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Impact Of Maternal Demographics On Infant Feeding Habits In American Samoa

Renu Nadkarni
Yale University, renu.nadkarni@yahoo.com

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Renu Nadkarni
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Abstract

Obesity and overweight prevalence in American Samoan adults are among the highest in the world, and levels are also high and increasing in children and infants. Obesity levels are believed to be due ultimately to the dramatic changes in lifestyle and diet over the past half century. A shift away from breastfeeding and to early introduction of formula and solid foods feeding is a dietary habit effected in this change, and can potentially influence a child's future body size and other health outcomes. As decisions about infant feeding are associated with certain maternal demographics in other populations, this study specifically looked at how American Samoan mothers' biological and socio-demographic characteristics influenced how they fed their child and their child's BMI in American Samoa. 160 mothers of infants 0-12 months were recruited at the Tafuna Health Center Well Baby Clinic for this cross sectional study. Investigator-administered surveys collected information on maternal characteristics, their child's feeding behaviors, and their child's size. Most mothers in the sample stopped exclusively breastfeeding and started formula feeding by the first four weeks of the child's life. Single mothers compared to mothers with a partner, unemployed compared to employed mothers, and overweight compared to normal weight or obese mothers were more likely to have a longer duration of exclusive breastfeeding. Years of education and parity were also positively associated with duration of exclusive breastfeeding. Single mothers compared to mothers with a partner, overweight mothers compared to normal or obese mothers, and mothers with more years of education compared to those with less than a high school education were also more likely to introduce formula later in the child's life. There was no relationship between duration of exclusive breastfeeding, duration of any breastfeeding, initiation of formula or initiation of solid foods and the infant's body size. While future interventions targeting infant feeding can be aimed towards these maternal groups, general early cessation of exclusive breastfeeding and early introduction of formula in this sample show that universal maternal education efforts may be the key to changing infant feeding practices in American Samoa.

Introduction

American Samoa and Chronic Disease

American Samoa is an unincorporated territory of the United States, obtained between the late 1800s and early 1900s. Influenced by the presence of the US military during World War II, American Samoa underwent rapid economic development, causing large changes in lifestyle and dietary choices following the Western diet of the United States (Bindon et al, 1988). Trends in food availability per capita in the last sixty years in the neighboring island of Samoa, an independent nation that shares a cultural background with American Samoa, show energy availability in terms of calories has increased by 47% between 1961 and 2007, while fat availability increased by 73% (Seiden et al, 2012). Similar changes have also been observed in American Samoa; the traditional farming lifestyle and foods such as taro, fruits, and fish were supplanted by supermarkets and meat and starch imports in the 1960s (Bindon et al, 1988).

These changes in lifestyle and diet are thought to be responsible for the drastic increase in chronic diseases such as obesity among the American Samoans. Worldwide, the prevalence of obesity almost doubled between 1980 and 2008 in men (4.8% to 9.8%) and women (7.9% to 13.8%)(Finucane et al, 2011). The prevalence of obesity in American Samoa is about six times as high as that worldwide. The study observing food availability trends in Samoa showed that along with the increase in energy and fat availability, between 1980 and 2010 the BMI of adults 35-44 years of age increased by 18% (Seiden et al, 2012). For both men and women the 18% increase pushed the BMI to 30 or higher, defined as obese by WHO standards. In a study that defined obesity as a BMI of over 32 (to account for the known higher lean mass per kg in Polynesians (Swinburn et al, 1999)), the prevalence of obesity in American Samoa increased from 28% to 59% in men, and 51 to 71% in women between 1976 and 2002 (Keighley et al, 2007). American Samoa currently has the highest prevalence of adult obesity in the world with a 74.6% obesity prevalence (as of 2007) compared to the 33% prevalence in the US in 2008 (Central Intelligence Agency, 2008). Poor dietary choices and high body weight are also associated with an increased risk of other chronic diseases seen in the American Samoan population. There was an estimated 47.3% prevalence of diabetes, 34.2% prevalence of hypertension, and 23.4% prevalence of raised cholesterol (defined as over 5.2 mmol/L) in adults 25 to 65 years of age in 2007 (American Samoa Department of Health, 2007). Another study suggests these numbers might be under-estimating the current disease burden- data collected in Samoa in 2010 of adults 25 to 65 years of age show a prevalence of high total cholesterol of 41.7%, with risk factors of hypertension, diabetes, and elevated total cholesterol significantly varying by age (Hawley et al, 2014b).

The high level of obesity is not only seen in adults, but also starting to appear in children as early as infancy; data collected between 2001 to 2008 show that 23.3% of boys and 16.7% of girls 15 months of age were found to be obese (Hawley et al, 2014a). As obesity in infants cannot be determined using BMI, overweight was defined as above the 85th centile and obese above the 95th centile based on the 2000 Center for Disease Control growth chart reference for weight-for-length. Obesity and overweight in childhood have implications beyond childhood health as well,

they can also be predictive of obesity, other metabolic disorders, and cardiovascular disease in adulthood (Daniels, 2006). While not all adult obesity can be traced to childhood obesity, a review of the literature has seen that obese children have a 2 to 6.5-fold risk of developing obesity as adults (Serdula et al, 1993). One method to reduce the high rates of adult obesity in American Samoa may be to target overweight and obesity at the childhood level, in turn reducing adult obesity risk.

Infant Feeding

To understand why obesity is occurring in infancy, it is important to look at infant nutrition and feeding habits. Infancy, defined as the period between 0 and 12 months of age, is a particularly nutrition dependent phase of growth. In this time the child undergoes the most rapid growth compared to any other point in life, and nutrition during this time is thought to determine later childhood body composition (Norgan, 2002).

It is believed that the composition of breast milk has evolved to match the nutritional needs of a child and should be sufficient to meet the energy needs during the first four to six months of phase of growth (Norgan, 2002). In line with this, current recommendations by the World Health Organization state that children should be exclusively breastfed for at least the first six months of life. Solid foods can be introduced after this point to complement breast milk at least until the child turns two (WHO, 2014).

Exclusive breastfeeding for the first six months of life and continued breastfeeding after this age pose several other important benefits to the child. Newborns who are breastfed have a lower risk of infections and mortality due to gastroenteritis and diarrhea (WHO, 2014), and greater protection against ear and chest infections, eczema, and childhood diabetes (Norgan, 2002). For older infants between 6 and 24 months breast milk can provide more than half the child's energy and nutrient needs (WHO, 2014). However, only 38% of children under six months globally are exclusively breastfed (WHO, 2014).

With the introduction of formula in the United States, breastfeeding has been replaced or supplemented by formula (Fomon, 2001). Some but not all studies have seen an association between a shorter duration of breastfeeding and later weight gain. When children in the United Kingdom with varying breastfeeding statuses were monitored for weight gain between birth and 3 years of age, it was seen that those who were breastfed for less than four months or not at all had an increased risk of faster weight gain between birth and three years compared to those who were breastfed longer (Griffiths et al, 2008). Reviews of studies on the effect of infant feeding on future overweight and obesity show similar results; children who are breastfed and breastfed for a longer duration are at a decreased risk for overweight and obesity later in life compared to those who are exclusively formula fed (Owen et al, 2005) (Harder et al, 2005).

In spite of the risks that might be associated with a lack of breastfeeding, many children are still weaned early. An analysis conducted in Gateshead, England, of why mothers chose to wean their child at a particular age showed that most parents decided to commence weaning because they personally believed it was the right time and that the baby seemed hungry. However, mothers who reported that a

book or leaflet helped them decide at what time to introduce solid foods also had a significantly later weaning age for their children (Wright et al, 2004). This suggests that women who have access to educational materials on infant feeding might choose to breastfeed their children for longer amounts of time.

American Samoa and Infant Feeding

Studies of infant feeding in American Samoa show less than optimal breastfeeding practices. In 1990 approximately 26% of infants were exclusively bottle fed and 49% exclusively fed breast milk by the age of three months; by twelve months exclusive bottle feeding increased to 60%, while exclusive breastfeeding dropped to 31% (Bindon et al, 1990). In a more recent retrospective cohort study looking at the association between infant feeding method and infant size in American Samoa, by 4 months of age only 28.2% of infants were exclusively breastfed, while about 19.6% of infants were exclusively formula fed (Hawley et al, 2014a). This study also reinforced the association between body size and feeding mode; boys in this sample who were exclusively fed formula were at an increased risk for a larger body size than exclusively breastfed boys. There is clearly a need for improvement in exclusive breastfeeding duration in American Samoan children under six months of age, and such an improvement may contribute to decreasing the incidence and prevalence of infant overweight and obesity.

Maternal Demographics and Infant Feeding

Decisions as to when breastfeeding should be stopped, exclusively or completely, and when solid foods or formula should be introduced depend on the mother's background, knowledge, and beliefs. Specific maternal characteristics have been shown to be associated with duration of breastfeeding. In Italy, low levels of maternal education and having a blue-collar job or being a housewife were associated with a complete lack of breastfeeding, and primiparous mothers were more likely to breastfeed for a shorter time compared to those of a higher parity (Bertini et al, 2003). In the United States, higher maternal age and being married were also associated with more positive feeding practices, including meeting the guidelines for duration of exclusive breastfeeding and waiting to introduce supplementary foods until 6 months of age. Furthermore, toddlers whose mothers had a college education were not only more likely to have been breastfed, but were also more likely to be given healthier snacks such as fruits rather than sweets (Hendricks et al, 2006). Mothers under 20 years of age and those that were unmarried were also shown to have a significantly higher risk of stopping breastfeeding by the time the child is two months old in a study of American mothers enrolled in the Women, Infants, and Children program (WIC) (Ozturk et al, 2001).

By investigating which maternal social and economic groups in American Samoa have higher rates of infant obesity or unhealthy child feeding habits, more effective interventions can be designed to target these groups. Previous studies have shown an association between maternal education/age and infant feeding practices; however these studies have been predominantly conducted in more economically developed regions of the world. American Samoa can also be considered a good

model for other rapidly developing countries, where accessibility to certain foods and lifestyle changes are evolving more quickly than the spread of health knowledge. The aim of this study was to determine which, if any, maternal characteristics, such as age, parity, or education, in American Samoa are associated with deviations from the guidelines of exclusive breastfeeding and introduction of supplementary foods in American Samoa and how this relates to infant obesity.

Methods

Data for this cross sectional study were collected through investigator-administered surveys. Surveys were administered to mothers in the waiting room of the Well Baby Clinic at the Tafuna Health Center, one of five local health clinics on the island of Tutuila located in the village of Tafuna. This study took place from May to August in 2014 on weekday mornings. A total of 160 women with babies aged 0 to 12 months participated, which was the maximum number of women that could be recruited during the time available for the study. The survey was administered by an interviewer in either English or Samoan based on the mother's preference and included questions about the mother and child's birthday, weight, and height, parity, infant feeding practices and child's age when introduced to certain foods, and infant eating behaviors. Each survey took approximately 20 minutes. The women recruited for this study were of Samoan ethnicity and birthed singleton children with no history of health issues. This was approved by the Yale University, Brown University, and American Samoan Department of Health institutional review boards.

The mothers' BMI was calculated using self-reported weight and height from the survey. Women were then placed in normal (BMI of under 25), overweight (BMI of 25 to 30), or obese (BMI of 30 or higher) weight categories based on WHO standards, so that future comparison with international body size data would be possible. Mothers also self-reported their child's weight and height, which were measured and told to the mothers during the child's clinic visit. As BMI cannot be used to classify children of the ages observed in this study, z-scores for each child were calculated using weight-for-length data. These z-scores were compared to the Centers for Disease Control 2000 references for growth in infants to determine weight status; children with z-scores between 1.04 (85^{th} percentile) and 1.64 (95^{th} percentile) were classified as overweight, and children with z-scores 1.64 or higher were classified as obese (Centers for Disease Control, 2000). Children's ages were calculated in weeks using by subtracting birthdate from interview date.

SAS (9.4) was used to examine associations between child's weight, maternal characteristics such as age, education level, employment status, marital status, parity, and BMI, and feeding behaviors such as the age of the child when any breastfeeding and exclusive breastfeeding were stopped, formula was introduced, and complementary foods were introduced. Mothers reported in weeks the age at which their infants had reached these feeding milestones, and the number of weeks was estimated for those who could only report in months. All maternal characteristics were modeled as categorical values (categories defined in Table 2), and all feeding behaviors were modeled as continuous variables (weeks of infant

age). Women who did not respond to certain questions due to running out of time or choosing not to respond were excluded from analyses on that characteristic.

Chi-square analyses were conducted to look at the distribution and association between maternal characteristics and current feeding method and deviation from WHO guidelines. Deviation from the guidelines was defined as cessation of breastfeeding under one year of age and introduction of solid foods or formula before six months of age. Infant feeding outcomes in chi-square testing could only be examined for women whose infants had reached that stage of feeding. For example, where the timing of solid food introduction was the outcome of interest, only infants who had commenced solid food feeding could be included. Statistical significance for was defined to be a p-value of under 0.05.

Kaplan-Meier curves were used to compare categories within maternal characteristics and feeding behaviors. Kaplan-Meier curves determined "failure" to be time of cessation in weeks of exclusive or total breastfeeding, or time of initiation in weeks of formula or solid food feeding. Women who did not report an end date for breastfeeding or a start date for supplementary food feeding were censored. Equality of curves was assessed by the likelihood ratio test.

Multinomial logistic regression analysis was conducted to find associations between feeding behaviors and child's size in the sample. The outcome variable measured in this analysis was infant's weight category: normal, overweight, or obese. As in the chi-square analysis, infant feeding outcomes in the logistic regression analysis could only be examined for women whose infants had reached that stage of feeding. Statistical significance for the was defined to be a p-value of less than 0.05. Survival analyses and logistic regression were univariate; the low number of participants who had each outcome and missing data resulted in smaller sample sizes that did not lend itself to multivariate analyses and would have created potentially imprecise estimates.

Results

Sample Characteristics

Mothers in this sample were an average of 28 years old. Most mothers were married, had completed high school, and were not employed at the time of the study. Average parity was 3.5 children, and average BMI was 34.8, with a 76.7% obesity prevalence in the sample. 52% of the children were male, and the average birthweight was 8.1 pounds. Approximately 70% of the children in this sample were younger than six months, the suggested age to begin supplementary feeding. Average weight for length z-score was 1.4 (92^{nd} percentile), with a 45% obesity prevalence in the sample at the time of the study (Table 1a).

Feeding Behaviors

In the sample 89% of mothers initiated breastfeeding. The average age at which exclusive breastfeeding ceased was 4.8 weeks, and for any breastfeeding 5.8 weeks. On average children started formula-feeding at 3.9 weeks and solid foods at 22.5 weeks. Eighty-one percent of the sample deviated from WHO guidelines that recommend exclusive breastfeeding until six months of age as well as continued

breastfeeding until at least 1 year (Table 1b). Table 2 further illustrates the distribution of these feeding behaviors at the time of the survey across different maternal characteristics and child's age. In this sample only 18.1% of children under six months, the WHO recommended guideline for introduction of supplementary foods, were exclusively breastfeeding. Chi-square analysis did not show any significant ($p<0.05$) differences between maternal demographic characteristics and feeding method at the time of the survey.

Table 1. Description of the sample

a. Maternal and Child Characteristics

Characteristic	(N = 158)[a]
Mother	
Age (years)	28.34 ± 6.5
Marital Status	
Never Married	31 (19.6)
Currently Married	115 (72.8)
Separated	5 (3.2)
Divorced	4 (2.5)
Widowed	0 (0)
Living with a partner	3 (1.9)
Education	
Less than primary school	0 (0)
Primary school completed	6 (3.8)
Secondary school completed	99 (62.7)
College/University completed	47 (29.8)
Postgraduate degree	6 (3.8)
Employment	
No	90 (57.0)
Yes, Full Time	57 (36.1)
Yes, Part Time	5 (3.2)
Student	4 (2.5)
On maternity leave	2 (1.3)
Parity	3.47 ± 2.4
BMI (kg/m^2)	34.75 ± 7.2
Normal	6 (7.0)
Overweight	14 (16.3)
Obese	66 (76.7)
Child	
Age (weeks)	16.84 ± 12.0
Under six months	105 (69.1)
Over six months	47 (30.9)
Gender	
Boy	79 (52.0)
Girl	73 (48.0)
Birth weight (lb)	8.05 ± 1.4
Weight-for-Length z-score (CDC)	1.44 ± 1.4
Normal	37 (33.3)
Overweight	24 (21.6)
Obese	50 (45.1)

Table values are mean ± SD for continuous variables and n (column %) for categorical variables.
[a]Sample size may not sum to total due to missing data, and percentages may not sum to 100% due to rounding.

b. Feeding Behaviors

Event	N[a]	Average Age of Child in Weeks
Initiated Breastfeeding	131 (89.1%)	-
Stopped Exclusive Breastfeeding	123	4.79 ± 7.9
Stopped Any Breastfeeding	60	5.83 ± 7.1
Started Formula	109	3.86 ± 5.3
Started Solid Food	43	22.53 ± 6.8
Deviated from WHO Guidelines	119 (81.0%)	-

[a]Number of those who have experienced event

Table 2. Associations between Maternal Characteristics and Child Age and Infant Feeding Mode at the Time of the Survey

Characteristic	N=158(%)[a]	%EBF[b]	%BF[b]	%Formula[b]	%Solids[b]	%Deviate[b]
Age (years)						
15-24	50 (31.7)	6.0	50.0	84.0	40.0	89.6
25-34	73 (46.2)	17.8	57.5	76.7	35.6	78.8
35-50	35 (22.2)	22.9	57.1	65.7	37.1	72.7
Marital Status						
Single	40 (25.3)	10.0	52.5	85.0	40.0	86.5
With a partner	118 (74.7)	17.0	55.9	73.7	36.4	79.1
Employment						
Non-Employed	94 (59.5)	18.1	58.5	71.3	38.3	79.6
Employed	64 (40.5)	11.0	50.0	84.4	35.9	83.1
Educational level (years)						
<12	6 (3.8)	0.0	33.3	100.0	50.0	100.0
12	99 (62.7)	15.2	55.6	74.8	40.4	78.5
>12	53 (33.5)	17.0	56.6	77.4	30.2	83.3
Parity						
1	38 (24.8)	7.9	47.4	84.2	36.8	88.9
2	24 (15.7)	12.5	58.3	75.0	33.3	87.5
3+	91 (59.5)	19.8	60.4	73.6	36.3	75.3
Body mass index (kg/m^2)						
<25	6 (7.0)	16.7	16.7	83.3	50.0	66.7
25 to <30	14 (16.3)	21.4	57.1	64.3	57.1	78.6
30+	66 (76.7)	7.6	47.0	86.4	40.9	88.1
Child Age						
Under six months	105 (69.1)	18.1	57.1	80.0	14.3	78.2
Over six months	47 (30.9)	8.5	53.2	68.1	85.1	86.4

Percentage of women or children with the characteristic that engage in specified feeding behavior at time of the survey. No significant ($p<0.05$) differences were found.

[a]Numbers may not sum to total due to missing data

[b]EBF- Exclusive breastfeeding, BF- Any breastfeeding, including mixed feeding, Formula- Formula feeding, Solids- Solid food feeding, Deviate- Deviating from WHO guidelines

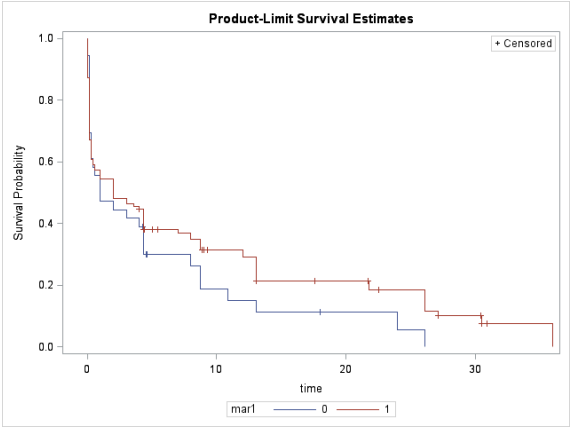
Maternal Characteristics and Feeding Behaviors

Survival analyses show that there are significant independent univariate relationships between duration of exclusive breastfeeding and marital status (p=0.028), education level (p=0.011), employment status (p=0.040), parity (p=0.004), and BMI (p=0.003), and age of introduction of formula and marital status (p=0.017), education level (p=0.009), and BMI (p=0.009) (Figure 1). Women with a partner exclusively breastfed for shorter amounts of time and initiated formula earlier compared to single mothers, and this was especially noticeable after the first five weeks of life. While women with a high school education had similar feeding behaviors as those with more years of education, women with less than a high school education were significantly more likely to exclusively breastfeed for shorter amounts of time and initiate formula feeding earlier. Mothers in the overweight category were more likely to exclusively breastfeed longer and start formula feeding later compared to normal weight or obese women; however, normal weight women do more closely resemble overweight women in terms of initiation of formula feeding compared to cessation of exclusive breastfeeding. Mothers who only had one child at the time of the survey were more likely to exclusively breastfeed for shorter amounts of time compared to women with multiple children, and employed women were also more likely to exclusively breastfeed for shorter amounts of time compared to unemployed women.

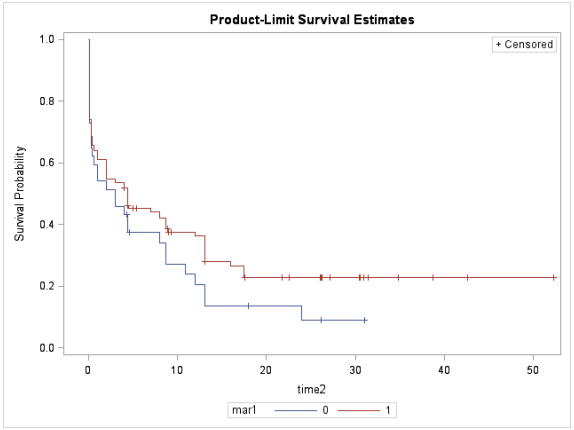
Figure 1. Significant Findings (p<0.05) of Survival Analyses on Maternal Characteristics and Feeding Behaviors

Marital Status[a]

Exclusive Breastfeeding

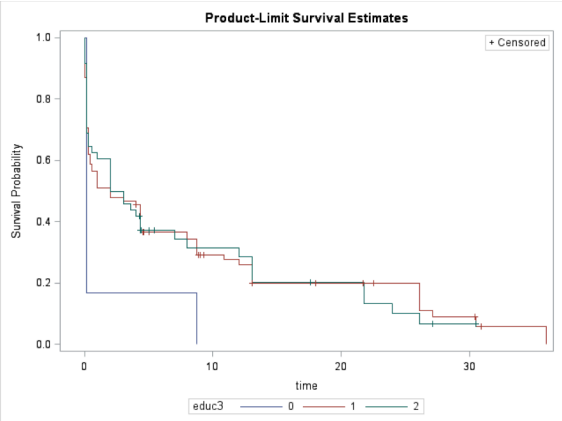


Initiation of Formula Feeding

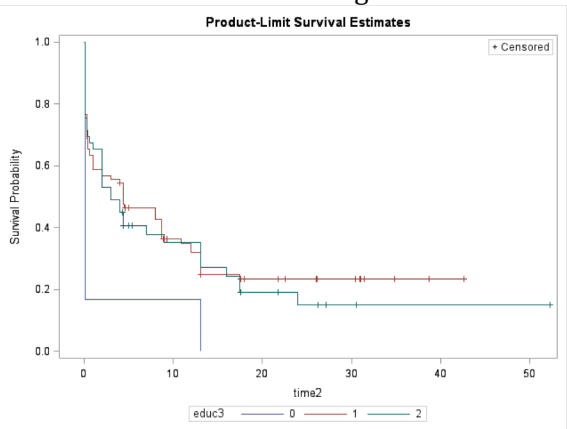


Education Level[b]

Exclusive Breastfeeding

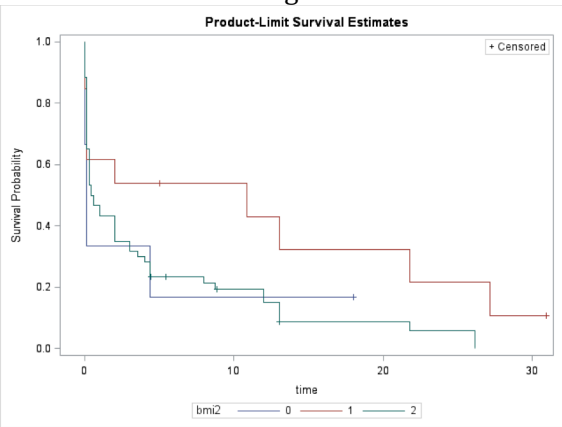


Initiation of Formula Feeding

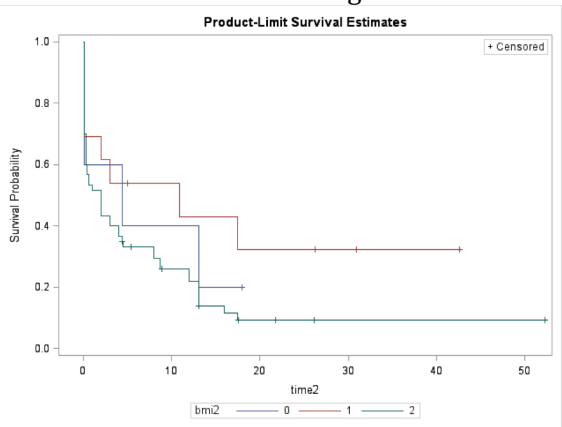


BMI[c]

Exclusive Breastfeeding

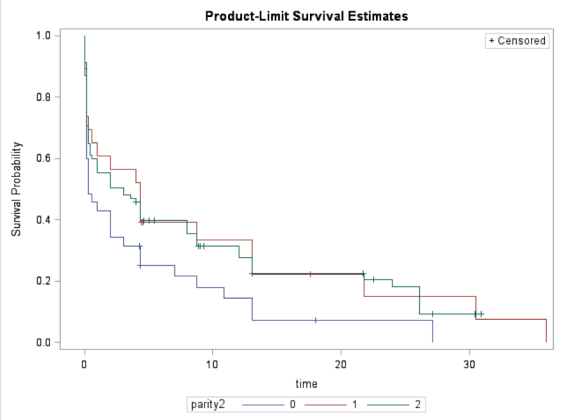


Initiation of Formula Feeding



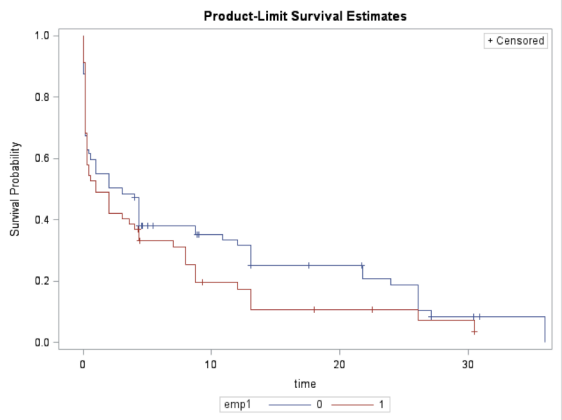
Parity[d]

Exclusive Breastfeeding



Employment Status[e]

Exclusive Breastfeeding



[a]0-Single, 1-With a partner

[b]0-Less than a high school education, 1-High school education, 2-More than high school

[c]0-Normal weight, 1-Overweight, 2-Obese

[d]0-One child, 1-Two children, 2-Three or more children

[e]0-Unemployed, 1-Employed

Feeding Behaviors and Child Size

Multinomial logistic regression was conducted to examine the relationship between either duration of feeding behaviors (for exclusive and total breastfeeding) or initiation times (of formula and solid food feeding) and whether the child was normal weight, overweight, or obese. This analysis showed no significant ($p<0.05$) relationship between feeding behavior and child's weight category (Table 3).

Table 3. Predicting infant weight category from feeding behaviors

Feeding Behavior	N[a]	Normal weight	Overweight p (95% CI)	Obese p (95%CI)
Duration of EBF[b]	93	Reference	0.953 (-0.06, 0.06)	0.779 (-0.05, 0.07)
Duration of BF[b]	45	-	0.741 (-0.10, 0.07)	0.581 (-0.13, 0.08)
Initiation of Formula[b]	82	-	0.633 (-0.10, 0.06)	0.064 (-0.32, 0.01)
Initiation of Solid Foods[b]	33	-	0.121 (-0.04, 0.33)	0.873 (-0.12, 0.14)

No significant ($p<0.05$) associations were found

[a]Number of those who have experienced event

[b]EBF- Exclusive breastfeeding, BF- Any breastfeeding including mixed feeding, Formula- Formula feeding, Solids- Solid food feeding, Deviate- Deviating from WHO guidelines

Discussion

Maternal Characteristics, Feeding Behaviors, and Size

This study investigated the influence of maternal socio-demographic characteristics on how mothers fed their children in the first twelve months after birth in American Samoa. The majority of mothers (81%) deviated from the WHO infant feeding guidelines for how long infants should be breastfed (World Health Organization, 2014). Based on these guidelines children should be exclusively breastfed for the first six months; however, in this sample the average age of introduction of formula was under one month. Further analysis showed that there were significant independent associations between marital status, education level, and BMI and duration of exclusive breastfeeding, and between parity and employment status and age of introduction of formula.

Mothers who were married or living with a partner were more likely to have a shorter duration of exclusive breastfeeding and would start formula feeding sooner. As there were no significant differences in cessation of any breastfeeding between married and unmarried women, it is possible that partners are supplementing the mother's breast milk with formula for convenience purposes. There is also promise for intervention in this group of women to increase duration of exclusive breastfeeding; a study in Brazil has shown that inclusion of a partner in educational interventions increases the duration of exclusive breastfeeding compared to when only the mother receives the intervention (Susin et al, 2008).

Employed mothers were also more likely to have a shorter duration of exclusive breastfeeding compared to non-employed mothers. These results agree with the findings of other studies on postnatal maternal employment and breastfeeding. Mothers in Australia who worked after their child's birth were less likely to be breastfeeding by the time their child is six months of age than women who were unemployed; this association was stronger in full-time workers than part-time workers (Cooklin et al, 2008). Due to the time required for exclusive breastfeeding, these findings are not surprising.

As was seen in the Italian breastfeeding study (Bertini, 2003), mothers who only had one child were more likely to stop exclusive breastfeeding early compared to mothers with more children. Results of studies that look at the association between parity and duration of breastfeeding have been mixed- while studies have found that multiparity is associated with a longer duration, others have found no significant association (Simard et al, 2004). It has been suggested by other reviews of the literature that rather than the number of previous children a woman has, previous breastfeeding experiences influences current breastfeeding practices (Hill et al, 1997). This indicates that a positive breastfeeding experience with an older child would increase initiation and duration of breastfeeding with subsequent children, which could explain the results seen in this study as well.

There was a significant association between education level and duration of exclusive breastfeeding and initiation of formula feeding with the women with less than a high school education more likely to start formula very early compared to women with a high school education or more. As there were only six women in this category, it is possible the results are biased. However, the association between education level and breastfeeding duration has been supported by a multitude of

studies. In a similar study conducted in Denmark, results also showed a high level of initiation of breastfeeding but then a strong positive association between number of years of education and duration of breastfeeding. Similarly, this was especially apparent between mothers with and without a high school education (Michaelsen et al, 1994).

Overweight mothers had a significantly longer duration of exclusive breastfeeding compared to normal weight or obese mothers, and overweight and normal weight mothers waited longer to introduce formula compared to obese mothers. Previous studies suggest that reasons obese women breastfeed less than women with a lower BMI may include physiological difficulties in producing milk or initiating breastfeeding, other medical complications beyond obesity, or even psychological barriers (Amir, 2007). Prolactin, the hormone responsible for producing milk, has been shown to have a lesser response to breastfeeding in overweight and obese women compared to normal weight women, which provides a biological explanation of why breastfeeding duration is shorter (Rasmussen et al, 2004). These reasons could explain in part why obese mothers in this sample had a shorter duration of exclusive breastfeeding and sooner introduction of formula. However, since in this sample overweight women fared better than normal weight women in terms of duration of exclusive breastfeeding, other factors may be in play. The number of normal weight mothers in this analysis was also much smaller than the number of overweight and obese mothers, which may have biased the results. It is also possible, in the context of a society where overweight and obesity are so prevalent that these women had other conditions that contributed to their lower weight and prevented them from breastfeeding for as long as the overweight mothers. Whether this is true should be investigated in future studies.

Contrary to previous findings that found associations between weight and length trajectories over the first fifteen months of life and formula feeding compared to breastfeeding in American Samoa (Hawley et al, 2014a) and findings from multiple studies on the association between infant obesity and feeding method (Arenz et al, 2004), no relationship between infant feeding practices and infant body size existed in this sample. The characteristics of this sample may explain this lack of relationship. While most mothers initiated breastfeeding, exclusive breastfeeding ended and formula feeding started within the first month across the entire sample, and the majority of mothers were deviating from the WHO guidelines for their child's age. This created a lack of variation within the sample that would make it difficult to see any associations between feeding method and child weight, as several feeding behaviors were not represented well in the sample. The infant size data was also collected through mothers' self-report; while some mothers were given the infant's weight and height during their clinic visit, others possibly relied on memory or guesswork which would have also affected the analyses.

Limitations

One of the major limitations of this study was the small sample size. Since many mothers had not experienced certain feeding markers, such as complete cessation of breastfeeding and solid food feeding, analyses on these feeding behaviors that occur later in the child's life used reduced sample sizes that might

have biased results. Number of responses per demographic question also varied, affecting the sample size. Another limitation was the use of self-report data, especially for mother and child's weight and height. Several mothers could not remember their height or weight, and while some mothers were able to get their child's weight and length information from their clinic visit, others relied on memory. Maternal demographic questions were subject to social desirability bias, and it is possible mothers adjusted their responses to what they believed was a "better" answer. There was also a lack of specificity about dates of certain variables, such as the child's age at cessation of breastfeeding, initiation of formula, or initiation of solid foods. While women were asked to report as precisely as possible in days and weeks, some mothers were only able to report in months, and number of weeks was calculated from these responses.

Implications

Infant obesity is a growing problem in American Samoa. The 77% prevalence of obesity in the mothers surveyed in the sample was slightly higher than the 75% population prevalence recorded in 2007; however, the infant obesity prevalence of 45% in this sample was two to three times as high as the prevalence in fifteen-month-olds measured at the same clinic in 2008 (Hawley et al, 2014a).

While this study showed no relationship between feeding behaviors and child size, other studies suggest that these feeding behaviors do have an impact on child health beyond obesity. Reviews of the literature have found strong association between breastfeeding and reduced incidence of gastrointestinal illnesses, and possible reductions in overall mortality, respiratory infections, and general immunity (Kovar et al, 1984). Exclusive breastfeeding to six months of age increases the protective effect against gastrointestinal illnesses and in some cases respiratory infection compared to exclusive breastfeeding only up to three months of age (Kramer et al, 2002). By being able to narrow down which maternal groups are more likely to participate in certain feeding behaviors, future work can design interventions tailored to these women. Since initiation of breastfeeding in this sample was high at 89%, there is promise for interventions to extend duration of breastfeeding. Duration of exclusive breastfeeding was the behavior most influenced by specific maternal characteristics. Future studies and policy work that focus on mothers with multiple children, married, employed, or obese can aim to improve perceptions and ease of breastfeeding in these groups to increase duration to the WHO recommended six months of age. However, while these were the characteristics that had the greatest association with infant feeding behaviors, results of this study also show that there is a universal lack of exclusive breastfeeding, and interventions to increase optimal child feeding behaviors for the maternal population as a whole in American Samoa can also prove to be beneficial.

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