ESTIMATION OF LACTATION PERFORMANCE USING URINARY LACTOSE CONTENT

M. ARSHAD HUMAYUN*
SUSAN M. POTTER**
TAJAMMAL HUSSAIN*

SUMMARY: Urinary lactose, creatinine and lactose/creatinine ratios were measured in 9 lactating mothers (at 1, 2, and 3 months postpartum) and 13 non-lactating women. Urinary lactose and creatinine were measured using commercially available kits. Mean urinary lactose content was significantly higher ($P < 0.05$) in lactating mothers than in non-lactating women (2.5 ± 1.8 vs 0.07 ± 0.05 nmol/L). Similarly, mean lactose/creatinine ratios were significantly higher ($p < 0.05$) in lactating mothers than in non-lactating women (0.31 ± 0.17 vs. 0.01 ± 0.01). The creatinine contents of lactating and non-lactating women were not significantly different ($p > 0.05$). Increased breastfeeding frequency (7.4 ± 1.7 times/day) resulted in increased lactose/creatinine ratios in lactating women. It is concluded that lactose creatinine ratios can be used for the estimation of lactation performance in lactating mothers.

Key Words: Lactation performance, lactose, creatinine, ratio.

INTRODUCTION

The primary function of human milk is to provide nutrients for the growth of infants and it is claimed that the ultimate test of adequacy of lactation in any mother is the growth and health of infant (1). Thus the evaluation of lactation performance is of fundamental importance to the health workers especially in developing countries. The present day lactation performance methods are either inadequate and insensitive or are invasive and difficult to perform.

The simplest qualitative measure of lactation performance is the duration of lactation. However, the existing information on the duration of breastfeeding is inadequate and all trends of infant feeding practices in developing world cannot be established (2).

Time of introduction of supplementary foods is also considered a measure of lactation performance. However, both in developed and developing countries there is considerable difference in the time after birth at which the supplementary foods are introduced and hence is not a particularly sensitive indicator of lactation performance. Moreover, time of supplementary food introduction depends more on beliefs than on nutritional needs.

*From Department of Human Nutrition, NWFP Agricultural University, Peshawar, Pakistan.
**From Division of Food and Nutrition, University of Illinois, Urbana Champaign, USA.

Table 1: Mean urinary lactose, creatinine, and lactose/creatinine ratios and breastfeeding frequencies of lactating and non-lactating women.

	Lactose (nmol/L) (Mean ± SD)	Creatinine (nmol/L) (Mean ± SD)	Lactose/Creatinine ratios (Mean ± SD)	Breastfeeding Frequency (Time/day)
Lactating women (n = 19)*	2.5 ± 1.8[a]	8.9 ± 5.6	0.31 ± 0.17[a]	7.4 ± 1.7[a]
Non-lactating control (n = 3)	0.07 ± 0.05	8.1 ± 5.9	0.01 ± 0.01	00 ± 00

* Nineteen urine samples of nine lactating subjects from 1-3 months postpartum.

a Mean differs signifcantly from control mean ($P < 0.05$).

Measures of lactational performance that rely on infant's growth are difficult to use because of many unsolved questions about valuable growth standards. Seward and Serdula (3) in a critical review of relationship between infant feeding and infant growth pointed out that the available growth references are based on infants who are predominantly bottle-fed, were introduced too early to solid foods and grew faster than breastfed infants on the first 6 months of life. Therefore they raised questions about the use of these references for exclusively breastfed infants, infants who are small of gestational age and for infants in developing countries.

Daily milk volume may be the most sensitive indicator of lactation performance (4). The most common method used for the determination of milk yield in women is test-weighing of women before and after nursing (5). Total expression of breasts is also used to estimate daily milk volume. However, both these methods are rather invasive and disrupt the natural feeding routine, and when used in large population studies, they are inherently subject to wide range of error as a result of low compliance and low motivation (6).

Finally the assessment of lactation performance by measuring composition of milk is also difficult (3,7) due to large normal ranges for most milk components.

Recently, Strand and Johnston (6) found that urinary lactose/creatinine ratio was significantly higher in lactating than in non-lactating women. Thus urinary lactose/creatinine ratio can be used as a simple and non-invasive method for lactation performance. The purpose of the present study is to confirm higher concentrations of urinary lactose in lactating versus non-lactating women and to correlate the infant feeding frequencies with urinary lactose excretion.

MATERIALS AND METHODS

Characteristics of subjects and infant feeding record

The lactating subjects were recruited at the local hospital in Urbana-Champaign (USA) during September, 1992. Only those subjects were recruited who were free from medical illness and substance abuse. A written consent form was signed by all the women at the start of the study. Nineteen single, random urine samples were collected from 9 lactating mothers at 1, 2 and 3 months postpartum. Non-lactating controls were recruited from local university population. Thirteen single, random urine samples were collected from 13 nonlactating women. Infant feeding records were obtained through a questionnaire. In the questionnaire mothers have to fill in total time and frequency of breastfeeding for each of three days before giving the urine samples.

Urine sample analysis

1. Lactose Determination

Urinary lactose was measured through a commercially available lactose/galactose kit (Catalog # 1767303, Boehringer Mannheim, Indianapolis, USA). The kit also included standard lactose solution for quality control. Strand and Johnston (6) confirmed that Bohringer Mannheim kit performed consistently during 6 months shelf life, inspite of repeated warming for use (mean interassay variation of purchased standards ± 2%). Lactose and galactose concentrations were stable for 6 months in urine stored at either 4°C or

20°C. The analysis were conducted in duplicate and standard curve was developed for lactose concentration in urine. The urinary lactose cocentration as obtained with mathematical formula were similar to those obtained through the standard curve.

2. Creatinine Determination

The creatinine in the urine was measured through a commercially available kit (Catalog No. 555, Sigma, St. Louis, USA). The kit contained standards for quality control. Manufacturer reported that urine containing thymol or toluene is stable for 2-3 days at room temperature (18-26°C) or at least 5 days refrigerated (2-8°C). The present study showed that creatinine contents of refrigerated urine, frozen urine samples containing toluene (1 ml/20 ml urine) and frozen urine samples without toluene were not significantly different ($p > 0.05$). All the analysis were done in duplicate and standard curve was determined for creatinine. The concentrations of toluene as obtained with mathematical formula were similar to those obtained through standard curve.

RESULTS AND DISCUSSIONS

Urinary lactose, creatinine and lactose/creatinine ratios of lactating and non-lactating women are shown in Table 1. Mean urinary lactose and lactose/creatinine ratios were significantly higher ($p < 0.05$) in lactating than in non-lactating women. Mean urinary creatine levels were not significantly different ($p > 0.05$) in lactating and non-lactating women.

Arthur *et. al.* (8) found that circulating lactose levels were less than 5 uM during prepartum period and in the week following birth lactose concentrations were markedly increased upto 130 uM. They concluded that the changes in lactose in plasma of women may provide information on secretory activity of mammary gland. Similarly Whitely *et. al.* (9) found that at parturation of sows the concentration of lactose in plasma rose to 102.8 ± 15.7 uM and peaked 6 hour later at 186.4 ± 56.1 uM. Hence, plasma lactose can be used as an indicator for the initiation of lactation in sows. Moreover, milk lactose concentrations remain quite stable to milk nitrogen or fat concentrations (10) and milk lactose levels parallels milk volume (11). Strand and Johnston (6) showed that mean urinary lactose and lactose/creatinine molar ratios were significantly higher ($p<0.05$) in lactating than in non-lactating women. The results of the present study also indicated that lactating women have significantly higher ($p < 0.05$) concentrations of urinary lactose and lactose/creatinine ratios as compared to non-lactating women. Hence, on the basis of the results of the present study and previous studies it can be concluded that urinary lactose and lactose/creatinine ratios can be used for the estimation of lactation performance in lactating mothers.

Breastfeeding Frequency

Mean nursing frequency for lactating mothers was 7.4 ± 1.7 time/day (Table 1). Since the lactose/creatinine ratios were higher in lactating than in non-lactating women therefore it can be concluded that high nursing frequency resulted in increased milk production.

De Carvalho *et. al.* (12) reported that during the first two weeks after delivery the infants of mothers who nursed more frequently took more milk and had significantly gained more weight from birth as compared to control group in which the mothers nursed their infants on 3-4 hour schedule. Similarly Rattigan *et. al.* (13) studying 27 nursing mothers found a significant correlation between nursing frequency and milk production. Data in animals also suggested that sucking stimulates the development of receptors to prolactin and the number of receptors per cell increase in early lactation and remain constant thereafter (14,15). Strand and Johnston also showed that mean lactose/creatinine ratios for frequently nursing mothers were significantly higher than that of minimal nursing mothers. The present study also showed significantly higher lactose/creatine ratios in more frequently lactating mothers and it can be concluded that higher nursing frequency increases milk yield.

CONCLUSION

The urinary lactose/creatinine ratios can be used for estimating lactation performance in lactating mothers. It is a non-subjective and non-invasive measure which can be easily obtained. However, more detailed

longitudinal and crossectional studies are needed to correlate data from test-weighings of infants and breast-feeding expression methods with urinary lactose/creatinine ratios in order to validate this method.

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Correspondence:
Tajammal Hussian
Department of Human Nutrition,
NWFP Agricultural University,
Peshawar, PAKISTAN.