CAN LIQUID INGESTION MODIFY THE OSMOLALITY OF HUMAN MILK?

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PROJECT OVERVIEW

- **Project Title:** Can Liquid Ingestion Modify the Osmolality of Human Milk?
- **Project Site:** Quetzaltenango, Guatemala
- **Organization:** Center for Studies of Sensory Impairment, Aging and Metabolism (CeSSIAM)
- **Preceptor:** María José Soto Méndez, MSc

OVERARCHING AIMS

- To understand (from the literature review) the implications of high/low breast milk osmolality on infants and how hydration status might affect it.
- To determine whether short-term water restriction/water intake influences the osmolality of breast milk.

HYPOTHESIS

- We hypothesize that there will be an asymmetrical change in breast milk osmolality. There will be a non-significant change in osmolality when women spend 90 minutes abstaining from food and water intake. There will be a decrease in osmolality when women drink 1 liter of water during 90 minutes.

PROJECT OVERVIEW

- Recruitment of 13 lactating women with infants between the ages of 3 and 6 months.
- Women came in twice, once for each condition:
  - Treatment 1: Consumed 1L of water over 90 min.
  - Treatment 2: Abstained from fluid intake for 90 min.
- Breast milk and urine samples were obtained before and after each condition
- Volume of samples were measured, divided into aliquots, and frozen at -20°C
- Samples were brought to room temperature, mixed, and the osmolality measured

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LITERATURE REVIEW

- Breast milk supplies infants with their nutritional needs, including water requirements
- Adequate nutrition from infancy is important for proper growth and development
- Nutritional status of mother influences fat concentration (i.e. energy content), fatty acid composition, and immunological properties of breast milk
- When fed ad libitum, infants regulate food intake on the basis of caloric needs

LITERATURE REVIEW

- Impact of high osmolar milk on infants:
  - Until 6 months of age, infant renal function is more limited, with lower renal concentrating and diluting capacity
  - High osmolar milk means that caloric needs are being met more easily, so infant will stop feeding sooner, thereby reducing fluid intake
  - High osmolar milk may slow the rate of gastric emptying, occasionally leading to hypertonic dehydration and gastroenteritis

LITERATURE REVIEW

- Prentice et al. (1984)
  - Water abstention in 10 lactating women during Ramadan
  - No significant changes in milk volume
  - Milk osmolality decreased by 3.2% during 14-hour fast
- Brown et al. (1986)
  - Hydration status of 40 exclusively breastfed infants in Peru
  - Healthy infants who were exclusively breastfed were able to maintain proper hydration levels in those environmental conditions (maximum home temperature between 26-33°C, relative humidity between 49-96%)

LITERATURE REVIEW

- Ertem et al. (2004)
  - Survey of 129 breastfeeding women during Ramadan
  - By self-report only 28 considered the volume of milk produced to be reduced
- Bjerg et al. (2006)
  - Studied short-term water intake and restriction in Holstein dairy cows while measuring osmolality of blood and milk
  - Osmolality of blood and milk were positively correlated, with milk osmolality lagging 1 hour behind blood osmolality
  - Dehydration was reflected slowly
  - Rehydration was reflected rapidly, with blood decreasing in osmolality within 30 minutes of water intake

LITERATURE REVIEW

- CeSSIAM studies
  - Breast milk osmolality of lactating Guatemalan women ranged from 288 to 448 mOsm/kg, with 90% between +/- 10% of 308 mOsm/kg
  - Lactating women living in rural, semi-rural, and urban areas had an average free liquid intake of 1900 mL/day (vs. the 3100 mL/day of free liquid intake recommended by the Institute of Medicine)
  - Freezing and thawing milk samples alters various assay values, including osmolality. Freezing samples for extended periods of time results in an increase of osmolality.

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POPULATION DESCRIPTIVES

Descriptive (n=13)	Min.	Max.	Mean	Std. Dev.
Subject age (years)	18	32	25.46	4.65
Number of children	1	4	2.06	1.19
Infant age (months) - 61.5% male - 38.5% female	3	6	4.62	1.33

POPULATION DESCRIPTIVES

Descriptive (n=13)		Frequency	Percent
Marriage status			
	Single	2	15.4
	Married	8	61.5
	Divorced	0	0.0
	Widowed	0	0.0
	Cohabitation	3	23.1

POPULATION DESCRIPTIVES

Descriptive (n=13)		Frequency	Percent
Education level			
	None	0	0.0
	Elementary school	7	53.8
	Middle school	0	0.0
	High school	5	38.5
	University	1	7.7

POPULATION DESCRIPTIVES

Descriptive (n=13)		Frequency	Percent
Employment			
	Housewife	10	76.9
	Sales Representative	1	7.7
	Office Worker	1	7.7
	Sales Clerk	1	7.7

SAMPLE DESCRIPTIVES: VOLUME (mL)

Sample	Min.	Max.	Med.	Mean	Std. Dev.
1-L Ingestion					
Breast milk – initial	5.00	122.00	35.00	46.31	40.62
Breast milk – final	3.50	64.00	36.00	32.42	21.11
Urine – initial	30.00	300.00	80.00	130.62	90.45
Urine – final	60.00	600.00	200.00	240.08	156.67
Fluid Restricted					
Breast milk – initial	6.00	71.00	30.00	28.15	22.27
Breast milk – final	4.00	78.00	18.00	30.34	24.80
Urine – initial	28.00	190.00	50.00	72.31	55.20
Urine – final	30.00	230.00	50.00	73.00	61.61

PRE- VS. POST-TREATMENT: CHANGES IN VOLUME (mL)

Sample	Min.	Max.	Med.	Mean	Std. Dev.
1-L Ingestion					
Milk volume	-78.00	45.00	-11.00	-13.88	31.33
Urine volume	-160.00	400.00	150.00	109.46	159.44
Fluid Restricted					
Milk volume	-38.50	48.00	3.50	2.19	22.64
Urine volume	-70.00	180.00	-7.00	0.69	61.17

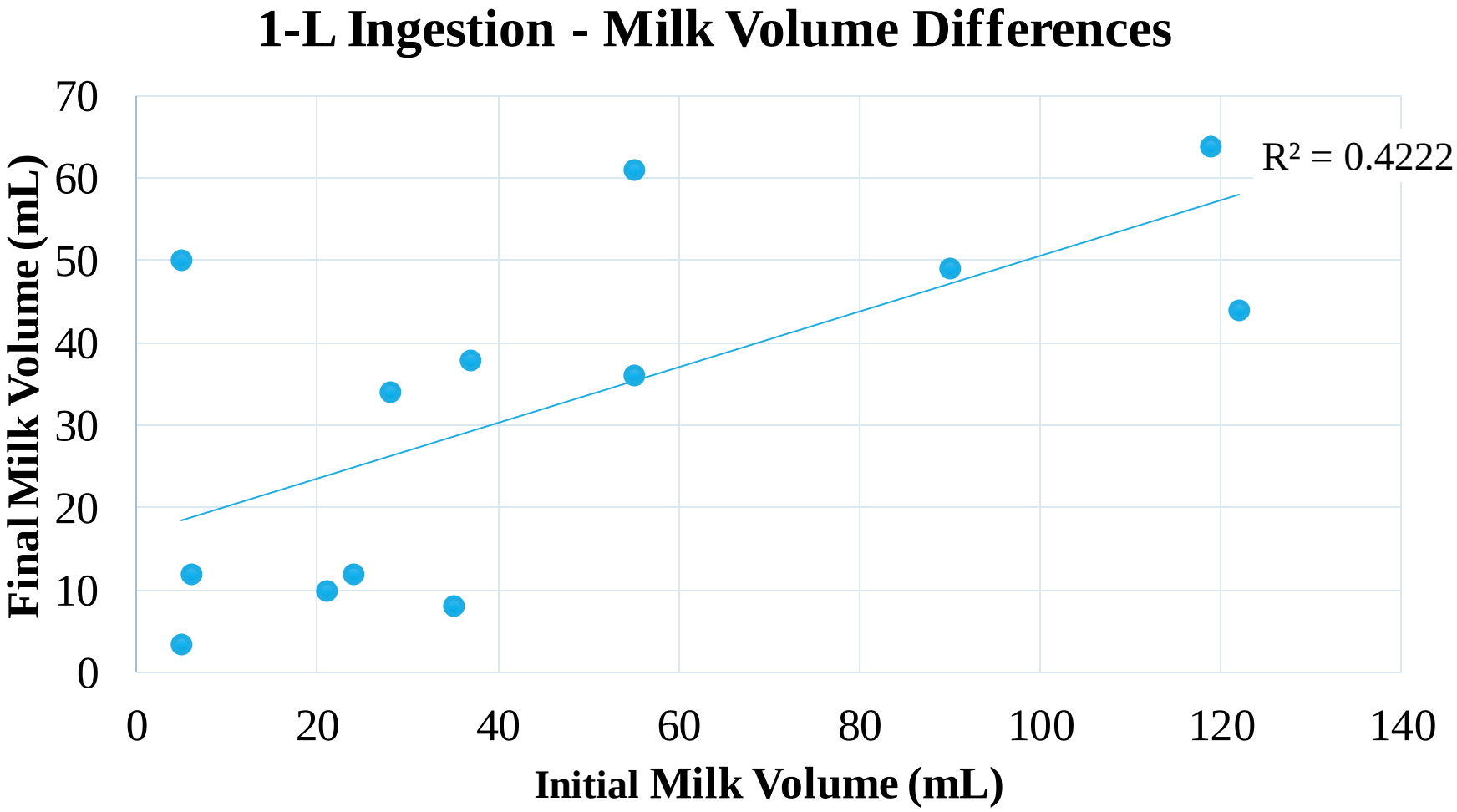
SAMPLE DESCRIPTIVES: OSMOLALITY (mOsm/kg)

Sample	Min.	Max.	Med.	Mean	Std. Dev.
1-L Ingestion					
Breast milk – initial	262.00	304.00	284.00	284.46	14.23
Breast milk – final	252.00	296.00	278.00	276.31	12.79
Urine – initial	201.00	1464.00	637.00	699.92	370.79
Urine – final	80.00	849.00	167.00	271.77	215.02
Fluid Restricted					
Breast milk – initial	254.00	304.00	284.00	283.23	15.23
Breast milk – final	265.00	304.00	280.00	283.77	13.29
Urine – initial	105.00	1375.00	757.00	718.00	351.13
Urine – final	168.00	1712.00	797.00	791.08	440.52

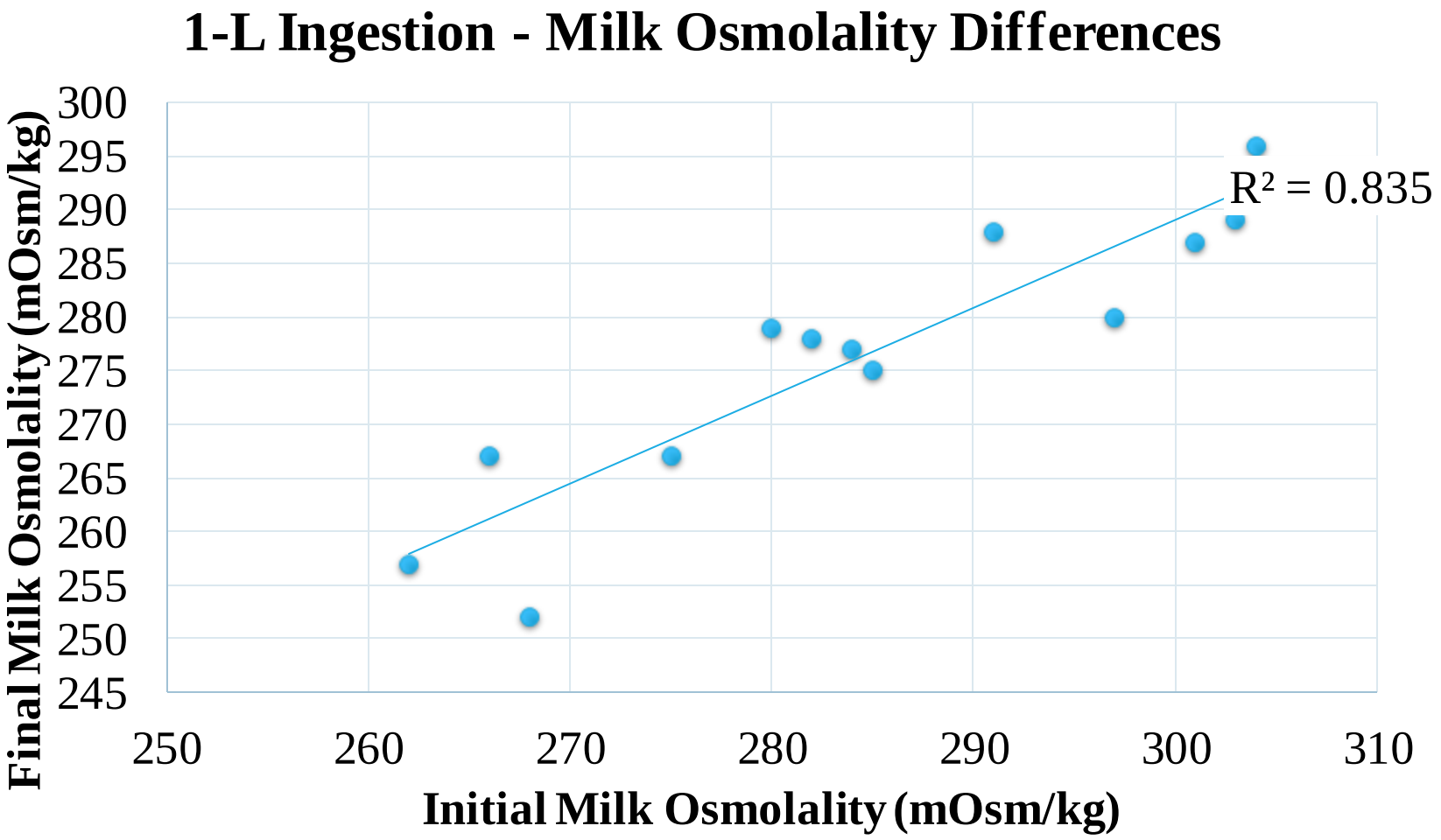
PRE- VS. POST-TREATMENT: CHANGES IN OSMOLALITY (mOsm/kg)

Sample	Min.	Max.	Med.	Mean	Std. Dev.
1-L Ingestion					
Milk osmolality	-17.00	1.00	-8.00	-8.15	5.79
Urine osmolality	-1176.00	-30.00	-404.00	-428.15	285.81
Fluid Restricted					
Milk osmolality	-9.00	-22.00	0.00	0.54	7.80
Urine osmolality	-291.00	337.00	55.00	73.08	168.66

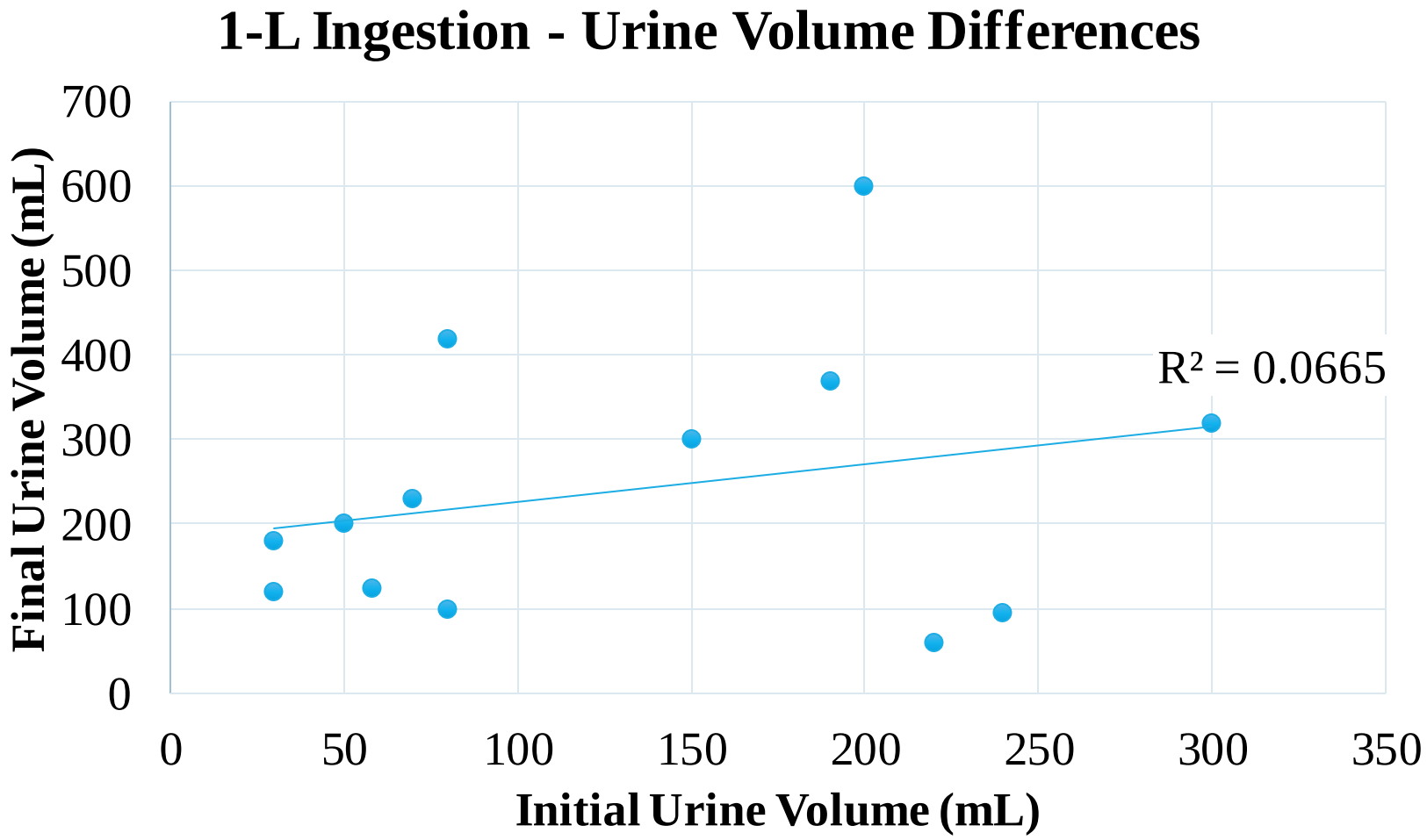
There **was not a significant** difference with 1-L Ingestion in the volume of milk for Initial (M=46.31, SD=40.62) and Final (M=32.42, SD=21.11) conditions; t(12)=1.59, **p=0.136**.



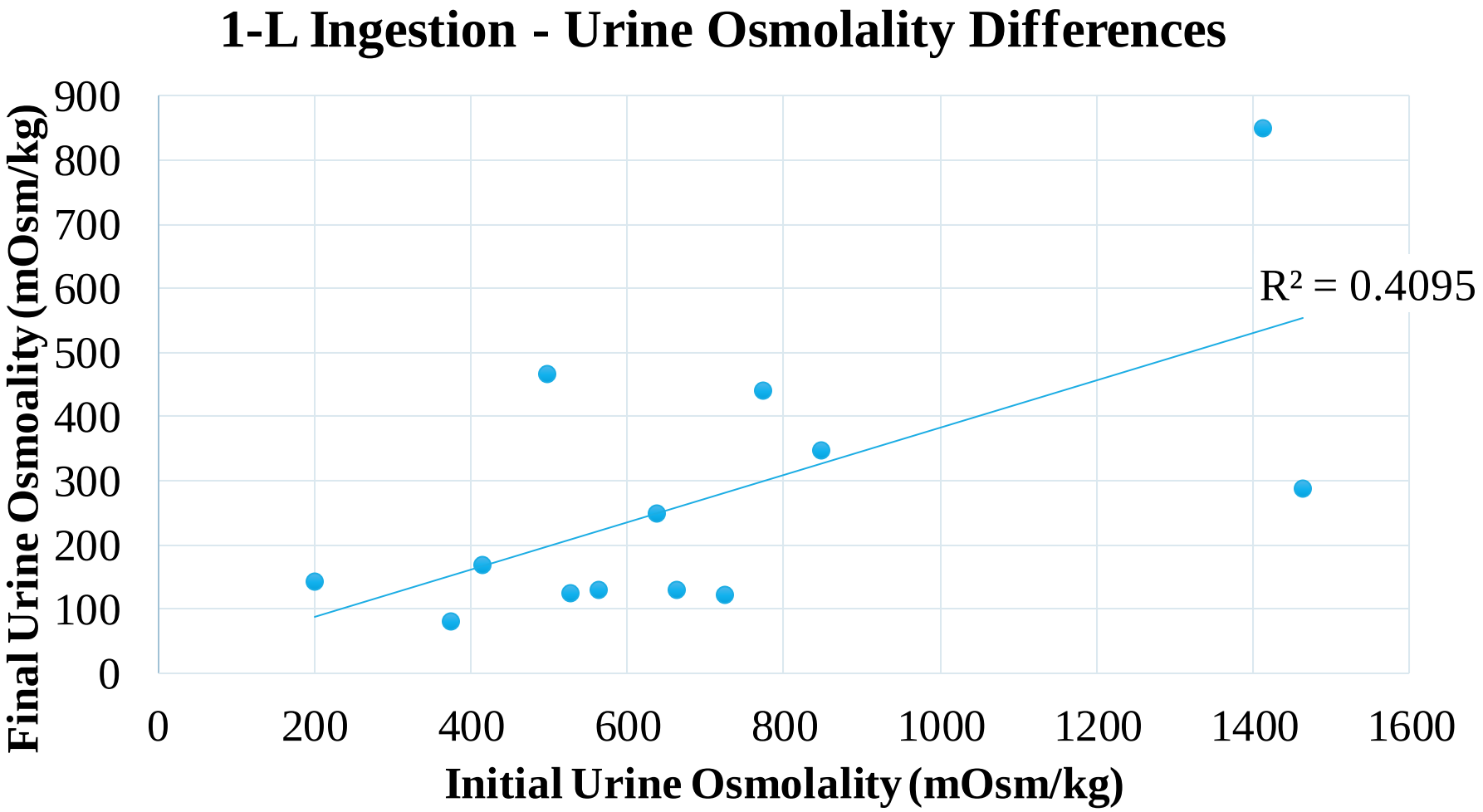
There **was a very significant** difference with 1-L Ingestion in the osmolality of milk for Initial (M=284.46, SD=14.23) and Final (M=276.31, SD=12.80) conditions; t(12)=5.08, **p<0.001**.



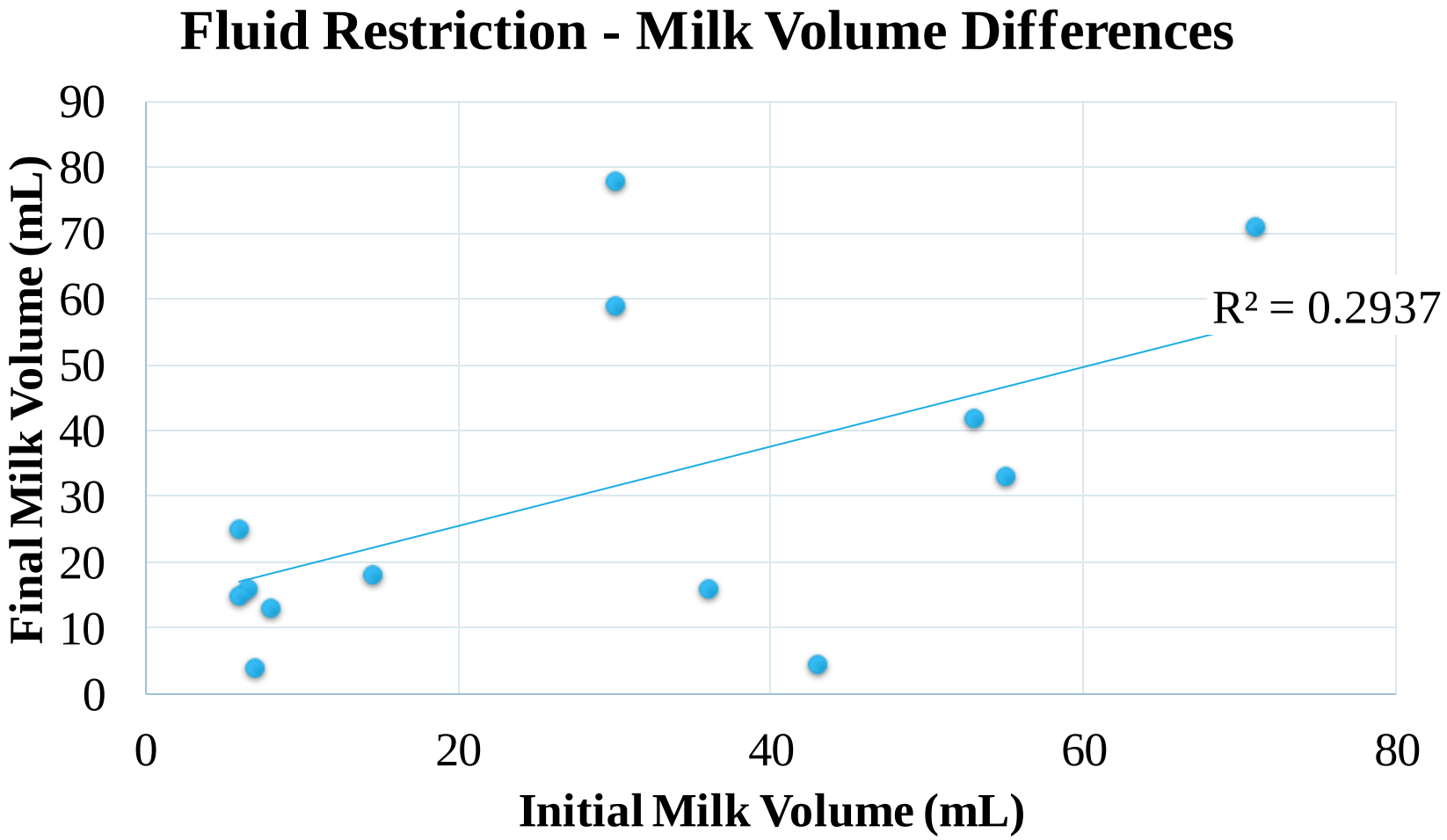
There **was a significant** difference with 1-L Ingestion in the volume of urine for Initial (M=130.62, SD=90.45) and Final (M=240.08, SD=156.67) conditions; t(12)=-2.48, **p=0.029**.



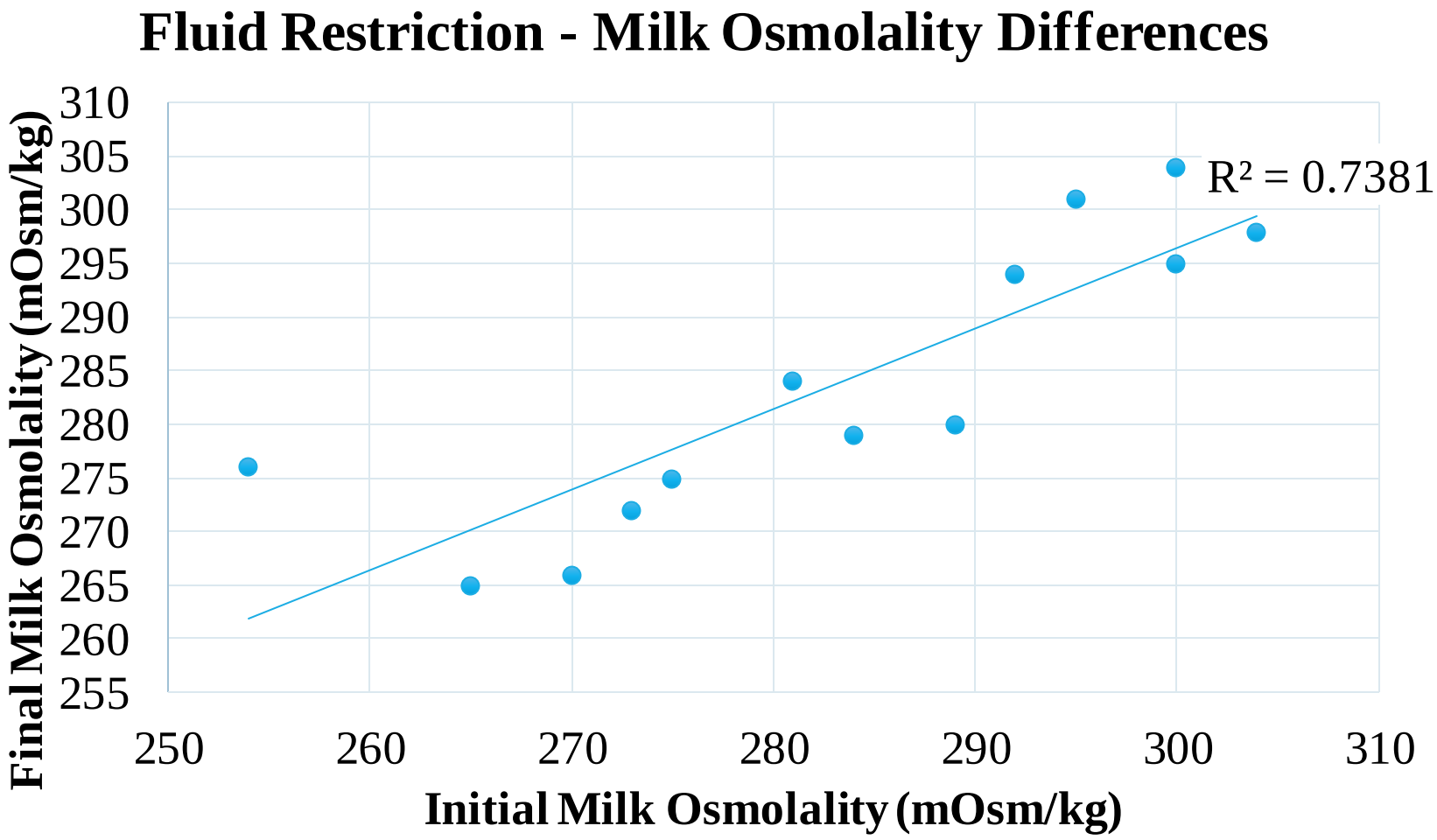
There **was a very significant** difference with 1-L Ingestion in the osmolality of urine for Initial (M=699.92, SD=370.79) and Final (M=271.77, SD=215.02) conditions; t(12)=5.40, **p<0.001**.



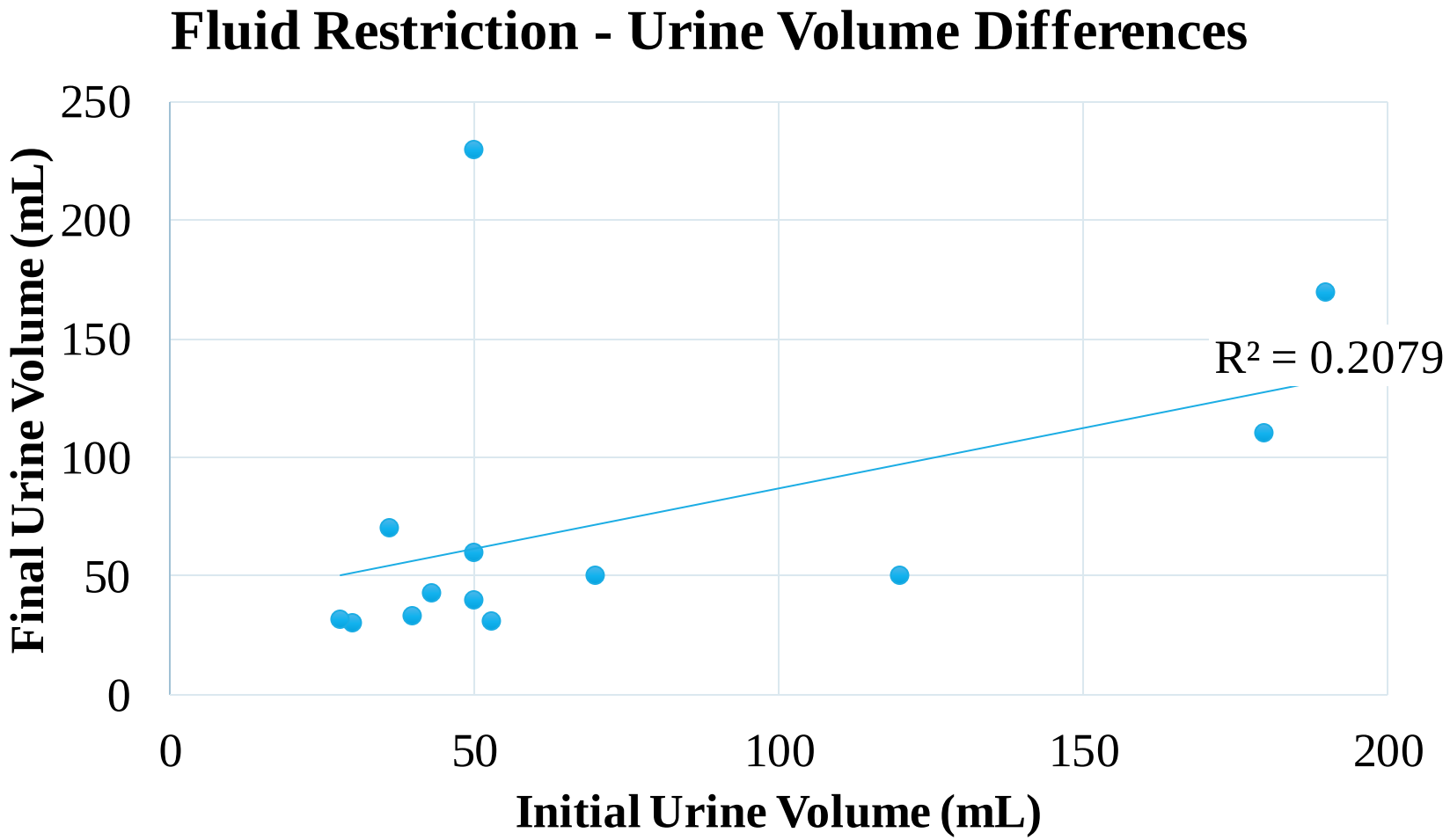
There **was not a significant** difference with Fluid Restriction in the volume of milk for Initial (M=28.15, SD=22.27) and Final (M=30.35, SD=24.80) conditions; t(12)=-0.35, **p=0.733**.



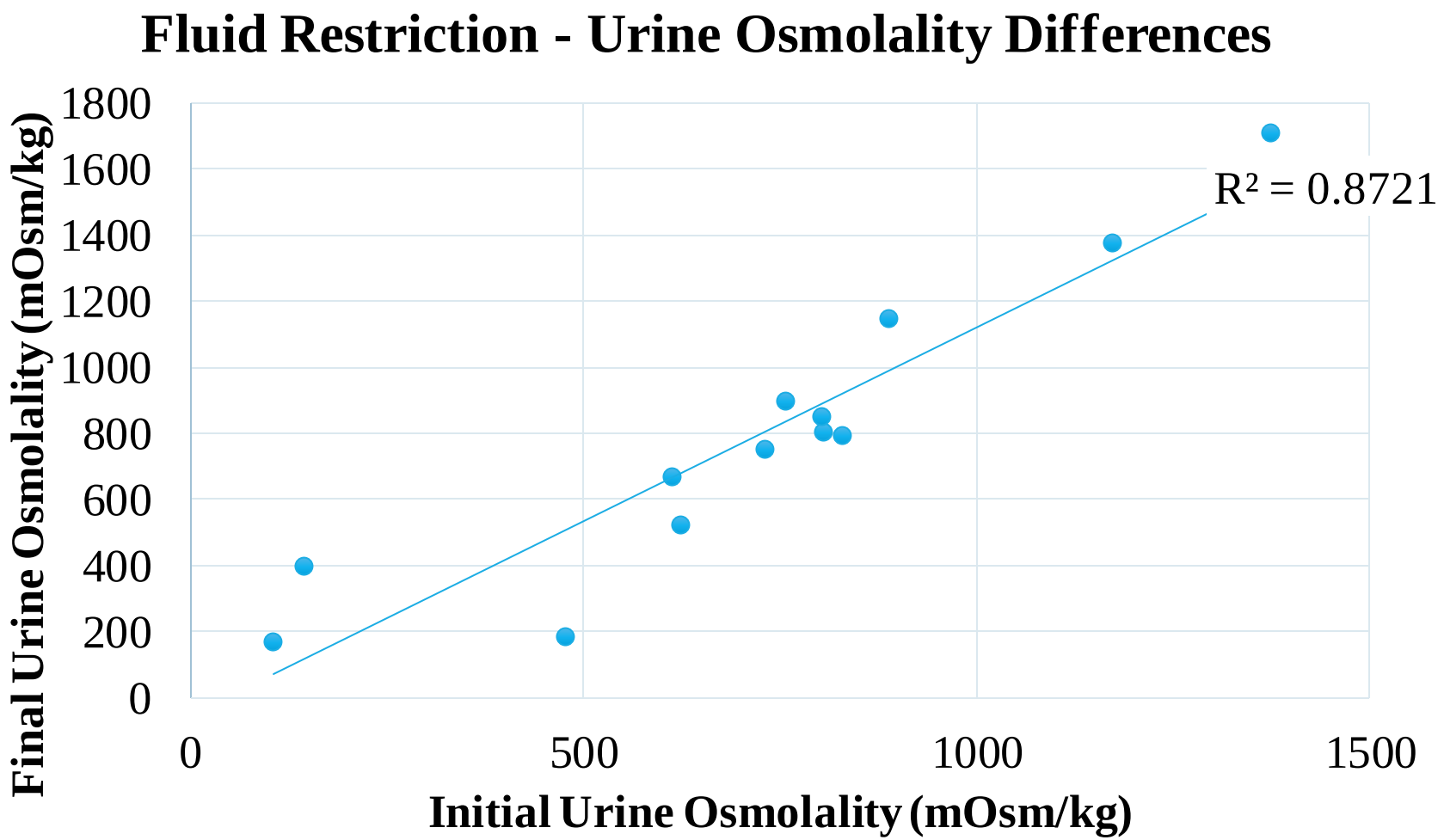
There **was not a significant** difference with Fluid Restriction in the osmolality of milk for Initial (M=283.23, SD=15.23) and Final (M=283.77, SD=13.29) conditions; t(12)=-0.25, **p=0.808**.



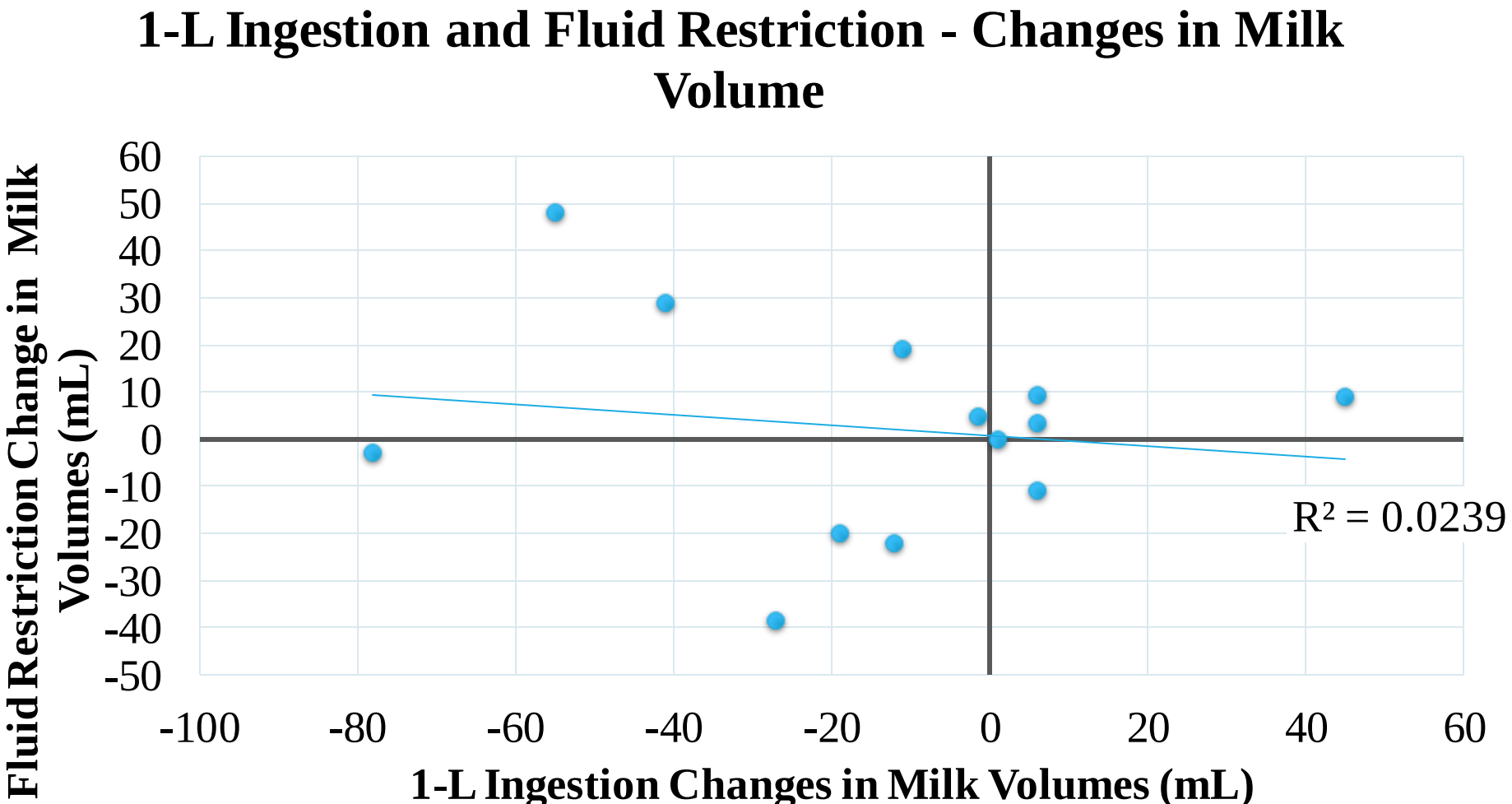
There **was not a significant** difference with Fluid Restriction in the volume of urine for Initial (M=130.62, SD=90.45) and Final (M=73.00, SD=61.61) conditions; t(12)=-0.04, **p=0.968**.



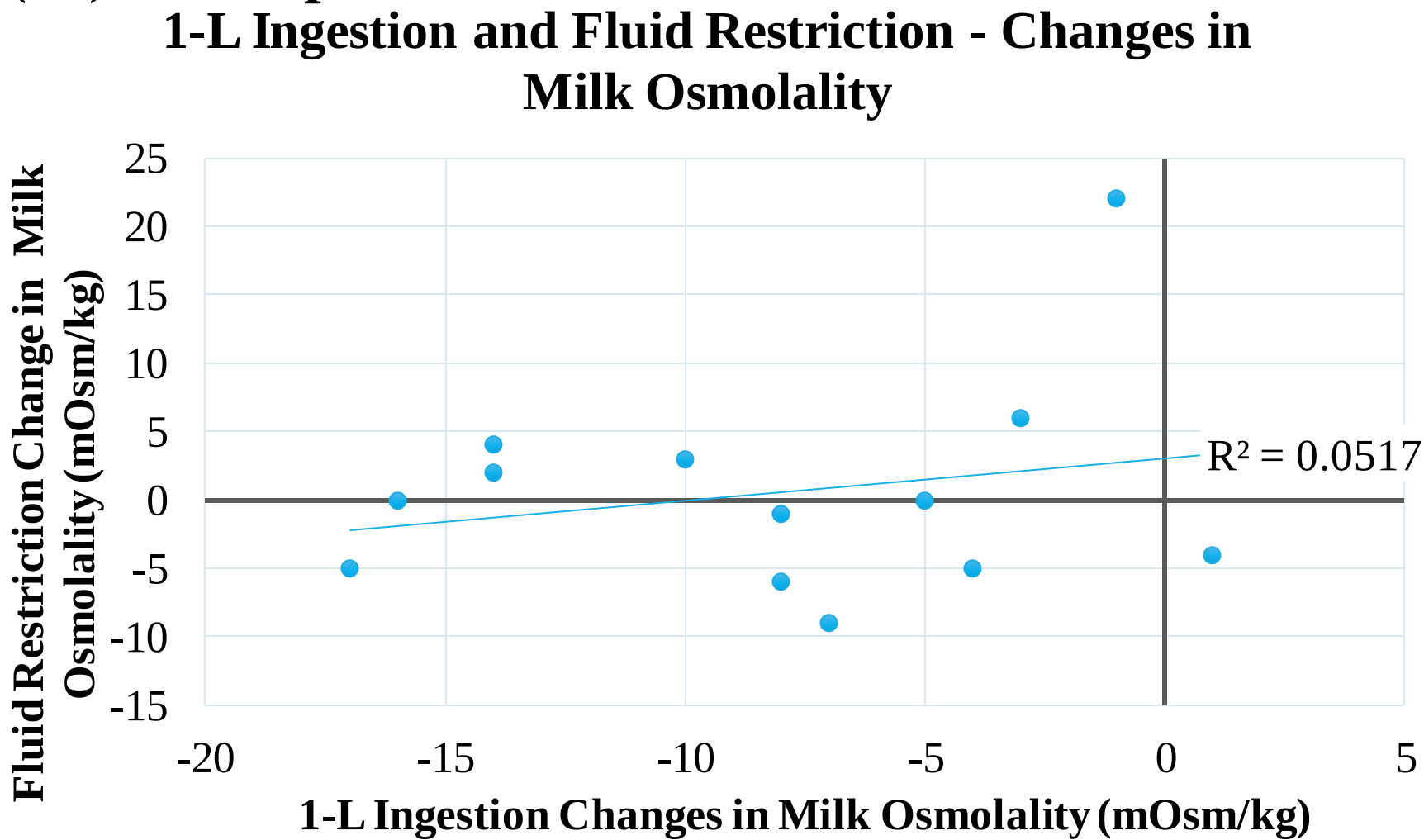
There **was not a significant** difference with Fluid Restriction in the osmolality of urine for Initial (M=718.00, SD=351.13) and Final (M=791.08, SD=440.53) conditions; t(12)=-1.56, **p=0.144**.



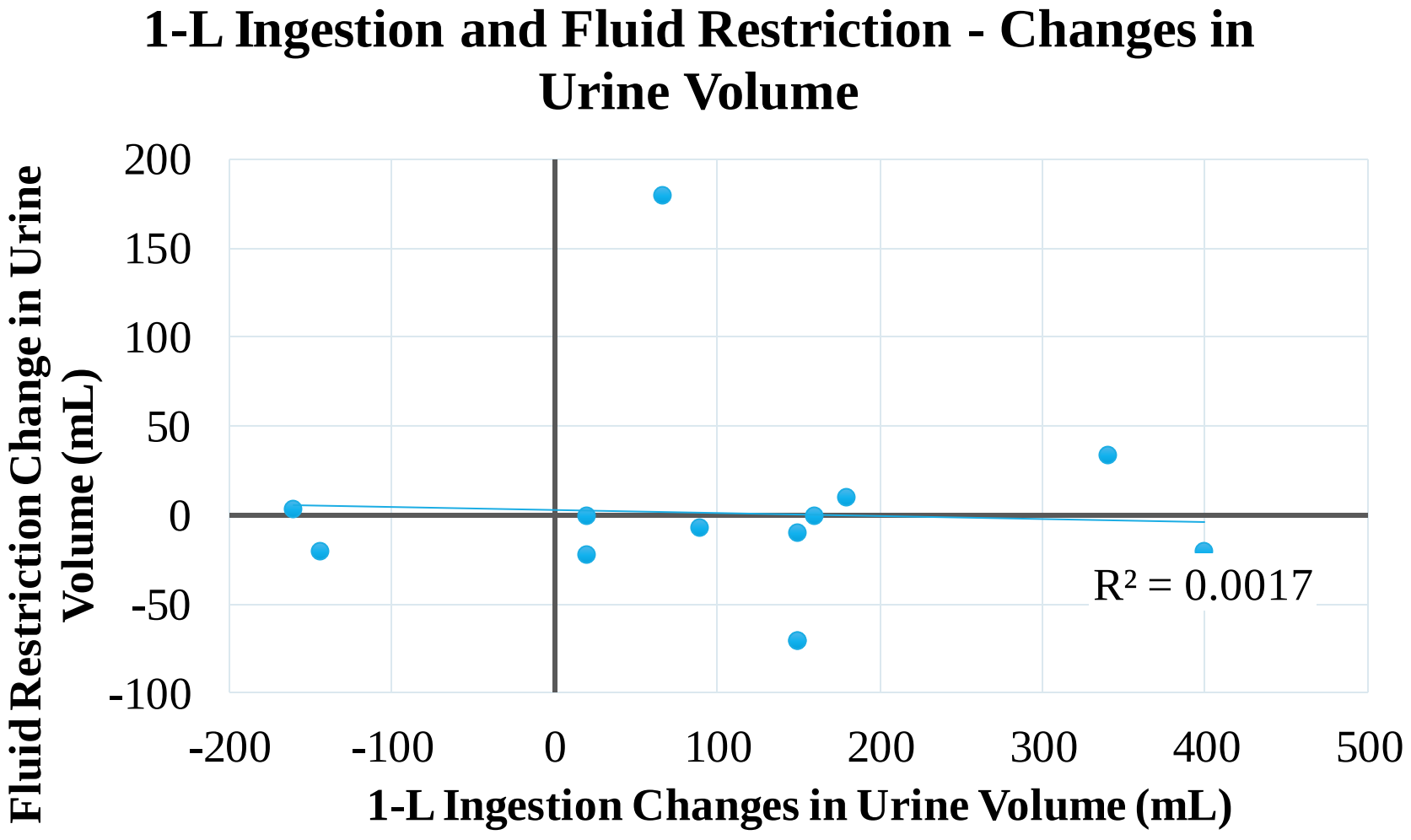
There **was not a significant** difference in the change of milk volume over the course of 1-L Ingestion (M=-13.88, SD=31.33) and Fluid Restriction (M=2.19, SD=22.64); t(12)=-1.40, **p=0.187**.



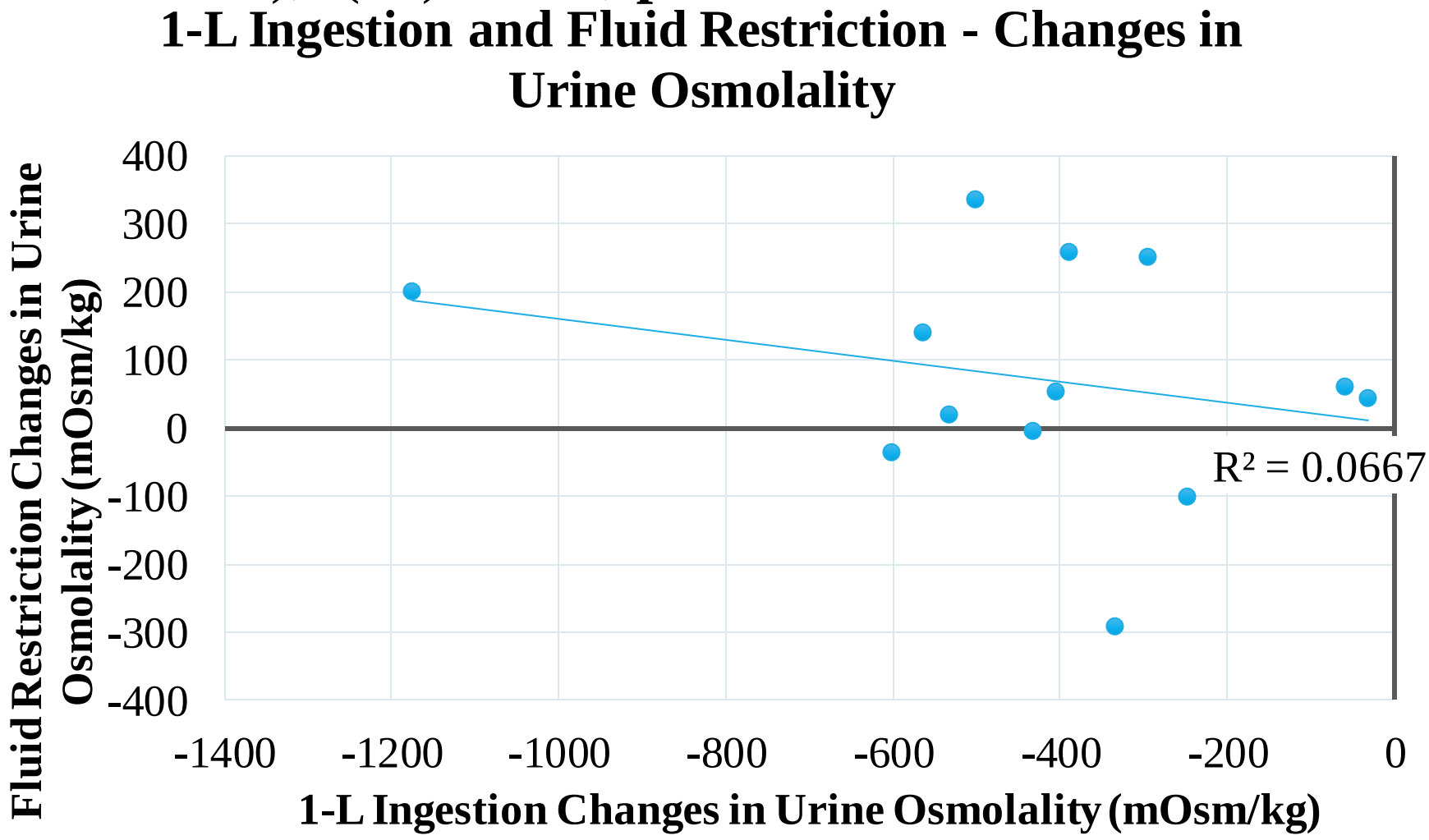
There **was a significant** difference in the change of milk osmolality over the course of 1-L Ingestion (M=-8.15, SD=5.79) and Fluid Restriction (M=0.54, SD=7.80); t(12)=-3.65, **p=0.003**.



There **was a significant** difference in the change of urine volume over the course of 1-L Ingestion (M=109.46, SD=159.44) and Fluid Restriction (M=0.69, SD=61.17); t(12)=2.27, **p=0.043**.



There **was a very significant** difference in the change of urine osmolality during the course of 1-L Ingestion (M=-428.15, SD=285.81) and Fluid Restriction (M=73.08, SD=168.66); t(12)=-4.92, **p<0.001**.



RESULTS

- **There was an asymmetrical change in breast milk osmolality.**
  - Significant difference in milk osmolality before and after 1-L Ingestion ($p<0.001$)
  - No significant difference in milk osmolality before and after Fluid Restriction ($p=0.808$)
- **There was a significant difference between the changes in breast milk osmolality over the course of 1-L Ingestion and Fluid Restriction ($p=0.003$)**

STUDY LIMITATIONS

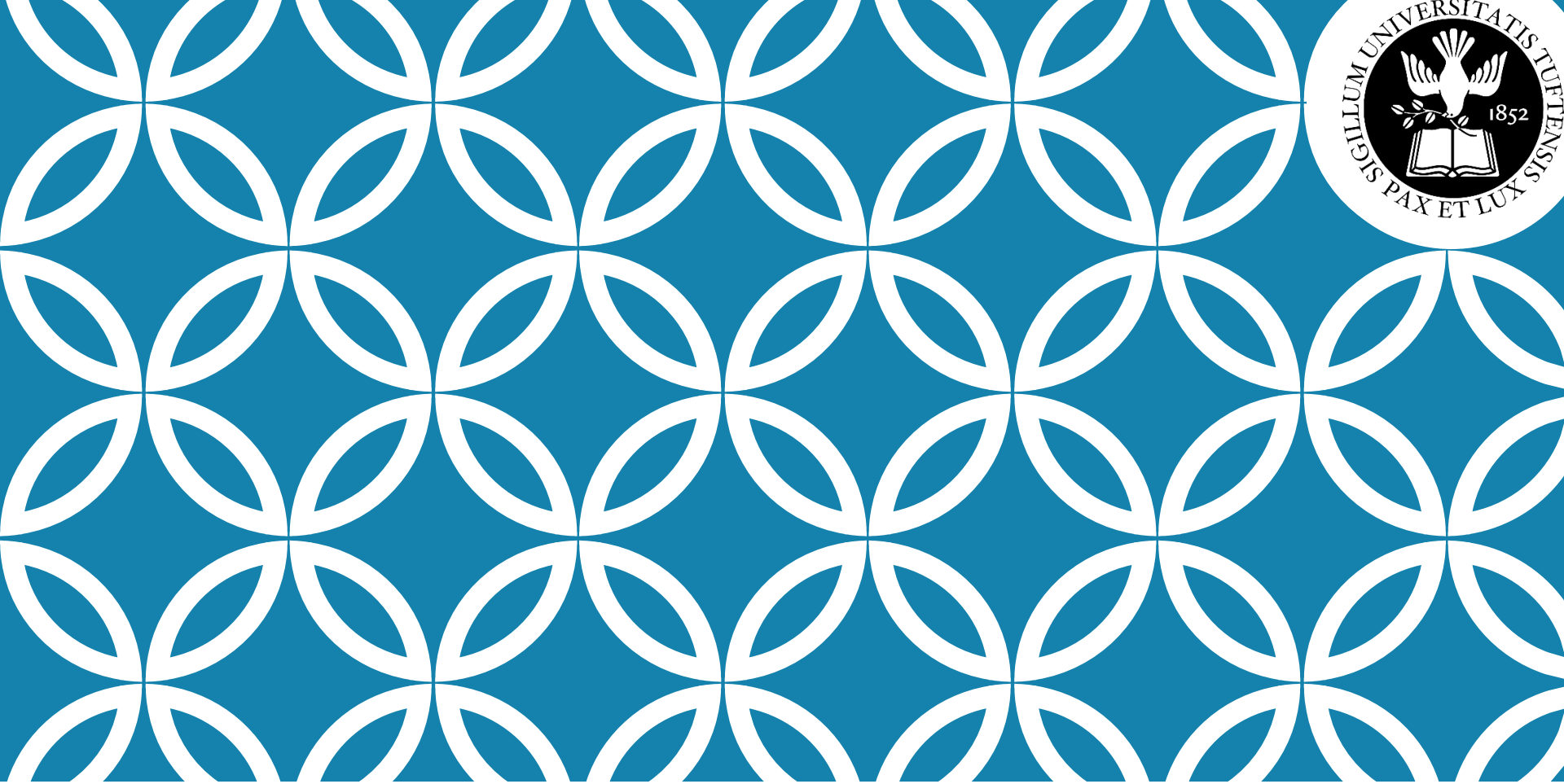
- Time limit of 90 minutes during which to consume 1 liter of water
  - Rate at which water was consumed
  - Temperature of the water
- Challenges in recruiting
  - Characteristics of women at original recruiting location
  - Competing studies
  - Fear and uncertainty

FURTHER STEPS

- Finish collecting data for the remaining 7 women
- Possible future research
  - Osmolality of mixed formula milk in bottle-fed infants
  - Impact of ixbut (*Euphorbia lancifolia*) on milk osmolality
  - Collect and disseminate information on the hydration status of lactating women, with a focus on rural areas
- Educate breastfeeding women on the importance of water intake and adequate hydration

CONCLUSIONS

- Fluid intake does not appear to influence the volume of breast milk, but it does impact that osmolality
- Fluid intake impacts both the volume and osmolality of urine
- More research is needed on the hydration status of lactating women in rural Guatemala



THANK YOU!