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ORIGINAL COMMUNICATION

Pulque intake during pregnancy and lactation in rural Mexico: alcohol and child growth from 1 to 57 months

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Objective: To examine maternal intake of a mildly alcoholic beverage (*pulque*) during pregnancy and lactation, and its potential effect on postpartum child growth and attained size.
Design: A prospective cohort study that followed mothers (during pregnancy and lactation) and their offspring (from birth to approximately 57 months of age).
Setting: Six villages in rural, central Mexico.
Subjects: Subjects are 58 mother–child pairs. *Pulque* intake was measured as part of a dietary assessment that was conducted for 2days/month during pregnancy and early lactation.
Results: Most mothers consumed *pulque* during pregnancy (69.0%) and lactation (72.4%). Among *pulque* drinkers, the average ethanol intake was 125.1 g/week during pregnancy and 113.8 g/week during lactation. Greater *pulque* intake during lactation, independent of intake during pregnancy, was associated with slower weight and linear growth from 1 to 57 months, and smaller attained size at 57 months. Low-to-moderate *pulque* intake during pregnancy, in comparison to either nonconsumption or heavy intake, was also associated with greater stature at 57 months.
Conclusions: *Pulque* intake during lactation may have adversely influenced postnatal growth in this population. Public health interventions are urgently needed in Mexico to reduce heavy intake of *pulque* by pregnant and lactating women, and to replace intake with foods that provide the vitamins and minerals present in the traditional alcoholic beverage.
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Introduction

Pulque has been consumed for thousands of years in central Mexico and remains popular in many communities (Super & Vargas, 2000). The mildly alcoholic beverage (~4–6% ethanol by volume) is consumed at meals by men, women and children, and is often a central feature of festive occasions such as weddings, birthdays and religious holidays. The beverage is popularly believed to have curative and health-promoting properties, and is often consumed postpartum with the goal of enhancing milk production (Villalpando *et al*, 1993). In some areas, *pulque* intakes can be considerable: the average household *pulque* intake in rural areas has been estimated to be 6.4 l/week, while in urban areas the traditional beverage contributes approximately 9% of all alcohol consumed (Medina-Mora *et al*, 2000). Pasteurized *pulque* in aluminum cans has recently become available in supermarkets throughout Mexico, and the product is exported to the US. Because this alcoholic beverage is commonly consumed by many thousands of pregnant and lactating women, *pulque* intake is of great public health significance in Mexico.

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Laboratory analyses show 0.5 l of *pulque*, the amount most commonly consumed at a sitting by women at the current research site (the Solís Valley), contains approximately 24 g of ethanol, 900 kJ (215 kcal), and several vitamins and minerals, including ascorbic acid (30 mg), thiamin (0.1 mg), riboflavin (0.1 mg) and iron (3.5 mg) (Backstrand *et al*, 2001). Epidemiological analyses show *pulque* was the most important source of ascorbic acid and the third most important source of iron among Solís Valley women in the 1980s (Backstrand *et al*, 2002). Additionally, greater *pulque* intake was associated with reduced risk of low iron stores (serum ferritin) and anemia (low hemoglobin). A high correlation between *pulque* intake and serum folate suggested that the traditional beverage might also be an important source of dietary folates. Therefore, both epidemiological and laboratory data suggest that *pulque* has the potential to positively influence the nutritional status of mothers in this undernourished population. Unfortunately, the beverage also contains significant quantities of alcohol.

Earlier, we examined the potential effect of maternal *pulque* intake during pregnancy on child growth, and identified curvilinear associations between *pulque* intake during pregnancy and infant length (at 1 and 6 months) after adjustment for potential confounders (Backstrand *et al*, 2001). The longest children were associated with *pulque* intakes in the range of 335 to 460 kJ/day (61–84 g/week of ethanol), while intakes above and below these values were associated with shorter length. In contrast, weight (1 and 6 months) and growth (from 1 to 6 months) showed little association with *pulque* intake during pregnancy. Bayley mental scores at 6 months also exhibited a curvilinear association with prenatal exposure to *pulque*.

The current paper examines the potential influence of maternal *pulque* intake during pregnancy and lactation on children's attained size at greater age (at 57 months), and on physical growth between 1 and 57 months. The analyses employ data collected by the Mexico Collaborative Research Support Program in Human Nutrition (NCRSP), a prospective cohort study that examined the diets of pregnant mothers and the growth of their subsequent infants (Allen *et al*, 1992). We supplement these data with follow-up anthropometry on these infants at approximately 57 months of age. The analytic sample is comprised of 58 children, 43 of whom had provided data for our prior article on *pulque* and infants (Backstrand *et al*, 2001).

Subjects and methods

The Mexico nutrition CRSP and follow-up study

Data on women and their infants were collected by the Mexico NCRSP between 1984 and 1986 (Allen *et al*, 1992). This prospective cohort study was a collaboration between the *Instituto Nacional de la Nutrición Salvador Zubirán* (INNSZ) in Mexico City and the University of Connecticut. Research protocols were approved by committees on the use of human subjects at both institutions. In January 1990, a follow-up study of Mexico NCRSP infants included observations of linear enamel hypoplasias and measurements of heights and weights. The human subjects committees of Hampshire College and INNSZ approved this second project.

The Solís Valley

Subjects were residents of six small villages located in the Solís Valley, a rural area in central Mexico at an altitude of approximately 2400 m. At the time of study, the principal economic activities in these communities were subsistence maize agriculture and low-skill wage labor. Maize tortillas were the principal source of energy for most individuals, and this core food was supplemented by a mix of purchased and gathered foods (Backstrand, 1990; Allen *et al*, 1992).

Subjects

The analytic sample is comprised of 58 mother–infant pairs for whom we had information on maternal diet during pregnancy and child anthropometry at 1 and 57 months. These infants represent a subset of the 125 births that occurred in the project villages between October 1984 and November 1985; all these mother–infant pairs were eligible for inclusion in the study. Of the 125 mother–infant pairs, 108 (86.4%) participated in the study, and all these received routine prenatal care at the Solís clinic. Nonparticipation in the study was largely due to logistical issues. Of these 108 pairs, 95 (87.9%) contributed data on the mother's diet (during pregnancy and lactation) and infant anthropometry at 6 months. The follow-up sample ($N = 58$) represents 46.4% of all births and 61.0% of those with diet and anthropometry data. Attrition between 1984–1986 and 1990 was largely due to migration to other areas of Mexico and North America, and to the difficult logistics of arranging measurements during a 3-day period in January 1990. Subjects and nonsubjects ($N = 67$) did not differ statistically by community, sex, household material wealth, household energy needs, maternal education, or the proportion of time that the male was present in the household. However, subject mothers tended to be somewhat older than nonsubjects ($P = 0.0464$). Of the 58 pairs in the present sample, 43 (74.1%) were in the analytic sample of 70 mother–infant pairs that was employed in our prior paper on *pulque* intake and infant size and psychomotor development (Backstrand *et al*, 2001).

Data collection and variable measurement

Anthropometry. Details of the anthropometric measurement techniques have been described in detail elsewhere (Backstrand *et al*, 2001). Maternal measures were scheduled for monthly collection, while infant weights, lengths, skinfolds and circumferences were measured at birth, 8 days, and monthly thereafter until 8 months. In the follow-up study, weights and heights of the children at a mean age of

57 months were obtained by a trained nurse at the Solís clinic under the supervision of one of the authors (AHG). WHO/NCHS *Z*-scores were calculated using a SAS program that employed algorithms published by Dibley *et al* (1987). Growth from 1 to 57 months was measured as residual size when 57 months weight or length was regressed on the comparable 1 month measure.

Maternal *pulque* intake

Maternal *pulque* and alcohol intake were calculated from dietary intake data. Details of the dietary methodology have been presented elsewhere (Backstrand *et al*, 2002). Dietary measurement was scheduled for two consecutive 24 h periods on a monthly basis. At the time of the last dietary data collection, infants were 253 ± 75 days postpartum. Mothers had 9.5 ± 5.8 days of dietary data during pregnancy, and 11.2 ± 1.8 days during lactation.

All recorded alcohol intake came from *pulque*. Daily ethanol intakes were estimated using a value of 47 g of ethanol per 100 ml of *pulque*, the midpoint of the range (29–65 g/100 ml) reported by Steinkraus (1996). *Pulque* intake was expressed as energy intake per day and alcohol intake per week. *Pulque* consumption was also expressed as (1) mean alcohol intake per drinking day (ie, days when *pulque* was consumed), (2) the mean alcohol intake per drinking event, (3) the percentage of days that *pulque* was consumed, (4) the percentage of days with heavy drinking (>40 g/day of alcohol), and (5) the mean number of drinking events per drinking day.

Potential confounders

The multivariate analyses examined the influence of several potential confounders, including the gender of the child, child age at anthropometry measurement, child birth order, maternal age and height, maternal energy intake during pregnancy, maternal education (years of schooling), and household material wealth. The household material wealth measure is derived from information on ownership of material goods and house construction (Backstrand, 1990). Household material wealth has been a good predictor of household and individual food intake in this population (Backstrand, 1990; Backstrand *et al*, 1997). Intercorrelations among these potential confounders have been presented elsewhere (Backstrand *et al*, 2001). The analyses also examined the potential influence of a range of maternal and infant nutrient and dietary intake variables.

Statistical methods

All statistical analyses were performed using SAS v. 8.2 (SAS Institute, Cary, NC, USA). Multiple regression was used to model attained size at 57 months and growth between 1 and 57 months. The adequacy of the multiple regression models was assessed using residual plots and influence statistics. All variance inflation factors (VIF) for the regression analyses were well under three, which indicates that multicollinearity (a concern given the small sample size and the number of control variables) was not excessive (Kleinbaum *et al*, 1988). All correlations presented are Spearman's rank-order correlations. PROC LOESS, which employs a locally weighted regression technique (loess), was used to illustrate the curvilinear relationships between *pulque* intake and child size and growth (Cohen, 1999).

Results

Characteristics of mothers and children

Table 1 provides the ages and WHO/NCHS *Z*-scores of the 58 children (28 girls and 30 boys) at two points in time. At 1 month, the children were already relatively short in stature, although of average weight-for-age; weights-for-length were well above the reference median. By 57 months, mean heights-for-age and weights-for-age had declined substantially. At this age, more than half of the children (52.7%) were stunted and nearly a quarter (24.1%) were underweight. One child (1.7%) met the criteria of wasted.

At parturition, most mothers were in their late 20s or early 30s. Mothers were relatively short, and of normal BMI at ~30 days postpartum. Most mothers (94.8%) had older, living children, and levels of education were generally quite low: 11 mothers (19.0%) reported no schooling and 26 (44.8%) reported 1–2 y of schooling. Only six mothers (10.3%) reported 6 or more years of school.

Maternal *pulque* intake

During pregnancy, more than 2/3 (69.0%). of women reported alcohol consumption during pregnancy——all in

Table 1 Distribution of maternal and infant characteristics ($N = 58$)

Infant		*Mean*	*s.d.*
Age	1 mo	1.1	0.2
	57 mo	57.0	4.0
Stature-for-age *Z*	1 mo	−0.99	0.85
	57 mo	−1.95	0.91
Weight-for-age *Z*	1 mo	−0.19	0.68
	57 mo	−1.30	0.85
Weight-for-stature *Z*	1 mo[a]	0.68	0.58
	57 mo	−0.15	0.71
Mother			
Age (y)		30.4	6.2
Height (cm)		152.5	5.5
Weight (30 days postpartum)(kg)[b]		57.1	7.9
BMI (30 days postpartum)[b]		24.6	2.9
Number of living children		4.6	2.7
Years of schooling		2.3	1.8

mo, months.
[a]$N = 52$.
[b]$N = 57$.

the form of *pulque*. Among the *pulque* drinkers ($N=40$), the median ethanol intake was 125.1 g/week. In all, 30% of drinking mothers consumed more than 200 g/week of ethanol, and two mothers reported consuming more than 400 g/week of ethanol. Among drinkers, greater *pulque* intake per day was associated with a higher percent of drinking days ($r=0.88$, $P<0.0001$), a larger proportion of days with heavy drinking (>40 g/day of alcohol) ($r=0.88$, $P<0.0001$), more *pulque* consumed per drinking day ($r=0.75$, $P<0.0001$), multiple drinking events per day ($r=0.63$, $P\leq 0.0001$), and a greater quantity consumed per drinking event ($r=0.45$, $P=0.0039$). Average ethanol intake per sitting was 23.5 g, or slightly less than the alcohol present in two American beers ($\sim$26 g).

During lactation, 72.4% of mothers reported *pulque* consumption. As might be expected, *pulque* intake during pregnancy and lactation were highly correlated ($r=0.69$, $P<0.0001$). Of 18 nonconsumers during pregnancy, seven (38.9%) reported *pulque* intake during lactation, while 31.2% of nonconsumers during lactation reported intake during pregnancy. During both periods, maternal *pulque* intake was poorly correlated with maternal age and education, the number of living children, and household material wealth (not shown).

Pulque intake and attained size at 57 months

Figure 1 shows the relationships of attained size at 57 months to maternal *pulque* intake during pregnancy and early lactation. As indicated by the loess curves, the tallest and heaviest children tended to have mothers who consumed (1) little or no *pulque* during early lactation, and (2) small-to-moderate amounts of *pulque* (50–300 mJ/day) during pregnancy.

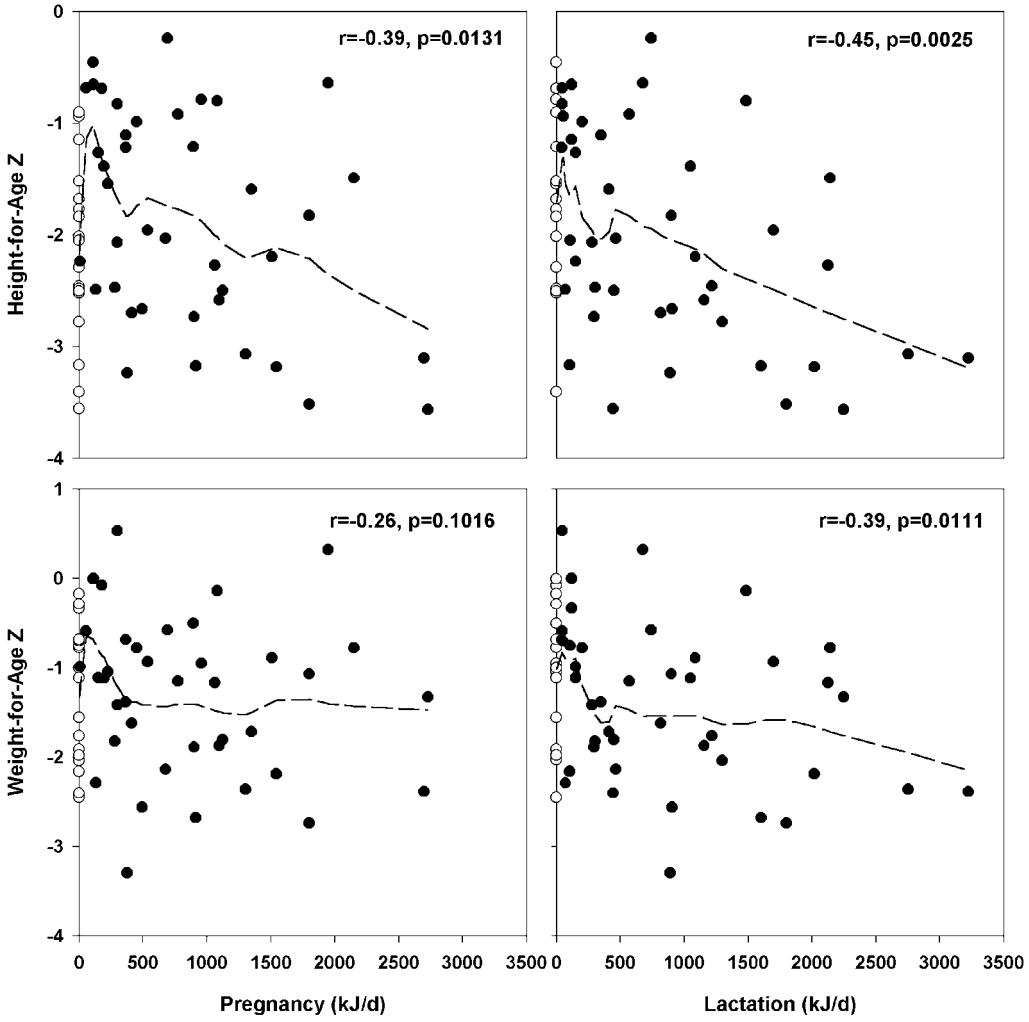

Figure 1 Scatterplots ($N=58$) show the associations between maternal *pulque* intake and attained size (height-for-age and weight-for-age) at 57 months. 'Drinkers' are dark circles, and 'nondrinkers' are white circles. Curves were fitted using PROC LOESS. Spearman's correlations are for the entire sample ($N=58$).

Table 2 Multiple regression models for predicting children's attained size at 57 months ($N = 58$)

		Weight (kg)		*Height (cm)*	
		Model 1	*Model 2*	*Model 1*	*Model 2*
Intercept		8.51202	−4.78687	76.70227	30.02016
Pulque intake	Pregnancy (linear)[a]	0.06262	0.02054	0.20668	0.08328
	Pregnancy (quadratic)[b]	−0.00033	−0.00159	−0.01932*	−0.02174**
	Lactation (linear)[c]	−0.11584***	−0.08955*	−0.28613****	−0.18429*
Child age (mo)		0.00409*	0.00510***	0.01423****	0.01689*****
Child gender (1 = male 0 = female)		1.27435***	1.33229***	2.48453**	2.58059***
Maternal age (y)		—	0.04419	—	0.08859
Maternal height (cm)		—	0.05452	—	0.22701**
Total energy, pregnancy (MJ/day)		—	0.17181*	—	0.39787*
r-square		0.38	0.46	0.48	0.59

mo, months.
[a]*Pulque* intake during pregnancy is transformed by square root and then centered.
[b]The square of centered *pulque* intake during pregnancy.
[c]Pulque intake during lactation is the square root of intake.
*$P < 0.05$.
**$P < 0.01$.
***$P < 0.005$.
****$P < 0.0005$.
*****$P < 0.0001$.

Table 2 shows multiple regression models that investigate the combined effects of *pulque* intake during pregnancy and lactation. Model 1 contains the covariates child age and gender, plus three *pulque* variables (linear and quadratic terms for intake during pregnancy, and a linear term for intake during lactation). After adjustment, *pulque* intake during pregnancy possessed a curvilinear relationship with height (but not weight) at 57 months (quadratic term: $P = 0.0223$), and heavier *pulque* intake during lactation was associated with lower weight ($P = 0.0022$) and height ($P = 0.0008$). Model 2 contains the same covariates in Model 1, plus maternal age, height and energy intake during pregnancy. *Pulque* intake during pregnancy retained a curvilinear relationship with height at 57 months (quadratic term: $P = 0.0287$), and associations were attenuated between *pulque* intake during lactation and child weight ($P = 0.0242$) and height ($P = 0.0287$). Adjustment for a range of other potential confounders (maternal education, household material wealth, birth order, early introduction of complementary foods, and maternal intake of several nutrient and dietary variables) had little effect on parameter estimates, standard errors and *P*-values (not shown).

Pulque intake and growth from 1 to 57 months

Figure 2 shows child growth between 1 and 57 months bore little relation to maternal *pulque* intake during pregnancy. In contrast, heavier maternal *pulque* intake *during lactation* was associated with slowed weight and linear growth. Model 1 contains as covariates the gender of the child and the days between anthropometry measures, plus the three *pulque* intake variables (Table 3). After adjustment, the child growth measures were essentially unrelated to *pulque* intake during pregnancy, but *pulque* intake during lactation was strongly associated with slowed postpartum growth (weight growth: $P = 0.0006$; linear growth: $P = 0.0002$). Model 2 (with additions of the three covariates maternal age, height and energy intake during pregnancy) again showed greater *pulque* intake during lactation was associated with slower weight ($P = 0.0054$) and linear ($P = 0.0073$) growth. Other models (containing maternal education, household material wealth, birth order, early introduction of complementary foods, and a range of nutrient and dietary intake variables) had little influence on associations between *pulque* intake during lactation and the child growth measures (not shown).

Patterns of *pulque* intake and child attained size and growth

Several other measures of *pulque* intake were associated with child size at 57 months and child growth (Table 4). In general, the attained size measures were associated with *pulque* intake during both pregnancy and lactation, while the child growth measures were only associated with intake during lactation. The best predictors of larger child size and better growth were a lower proportion of days with *pulque* consumption, a lower percentage of days with heavy *pulque* intake, less *pulque* intake per drinking day (days on when *pulque* was consumed) and fewer drinking events per day.

Discussion

Pulque is a nutrient dense, mildly alcoholic beverage that is consumed in large quantities by many Mexican women. As such, the traditional food has great potential for both positive and negative biological effects. The current paper

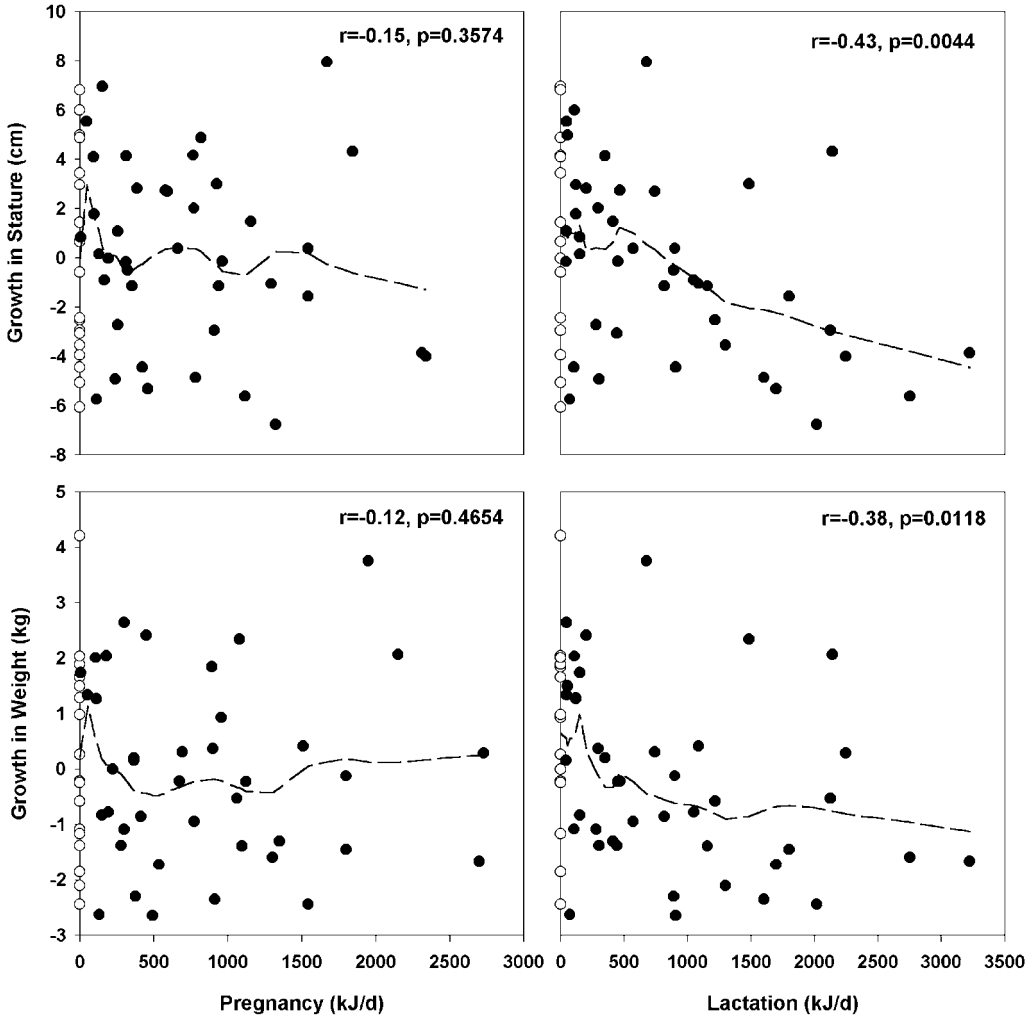

Figure 2 Scatterplot ($N = 58$) show the associations between maternal *pulque* intake and child growth (measured as residual size) from 1 to 57 months. 'Drinkers' are dark circles, and 'non-drinkers' are white circles. Curve was fitted using PROC LOESS. Spearman's correlations are for the entire sample ($N = 58$).

documents a curvilinear association between *pulque* intake during pregnancy and child height at 57 months such that the tallest children were those whose pregnant mothers had consumed low-to-moderate quantities of *pulque*. This observation is consistent with our earlier report of curvilinear associations between *pulque* intake during pregnancy and both infant length (at 1 and 6 months of age) and Bayley mental performance at 6 months (Backstrand *et al*, 2001).

Because of *pulque*'s micronutrient content (Cravioto *et al*, 1951; Steinkraus, 1996), and its central role in a rural Mexican diet that is often deficient in a range of vitamins and minerals (Calloway *et al*, 1993; Murphy *et al*, 1993; Allen *et al*, 2000; Backstrand *et al*, 2002), we have suggested that low-to-moderate *pulque* intake may have fostered better fetal growth in this population (Backstrand *et al*, 2001). *Pulque* intake is a strong predictor of better iron and folate status in this population (Backstrand *et al*, 2002). Unfortunately, heavy ethanol consumption during pregnancy can seriously damage the normal growth and development of the human fetus, and have a long-lasting influence on child size (Sampson *et al*, 1994; Bell & Lau, 1995; Allebeck & Olsen, 1998; Larroque & Kaminski, 1998; Day *et al*, 1999). In agreement with much larger studies conducted in industrialized countries, the current analyses show *pulque* intake during pregnancy was associated with size deficits that were sustained for years.

The present analyses also show heavier *pulque* intake during early lactation was associated with smaller attained size (at 57 months) and slowed growth (between 1 and 57 months). A negative effect of *pulque* intake during lactation on postpartum growth might be explained by an adverse effect of alcohol intake on breastfeeding performance.

Table 3 Multiple regression models for predicting children's growth from 1 to 57 months ($N=58$)

		Weight growth[a]		*Linear growth*[b]	
		Model 1	*Model 2*	*Model 1*	*Model 2*
Intercept		−6.40002	−17.30694	−19.49488	−61.57101
Pulque intake	Pregnancy (linear)[c]	0.06170	0.02698	0.21549	0.12900
	Pregnancy (quadratic)[d]	0.00366	0.00255	−0.00369	−0.00412
	Lactation (linear)[e]	0.03295****	−0.10265**	−0.29286*****	−0.21231**
Time between measures (days)		0.00403*	0.00497***	0.01290*****	0.01508******
Child gender (1 = male 0 = female)		0.84397*	0.89220*	0.85349	0.83360
Maternal age (y)		—	0.05170	—	0.11680
Maternal height (cm)		—	0.03941	—	0.20610**
Total energy, pregnancy (MJ/day)		—	0.16053*	—	0.27237
r-square		0.37	0.46	0.40	0.53

[a]Weight growth is measured as the residual when 57 months weight is regressed on 1 month weight.
[b]Linear growth is measured as the residual when 57 months height is regressed on 1 month length.
[c]*Pulque* intake during pregnancy is transformed by square root and then centered.
[d]The square of centered *pulque* intake during pregnancy.
[e]*Pulque* intake during lactation is the square root of intake.
*$P<0.05$.
**$P<0.01$.
***$P<0.005$.
****$P<0.001$.
*****$P<0.0005$.
******$P<0.0001$.

Table 4 Spearman's correlations of attained size and growth measures with maternal intake of *pulque* during pregnancy ($N=40$) and the lactation ($N=42$)

	57 months				*1–57 months*			
	Height-for-age		*Weight-for-age*		*Linear growth*		*Weight growth*	
	Preg	*Lact*	*Preg*	*Lact*	*Preg*	*Lact*	*Preg*	*Lact*
Percent of days that *pulque* was consumed	−0.41**	−0.49****	−0.32*	−0.41**	−0.07	−0.42**	−0.10	−0.39*
Percent of days with heavy drinking	−0.32*	−0.41**	−0.19	−0.32*	−0.23	−0.40**	−0.20	−0.33*
Mean amount consumed per drinking day	−0.15	−0.37*	−0.05	−0.30	−0.09	−0.38*	−0.04	−0.35*
Mean amount consumed per drinking event	−0.14	−0.15	0.20	−0.18	0.11	−0.24	0.14	−0.28
Mean number of drinking events per day	−0.34*	−0.45***	−0.28	−0.34*	−0.22	−0.32*	−0.17	−0.31*

*$P<0.05$.
**$P<0.01$.
***$P<0.005$.
****$P<0.001$.

Breastmilk alcohol concentrations parallel blood alcohol levels with concentrations peaking approximately 30–60 min after ingestion. In human infants, 20% reductions in the amount of breastmilk consumed have been seen during the 3–4 h following acute maternal intake of alcohol (Mennella & Beauchamp, 1991; Mennella, 2001). This decline in intake is due to reduced breastmilk production, rather than rejection of the mother's milk, a lower number of feeds, or a reduction in the breastfeeding time. Mennella (2001) has shown that human infants are able to compensate for earlier lower breastmilk intake by consuming additional breastmilk 8–12 h after acute alcohol exposure. However, the potential for breastmilk alcohol to increase intake of complementary food is unexplored—an effect that might be important in populations (such as rural Mexico) in which breastfeeding is prolonged and complementary foods are of poor nutritional quality.

In the rat, maternal alcohol intake during lactation adversely effects offspring growth (Subramanian, 1997; Oyama *et al*, 2000; Murillo-Fuentes *et al*, 2001). In humans, epidemiological information on breastmilk alcohol and growth is equivocal and restricted to two small studies. In an Otomí Indian community (located in proximity to our research site in Mexico), women were categorized as either drinkers ($N=32$) or nondrinkers ($N=62$), based on self-reported intake of 1–2 l/day of *pulque* during pregnancy and anticipated continued intake during lactation (Flores-Huerta *et al*, 1992). Comparing the two groups, no differences were seen in growth velocity during the first 3 and 6 months of life; differences in attained size at 3 and 6 months were not

assessed. In a second study conducted in Seattle, breastfeeding mothers ($N = 333$) were asked to characterize their current alcohol intake when1–3 months postpartum (Little *et al*, 1994). At 1 y of age, the infants of the 31 heavier drinkers (2+ drinks/day) were slightly lighter, shorter and thinner than the infants of mothers who had consumed less alcohol (or none); the researchers did not assess postnatal growth (change in size).

The current study possesses several design strengths in comparison to the Seattle and Otomí Indian studies. First, we assessed *pulque*/alcohol intake via multiple 24 h recalls, and during both the pregnancy and lactation periods. Second, our analyses investigate both attained size and postpartum growth as outcome variables. Third, our analyses adjust for a range of potential confounders (including *pulque* intake during pregnancy) and show the association between *pulque* intake during lactation and child growth to be robust. Nevertheless, our research is observational in design, and a range of alternative explanations might explain associations between maternal *pulque* intake and child attained size and growth. The sample size is relatively small, and the subjects are imperfectly representative of the larger population. *Pulque* intake may have served as a proxy for other variables that influenced child growth and development. Alternatively, *pulque* may have adversely influenced postpartum growth via biological constituents other than alcohol (eg, contaminants), or by way of a range of behavioral pathways such as maternal caregiving (Backstrand *et al*, 1999).

In summary, our analyses show heavy maternal intake of *pulque* during pregnancy was associated with smaller child height and weight at 57 months of age. This finding suggests persistent, adverse effects of prenatal *pulque* exposure on child size, which is consistent with an adverse effect of alcohol exposure *in utero* on child development. Additionally, we found that heavier *pulque* intake during lactation was associated with poorer child growth between 1 and 57 months, and smaller attained size at 57 months. This result might be attributable to reduced intake of breastmilk and increased consumption of poor quality, complementary foods due to alcohol in breastmilk. Additional research is needed to more fully characterize the risks associated with maternal intake of *pulque*. In the interim, public health interventions are urgently needed to reduce heavy intake of *pulque* by pregnant and lactating women, and to increase intakes of foods that provide the vitamins and minerals present in the traditional alcoholic beverage.

Acknowledgements

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