Composition of Foremilk and Hindmilk Produced by Mothers of Very Low Birth Weight Infants Born <28 Weeks Gestation

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Research Team

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Background

- VLBW infants (< 1500g at birth) fed fortified human milk commonly exhibit postnatal growth failure.
- Approaches to the further enhance nutritional intake of VLBW infants include
  - addition of fat, carbohydrate and/or protein modules
  - selective feeding of preterm hindmilk.

Preterm Hindmilk

- Produced in latter part of pumping
- Increased fat and energy content
- Use has become widespread
- Gaps in the knowledge in composition
  - fat soluble vitamins
  - fatty acid profile

- Knowledge of vitamin content of hindmilk essential if fortified hindmilk is to be used

Objectives

1. To fractionate the milk produced by mothers of VLBW infants into foremilk and hindmilk
2. To measure and compare concentrations of vitamin A, vitamin E, fat, and energy in each fraction

Objectives

3. To describe the relationships between milk vitamins A and E concentrations and
    - milk fat concentration
    - milk energy content
    - maternal intake of vitamins A and E from food and supplements

Methods

Inclusion Criteria

- Mothers of VLBW infants born at less than 28 completed weeks gestation and admitted to the NICU at S&W and St. Michael's Hospital
- Mothers expressing their milk at least four times daily and producing a volume of milk exceeding their infants' needs by 20% at the time of study

Exclusion Criteria

- Mothers acutely ill

Foremilk and Hindmilk

Foremilk:

- Milk collected for 3 min after milk flow begins when using an electric pump

Hindmilk:

- Remainder of milk collected until the breast was emptied

Composite milk:

- Combination of foremilk and hindmilk

`(Valentine et al 1994)

Study Procedure Procedure and Sample Collection

- Stop-watch was used to signal the first 3 min after milk flow began
- 24 h milk collection, at 21-30 d postpartum
- Administration of Willett-Harvard 96/97 General Purpose semi-quantitative food frequency questionnaire, same week as milk collection

Analysis

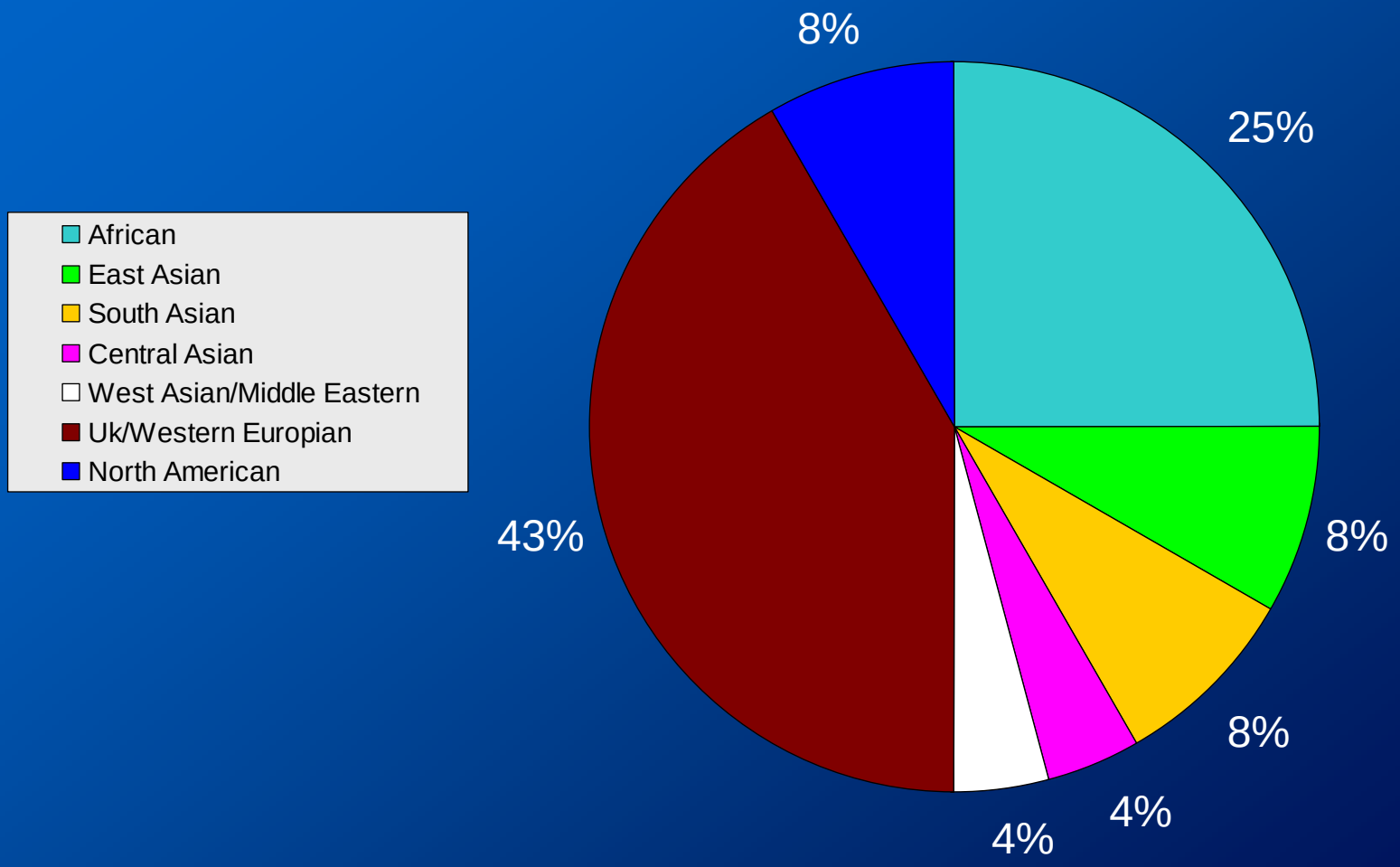
- Retinol, α-tocopherol and γ-tocopherol by HPLC
- Fatty acids by gas chromatography
- Energy by adiabatic bomb calorimetry

RESULTS

Characteristics of Mothers (n=24)

	Frequency	Median (range)
Age at Delivery (y)		34.5 (22,45)
Pre-pregnancy BMI (Kg/m^2)		23.1 (19.4,39.1)
Multiples (yes,no)	(4,20)	
Smoking (yes, no)	(1,23)	
Primiparous (yes,no)	(8,16)	

Ethnicity of Mothers



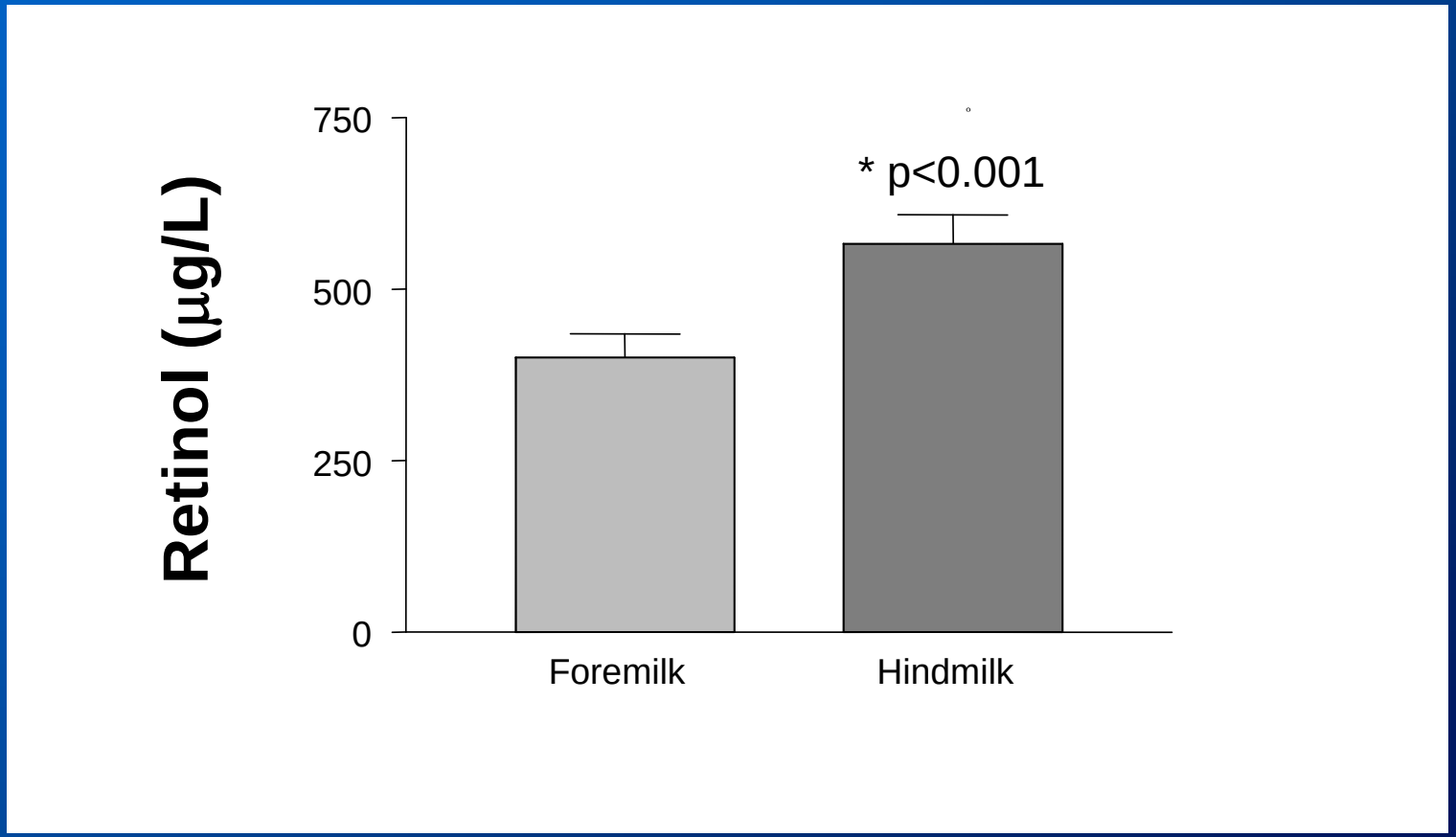
Characteristics of Infants at Birth (n=30)

	Frequency	Median (min,max)
Gender (Female, Male)	(16,4)	
Birth Weight (g)		818 (460,1266)
Gestational Age		$26^{+3/7}$ ($24,27^{+6/7}$)
24 wks	4	
25 wks	8	
26 wks	8	
27 wks	10	

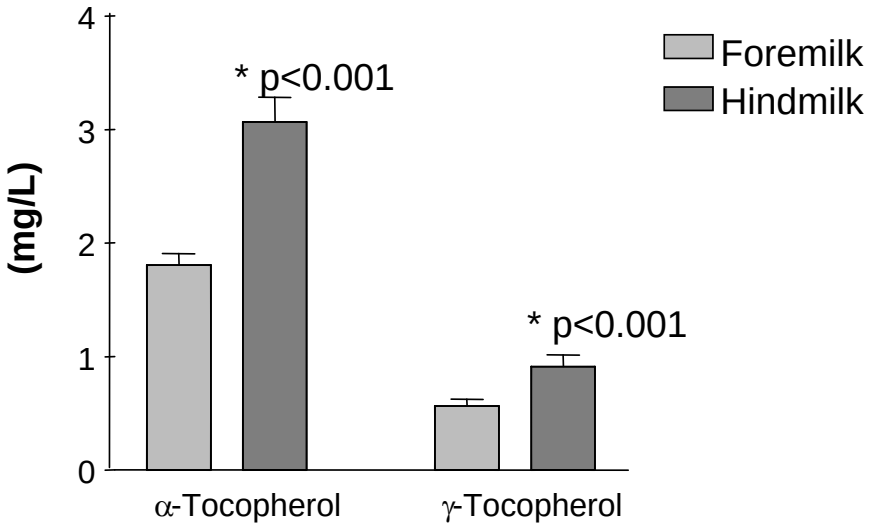
Milk Pumping and Volumes Achieved

	Median (min,max)
Postnatal day of milk collection	23 (21,30)
Frequency of pumping (pumps/24 h)	7 (5,9)
Average time pumping foremilk (min)	3 (3,3)
Average time pumping hindmilk (min)	12 (6,21)
Foremilk volume (mL/24 h)	183 (80,810)
Hindmilk volume (mL/24 h)	318 (98,1007)
Composite milk volume (mL/24 h)	545 (224,1817)

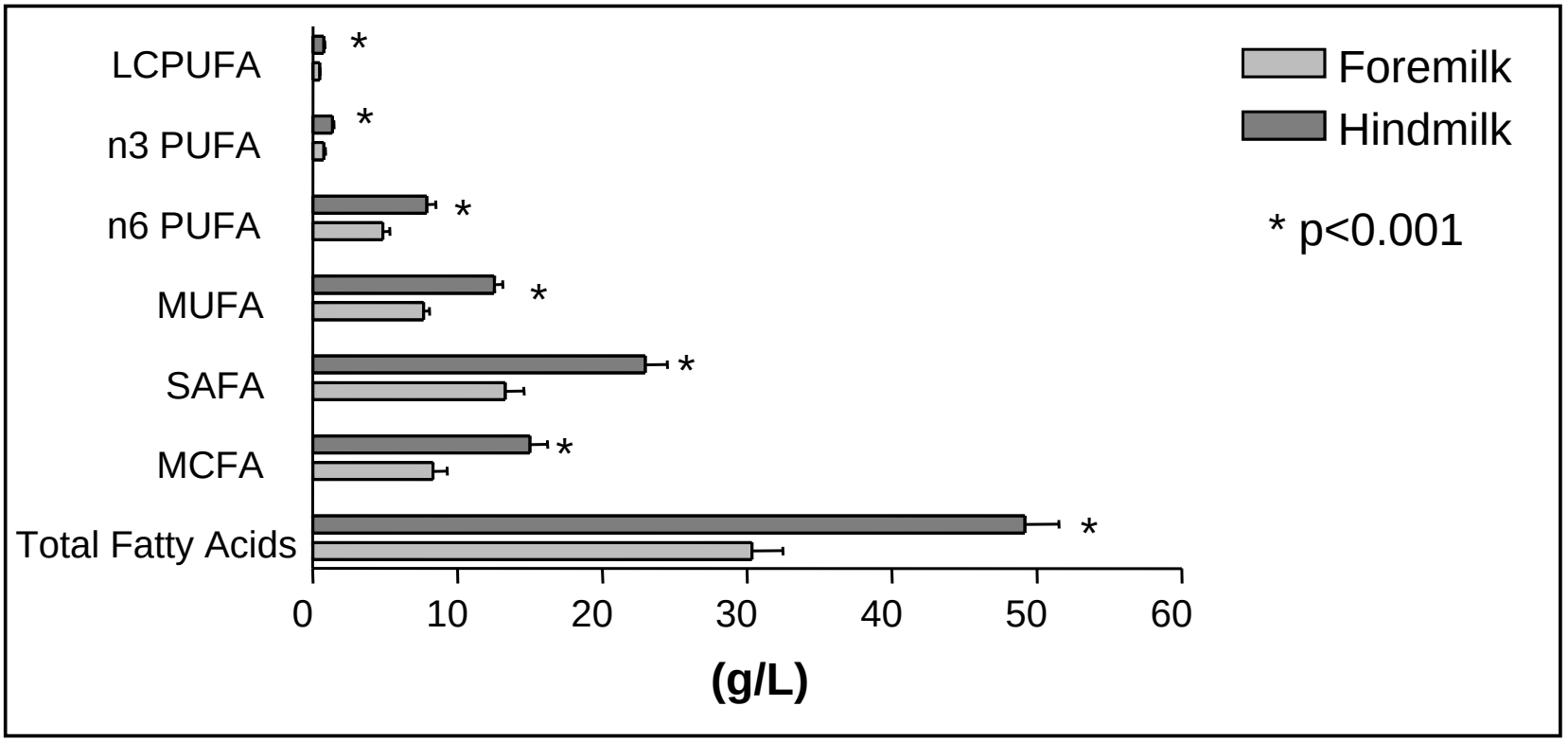
Retinol Concentration in Foremilk and Hindmilk



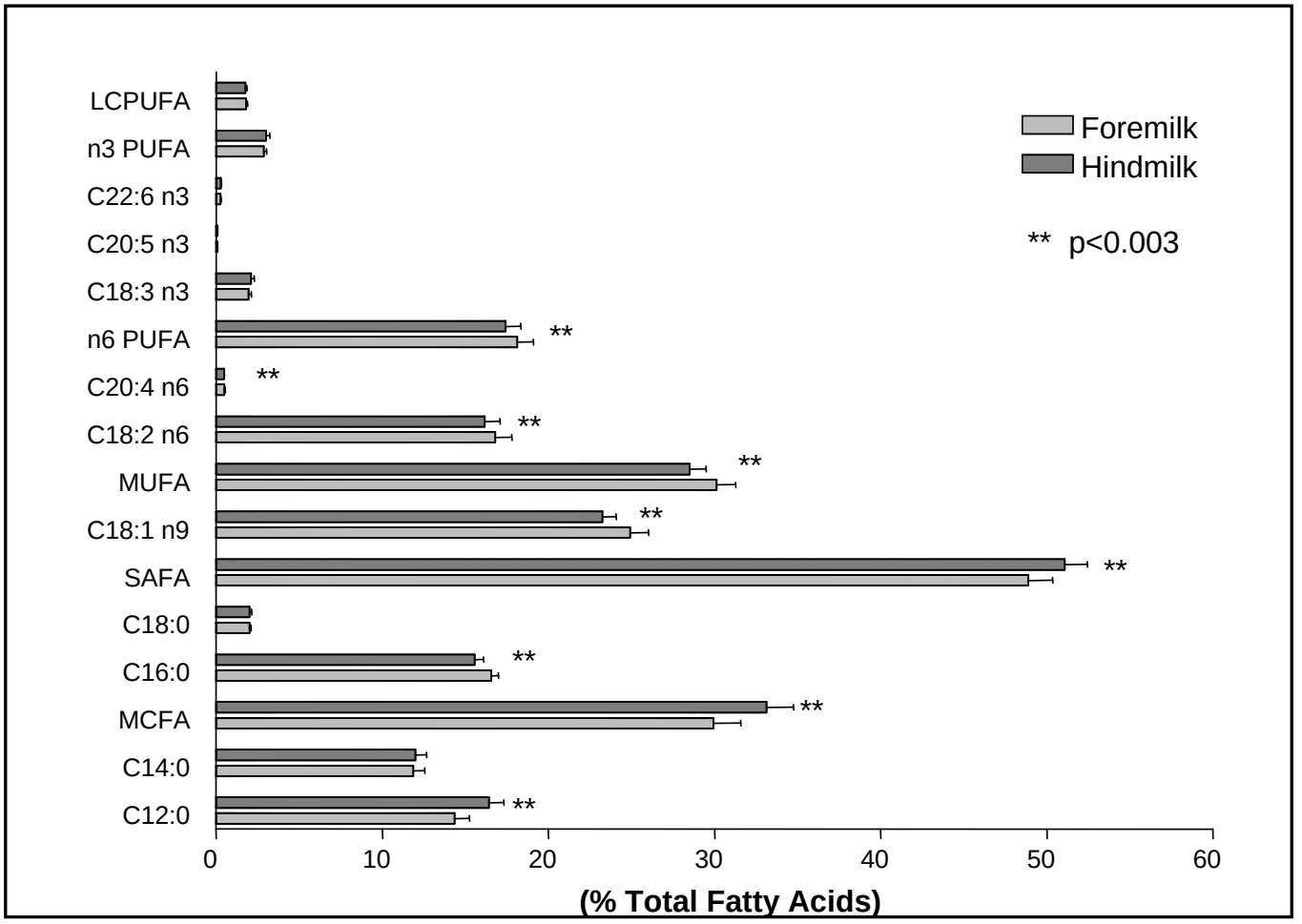
α- and γ-Tocopherol Concentrations in Foremilk and Hindmilk



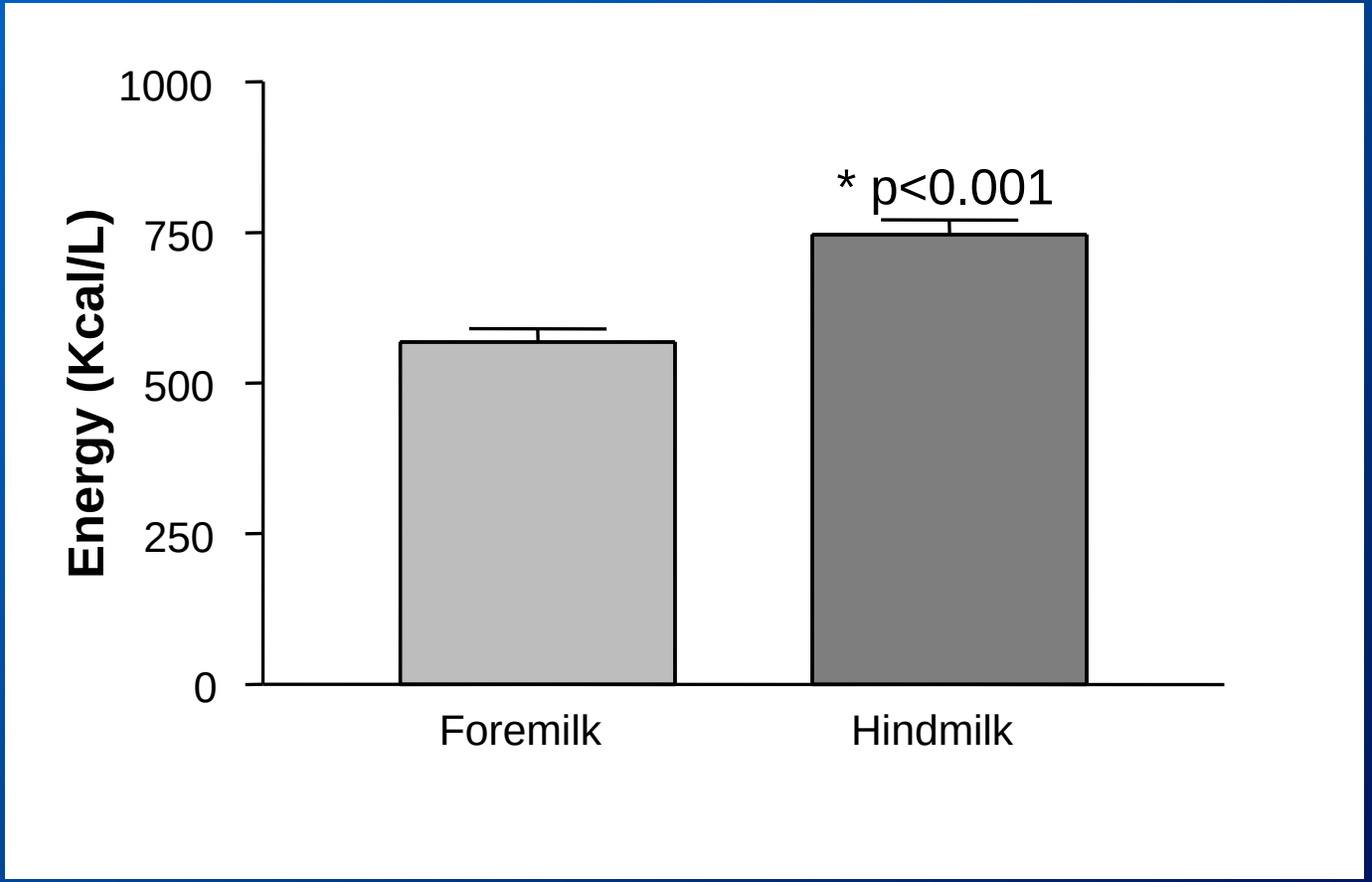
Fatty Acid Composition (g/L) of Foremilk and Hindmilk



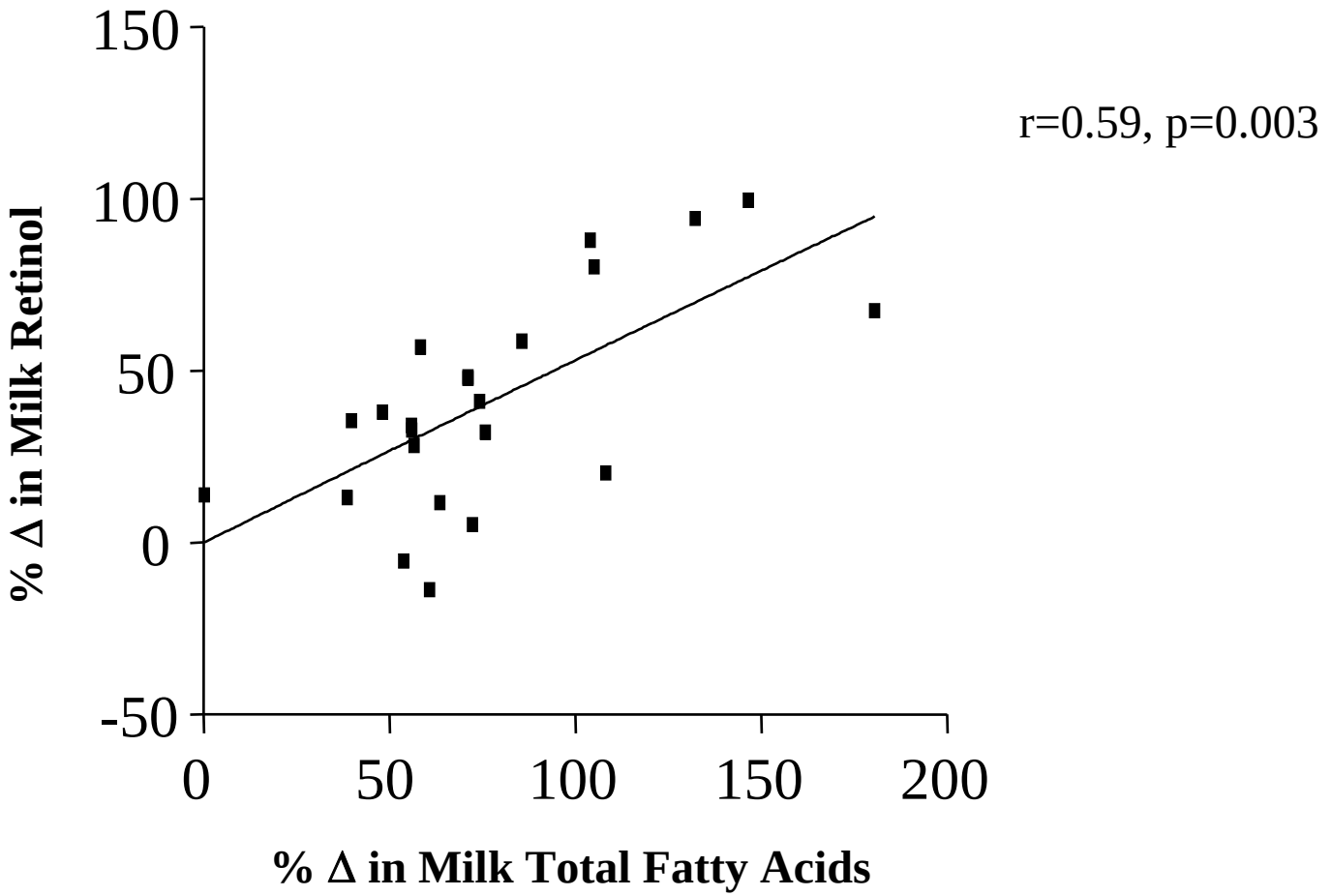
Fatty Acid Composition (% Total Fatty Acid) of Foremilk and Hindmilk



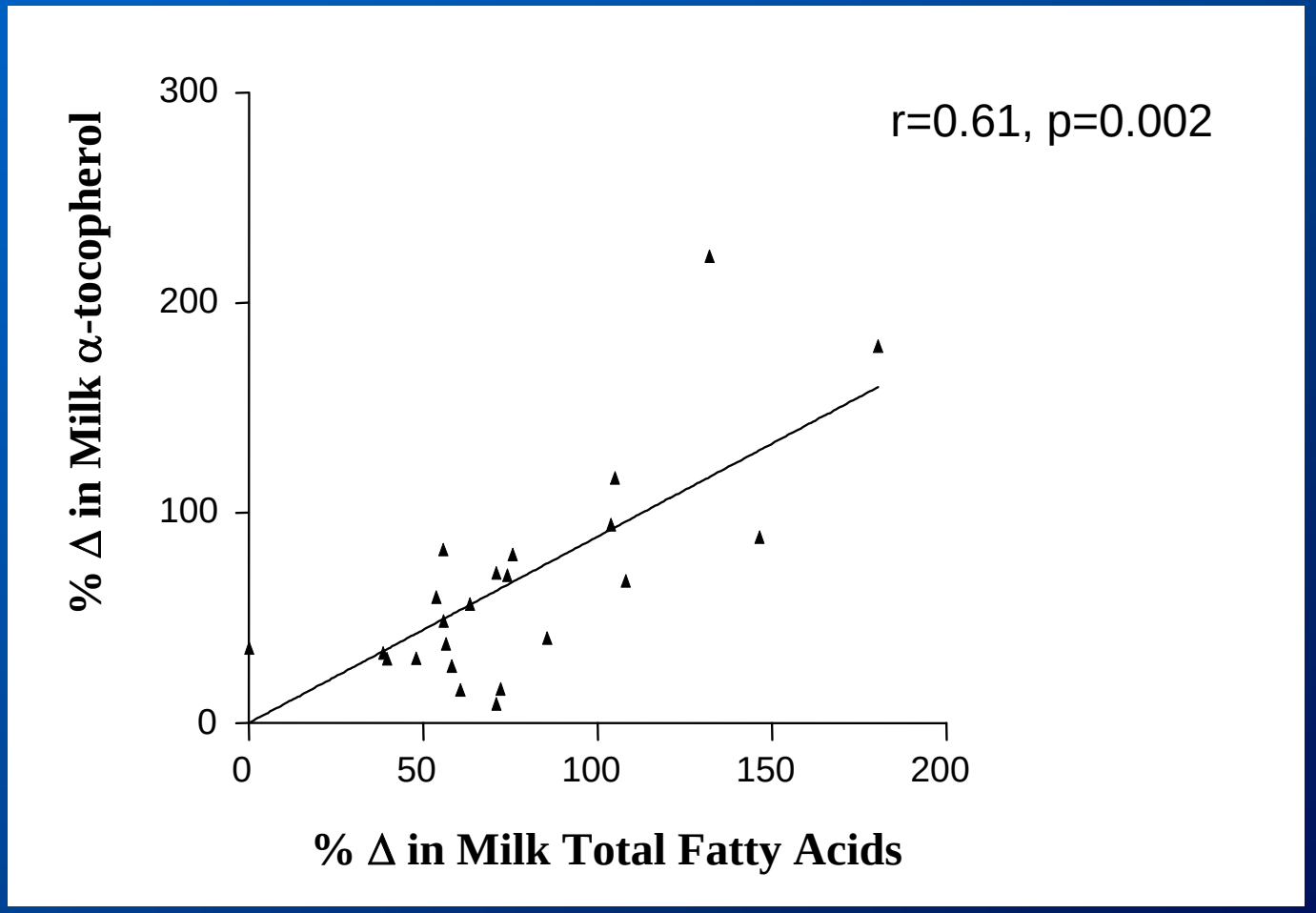
Energy Concentration of Foremilk and Hindmilk



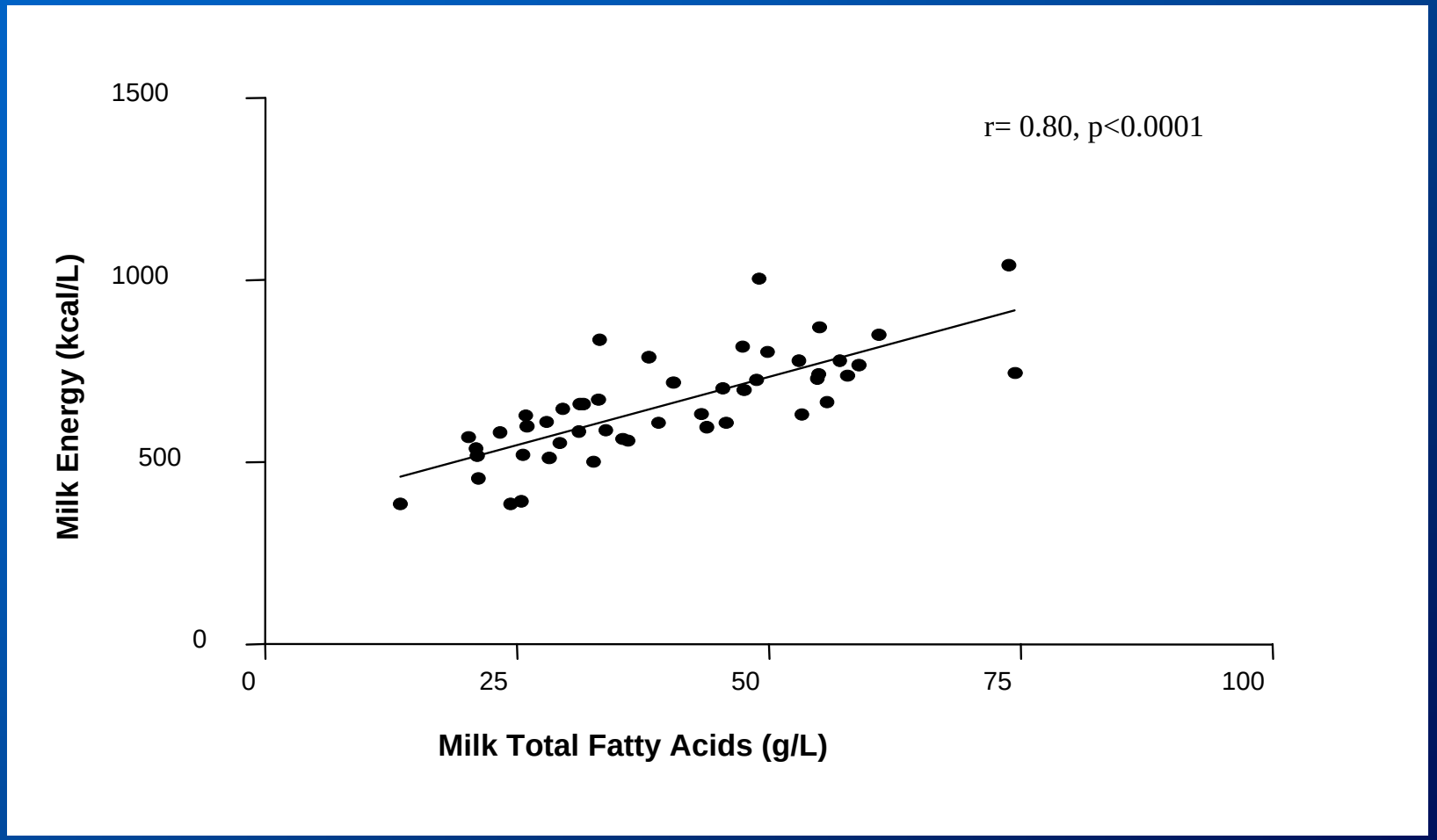
Relationship Between % Change in Retinol vs % Change in Total Fatty Acids from Foremilk to Hindmilk



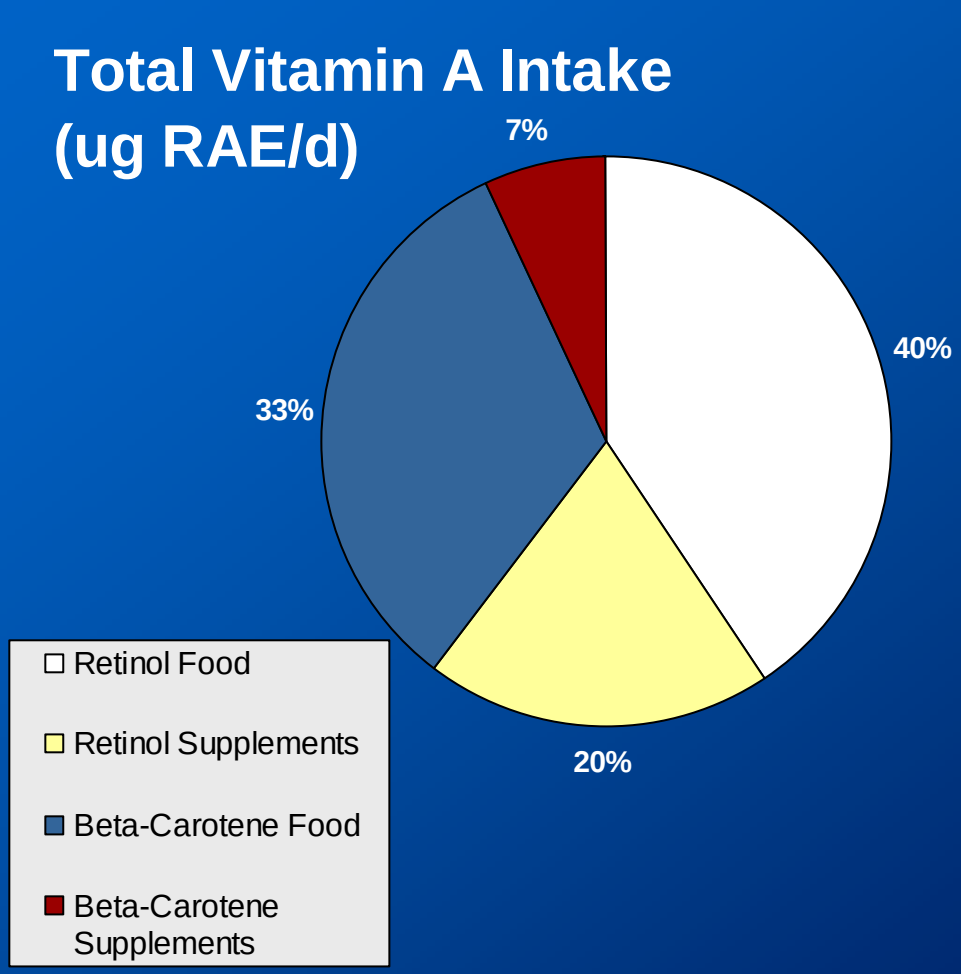
Relationship Between % Change in α-Tocopherol vs % Change in Total Fatty Acids from Foremilk to Hindmilk

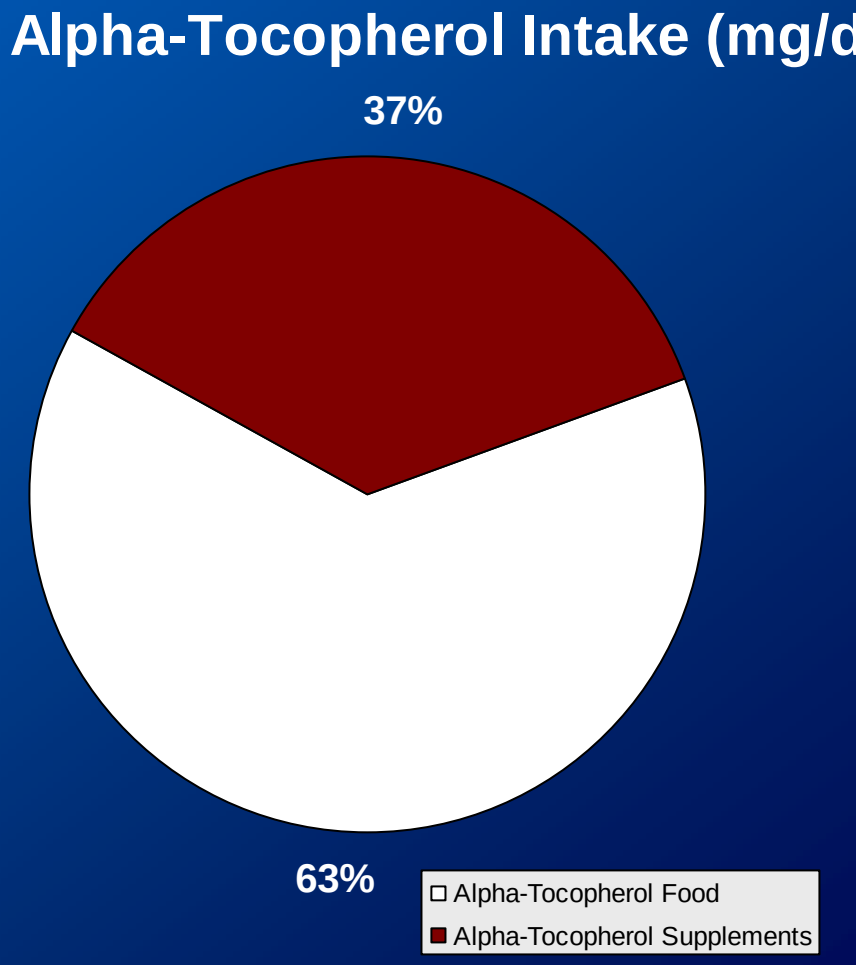


Relationship Between Energy Concentration (kcal/L) and Total Fatty acid Concentration (g/L) in Foremilk and Hindmilk

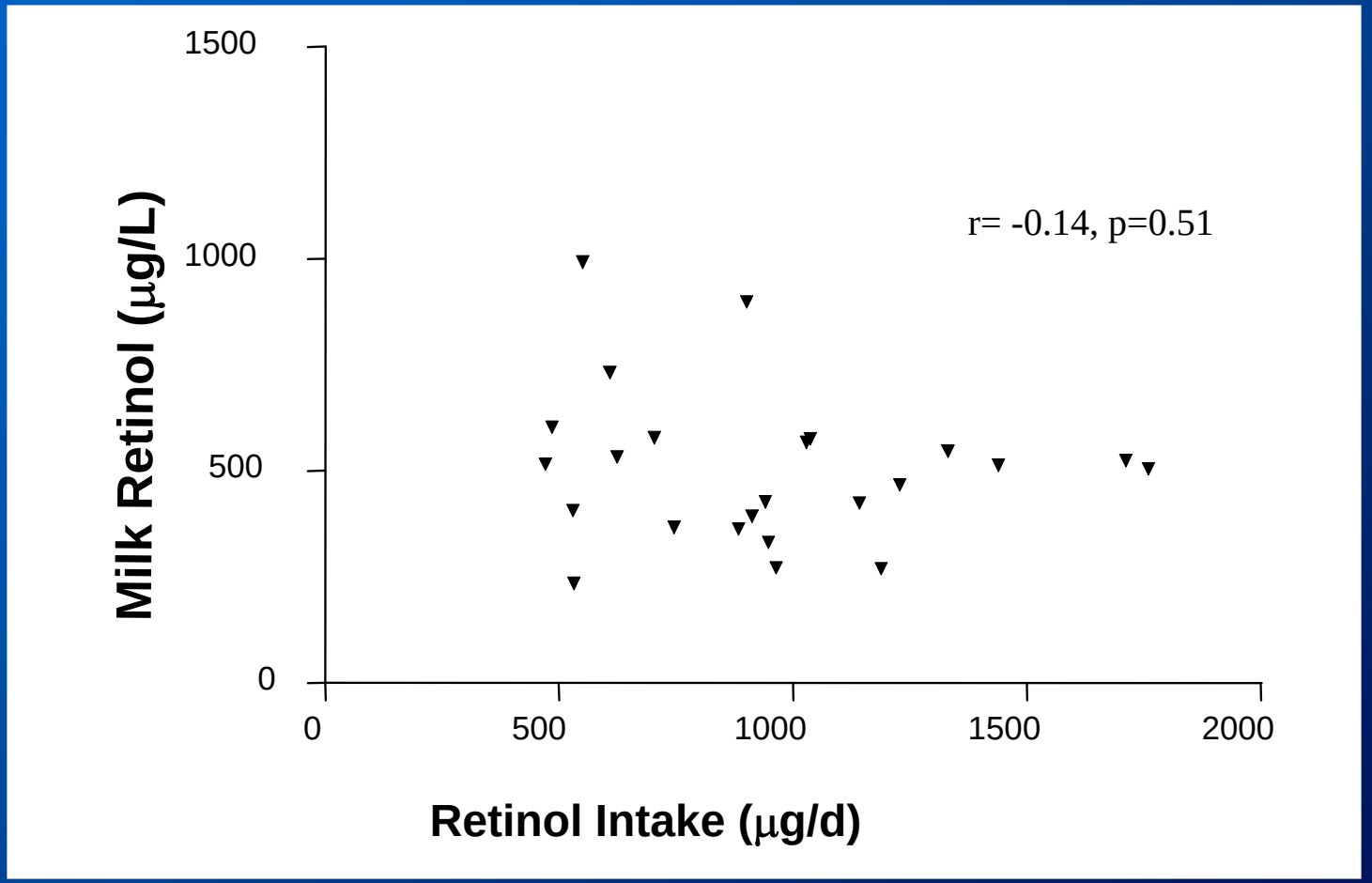


Maternal Vitamin A and E Intakes From Food and Supplements





Relationship Between Retinol Concentration (μg/L) in Composite Milk and Retinol Intakes from Food & Supplements (μg/d)



Conclusions

- Compared to foremilk, hindmilk had significantly higher concentrations of retinol (48%), α-tocopherol (76%), and γ-tocopherol (66%), fat (70%) and energy (30%).

- Composition of normalized fatty acids (% of total) was significantly altered in hindmilk vs. foremilk, in contrast to results from previous studies in term milk.

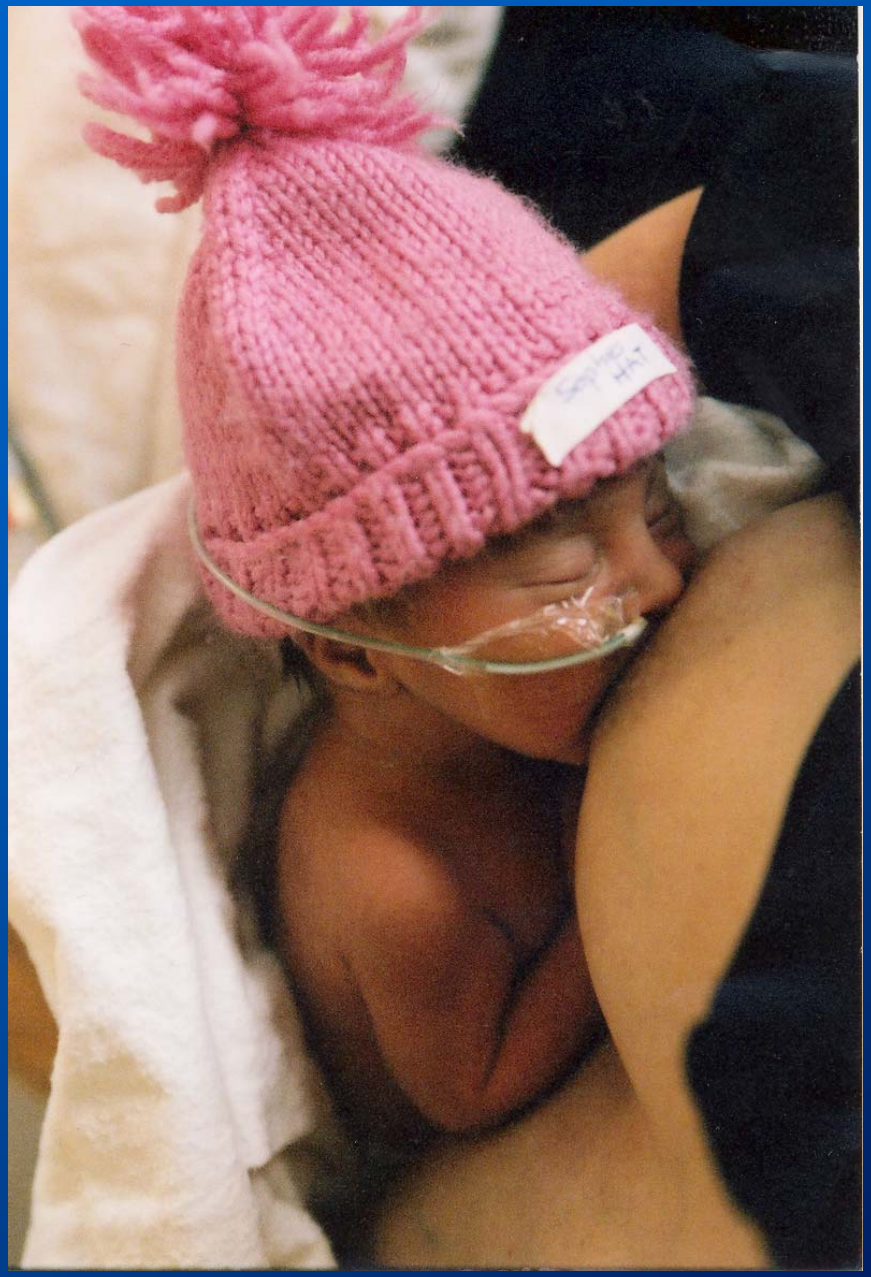
- Changes in concentrations of milk retinol, α-tocopherol, and γ-tocopherol were positively related ($p<0.01$) to changes in milk fatty acid concentrations.

- No relationship between maternal vitamin intakes and respective vitamin content in foremilk, hindmilk or composite milk, consistent with previous findings on well-nourished women

Implications

- These results support the hypothesis that a large fraction of retinol and tocopherol are secreted into preterm milk via milk lipid globule TAG core.

- These findings have implications in assessing the fat-soluble vitamin content of human milk fortifiers for feeding VLBW infants.



Publications/Presentations

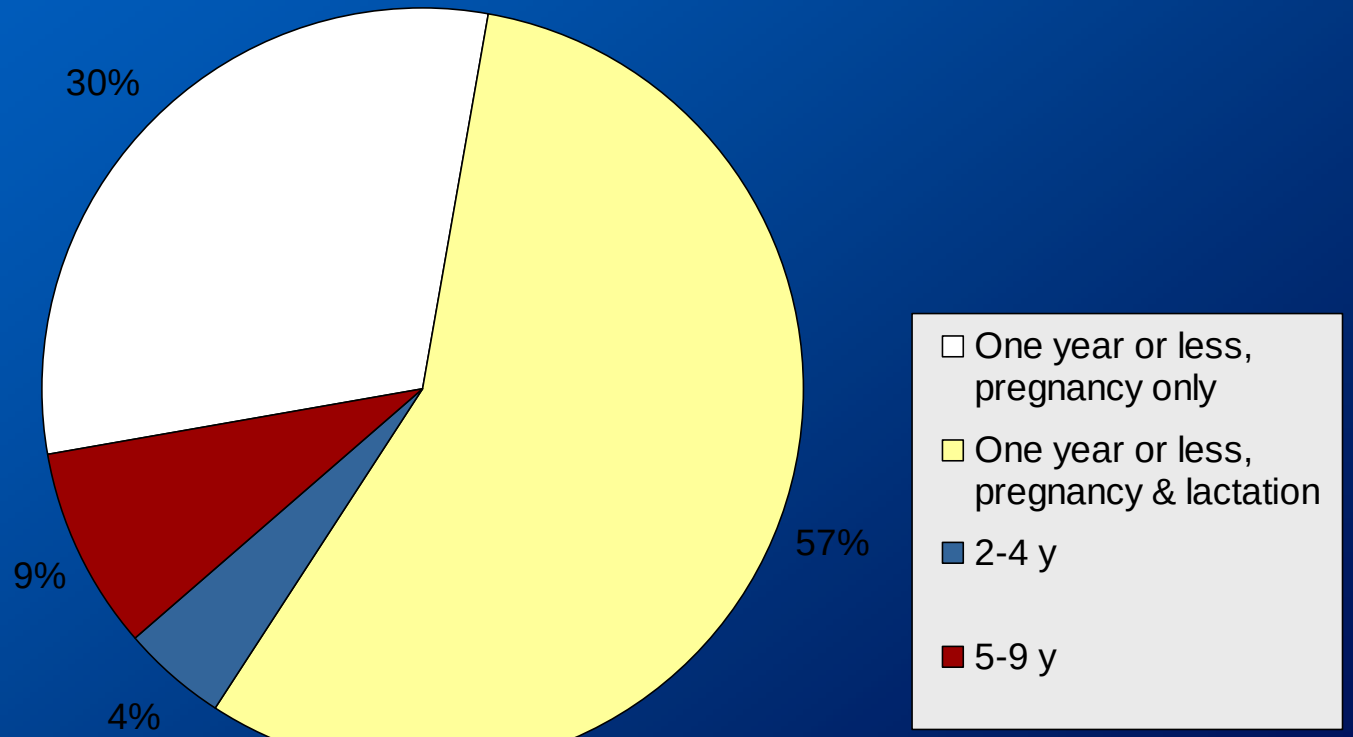
- Bishara R, Dunn M, **Darling PB**. Composition of Foremilk and hindmilk produced by mothers of very low birth weight (VLBW) infants born at <28 weeks. The FASEB Journal 2005; 19(5) A1699.

- Merko S, Bishara, Dunn M, **Darling PB.** Nutrient composition of hindmilk produced by mothers of very low birth weight (VLBW) infants born < 28 weeks gestation. Can J Diet Pract Res 2005;66(2):S128.

- Manuscript submitted to AJCN, September 2006

MULTIVITAMIN (MVI) SUPPLEMENT USE BY MOTHERS

Duration of MVI Intake



DRI FOR VITAMINS A & E

	Vitamin A ug RAE/d		Vitamin E mg/d	
	Pregnancy	**Lactation**	**Pregnancy**	**Lactation**
EAR	550	900	12	16
<EAR	0	0	38	46
UL	3,000	3,000	1,000	1,000
>UL	0	0	0	0