GM, Lam TH, Schooling CM: Milk consumption and cardiovascular risk factors in older Chinese: the Guangzhou Biobank Cohort Study. *PLoS One* 2014; 9:e84813.
24. Astrup A, Geiker NRW, Magkos F: Effects of Full-Fat and Fermented Dairy Products on Cardiometabolic Disease: Food Is More Than the Sum of Its Parts. *Advances in nutrition (Bethesda, Md)* 2019; 10:924S-930S.
25. Panagiotakos DB, Pitsavos CH, Zampelas AD, Chrysoshoou CA, Stefanadis CI: Dairy products consumption is associated with decreased levels of inflammatory markers related to cardiovascular disease in apparently healthy adults: the ATTICA study. *J Am Coll Nutr* 2010; 29:357-364.
26. de Oliveira Otto MC, Mozaffarian D, Kromhout D, Bertoni AG, Sibley CT, Jacobs DR, Jr., Nettleton JA: Dietary intake of saturated fat by food source and incident cardiovascular disease: the Multi-Ethnic Study of Atherosclerosis. *Am J Clin Nutr* 2012; 96:397-404.
27. Soedamah-Muthu SS, Ding EL, Al-Delaimy WK, Hu FB, Engberink MF, Willett WC, Geleijnse JM: Milk and dairy consumption and incidence of cardiovascular diseases and all-cause mortality: dose-response meta-analysis of prospective cohort studies. *Am J Clin Nutr* 2011; 93:158-171.
28. Hirahatake KM, Bruno RS, Bolling BW, Blesso C, Alexander LM, Adams SH: Dairy Foods and Dairy Fats: New Perspectives on Pathways Implicated in Cardiometabolic Health. *Adv Nutr* 2020; 11:266-279.
29. Zhang Y, Florath I, Saum KU, Brenner H: Self-reported smoking, serum cotinine, and blood DNA methylation. *Environ Res* 2016; 146:395-403.
30. Gao X, Gao X, Zhang Y, Breitling LP, Schöttker B, Brenner H: Associations of self-reported smoking, cotinine levels and epigenetic smoking indicators with oxidative stress among older adults: a population-based study. *Eur J Epidemiol* 2017; 32:443-456.
31. Drehmer M, Pereira MA, Schmidt MI, Alvim S, Lotufo PA, Luft VC, Duncan BB: Total and Full-Fat, but Not Low-Fat, Dairy Product Intakes are Inversely Associated with Metabolic Syndrome in Adults. *J Nutr* 2016; 146:81-89.
32. Azadbakht L, Mirmiran P, Esmailzadeh A, Azizi F: Dairy consumption is inversely associated with the prevalence of the metabolic syndrome in Tehranian adults. *Am J Clin Nutr* 2005; 82:523-530.
33. Fumeron F, Lamri A, Abi Khalil C, Jaziri R, Porchay-Baldérelli I, Lantieri O, Vol S, Balkau B, Marre M: Dairy consumption and the incidence of hyperglycemia and the metabolic syndrome: results from a french prospective study, Data from the Epidemiological Study on the Insulin Resistance Syndrome (DESIR). *Diabetes Care* 2011; 34:813-817.
34. Khan B, Nowson CA, Daly RM, English DR, Hodge AM, Giles GG, Ebeling PR: Higher Dietary Calcium Intakes Are Associated With Reduced Risks of Fractures, Cardiovascular Events, and Mortality: A Prospective Cohort Study of Older Men and Women. *J Bone Miner Res* 2015; 30:1758-1766.
35. Samara A, Herbeth B, Ndiaye NC, Fumeron F, Billod S, Siest G, Visvikis-Siest S: Dairy product consumption, calcium intakes, and metabolic syndrome-related factors over 5 years in the STANISLAS study. *Nutrition* 2013; 29:519-524.
36. Shin BR, Choi YK, Kim HN, Song SW: High dietary calcium intake and a lack of dairy consumption are associated with metabolic syndrome in obese males: the Korean National Health and Nutrition Examination Survey 2010 to 2012. *Nutr Res* 2016; 36:518-525.
37. El Khoudary SR, Shields KJ, Janssen I, Budoff MJ, Everson-Rose SA, Powell LH, Matthews KA: Postmenopausal Women With Greater Paracardial Fat Have More Coronary Artery Calcification Than Premenopausal Women: The Study of Women's Health Across the Nation (SWAN) Cardiovascular Fat Ancillary Study. *J Am Heart Assoc* 2017; 6.

38. Wang M, Gong WW, Hu RY, Wang H, Guo Y, Bian Z, Lv J, Chen ZM, Li LM, Yu M: Age at natural menopause and associated factors in adult women: Findings from the China Kadoorie Biobank study in Zhejiang rural area. PLoS One 2018; 13:e0195658.

39. Aihua L, Zhicai Y: 2020 China Statistics Theory and Practice. Beijing: China Statistics Press; 2021.

Figures

Figure 1

Subgroup analysis of associations between dairy consumption ≥4 days/week and IHD according to baseline characteristics in males. Adjusted HRs (95% CIs) dairy consumption by subgroups, age at baseline (years), gender (male or female), education(below high school, high school and above), household income, occupation, marital status(married, live along), and food consumption(eggs, fresh fruit, fresh vegetables, soybean, red meat, poultry), alcohol consumption, smoking status, MET(MET-h), family history of MI, BMI, SBP, DBP, random glucose. MI: myocardial infarction; MET: exercise metabolic equivalent; BMI: Body Mass Index; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure.

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