



Maternal & Child Health Epidemiology

Breastfeeding and New Jersey Maternity Hospitals:

A Comparative Report

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Summary and Objectives

Breastfeeding is universally accepted as optimal for infant, maternal and public health. Breastfeeding provides superior nutrition, prevents disease, and enhances infant development. The choice to breastfeed is personal, but that choice can either be supported or undermined by what happens in the hospital in the first few days after delivery. The implementation of hospital policies that specifically support breastfeeding have been documented by research to dramatically increase exclusive breastfeeding rates and improve the health of mothers and infants after discharge. The first part of this report summarizes the evidence and rationale for making New Jersey's maternity hospitals the focus of redoubled efforts to increase breastfeeding among all new mothers.

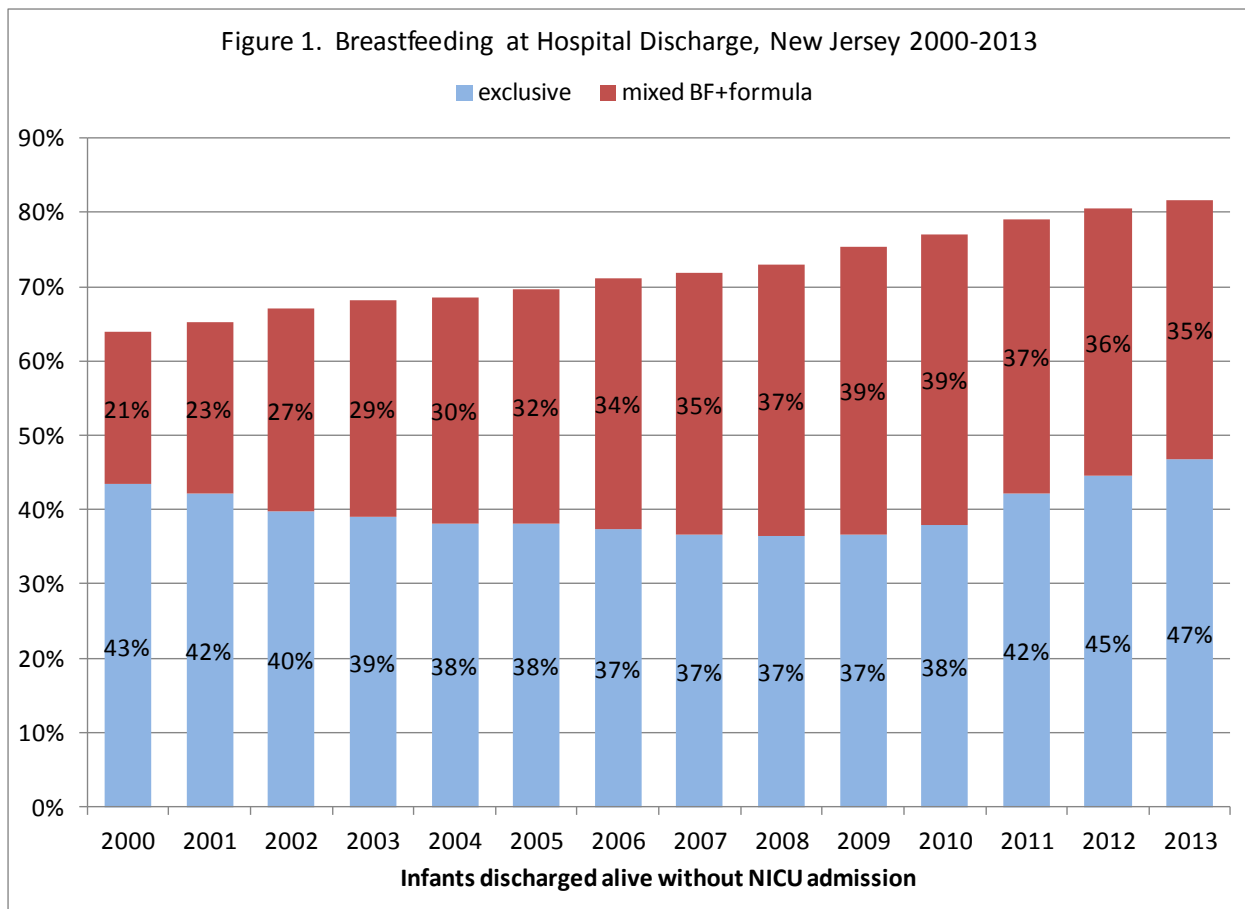
This report replicates methodology, first introduced in 2008, that accounts for patient mix differences among hospitals. The standardized scores in Table 1 allow meaningful comparisons among all hospitals, and identify some outstanding hospitals that produce breastfeeding results far beyond expectations based on patient mix. Finally, the report includes a model self-assessment tool and a list of resources that will allow hospitals to begin the process of enhancing breastfeeding through their core maternity care policies and practices.

Background

Breastfeeding is universally accepted as the optimal way to nourish and nurture infants, and it is recommended that infants be exclusively breastfed for the first six months.¹ Extensive research documents the compelling benefits to infants, mothers, families, and society from breastfeeding.^{1,4} Breastfeeding decreases the incidence of infectious diseases (diarrhea, lower respiratory infection, otitis media, bacteremia, and urinary tract infection), obesity, sudden infant death syndrome, asthma, insulin-dependent diabetes mellitus, and chronic digestive diseases. Breastfeeding has been documented to enhance cognitive development. Women who do not breastfeed experience delayed return to pre-pregnancy weight, earlier resumption of ovulation and shorter intervals between births, poor postpartum bone re-mineralization and increased risk of ovarian and premenopausal breast cancer. In addition to the contributions to individual health, breastfeeding has significant social and economic impacts. In the first year after birth, breastfeeding infants generate lower average health care costs, and their parents miss less work time.

Infants who are exclusively breastfed from birth are more likely to continue breastfeeding for the recommended six months. Rates of breastfeeding initiation in New Jersey's maternity hospitals meets the first of two *Healthy New Jersey 2010* goals:²

- To increase the proportion of mothers who breastfeed their babies (exclusively or in combination with formula) at hospital discharge to at least 75 percent.
- To increase the proportion of breastfeeding women whose infants are breastfed exclusively at hospital discharge to 90 percent.



The second goal, promoting exclusive breastfeeding, has been harder to achieve. Although the initiation of breastfeeding has been rising steadily since 2000, many infants have been receiving formula in combination with human milk.³ As shown in Figure 1, among infants in New Jersey not admitted to the neonatal intensive care unit (NICU), the percentage that were exclusively breastfeeding prior to hospital discharge declined slightly through 2009. At the same time, breastfeeding supplemented by formula feeding nearly doubled. This trend away from exclusive breastfeeding had been consistent across differences in mothers' sociodemographic characteristics, but appears finally to have been reversed.

How Do Hospitals Affect Breastfeeding?

Delivery hospitals have widely varying rates of exclusive breastfeeding initiation, due partly to differences in patient composition and partly to differences in maternity care practice.⁴ According to the Maternity Practices in Infant Nutrition and Care (mPINC) Survey⁵ conducted by the Centers for Disease Control and Prevention (CDC), the use of evidence-based practices to support exclusive breastfeeding vary widely among hospitals.⁶ For example, in many hospitals it is common practice to supplement

The Ten Steps To Successful Breastfeeding

- 1 - Maintain a written breastfeeding policy that is routinely communicated to all health care staff.
- 2 - Train all health care staff in skills necessary to implement this policy.
- 3 - Inform all pregnant women about the benefits and management of breastfeeding.
- 4 - Help mothers initiate breastfeeding within one hour of birth.
- 5 - Show mothers how to breastfeed and how to maintain lactation, even if they are separated from their infants.
- 6 - Give infants no food or drink other than breastmilk, unless medically indicated.
- 7 - Practice "rooming in" - allow mothers and infants to remain together 24 hours a day.
- 8 - Encourage unrestricted breastfeeding.
- 9 - Give no pacifiers or artificial nipples to breastfeeding infants.
- 10 - Foster the establishment of breastfeeding support groups and refer mothers to them on discharge from the hospital or clinic.

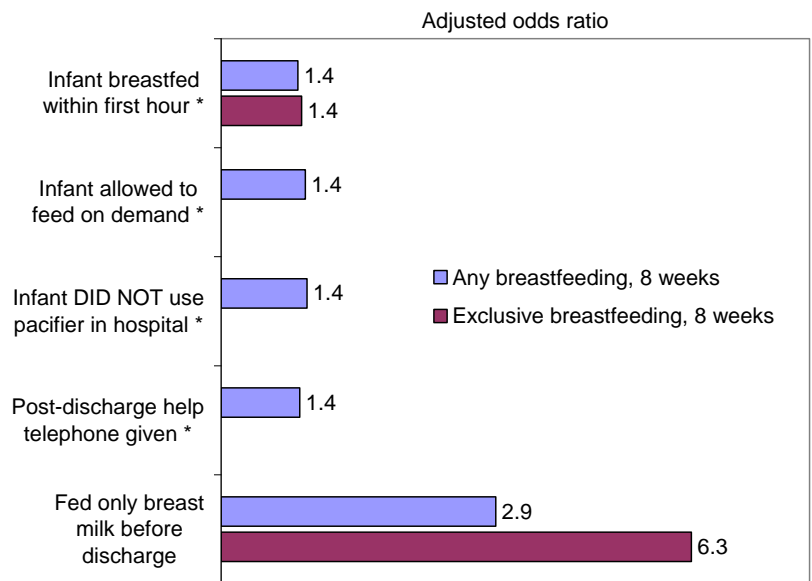
Source: WHO/UNICEF⁷

breastfeeding with water or formula, while in others supplementation requires written consent by the mother or an order on the medical chart. What happens in the hospital during the first few days after delivery plays a crucial role in establishing breastfeeding and helping mothers to continue breastfeeding after leaving the hospital. *The Ten Steps to Successful Breastfeeding*,⁷ developed and published by WHO/UNICEF, represents a comprehensive plan to optimize parental education, maternity department policies and practices, and post-discharge support.

From 2004 to 2007, the New Jersey Pregnancy Risk Assessment Monitoring System (NJ-PRAMS), a monthly sample survey of new mothers, included eight questions on practices in the hospital that relate to breastfeeding.⁸ Figure 2 reports the estimated effects of five of these practices, after adjusting for the age, education, number of prior children, immigrant status, race and Hispanic origin of the mother. The largest difference was for avoiding supplemental feeding:

when a mother reported breastfeeding exclusively until discharge, the odds of any breastfeeding at eight weeks postpartum were 2.9 times greater, and the odds of exclusive breastfeeding at eight weeks were 6.3 times greater. These mothers were also very likely to report that their hospital adhered to other features of the Ten Steps, for example, initiating breastfeeding within the first hour after delivery and feeding whenever infants signaled demand.

Figure 2. Hospital Factors Affecting Persistence of Breastfeeding at 8 Weeks (* Among Initiators with Formula Supplementation in Hospital) (Adjusted for maternal factors, n=5,600)



When infants were given supplemental formula in the hospital, these other elements were also more likely to vary, and they had less powerful effects on the persistence of breastfeeding. For example, among infants that received formula before they left the hospital, those that breastfed within the first hour of life were only about 40% more likely to be doing any breastfeeding or be exclusively breastfeeding at eight weeks. Recommended practices such as feeding on demand, avoiding pacifiers, and providing post-discharge telephone help also had modest effects on persistence of any breastfeeding, but no effect on persistent exclusive breastfeeding.

These effects were assessed via mothers' reports of their own experiences, rather than from hospital-provided practice data. The PRAMS results nevertheless add to the mounting evidence that what hospitals do matters. A comprehensive review of practice improvements and the evidence base supporting them is presented in *The CDC Guide to Strategies to Support Breastfeeding Mothers and Babies*,⁹ which considers potential interventions for prenatal

education, post-discharge support and social acceptance as well as hospital maternity care. Hospitals administrators and practitioners seeking to improve breastfeeding outcomes will find this document a valuable resource. Baby-Friendly USA, Inc., a WHO affiliate, helps American hospitals achieve the Ten Steps and awards a formal Baby-Friendly® designation. Their program starts with a self-assessment tool available at:

http://assets.bfusa.s3.amazonaws.com/cms/files/59/files/original/Self_Appraisal_Tool_SAMPLE_for_website.pdf

A State Initiative to Promote the Ten Steps at New Jersey Hospitals

In 2010 the New Jersey Department of Health launched an initiative to assist hospitals in implementing the WHO/UNICEF Ten Steps model for a breastfeeding-friendly hospital environment. Using the PDSA process improvement model and other resources, an initial cohort of ten hospitals achieved an average of four of the steps and increased exclusive breastfeeding rates an average of 11 percent. Three attained Baby-Friendly® designation as a result of their participation. (One additional hospital did so on its own.)

At the June 9, 2014 statewide Mother-Baby Summit, the New Jersey Hospital Association released a survey on hospitals' progress in promoting breastfeeding within maternity practice. Fifteen hospitals are currently in advanced stages of pursuing that designation. Nine hospitals are in early developmental stages of the program. Hospitals participating in the State initiative were more likely to have adopted the following practices:

- WHO/UNICEF recommended skin-to-skin and rooming-in practices.
- RN staff receive 15 hours of breastfeeding education meeting WHO/UNICEF international guidelines, including five hours of hands-on training with a lactation consultant. Physician staff receive three hours of breastfeeding education.

- On discharge, new mothers are enrolled in or referred to breastfeeding support services.
- Hospital has a breastfeeding steering committee led by nursing director or manager that meets at least monthly. Hospital is engaged in performance improvement activities.

Employing additional insights gleaned from the New Jersey Mother Baby Summit and the Statewide Perinatal Safety Collaborative, the New Jersey Hospital Association will provide technical assistance to a second cohort of sixteen hospitals. This cohort was selected for demonstrated organizational infrastructure and readiness for change. More information about the accomplishments and key challenges implementing the Ten Steps in the initial cohort is available at:

http://www.state.nj.us/health/fhs/shapingnj/home/hottopics/approved/20121126_bfhievalreport.html

Leveraging Other Tools and Resources

Standard Measurement. On January 1, 2014, the perinatal core measure set proposed by The Joint Commission (a national accreditation body, formerly known as JCAHO) became mandatory for hospitals with 1,100 or more births per year.¹⁵ Measure PC-05 reports the proportion of all newborns that were exclusively fed breast milk during the entire hospitalization.¹⁶ A subset measure, PC-05a, excludes mothers who chose not to breastfeed. These measures are not population adjusted, and are used by hospitals internally for quality improvement.

State Hospital Regulations. Also in January 2014, the New Jersey Department of Health adopted new rules that require hospitals to implement evidence-based breastfeeding practices— those generally consistent with the Ten Steps. The rules require:

- Policies and procedures for identifying the needs of a breastfeeding mother/child at any point of entry into the hospital, e.g., emergency department, pediatrics, maternal

admission; and supporting those needs through the hospital stay, e.g., proper management of expressed breast milk.

- Development and review in a three-year cycle of written policies and procedures for the delivery, nursery and mother-baby units. Policies must address staff competencies and training, professional resources, formula supplementation, establishing breastfeeding in the first hour after delivery, rooming in and other evidence-based practices.
- Comprehensive evaluation of infant feeding, with follow-up as necessary, performed by a lactation consultant or obstetrics staff member with demonstrated core competencies in infant feeding. A discharge plan with community-based resources.
- Establishment an interdisciplinary hospital breastfeeding team with quality improvement functions.

The regional *MCH Consortia* (<http://nj.gov/health/fhs/professional/mchfact.shtml>) offer numerous resources and professional forums that support the adoption of the new rules. Resource materials are also available from the NJ WIC breastfeeding coordinator (florence.rotondo@doh.state.nj.us), and NJHA (mditri@njha.com).

Post-discharge Resources. Results from the 2011 CDC mPINC survey indicated that only 16% of New Jersey facilities provided hospital discharge care that included a phone call to the patient' home, opportunity for follow-up visit, and referrals to community breastfeeding support groups. There are two established community breastfeeding support groups in the State to which hospitals can make referrals on discharge.

The Special Supplemental Nutrition Program for Women, Infants, and Children serves roughly 40% of infants in the state. WIC has a comprehensive breastfeeding peer counselor program for WIC participants that provides peer counselor support and information and International Board Certified Lactation Consultants who provide assessment and intervention beyond the scope of peer counselors. There is at least one WIC local agency in the service area

of every delivery hospital. To find WIC local agencies:

<http://nj.gov/health/fhs/wic/localagencies.shtml>.

La Leche League in New Jersey helps mothers to breastfeed through support, encouragement, information, and education to all women interested in breastfeeding. To find La Leche League groups in New Jersey: <http://www.llli.org/web/newjersey.html>.

Hospital Statistics and Population Adjustment

Breastfeeding statistics for any hospital depend in part on its population of patients. Maternal age, race, Hispanic origin, education, and foreign birth, and delivery characteristics such as plural birth and neonatal intensive care are well known to affect breastfeeding initiation.¹⁰ Variations in patient mix across hospitals can therefore be expected, all else equal, to produce differences in hospitals' individual breastfeeding outcomes. Such differences, by themselves, are outside the hospitals' control, and should not be automatically attributed to variations in healthcare practice.

New Jersey does not at this time collect data describing hospital maternity policies and practice standards that relate to breastfeeding, nor does PRAMS support hospital level assessments of practice. For now, this report has a more limited objective: [a] to compare New Jersey hospitals according to rates of exclusive breastfeeding at discharge; and [b] to present an adjusted measure of hospital rates that minimizes the effect of patient population. Population adjustment methods aim to:

- assess the degree to which a hospital's outcomes match expectations based on its patients' demographic and/or medical characteristics;
- estimate what each hospital might achieve if it had the same patient mix as every other; such approaches are also referred to as *standardization*.

Identifying hospitals that do better than would be expected from their patient mix satisfies two objectives. In the short term, prospective mothers with strong preferences about breastfeeding are guided to hospitals most suited to their needs. In the long term, all hospitals and consumers benefit from discovering and evaluating potential best practices.

Other states have recently produced similar hospital specific breastfeeding reports.^{11, 12} In 2010, The Joint Commission and the National Quality Forum, two leading organizations in measurement of healthcare quality, called for including breastfeeding at discharge as one of five core perinatal care quality indicators. New Jersey has chosen to focus specifically on exclusive breastfeeding, and to address hospital differences in population mix as part of its evaluation. This report uses a technique called logistic regression, with variables routinely available on the electronic birth certificate (EBC), to accomplish this population adjustment. (See Appendix 1 for a complete exposition.) The use of this methodology for breastfeeding was peer-reviewed and published in 2005 in the obstetrical journal *Birth: Issues in Perinatal Care*.⁴ The article documented that, in New Jersey, patient mix accounts for about sixty percent of differences in breastfeeding among hospitals. The other forty percent is presumably where hospital staff and practices play a key role, independently influencing the transition from maternal knowledge and intention to actual discharge outcomes.

Results: Hospital Ratings

Table 1 presents ratings for each hospital, grouped within eight geographic regions. The hospitals are ranked within region from highest to lowest value on the current year standardized score.

The specific columns:

- *Births discharged home*: These are normal newborns, excluding those that died or were transferred to neonatal intensive care or another hospital.
- *Exclusive breastfeeding*: The proportion of newborns discharged home who were recorded on the standard birth certificate item as exclusively breastfeeding during the twenty-four hours prior to discharge. Without any adjustment, this is called the “crude” rate.
- *Standardized score*: A ratio measuring how the hospital’s crude exclusive breastfeeding rate compares to expectations based on demographic and medical characteristics of the patient population at that hospital (i.e., the *population component* described in Appendix 1). A score of 1.0 indicates an “average” performance compared to the population expectation.
- *Crude exclusive rate for previous year*. This is offered for rough comparative purposes; comparing crude rates over short time intervals is a little more intuitive than comparing the standardized scores and each hospital’s population component rarely changes much from year to year.

Within the North Jersey region St. Mary’s Hospital in Passaic had the highest standard score, 1.66, indicating that its crude rate of 59% was much higher than predicted by patient mix (36%). St. Joseph’s Regional Medical Center, a large, urban, high-tech hospital serving a disproportionately minority population, exemplifies how the standardized score can identify problems with routine breastfeeding care. St. Joseph’s standardized score of 0.55 suggests that if it could do just an “average” job with the population it serves—i.e., raise its standardized score to 1.0—it would raise its crude rate from 20% to 36% exclusive breastfeeding.

Each region had at least one hospital with a standardized score well above 1.0, but these hospitals were not all the same. Some are basic care facilities in non-urban settings with a low volume of deliveries (e.g., Hackettstown Community Hospital), while others were quite different. The hospital with the highest standardized score in 2013 was Capital Health at

Table 1

1-Hackensack/North Jersey Region

	2013				
	Births discharged home	Standardized score	Exclusive BF rate	Population component	Exclusive BF rate 2012
St. Mary's Hospital Passaic	799	1.66	59%	36%	67%
The Valley Hospital	2,364	1.15	64%	55%	59%
Pascack Valley Hospital	65	1.14	54%	47%	.
Englewood Hospital and Medical Center	1,590	0.96	48%	51%	75%
Hackensack University Medical Center	4,931	0.71	33%	47%	31%
Holy Name University Medical Center	1,292	0.70	32%	45%	33%
St. Joseph's Regional Medical Center	2,685	0.55	20%	36%	12%

2-Morristown Region

	2013				
	Births discharged home	Standardized score	Exclusive BF rate	Population component	Exclusive BF rate 2012
Hackettstown Community Hospital	161	1.39	73%	52%	76%
Newton Memorial Hospital	392	1.30	64%	49%	66%
Morristown Memorial Hospital	3,543	1.26	65%	51%	64%
Chilton Memorial Hospital	805	0.98	53%	54%	42%
Saint Clare's Hospital/Denville	1,082	0.97	49%	50%	49%

3-Newark Region

	2013				
	Births discharged home	Standardized score	Exclusive BF rate	Population component	Exclusive BF rate 2012
The Mountainside Hospital	1,206	1.43	64%	45%	60%
Univeristy of Medicine & Dentistry of New Jersey - University Hospital	1,135	1.33	39%	30%	58%
Palisades Medical Center - New York Presbyterian Heathcare System	1,480	1.13	47%	42%	49%
Saint Barnabas Medical Center	4,315	0.96	48%	51%	49%
Liberty HealthCare System, Inc. - Jersey City Medical Center	1,679	0.65	25%	38%	23%
Hoboken University Medical Center	1,166	0.60	24%	40%	23%
Liberty HealthCare System, Inc. - Meadowlands Hospital Medical Center	690	0.52	22%	42%	19%
Clara Maass Medical Center	1,389	0.46	17%	37%	17%
Christ Hospital	830	0.35	12%	34%	8.90%
Newark Beth Israel Medical Center	2,576	0.28	9.10%	33%	6.20%

4-New Brunswick Region

	2013				
	Births discharged home	Standardized score	Exclusive BF rate	Population component	Exclusive BF rate 2012
Somerset Medical Center	710	1.49	68%	45%	68%
Overlook Hospital	2,250	1.32	68%	51%	64%
Raritan Bay Medical Center	1,156	1.23	45%	37%	67%
Trinitas Hospital	2,068	1.20	40%	33%	31%
Hunterdon Medical Center	649	1.06	58%	54%	55%
Robert Wood Johnson University Hospital	1,643	0.99	45%	46%	36%
JFK Medical Center	2,271	0.84	37%	44%	23%
Saint Peter's University Hospital	4,397	0.80	37%	46%	34%

Table 1

5-Trenton Region

	2013				
	Births discharged home	Standardized score	Exclusive BF rate	Population component	Exclusive BF rate 2012
Capital Health Medical Center - Mercer (Hopewell)	1,455	2.00	84%	42%	78%
Capital Health Regional Medical Center - Helene Fuld	216	1.91	54%	28%	49%
University Medical Center at Princeton	1,686	1.26	63%	50%	56%
RWJ University Hospital at Hamilton	905	0.93	39%	42%	36%

6-Toms River Region

	2013				
	Births discharged home	Standardized score	Exclusive BF rate	Population component	Exclusive BF rate 2012
Monmouth Medical Center	4,112	1.55	78%	50%	76%
CentraState Healthcare System	1,324	1.40	71%	51%	72%
Community Medical Center	1,355	0.94	46%	49%	45%
Meridian Health - Riverview Medical Center	1,280	0.90	49%	54%	48%
Meridian Health - Jersey Shore	1,533	0.90	45%	50%	41%
Meridian Health - Southern Ocean Medical Center	343	0.85	42%	50%	46%
Meridian Health - Ocean Medical Center	845	0.65	33%	52%	36%
Kimball Medical Center	891	0.23	9.80%	42%	11%

7-Camden Region

	2013				
	Births discharged home	Standardized score	Exclusive BF rate	Population component	Exclusive BF rate 2012
Kennedy University Hospital- Washington Township	790	1.45	67%	47%	60%
Our Lady of Lourdes Medical Center	779	1.44	50%	35%	40%
Virtua Memorial Hospital of Burlington County	2,068	1.36	62%	46%	58%
Virtua West Jersey Hospital - Voorhees	4,856	1.24	67%	54%	63%
Underwood Memorial Hospital	778	0.86	41%	48%	45%
The Cooper Health System	1,434	0.84	31%	36%	25%

8-Atlantic City Region

	2013				
	Births discharged home	Standardized score	Exclusive BF rate	Population component	Exclusive BF rate 2012
South Jersey - Elmer	315	1.66	90%	54%	87%
South Jersey Regional Medical Center- Vineland	1,704	1.60	58%	36%	55%
AtlantiCare Regional Medical Center- Mainland Division	1,676	1.15	46%	40%	41%
Cape Regional Medical Center	417	1.04	44%	42%	44%
Shore Memorial Hospital	906	0.92	46%	49%	42%
The Memorial Hospital of Salem County, Inc.	181	0.46	15%	34%	10%

Hopwell (Trenton Region), a high-tech facility serving a diverse population, where the predicted rate was about average— 42%. This hospital recently achieved “Baby Friendly Hospital” designation from BabyFriendly USA.

The ability to identify hospitals that produce relatively good outcomes with populations not predisposed to breastfeeding is a major strength of standardization. Several other hospitals serving New Jersey’s most vulnerable populations can also claim positive outcomes, notably Inspira Health Network in Vineland (Atlantic City region) and Raritan Bay Medical Center (New Brunswick region).

Cautions

Several caveats should be attached to this collection of statistics, as to most others. First, while large differences in rankings between crude rate and standardized score for an individual hospital suggest that practices there may be especially well (or especially poorly) adapted to their distinctive populations, smaller differences may not be as meaningful. Our main goal has been to distinguish hospitals doing the very best job, taking into account the populations they serve.

Second, every population adjustment model is incomplete. Extreme scores in either direction are likely to be under-adjusted, and therefore overstated. Some unique population profiles may be inadequately captured. Therefore, the most positive standardized scores are only suggestive of potential “best” practices. The purpose of such measures is to identify candidates for imitation or intervention, not to crown winners and losers.

Third, statistical measures like these are only as good as the reporting done by hospitals on the electronic birth certificate. Some extremely low scores or wide discrepancies may be attributable to incorrect (or recently improved) coding. One of the benefits of public reports like

this one is to increase the incentive for quality of reporting. Future versions of this report may see a dramatic decline in unusually low scores.

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16. <http://www.usbreastfeeding.org/HealthCare/HospitalMaternityCenterPractices/ToolkitImplementingTJCCoreMeasure/tabid/184/Default.aspx>

Policy Statements and Resources on the Web

National Women's Health Information Center. <http://www.womenshealth.gov/breastfeeding/>
(Includes HHS blueprint and breastfeeding policy statements)

United States Breastfeeding Committee. <http://www.usbreastfeeding.org/>

WHO/UNICEF Baby-Friendly Hospital Initiative. <http://www.babyfriendlyusa.org/eng/01.html>

American Academy of Pediatrics initiatives page. <http://www2.aap.org/breastfeeding/>

The Academy of Breastfeeding Medicine clinical protocols.

<http://www.bfmed.org/Resources/Protocols.aspx>

American Academy of Family Practice policy statement.

<http://www.aafp.org/online/en/home/policy/policies/b/breastfeedingpositionpaper.html>

CDC breastfeeding resources webpage. <http://www.cdc.gov/breastfeeding/>

New Jersey Division of Family Health Services, Breastfeeding resource page.

<http://www.state.nj.us/health/fhs/newborn/feed.shtml>

International Lactation Consultant Association clinical guidelines.

<http://www.ilca.org/files/resources/ClinicalGuidelines2005.pdf>

La Leche League international website. <http://www.lalecheleague.org/>

ShapingNJ website: www.shapingnj.gov

NJ Baby Friendly Hospital Initiative as implemented by the NJ Pediatric Council on Research and Education (PCORE). <http://www.aapnj.org/showcontent.aspx?MenuID=1389>

Appendix 1: Data Source and Methods

New Jersey's Electronic Birth Certificate (EBC) collects, for all live births: ⁸

- Feeding method in the twenty-four hours prior to hospital discharge: exclusive breastfeeding, formula feeding, combination, other, or unknown).
- Maternal race, Hispanic origin, birthplace, age, marital status, education.
- Number of previous births (parity), prenatal care utilization, and neonatal intensive care admission.
- Hospital delivery volume was aggregated from EBC records.
- Perinatal designation level of the hospital was obtained from state administrative data.

To focus attention on situations where breastfeeding is most feasible, records were included only for singleton newborns that were discharged directly from the delivering hospital to home, and excluded for newborns that were admitted to the neonatal intensive care unit (NICU), were transferred to another hospital for any reason or duration, died before ever being discharged or were twins or higher plurality.

Population Adjustment Method

Population adjustment methods are designed to isolate the demographic and/or medical effects of patient mix from overall aggregate outcomes for a hospital, and then to compute a *residual* effect for each hospital to allow controlled comparison.⁴ Such adjustments are required because patients are not randomly assigned to hospitals, and often the patient profiles of particular hospitals are differentially prone to certain outcomes. The goal of population adjustment may be restated as estimating what each

hospital could be expected to achieve if it had the same patient mix as every other, so such approaches are also referred to as *standardization*. Conceptually, if not technically, the terms are equivalent.

Population adjustment (or standardization) is performed in three steps.

1) A general model to predict individual breastfeeding outcomes, based only on individual characteristics, in the entire population.

The outcome to be standardized is the proportion of infants who are breastfed exclusively at discharge (BFED) at each delivery hospital. In the first stage individual model we use logistic regression to predict this outcome for individual newborns, with maternal race, Hispanic origin, native or foreign birth, age, education, parity, plurality (twins, etc.), month of first prenatal care visit, and marital status as predictors. These variables were selected because they are known to have large independent effects on individual breastfeeding decisions,^{4,7,8} and because they represent the patient mix differences that hospitals cannot (indeed, should not) control.

Severe delivery complications and newborn conditions that would most likely inhibit breastfeeding are mostly excluded by the case selection criteria: singletons discharged to home with no NICU utilization.

Exhibit 1 presents the analytical results for this logistic regression model. The effects of each variable are expressed as *adjusted odds ratios*, an estimate of the relative difference in the likelihood of breastfeeding for a newborn in one category compared to the *reference category*, assuming all other factors are the same. For example, compared to newborns with native-born white mothers, most others are only about 40-60% as likely to breastfeed exclusively at discharge (all but two categories have adjusted odds ratios between .43 and .58). All of the variables in this model are

statistically significant, which means that the odds ratios are very unlikely to show the differences they do only by chance. Other opportunities to assess the strength and validity of the model will be noted below.

2) Crude rates and a *population component* computed for each hospital.

The predicted probability of BFED produced by the logistic regression procedure was computed for each newborn, and then averaged for all births at each hospital. This quantity is called the *population component*. Other statistics, such as the proportion of newborns discharged as exclusively breastfeeding, are also computed for each hospital during this step.

3) The final, *standardized score*.

The ratio of the crude hospital rate to the population component is the most directly useful measure of the hospital's net contribution to the outcome measure, after isolation and removal of population influences. A score of 1.0 is the baseline, indicating that outcome exactly matches expectation. In other applications of this methodology a further transformation is often applied to the ratio to improve the score's symmetry or other properties. None seems necessary in this case.

Exhibits 2-3 describes the relationship between the crude BFED rate, the population component and the standardized score. Exhibit 4 displays the relationship between standardized scores in 2007 and 2009. These exhibits suggest that the measurement approach is robust and fairly stable over time.

Exhibit 1. Results of Risk Adjustment Analysis, 2007-09

Logistic Regression Analysis

	adjusted odds ratio	joint test chi- square	joint test p- value
<i>Marital race/ethnicity/birthplace</i>			
US-born white, not Hispanic	1.00	6683.97	<.0001
US-born black, not Hispanic	0.49		
US-born Hispanic	0.57		
Foreign-born Hispanic	0.43		
Asian, not Hispanic	0.45		
Other foreign-born other/DK	0.72 0.85		
<i>Marital status</i>			
married	1.00	2518.42	<.0001
not married	0.57		
<i>Maternal education</i>			
lt HS	0.90	3831.11	<.0001
HS grad	1.00		
college	1.84		
<i>Maternal age at delivery</i>			
teen	0.88	70.42	<.0001
20-24	0.97		
25-29	1.00		
30-34	1.01		
35+	0.94		
<i>Number of previous births</i>			
high for age	1.09	272.65	<.0001
3, over age 25	0.97		
2, over age 18	1.00		
first birth	1.15		
<i>First prenatal care visit</i>			
never	0.35	417.82	<.0001
1st trimester	1.00		
2nd trimester	0.91		
3rd trimester	0.77		

Exhibit 2. Standardized Score by Hospital Crude Rate, 2009

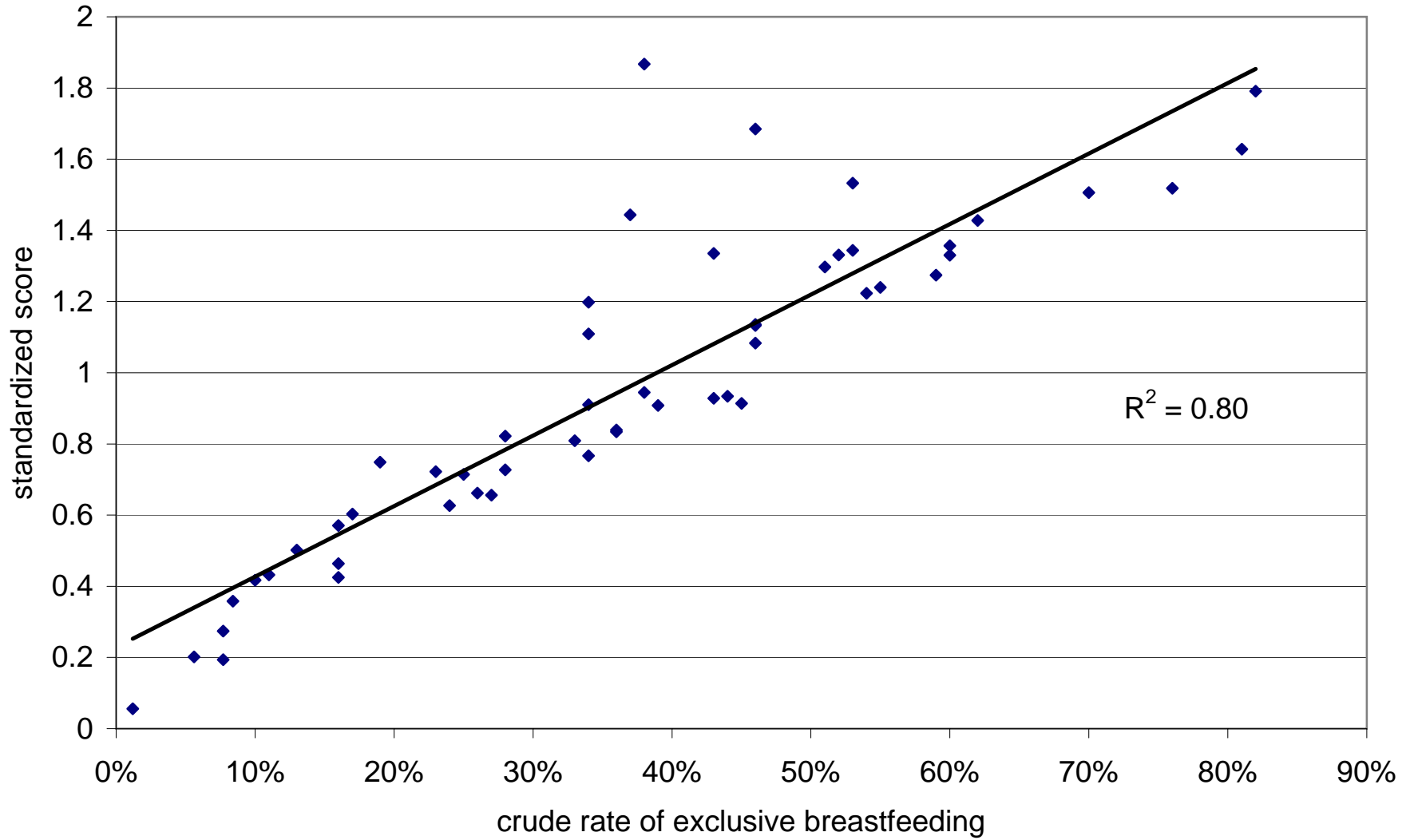


Exhibit 3. Distribution of Standardized Score by Population Component, 2009

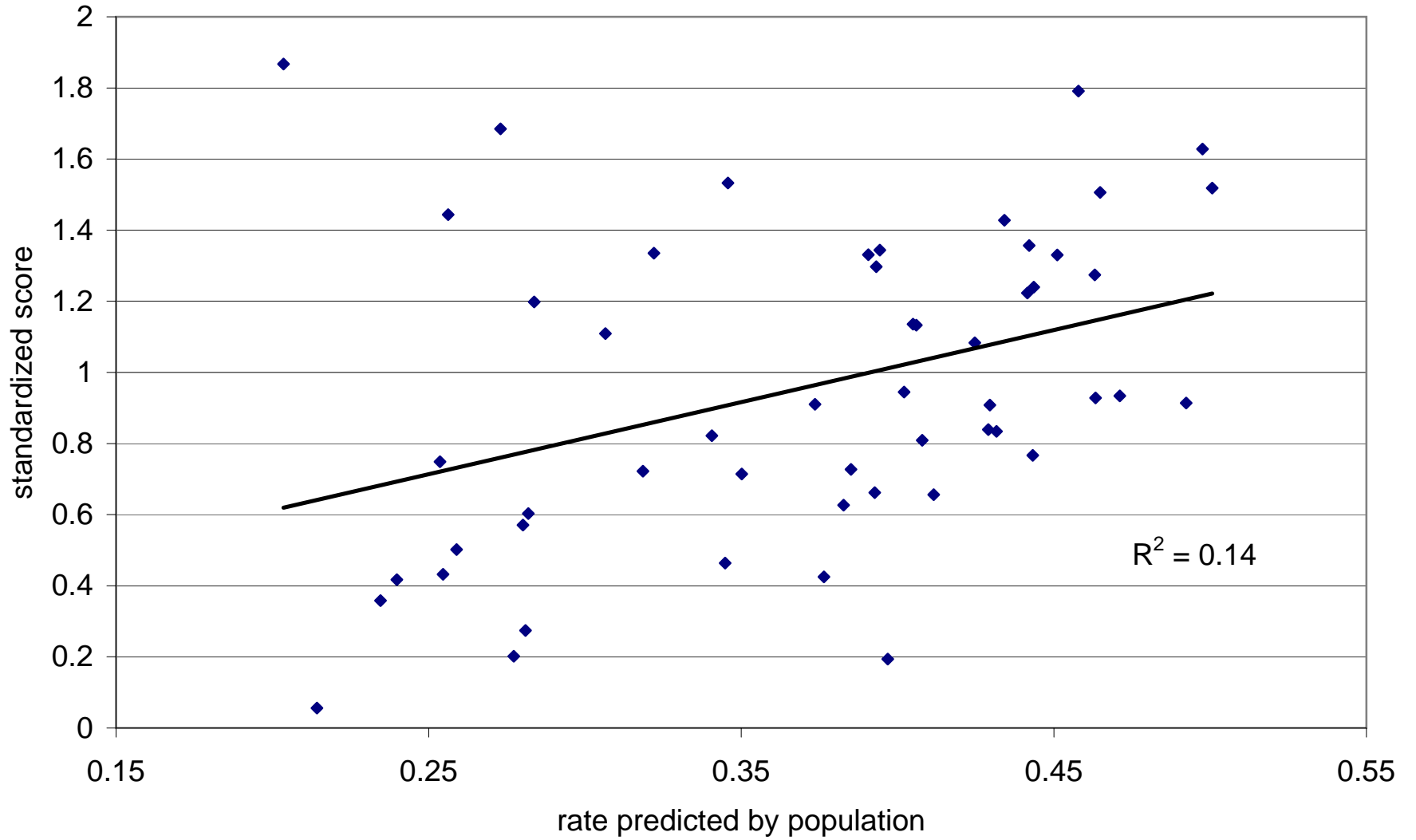


Exhibit 4. Change in Standardized Score, 2007-09

