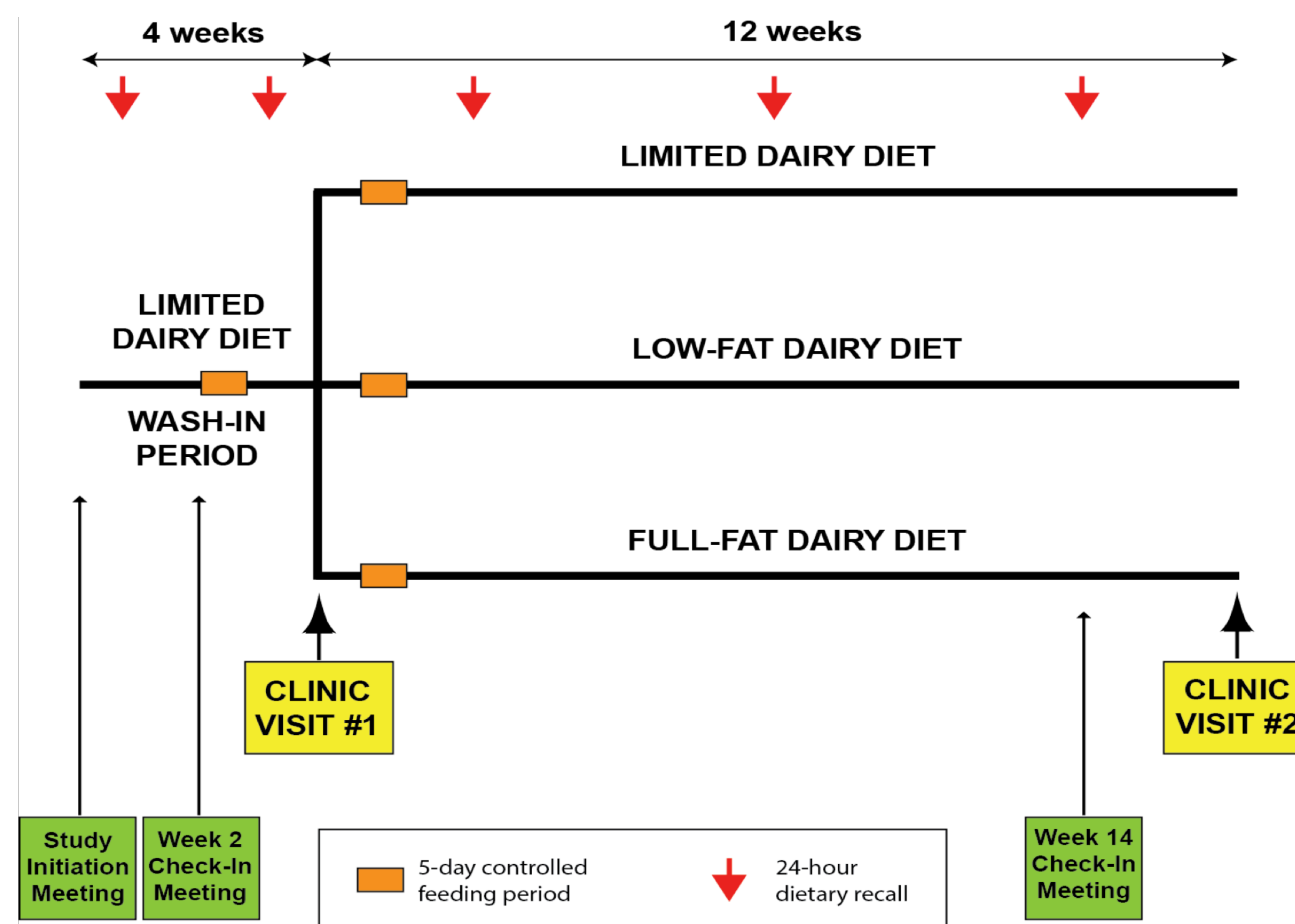


Background

Observational studies: Both low-fat and full-fat dairy products have been associated with a decreased risk of diabetes mellitus.

Randomized Control Trials: There is only one RCT that directly compares the effect of low-fat to full-fat dairy consumption on glucose homeostasis.

Methods



Subjects: 72 individuals with the metabolic syndrome

Diets: All subjects were asked to consume no other dairy products other than those provided and to otherwise eat their habitual diet ad libitum.

Limited – maximum of 3 serv/wk of non-fat milk

Low-fat – 3.3 serv/day of low-fat dairy products (milk, yogurt, and cheese)

Full-Fat – 3.3 serv/day of full-fat dairy products (milk, yogurt, and cheese)

Clinic Visits:

- Abdominal magnetic resonance imaging scan
- Height, weight, waist & hip circumference
- Vital signs (pulse, temperature, blood pressure)
- Dual-energy x-ray absorptiometry scan
- Fasting blood draw
- Frequently sampled oral glucose tolerance test

Results

Table 1. The effect of dairy consumption on glucose homeostasis (per protocol analysis).

	Baseline	Follow-up	Delta	RM-ANOVA (time x diet intervention)
Fasting Glucose (mg/dL)				
Limited dairy (n= 22)	101 (93;109)	101 (94;108)	1.00(-5.3;4.9)	0.084
Low-fat dairy (n= 24)	110 (101;119)	110 (108;116)	1.5 (-6.1;9.5)	
Full-fat dairy (n= 21)	107 (102;116)	110 (106;119)	2.5 (-0.25;8.25)	
Fasting Insulin (uU/mL)				
Limited dairy (n= 22)	9.8 (7.1;14.6)	9.7 (6.4;14.1)	-0.7 (-2.7;1.0) ^a	0.025
Low-fat dairy (n= 24)	12.3 (6.1;15.6)	11.0 (8.2;18.7)	2.5 (-1.4;4.9) ^b	
Full-fat dairy (n= 21)	11.3 (7.9;14.4)	14.7 (9.4;19.0)	2.1 (0.3;4.4) ^b	
HOMA[#]				
Limited dairy (n= 22)	2.5 (1.9;3.5)	2.5 (1.6;3.9)	-0.44 ^a	0.004
Low-fat dairy (n= 24)	3.3 (1.6;4.4)	3.1 (2.3;6.1)	0.75 ^b	
Full-fat dairy (n= 21)	3.0 (1.7;4.4)	3.9 (2.4;5.6)	0.82 ^b	
Glycosylated Hemoglobin (%)				
Limited dairy (n= 22)	5.4 (5.0;5.5)	5.3 (5.1;5.6)	0.05 (-0.10;0.10)	0.156
Low-fat dairy (n= 24)	5.8 (5.5;6.2)	5.8 (5.4;6.2)	0.00 (-0.10;0.10)	
Full-fat dairy (n= 21)	5.7 (5.4;5.9)	5.7 (5.5;5.9)	0.00 (-0.10;0.10)	
Area under the curve Glucose				
Limited dairy (n= 22)	25,195 (23,445;30,708)	25,820 (23,451;29,356)	-919 (-2,549;1,371)	0.340
Low-fat dairy (n= 24)	29,895 (26,495;32,849)	31,060 (21,213-48,060)	746 (-1,133;2,764)	
Full-fat dairy (n= 21)	27,888 (24,831;29,881)	27,718 (24,561;32,756)	130 (-1,579;2,260)	
Matsuda- insulin sensitivity				
Limited dairy (n= 22)	2.7 (2.0;3.8)	2.8 (2.0;4.3)	0.18 (-0.84;0.85)	0.096
Low-fat dairy (n= 24)	2.4 (1.8;3.8)	2.3 (1.5;3.5)	-0.36 (-0.98;0.25)	
Full-fat dairy (n= 21)	2.3 (1.9;3.4)	1.9 (1.5;2.8)	-0.25 (-0.92;0.21)	
Insulinogenic index				
Limited dairy (n= 22)	1.0 (0.6;1.5)	1.2 (0.7;1.9)	-0.01 (-0.16;0.44)	0.324
Low-fat dairy (n= 24)	0.7 (0.4;1.4)	0.8 (0.4;1.4)	0.12 (-0.26;0.18)	
Full-fat dairy (n= 21)	1.2 (0.7;1.9)	1.0 (0.7;1.4)	-0.01 (-0.62;0.19)	
Oral Disposition index				
Limited dairy (n= 22)	2.3 (1.4;4.5)	3.1 (1.9;5.1)	0.38 (-0.39;1.15)	0.060
Low-fat dairy (n= 24)	2.3 (1.4;3.2)	2.0 (0.8;3.8)	-0.70 (-1.07;0.03)	
Full-fat dairy (n= 21)	2.8 (1.5;4.8)	1.9 (1.4;3.6)	-0.40 (-1.68;0.17)	
Glucose sensitivity				
Limited dairy (n= 22)	92 (64;120)	92 (70;138)	14 (-7;31)	0.598
Low-fat dairy (n= 24)	74 (41;103)	73 (48;100)	5 (-23;21)	
Full-fat dairy (n= 21)	86 (68;110)	89 (62;122)	-7 (-18;13)	

^aValues are mean ± SD or median (25th;75th percentile) if non-normally distributed data.

[#]Reflects an overall comparison of the three dietary phases by RM-ANOVA

[#] Homeostasis Model Assessment of Insulin Sensitivity

^a Significantly different from b

^b Significantly different from



Results Continued

Liver fat and Inflammation:

- Dairy consumption had no impact on liver fat content or inflammatory markers (IL-6, CRP, or Adiponectin)

ITT, Sensitivity, and Secondary analyses:

- Results were unchanged in the ITT analysis
- Results were unchanged after adjustment for change in fat mass and change in physical activity

Compliance during the intervention:

Diet	Non-study dairy (servings)	Dairy provided consumed (%)
Limited	0.6	75.3%
Low-fat	0.6	98.2%
Full-fat	1.3	97.8%

Conclusion

In individuals with the metabolic syndrome, consuming three servings of dairy per day, regardless of whether it is low-fat or full-fat, does not have an effect on AUC glucose. However, it does result in a modest increase in insulin resistance. This effect is not explained by change in body fat, inflammation, or liver fat content. Future studies should look into other potential mechanism and assess whether similar results are seen in individuals with normal metabolic health.

Acknowledgements

Thank you:

- All the DAIRY Study participants!
- My committee members: Mario Kratz, PhD; Michael Rosenfeld, PhD; Sarah Holte, PhD; Kristina Utzschneider, MD; Kerryn Redding, MPH PhD
- Faculty of the Nutritional Sciences Program and Graduate Coordinated Program in Dietetics

Funding:

- Dairy Research Institute / Dairy Management Inc. (U.S.)
- The Fred Hutch Reservoir Fund
- Cancer Prevention Training grant (T32), PI Polly Newcomb, Ph.D.