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# The Relationship Between Magnet and Non-Magnet Designated Sites and Severe Maternal Morbidity for New Jersey Hospitals

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This is to certify that the doctoral study by

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has been found to be complete and satisfactory in all respects,
and that any and all revisions required by
the review committee have been made.

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Walden University

2024

Abstract

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MS, University of Delaware, 2012

Doctoral Study Submitted in Partial Fulfillment

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Abstract

For the past 25 years U.S. health care providers have reported higher than expected severe maternal morbidity (SMM). Magnet status is a designation through the American Nurses Credentialing Center (ANCC). Studies indicate that hospitals with Magnet recognition provide better patient care resulting in better quality outcomes. The recent COVID-19 pandemic (COVID-19) created a global-wide disruption, presenting new systemic challenges for U.S. health care providers in providing accessible, timely patient health services. The purpose of this study was to determine if there is a statistically significant difference between Magnet and non-Magnet hospitals in New Jersey (NJ) for SMM rates during COVID-19 in 2021. Donabedian's conceptual model was the framework used to guide the study. The structure included the hospital, the process was Magnet status, and the outcome was SMM rates. The research question assessed the relationship between Magnet and non-Magnet designated hospitals for addressing severe SMM rates in NJ hospitals during COVID-19. Data were collected from the ANCC database for the Magnet status and by the Healthcare Cost and Utilization Project (HCUP) for SMM rates. A quantitative, quasi-experimental, retrospective design was conducted. Data were analyzed using the parametric, independent two-tailed *t* test. The results yielded a statistically significant difference between Magnet and non-Magnet designated hospitals, during COVID-19 in 2021 for SMM rates ($p$ = .013). Magnet hospitals statistically have significantly fewer SMM rates. This study will contribute to positive social change by adding to the growing body of knowledge on the impact Magnet status makes to improving patient outcomes.

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# Dedication

To my mother, who before her passing, said to me right before I completed my master's program in 2012 how proud she was of my accomplishments. My academic journey culminating with my eventual doctoral degree is a direct reflection of my mother's belief in me, support and love. I miss and think about her every day.

Acknowledgments

Working in healthcare for over 30 years I have always had a passion for partnering with clinicians, especially nurses as they are a patient's primary care giver. In high school I wanted to be a nurse, however quickly realized after a week as a nursing aid in a long-term care facility that was not the right professional for me, leading me to the business side of medicine. During this time, I have had the privilege of working side-by side with caring, talented nurses and physicians understanding the direct impact those disciplines had on all aspects of the health care industry. The past three years have been particularly challenging for clinicians, especially nurses with the COVID-19 pandemic impacting every aspect of patient care. Nurses are the core foundation on how clinical excellence and good medicine is measured. As such, I would like to acknowledge nurses, whether at the bedside, in leadership, or in supportive roles who remained committed to their patients during the pandemic. In addition, we were blessed in 2021 with our own COVID-19 baby, our first grandchild. And although he is perfect in every way, my daughter, a healthy 28-year-old suffered a complication during labor which required medical care post-partum. My daughter's courage and experience taught me that while we have great health care system services in the U.S. it is imperfect, providing opportunities to further first understand the risks associated with maternal health care then investigate strategies to mitigate.

In addition, I wish to acknowledge:

- My husband who supported me throughout this process with dinner, encouragement, and the opportunity to vent when needed

- My four beautiful children, son-in-law, and grandson who inspire me every day to be the best mother/grandmother
- My sister, a master's prepared perioperative nurse, who personally connected with each of her patients, a constant inspiration for me, and available for advice at any time
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- And my Chair, Dr. Donna Clews, who has become a friend over these past two years, for her patience, guidance, support, and humor during this process

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Section 1: Foundation of the Study and Literature Review

## Introduction

The U.S. health care spends a larger percentage of the gross domestic product than other comparable countries, yet consistently exhibits worse clinical outcomes (Liu, 2018; U.S. Department of Health and Human Services [HHS], 2020). *Maternal health* death and associated complication rates in the United States are worse comparably to other countries within the Organization for Economic Co-operation and Development (OECD) (HHS, 2020). The Centers for Disease Control and Prevention (CDC) (2019) noted that between 2008 and 2020, the United States experienced a 15% decrease in maternal deaths, however *severe maternal morbidity* (SMM) rates increased (CDC, 2022; HHS, 2020).

Groundwork and advancing empirical research establish *Magnet designation* as synonymous with high quality nursing care practices within a hospital, typically resulting in better patient outcomes and lower nursing vacancy rates (Drenkard, 2019; Graystone, 2019; Haller et al., 2018; Kutney-Lee et al., 2015). Magnet's framework influences the structural workplace environment within a health care organization for promoting nursing professional practices which are directly correlated to improved patient care (Drenkard, 2019; Graystone, 2019; Haller et al., 2018). Over the past 10 years multiple researchers in comparing Magnet and non-Magnet designated organizations have concluded that Magnet hospitals outperform their peers with better outcomes for adult patients regarding nursing sensitive indicators, 30-day mortality, and failure to rescue measures (Friese et al., 2015; Haller et al., 2018; Kutney-Lee et al., 2015; Tubbs-Cooley et al., 2017). A positive correlation between Magnet hospitals and maternal health outcomes has been recognized for very low birth infants for mortality and infection (Haller et al., 2018; Tubbs-Cooley et al., 2017) however limited evidence relating Magnet with the CDC defined SMM outcomes.

In 2020, the HHS partnered with the surgeon general's office releasing a report outlining how prevailing worse than expected maternal health outcomes were compounded by the *COVID-19 pandemic* (COVID-19) (HHS, 2020). Groundwork research conducted by Villar et al. (2021) also confirmed an increased risk of the composite maternal morbidity indices during COVID-19. Preliminary research finds multiple factors were attributed to inferior maternal health results related to the pandemic including diminished clinical maternal health services due to reduced capacity and resources, therefore limiting access to medical care (HHS, 2020; Karkee & Morgan, 2020; Kotlar et al., 2021; Pawar, 2020). Black and Hispanic women maternal health outcomes were particularly affected by COVID-19 experiencing higher incidence of SMM (HHS, 2020; Villar et al., 2021). COVID-19 further exasperated clinical workforce shortages compromising nursing staffing ratios, forcing health care executives/board members to differentiate how their organization provide high quality services (Blumenthal et al., 2020; Karim et al., 2018a; Pawar, 2020; Vanhaecht et al., 2021). The aim of this study was to compare if Magnet designation vs non-Magnet designation affected SMM outcomes during the recent COVID-19, of 2021, for New Jersey (NJ) hospitals. This research is significant for positive social change in that it may add to the growing body of knowledge in how Magnet designation affected an organization's effectiveness in managing SMM indicators during an extreme public health crisis.

Limited outcome data indicators during the recent pandemic reveal global and U.S. maternal complication rates have recently increased (Karkee & Morgan, 2020) with the United States experiencing a statistically significant difference evidenced by the over two-thirds of deaths identified as preventable (HHS, 2020). Continued research was needed utilizing Donabedian's conceptual framework and outcome data for understanding the clinical quality effects on maternal morbidity rates during the COVID pandemic (Kotlar et al., 2021; Villar et al., 2021). The evidence collected and analyzed in this study may also provide health care leaders greater insights between Magnet designation and improved patient outcomes.

Section one reviews the research problem statement, the focus of the study, research question with null and alternative hypothesis, which theoretical foundation was referenced for the study, research design, current literature search and reviews, term definitions, investigator assumptions, research scope, and delimitations.

## Problem Statement

Over the past 25 years, health care providers at the national and NJ state levels reported higher than expected SMM outcomes which per the CDC was further exacerbated during the recent COVID-19 pandemic (CDC, 2022; HHS, 2020). SMM is defined as preventable yet life-threatening complications impacting a women's short- and/or long-term health with a higher incidence for certain vulnerable populations (CDC, 2019; Fernandes et al., 2019; HHS, 2021; Liu, 2018). In the United States, undesirable maternal health outcomes are higher when compared to other industrialized countries, with over two-thirds of deaths identified as preventable (HHS, 2020; St Pierre et al., 2018). The recent pandemic presented new systemic infrastructure challenges for health care providers, accentuating previously documented health equity disparities existent within the U.S. population (HHS, 2020; Kotlar et al., 2021). In 2020, the HHS partnered with the surgeon general's office releasing a report outlining how prevailing worse than expected maternal health outcomes were compounded by COVID-19 (HHS, 2020).

HHS (2020), Howell (2018), and the Publication of the Office of the First Lady, Trenton, New Jersey (2020) concurred accessible, evidenced-based patient care services for women prior to conception through *antepartum, intrapartum*, and *postpartum* periods significantly mitigate the short- and long-term health consequences for the mother. Limited research throughout COVID-19 recent reveals a substantial increase in global and U.S. maternal complication rates (Karkee & Morgan, 2020). In addition, data collected by the HHS (2020) demonstrated higher than expected maternal morbidity rates in rural, urban areas with racially and ethnically diverse patient populations during the pandemic (Mor et al., 2021). NJ currently ranks 47$^{th}$ in maternal health outcomes (Publication of the Office of the First Lady, Trenton, New Jersey, 2020) prompting a state-wide initiative led by the Governor's office focusing on promoting safe and appropriate guidelines. Preliminary evidence finds multiple factors relating to the pandemic including compromised clinical practices and decreased services resulting in women experiencing limited access to medical care resources, conversely impacted maternal morbidity outcomes (HHS, 2020; Karkee & Morgan, 2020; Kotlar et al., 2021). While the Magnet's framework positively influences the structural health care workplace environment promoting nursing professional practices resulting in improved patient care (Drenkard, 2019; Graystone, 2019; Haller et al., 2018), a thorough review of existing literature reflects very little or no literature differentiating if Magnet designated hospitals performed better with SMM rates during the COVID-19 pandemic.

There is a gap in the literature utilizing empirical data for understanding the clinical quality practices effects (Magnet) on SMM rates during the COVID pandemic (Kotlar et al., 2021; Villar et al., 2021). Additional knowledge in understanding the differentiating factors impacting SMM outcomes during the COVID pandemic provide health care executives/board members differentiators in the provision of high-quality services (Blumenthal et al., 2020; Karim et al. 2018a; Kotlar et al., 2021; Vanhaecht et al., 2021; Villar et al., 2021).

## Purpose of Study

The purpose of this quantitative, quasi experimental retrospective study, using secondary data, was to evaluate if there is a statistically significant relationship between magnet versus nonmagnet designated NJ hospitals for SMM rates during the COVID pandemic, in New Jersey, for the year of 2021. In 2015 the CDC ascertained 21 *international classifications of diseases* (ICD-10) conditions associated with SMM, monitored using hospital discharge data (CDC, 2015; CDC, 2019a; CDC, 2021). The CDC defines SMM as unintended health related outcomes resulting in short or long-term complications for a woman's quality of life (CDC, 2021). The independent variable for this study is Magnet designation, while the dependent variable is SMM mean outcomes.

## Research Question and Hypothesis

The study includes one research question and the corresponding hypothesis:

RQ: What is the relationship between Magnet and non-Magnet designated hospitals for addressing severe maternal morbidity, (SMM) rates in NJ hospitals during COVID-19?

$H_0$- There is no statistically significant relationship between Magnet designation and non-Magnet designation in severe maternal morbidity outcomes for NJ hospitals during the recent COVID-19 pandemic.

$H_a$- There is a statistically significant relationship between Magnet designation and non-Magnet designation for severe maternal morbidity outcomes for NJ hospitals during the recent COVID-19 pandemic.

## Theoretical Foundation

The concepts that ground this research utilize Avedis Donabedian published work, “Evaluating the quality of medical care” (Donabedian, 1966), in which Donabedian postulated the existence of interrelationships within a health care system between environmental factors, provider to patient transactions, and clinical effectiveness (Donabedian, 1966; 1985; 2005). In this study, Donabedian’s conceptual framework will be referenced for evaluating structure at NJ hospitals, with process defined as Magnet designation, and the outcome of SMM rates. Donabedian was a physician and faculty member at the University of Michigan, who published “Evaluating the quality of medical care” (Donabedian, 1966). Donabedian (1988) further investigated his conceptual works through the comprehensive approach of utilizing a structure, process, outcome methodology for assessing clinical quality, which acknowledged the equal importance of evaluating multiple components within the care delivery model for establishing and evaluating the quality of patient care delivery model. Donabedian’s conceptual model supports this study for examining maternal health through evaluating different NJ hospitals (structure) based on their Magnet designation (process) and comparing their severe maternal morbidity rates (outcome) (Donabedian 1966; Donabedian, 1988). Effective and safe patient care resulting in quality outcomes is directly related to the interdependence between systemic operational features or structures, care delivery models or process, and health status or outcomes (Donabedian, 1988; Donabedian, 2005).

## Nature of Study

To address the research questions, a quantitative , quasi-experimental, retrospective  design was utilized for this research study for evaluating the possible cause and effect of two groups (Harris et al., 2006). The independent variable (IV) of interest is Magnet designation, and the dependent variable (DV) is SMM. The secondary quantitative data sets that will be used are the American Nurses Credentialing Center (ANCC) for Magnet status (IV). The Healthcare Cost and Utilization Project (HCUP) will provide cross-sectional patient encounter-level information including the 21 indicators of SMM (DV) as classified by the CDC (CDC, 2019a; Hutchinson-Colas et al., 2022). The quantitative, quasi-experimental design provided the structure for measuring the impact of Magnet designation on SMM outcomes during the COVID pandemic in calendar year 2021. The study included conducting an independent, two-tailed *t* test for analyzing the significant differences between Magnet and no-Magnet hospitals mean severe morbidity rates in NJ during COVID-19.

## Literature Research Strategy

The  research articles were reviewed w using Google search, CINAHL & MEDLINE Combined Search, CINAHL Plus with Full Text, MEDLINE with Full Text, and ProQuest Health & Medical Collection provided by Walden Library and Google Scholar databases. The keywords and databases searched included selected articles correlating to severe maternal morbidity rates, the impact of Magnet designation on patient outcomes, and COVID-19 pandemic effects on effective patient care are described within this text. The keywords searched were *maternal mortality, maternal morbidity, severe maternal morbidity, nursing, value-based care, Magnet designation, leadership, COVID-19, Donabedian, and influence*. The scope of the literature review consisted of current peer-reviewed journals from 2016 through 2023 along with landmark studies relevant to the research.

## Literature Review Related to Key Variables

The purpose of this quantitative study was to investigate the impact of the COVID-19 pandemic comparatively between Magnet and non-Magnet designated hospitals on SMM rates. The independent variable was Magnet designated hospitals contrasted to non-Magnet hospitals. Amaral and Vidinha (2014), Drenkard (2019), and Health Research and Educational Trust (2014) independent investigations supported the relationships between high quality health care organizations along with Magnet designations. According to Haller et al. (2018) and Kutney-Lee et al. (2015) magnet designated hospitals outperform their non-Magnet peer in patient outcomes therefore providing a criteria framework for comparing organizational capacity in preventing maternal morbidity. The dependent variable was SMM using the 21 ICD-10 unintended associated conditions from pregnancy and birth resulting in short/long-term adverse complications for the mother’s health (CDC, 2021; Kilpatrick et al., 2016). Understanding the clinical quality effects on SMM rates during COVID-19 requires segmenting the comparative outcome data during the pandemic (Kotlar et al., 2021; Villar et al., 2021). Donabedian's conceptional model provides a framework for examining medical care quality components consisting of evaluating different NJ hospitals [structure] based on their magnet designation [process] and comparing their severe maternal morbidity rates [outcome] (American Nurses Association, n.d.; Gardner et al, 2014). This study seeks to determine whether there is a statistically significant difference between Magnet and non-Magnet hospital in managing SMM during the recent COVID pandemic.

## Theoretical Model

Donabedian's conceptual model constructs require researchers to deploy a multivariate analysis approach in the assessment of reliable, timely data representing different organizational structural, process, and outcome indicators (Donabedian, 1966; 1985; 2005). Effective and safe patient care resulting in quality outcomes is directly related to the interdependence between systemic operational features or structures, care delivery models or process, and health status or outcomes (Donabedian, 1988; 2005).

## Magnet Certification

A hospital with Magnet designation signals to the health care and nursing industries an organization that exemplifies and supports effective nursing care (American Nurses Association, n.d.; Friese et al., 2015; Graystone, 2019). Magnet was introduced in 1994 by the American Nurses Association, through the creation of the subsidiary American Nurses Credentialing Center (ANCC), as a volunteer process available to hospitals, committed to nursing excellence in patient care delivery (Abuzied et al., 2022; Friese et al., 2015; Haller et al., 2018; Kutney-Lee et al., 2015). Magnet designation is contingent upon five key principles including transformative leadership, staff empowerment, exemplary clinical practice, and demonstrated performance indicators (American Nurses Association, n.d; Haller et al., 2018). Evidence reported by multiple sources reveals Magnet hospitals comparatively to non-Magnet organizations are associated with higher nursing engagement scores, lower 30-day mortality rates, decreased failure to rescue deaths, improved nursing sensitive indicators, and enhanced patient satisfaction scores (Drenkard, 2019; Friese et al., 2015;  Graystone, 2019; Haller, et al., 2018; Karim et al., 2018b; Kutney-Lee et al., 2015; McHugh et al., 2013). Evidence also reveals that most Magnet designation is more likely attained by larger, academic health care organizations that are supportive of progressive clinical care models (Abuzied et al., 2022; Lasater et al., 2019; Kutney-Lee et al., 2015; McHugh et al., 2013). The capacity for executing continuous improvement strategies similar to Magnet that impact clinical performance, quality outcomes, customer service, and/or market share in juxtaposition with implementing value-based care models requires an adaptive, dynamic corporate culture ( Kash et al., 2014; Lasater et al., 2019).

### *Organizational Effectiveness*

Nursing services is the largest patient care department in a hospital with substantial influence in the delivery of medical services (Abuzied et al., 2022; Amaral & Vidinha, 2014). Building an effective nursing department relies on the prioritization hospital leaders on understanding the relationships between structural and process indicators on outcomes is crucial for improving institutional results (Abuzied et al., 2022; Amaral & Vidinha, 2014). Amaral and Vidinha (2014) conducted a cross-sectional, longitudinal study in Portugal, evaluating 26 nursing units within four hospitals, involving 1764 patients and 364 nurses. The authors utilized a literature search for identifying the best method in evaluating nursing quality within the acute care setting adopted Irvine, Sidani and McGillis's (1998) Nursing Role Effectiveness Model (NREM). Patient data was collected by nursing assessment instrument evaluating patient health status. Nursing data was collected by an anonymous questionnaire. Assumptions for the data analysis included defining structure variables as organizational, nursing, or patient. Examples of structural indicators for the organization were the number of nursing hours per day, for nursing the percentage of specialized certifications within the staff, and for patients age, diagnosis, previous health history, and average length of stay. Process indicators included nursing perspectives of providing individual care, communication with patients and family, and the ability for nursing to collaborate with physicians. The outcome variable was patient functional status.

The investigators utilized structural equation modeling (SEM) to test the causal relationships between structural and process (independent variables) with outcomes (dependent variable). However, prior to the SEM, variable results were aggregated and tested using the one-way analysis of variance and *F* test assess for statistical significance between the structure and outcomes variables. In addition, a linear regression was conducted on the patient variables age, length of stay, diagnosis, and outcomes in determining nursing's influence. The results showed higher ratios of specialist nurses had a significant positive direct association on providing individualized care and fostering nurse-physician relationships. Specialist nurses also indirectly positively correlated to a patient's functional status. Nursing hours per patients had a positive, direct influence on individualized care plans and physician collaboration, with a significant negative direct effect on the communication with patients and their families.

Embarking on the Magnet certification is a multiyear commitment requiring at the top organizational executive levels for developing a business case to prioritize the upfront financial and resource investments associated with Magnet (Drenkard, 2019; Hamadi et al., 2021). Hamadi et al. (2021) studied data from July 1, 2014, through December 30, 2015, using the ANCC, CMS, AHA, and CMS Hospital Acquired Conditions Reduction Program (HACRP) databases. The authors used a cross-sectional design for investigating the impact of Magnet status on HACRP (Hamadi et al., 2021). Logistic regression modeling was used in identifying the impact of Magnet as the IV on HACRP as the DV, using a combination of two propensity scores: patient safety indicators (PSI-90); and overall HACRP scores based on hospital acquired infection measures (HAI) and total hospital acquired conditions (HAC) (Hamadi et al., 2021). 390 hospitals had received Magnet designation either within the prior two years or greater than five years; 2,594 were non-Magnet organizations (Hamdi et al., 2021). Hospital factors were measured using categorial variables for geographical location, teaching hospitals, ownership models, operation margin, percentage of Medicare/Medicaid patients and ratio factor for market competition (Hamadi et al., 2021).

The results for domain one, PSI-90 propensity score was coterminous. with other studies, indicating better outcomes associated with Magnet hospitals ($\beta = -.30$, CI 95%: .42 - .18) (Drenkard, 2019; Hamdi et al., 2021). Magnet organizations outperformed their non-Magnet peers in outcomes including hospital acquired pressure rates, inpatient falls, and post-operative respiratory failure, sepsis, wound dehiscence (Hamdi et al., 2021).

However, there was no statistically significant difference between Magnet and non-Magnet hospitals in HACRP scores, except with Magnet performing better in managing Methicillin-resistant Staphylococcus Aureus (MRSA) and non-Magnet hospitals reporting better results in catheter acquired urinary tract infections (CAUTI) and surgical site infections (SSI). The authors postulated the outcomes associated with nursing care performed better in the Magnet hospitals, but other patient results were co-dependent upon multiple caregivers (Hamdi et al, 2021).

***Nursing Effectiveness***

A strong relationship exists within a health care organization between nursing services that are well structure constructed on evidenced-based practices and high-quality patient outcomes (Haller et al., 2018; Salmond et al., 2009). Kutney-Lee et al. (2015) investigated the changes in patient and nursing outcomes associated with a hospital achieving Magnet recognition. The authors objectively examined and compared the outcomes between 136 PA hospitals with either emerging Magnet status or none through a retrospective two stage panel design methodology. The time-frame for the project was 1996 and 2006, comparing the performance of 11 emerging Magnet and 125 non-Magnet organizations. The population was limited to general, orthopedic, and vascular surgical procedures for patients between 22 and 88 years old. Using descriptive statistics and *t*-tests, the study reviewed and analyzed patient plus organizational indicators using along with patient and nursing outcomes for measuring the differences between emerging Magnet and non-Magnet hospitals for the two distinct time points (1999 and 2006). The nurse work environment was measured using the Practice Environment Scale of the Nursing Work Index (PES-NWI), endorsed by the National Quality Forum Work for monitoring environment changes (Kutney-Lee et al., 2015). Patient outcomes measured were the 30-day surgical mortality and failure to rescue preventable complication measures through the utilization of patient discharge and death records. Nurse-reported quality of care encompassed three outcomes collected through a nurse survey using a four-point Likert scale: overall quality, nurse job outcomes including burnout and job dissatisfaction. Hospital-level indicators for nurse staffing and nursing educational levels were collected through the distributed surveys. Other hospital characteristics, such as teaching status, technology status, and bed size were also included as control variables for modeling.

A two-period difference model was used for evaluating if changes in outcomes in emerging Magnet hospitals were significantly different from hospitals that remained non-Magnet (Kutney-Lee et al., 2015). The investigators deployed the fixed effects difference model which theoretically controls for all unmeasured characteristics of hospitals that did not change over the time period. The analysis revealed when compared to non-Magnet hospitals, emerging Magnet hospitals experienced significantly greater improvement in patient and nurse outcomes over time, indicating Magnet recognition, in general, is an intervention that may result in improved nursing and better patient outcomes (Kutney-Lee et al., 2015).

Organizations undergoing the Magnet designation process had considerable improved workforce stability outcomes (Kutney-Lee et al., 2015; Lundmark et al., 2012). A comparison between the two-time cohorts revealed a 16% decrease in job dissatisfaction (Kutney-Lee et al., 2015). Magnet organizations also had statistically significantly higher percentages of baccalaureate-prepared nurses than non-Magnet hospitals (1999: 43% vs. 31%, $p < 0.01$; 2006: 45% vs. 33%, $p < 0.01$), and lower patient to nurse ratios (1999: 5.0 vs. 5.8, $p = 0.02$; 2006: 4.9 vs. 5.8, $p < 0.001$) for both time periods (Kutney-Lee et al., 2015). The PES-NWI overall scores improved significantly ($p < .05$) for emerging Magnet hospitals for all indicators except staffing and resource adequacy where the improvements were notable ($d = .16$, $p = .06$) (Kutney-Lee et al., 2015). 30-day surgical mortality was markedly lower in hospitals attaining Magnet comparatively (1.28%, 1.51%, $p = .05$), however no differences in failure to rescue (Kutney-Lee et al., 2015). Emerging Magnet organizations also had lower rates of burnout (29.7%, 38.4%, $p < 0.001$), job dissatisfaction (21.2%, 30.9%, $p < 0.001$) and intentions to leave their employer (8.9%, 13.4%, $p < 0.01$) (Kutney-Lee et al., 2015). Limitations with the study is the small sample size of emerging Magnet hospitals, effects of magnet understated, covariates not accounted for including palliative and transitional care programs. The authors identified the need for additional research in broadening the causal assumptions (Kutney-Lee et al., 2015).

The value of magnet designation has strongly been correlated to improved patient outcomes through the provision of good nursing care (American Nurses Association, n.d.; Graystone, 2019). Tubbs-Cooley et al. (2017) performed a secondary analysis based on a previously conducted observational study of patient care practices by nurses in U.S. neonatal intensive care units (NICU). A random sample from the original from April 2012 survey of certified NICU nurses was collected using the cross-sectional web-based survey to specifically analyze if Magnet designation impacted two independent variables, nursing reporting missed care and the reasons why patient care was not provided (Tubbs-Cooley et al., 2017). As cited by Kalisch et al. (2009), missed nursing care is defined as necessary evidence-based medical interventions not performed by the caregiver (Tubbs-Cooley et al., 2017). 1,850 nurses from seven states, selected due to the higher percentages of certification specialization and regional diversity, were invited to participate resulting in a 22% response rate equal to 402 (Tubbs-Cooley et al., 2017). The researchers utilized a logistic regression model for measuring the differences between Magnet and non-Magnet facilities along with descriptive statistics for comparing sample characteristics between the two groups.

The final number of responses referenced in the investigation was 230, with 47% Magnet and 53% non-Magnet, resulting in no statistical relationship between Magnet and non-Magnet hospitals in nursing reported missed patient care (Tubbs-Cooley et al., 2017). Preparation for patient discharge was the only measure Magnet organizations statistically performed better than their peers for missed care ($p < .05$, .25, CI 95%: .09 - .71) (Tubbs-Cooley et al., 2017). However, there were significant differences in the reasons for why care was missed with nurses working within a Magnet organization less likely to cite communication breakdowns with patients, caregivers, or team members, available supportive resources, work-related stress, and knowledge of policies (Tubbs-Cooley et al., 2017). Magnet certified nurses were 64% more informed regarding hospital policies ($p = .006$, .36, CI 95%: .17-.75), 49 percent less likely to report stress ($p = .000$, .51, CI 95%: .03 - .91), 68% less probable communication breakdowns within the interdisciplinary (p < .05, .32, CI 95%: .18 - .59), and 47 percent less expected to cite lack of supportive resources ($p = .013$, .53, CI 95%: .31 - .92) (Tubbs-Cooley et al., 2017). While the findings were not conclusive in differentiating performance between Magnet and non-Magnet organizations in missed nursing care, the statistically significance within specific components for reasons provides non-Magnet leaders additional support and education opportunities (Graystone, 2019; Tubbs-Cooley et al., 2017). The authors postulated that Magnet hospitals may be more financially stable than their non-Magnet peers, which may account for a portion of the differences but did not utilize financial indicators in their study (Tubbs-Cooley et al., 2017).

### *Patient Outcomes*

Magnet designation results in better outcomes through creating a supportive, empowering working environment that promotes nursing practices through an interdisciplinary approach for delivering patient care (Graystone, 2019; Tubbs-Cooley et al., 2017). Overall, the health care industry has a heightened awareness and organizational focus on pay for performance reimbursement programs resulting in organizations prioritizing improvement strategies for improving patient outcomes, attracting qualified staff, and achieving national recognition (Friese et al., 2015; Graystone, 2019). Friese et al. (2015) evaluated if hospitals in the Magnet program showed better patient outcomes on mortality measures when compared to non-Magnet hospitals. The investigators used a multivariable analysis and linear mixed models to examine Medicare patients admitted for one of three surgical procedures frequently performed within acute care settings, coronary artery bypass graft (CABG), colectomy, and lower extremity bypass (Friese et al., 2015). The sample population was collected from 1,897,019 patients from 993 hospitals, 65 years or over, fee for service Medicare patients with the appropriate ICD codes, over a 13-year period 1998 through 2010 (Friese et al., 2015).

Outcomes measured included risk adjusted mortality and failure to rescue or post-operative complications leading to death by comparing similar hospitals by using a propensity scoring model encompassing seven hospital characteristics to match Magnet organizations, representing 44.3% patients at 33.3% hospitals, with two similar non-Magnet organizations (Friese et al., 2015). A sensitivity analysis used to increase confidence in results (Friese et al., 2015). Overall, the Magnet facilities demonstrated better outcomes than their non-Magnet peers with 7.7% less likely to die in 30 days, 8.6% lower post operative complications, and significant superior mortality rates, 5.8 percent, 6.3% (Friese et al., 2015). Magnet organizations on average were larger in staffed beds than the non-Magnet facilities, 421, 371 respectively, offered transplant programs, and demonstrated better nursing to patient staffing; however, these three indicators were not statistically significant (Friese et al., 2015). Limitations in the study showed post Magnet designation hospitals did not realize significant improvements in outcomes for the three designated surgical procedures (Friese et al., 2015). Also, the study did not adjust for criteria changes in Magnet during the designated time period, as well as unmeasured differences between hospitals, patient characteristics, hospital closures, mergers, or acquisitions (Friese et al., 2015).

McHugh et al. (2013) validated previous studies that had proven the positive impacts of Magnet designation on nurse recruitment and retention but questioned how does achieving Magnet status impact the organization’s patient outcomes. Investigators collected data from four states, FL, CA, PA, and NJ, during 2006-2007 from 56 Magnet and 508 non-Magnet facilities. The study directly measured the work environment through utilization of the PES-NWI survey to assess organizational level nursing performance (McHugh et al., 2013). Data on structural characteristics of the different hospitals, were obtained from the 2006 to 2007 American Hospital Association annual hospital surveys. Magnet status was abstracted from the ANCC database. Patient outcomes were collected through the hospital discharge databases from the four states. The study was scoped to patients between the ages of 21 and 85 hospitalized for general, orthopedic, or vascular surgical procedures.

The findings revealed within the study cohort and consistent with 1994 findings, a larger proportion of Magnet hospitals were large, nonprofit, high-technology, teaching facilities (Friese et al., 2015; McHugh et al., 2013; Tubbs-Cooley et al., 2017). Per the PES-NWI reflected better nursing working environments in Magnet designated hospitals, with an overall score of 2.65 for Magnet hospitals, compared to 2.66 for non-Magnet ($p <$ .0001) (McHugh et al., 2013). Magnet facilities also had higher percentages of bachelor degreed nurses, (0.46%, 0.39%, $p < .001$), higher levels of specialty certified nursing personnel (0.40%, 0.36%, $p < 0.03$), and lower utilization of agency nursing (0.39%, 0.51%, $p < 0.03$) (McHugh et al., 2013). Surgical patients from Magnet hospitals experienced lower complications (3.8%, 4.6%, $p < .001$) and lower mortality levels (1.5%, 1.8%, $p$ <. 001) than non-Magnet hospitals (McHugh et al., 2013). The authors conclusion was that Magnet designation establishes stronger working environments for nurses which result in statistically significantly better patient outcomes for surgical patients (McHugh et al., 2013).

**Severe Maternal Morbidity**

*Maternal mortality* and morbidity rates in the United States are already a national health crisis which was further exacerbated by the recent COVID pandemic (HHS, 2020;

Kilpatrick et al., 2016; Mishkin et al., 2021). SMM is defined by the CDC as preventable complications during the labor and delivery process resulting in a significant consequence to a woman's well-being (CDC, 2021; HHS, 2020; Kilpatrick et al., 2016). Blood transfusions, usually experienced when there is excessive bleeding during delivery, continue to be the biggest risk indicator for SMM with a 200% increase in blood transfusions complications from 1993 to 2014 (CDC, 2021). Women of racial and ethnic minorities have higher incidences of SMM with non-Hispanic Blacks, American Indians, and Alaskan indigenous populations experiencing 150% greater risk of experiencing an unexpected outcome during the pregnancy, delivery, and/or post-partum periods (CDC, 2021; HHS, 2020; Howell, 2018). Other contributing factors for SMM are prior chronic *health disparities* including diabetes, hypertension, obesity, substance abuse, mental health, along with age and geographics (HHS, 2020). SMM is considered a strong predictor for maternal morbidity with HHS (2020) postulating a 50% reduction of maternal related deaths when evidence-based protocols are followed in mitigating SMM conditions (Howell, 2018; St Pierre et al., 2018). The reviewed literature search resulted in five distinct areas of research for gaining further insights to SMM: national/state level maternal health indices; causation of unexpected outcomes; impact of *social determinants of health* (SDOH); data monitoring and surveillance; and COVID-19 effects.

### ***National and State Maternal Health Indices***

HHS (2020) surgeon general's multidisciplinary report on maternal health acknowledged a poorer outcome performance in the U.S. for mortality and morbidity rates when compared to other Organization for Economic Co-operation and Development (OEDC) countries. A retrospective quantitative review of morbidity and mortality outcomes in the U.S. was conducted, evaluating along with causation, population segmentation proposed evidence-based interventions (HHS, 2020). The study identified multiple independent variables correlating to SMM outcomes including variations in clinical practice, race and/or ethnicity, SDOH, and pre-existing conditions (HHS, 2020). The research further determined the leading complications associated with SMM included intravascular coagulation or blood clotting disorders, gestational diabetes, hemorrhaging or severe blood loss, acute kidney infarction or failure, sepsis or infection, and respiratory distress (HHS, 2020). Consequently, the research found SMM complications can have longer term women's health implications, with evidence revealing half of women diagnosed with gestational diabetes will develop Type II diabetes at a later age (HHS, 2020).

The results and recommendations of the study focused on addressing SMM with non-Hispanic Black women who significantly experience higher incidences of blood transfusions along with disseminated intravascular coagulation, hysterectomy, acute kidney failure, sepsis, and adult respiratory distress (HHS, 2020; CDC, 2021). Other contributing factors to poor maternal health outcomes include housing, provider/care accessibility, system continuum of care issues, low health literacy levels, geographic factors, and mother's age (HHS, 2020). The study also identified a national need for standardized mortality and morbidity review committee audits (MMRC) audits and real-time surveillance data (HHS, 2020). HHS (2020) study further validated the systemic need for evidence-based interventions when the immediate need for prenatal accessible care/services, managing pre-existing conditions, including hypertension, obesity, diabetes, infectious diseases, substance abuse, and post-partum care. The surgeon general's report also indicates minority women have two to three times higher incidences of poor maternal health outcomes especially when residing in rural communities, however, does not cite data-driven specific interventions for implementation (HHS, 2020).

Tammy Murphy, the First Lady of NJ recently coordinated multidisciplinary stakeholders for a comprehensive compilation of maternal health issues and proposed recommendations (The state of NJ recent publication by Publication of the Office of the First Lady, Trenton, New Jersey, 2020). Although NJ has the fourth highest maternal mortality in the U.S., the state ranks favorably as the eighth healthiest and social indices. The study was a retrospective quantitative review of 2018 morbidity and mortality outcomes in NJ through a review of clinical practices, race, ethnicity, and SDOH factors to isolate associated causation with significant correlation (The state of NJ recent publication by Publication of the Office of the First Lady, Trenton, New Jersey, 2020). The aggregated results revealed non-Hispanic Black women the highest incidences of SMM in NJ, 192.2 per 10,000 deliveries, with a blood transfusion rate of 377 per 10,000 deliveries verses white women at 135 per 10,000 deliveries (The state of NJ recent publication by Publication of the Office of the First Lady, Trenton, New Jersey, 2020; Hutchinson-Colas, et al., 2022). Aside from blood transfusions the leading cause of SMM for non-Hispanic Black women were similar to the national study: disseminated intravascular coagulation, 30.8 per 10,000 deliveries; acute renal failure, 29.2 per 10,000 deliveries; shock, 21.3 per 10,000 deliveries; eclampsia, 15 per 10,000 deliveries; sepsis 15 per 10,000 deliveries; and air and thrombosis embolisms, 11.1 per 10,000 deliveries

(The state of NJ recent publication by Publication of the Office of the First Lady, Trenton, New Jersey, 2020).

The researchers assessed the correlation between poor maternal health outcomes and social determinants of health (SDOH) indicators including federal poverty levels, unemployment rates, per capita income, and food insecurities (The state of NJ recent publication by Publication of the Office of the First Lady, Trenton, New Jersey, 2020). Although non-Hispanic black women represent 12.8% and white women 54.6% of the NJ population, respectfully 16.1, 5.5% live below the federal poverty level, 9.0, 4.1% are unemployed, the per capita income is $29,459, $52,084, and 10.6, 9.6% (NJ average) suffer food insecurities (The state of NJ recent publication by Publication of the Office of the First Lady, Trenton, New Jersey, 2020). The investigation identified care gaps throughout the maternal health continuum concerning health care accessibility, variations in clinical practice, appropriate community services, managing pre-existing conditions throughout a pregnancy, and clinical biases pertaining to the critical race theory (The state of NJ recent publication by Publication of the Office of the First Lady, Trenton, New Jersey, 2020).

***Causation of unexpected outcomes***

Hutchinson-Colas et al. (2022) and Kilpatrick et al. (2016) research identified consistent themes regarding the preventing maternal mortality rates (MMR) through the identification and management of SMM. The CDC (2021) defines SMM as “unexpected outcomes of labor and delivery that result in significant short-or long-term consequences to a woman’s health status with a high rate of preventability”. Bomela (2020) investigated the causation of MMR by evaluating the socio-demographic characteristics of women's deaths in South Africa during the period of 2007–2015. The study reviewed 14,900 maternal deaths utilizing a quantitative secondary data retrospective review, analyzing the information using frequency tables, cross tabulation, and logistic regression. The dependent variable was maternal mortality and the independent variables segmented by SDOH included abortion, hypertension, maternal care conditions, labor and delivery complications, post-partum complications, hemorrhaging, sepsis, and other infections. Despite the decline in MMR in South Africa, a maternal age of 20 to 34 years and 35 or older is a strong indicator, 83.1% of MMR, similar to the WHO and U.S. data (Bomela, 2020). In addition, the study revealed an increase of MMR associated with viral disease, 10.4%, hypertension, 17%, Human Immunodeficiency Virus (HIV), 23%, and infections, 18.3% (Bomela, 2020). Recommendations for lowering MMR in South African populations include programs and services through the pre-conception, antenatal, and post-partum phases, focusing on birth control education, along with clinical management of pre-existing conditions that may put a woman at risk including obesity, HIV, cardiovascular disease (Bomela, 2020; Kilpatrick et al., 2016). Limitations of the study include addressing incomplete data sources including death certificate information and further understanding the contrasts in outcomes between the different geographical regions within South Africa.

Chen et al. (2021) conducted a retrospective cohort study to further understand the factors associated with SMM women experience post-hospital discharge. The authors utilized the IBM Marketscan Medicaid and Commercial Claims databases to assess outcomes for women in the U.S. between the ages of 15 and 44 years discharged from a hospital with a diagnosis of delivering between January 2010 and September 2014 (Chen et al., 2021). The study included 2,667,325 births with 809,377 (30.3%) Medicaid patients and 1,857,948 (69.7%) commercial insured patients (Chen et al., 2021). The authors utilized the CDC ICD-10 21 defined SMM diagnosis, segmenting the population into three groups: no SMM during or post-delivery; one SMM diagnosis; and any SMM diagnosis 42 days post-discharge. Pearson's Chi-Square was used for analyzing the three segmented SMM categorial variable rates and regression for testing associations between SMM and different demographic indicators. Women with Medicaid coverage experienced a SMM 2.2% rate (17,584) during delivery and .4% (3,265) with a newly diagnosed SMM post-discharge (Chen et al., 2021). Commercial patients had a 1.7% (32,079) SMM rate during childbirth and .3% (5,275) post-discharge complications (Chen et al., 2021). Non-Hispanic Black women with Medicaid insurance had the highest incidences of post-discharge SMM, adjusted odds ratio, ($p < .02$; 1.53, CI 95%: 1.48 – 1.58) compared to Hispanic and other groups with Medicaid (1.46, CI 95%: 1.37 – 1.57; 1.40, CI 95%: 1.33 – 1.47) (Chen et al., 2021). The largest disparity comparatively for post-discharge SMM was between non-Hispanic Black women and white women (1.69, CI 95%: 1.57 – 1.81) (Chen et al., 2021).

The overall results of the variables associated with SMM during the course of delivery differed slightly with those associated with complications post-discharge (Chen et al., 2021). The prominent SMM during the course of labor was blood transfusions of four or more units of blood to the mother (Chen et al., 2021; Kilpatrick et al., 2016). Within the Medicaid patient population, the dominant SMM were disseminated intravascular coagulation, heart failure or cardiac arrest, eclampsia, acute respiratory distress syndrome and pulmonary edema or acute heart failure (Chen et al., 2021). Post-hospital discharge, the highest rates of SMM were associated with pulmonary edema or acute heart failure, adult respiratory distress syndrome, sepsis, air and thrombotic embolism, and eclampsia (Chen et al., 2021). Geographical factors within the U.S. were compared for women with commercial insurance residing in the western and southern states compared to the northeast region experienced a higher incidence of SMM during their hospitalization ($p < .001$; 1.37, 95% CI: 1.32 – 1.41; 1.29, 95% CI: 1.18 – 1.39) (Chen et al., 2021). Stillbirth and cesarean section deliveries accounted for a three to four times likelihood of SMM respectively, ($p < .01$; 3.80, 95% CI: 3.53 – 4.10; 2.89, 95% CI: 2.82-2.95) (Chen, et al., 2021). The results showed how providing coordinated, timely and high-quality maternal health care services throughout pregnancy and post-discharge for women are a differentiator in reducing complications, especially in areas with diverse health disparities (Chen et al., 2021).

***Impact of social determinants of health (SDOH)***

Crear-Perry et al. (2021) and Howell (2018) studied the impact of social determinants of health (SDOH) on maternal health. SDOH are factors impacting a vulnerable population from receiving accessible and appropriate medical care: socioeconomic factors including housing, education, working conditions; government subsidiaries, policies that impact the community members' lifestyle; and/or pre-existing chronic illnesses including depression (Crear-Perry et al., 2021; Howell, 2018). Wang et al. (2020) assessed the impact of environment and community on maternal child health (MCH) outcomes utilizing a needs assessment tool measuring 66 indicators within six domains. The researchers utilized data from PA hypothesizing that adverse MCH are disproportionately associated with SES, racial and ethnicity indictors, and contextual factors including income, education, exposure to violent crimes (Wang et al., 2020). The study categorized the data into quartiles, adjusting for non-normal variation, and segmented by county level. Sources for obtaining the data for 2016 included publicly available information through HCUP, medical billing claims, and patient surveys (Wang et al., 2020). County levels were utilized because of health resources and services administrative (HRSA) state oversight, federal funding allocations, and community needs based on geographical locations (Wang et al., 2020).

Data was organized using a composite needs score calculated as a weighted average of the needs scores within two domains, MCH and community/environmental (Wang, et al., 2020). Evidence from prior studies evaluating the CDC SMM indicators reveals greater risks associated with minority women including pre-pregnancy hypertension, eclampsia, and mental health (Crear-Perry et al., 2021; Vedam et al., 2019; Wang et al., 2020). While Wang et al. (2020) did not directly measure the CDC defined mortality outcomes associated with the preconception, prenatal, antenatal, and post-partum phases, there were several maternal specific outcomes evaluated relevant to understanding correlations to poor SMM outcomes. 44 out of 67 counties achieved an elevated needs status in at least one category including SES (44%) and substance abuse (44%) (Wang et al., 2020). In addition, there was variation in county level outcomes comparing outcome domain needs scores with community and environmental factors. The authors note managing health disparities for MCH is complex although by understanding the community level factors associated with poor outcomes, federal and state dollars can be allocated effectively in addressing family planning, preventative care, community investments based on geographical factors (Crear-Perry et al., 2021; Wang et al., 2020)

The impact of discrimination based on lower socioeconomic status (SES), race, and/or SDOH indicators correlates directly to poor maternal health outcomes in the U.S. (Crear-Perry et al., 2021; Howell, 2018; Vedam et al., 2019). Vedam et al. (2019) referencing the World Health Organization (WHO) eight dimensions of maternity care (World Health Organization, 2019) created an on-line cross-sectional study, Giving Voice to Mothers (GVtM), measuring the levels of maternal health outcomes for diverse women in the U.S. 2,700 women across all 50 states participated in the survey with 2,318 completing the survey (Vedam et al., 2019). The researchers strategically solicited participation in geographical regions with higher levels of minority women resulting in the highest input from NY (29.7%), ages 25 through 35 (64.5%), and 90% born in the U.S. (Vedam et al., 2019). The study was designed for measuring indicators that measured different forms of mistreatment based on input from a multi-divers group of stakeholders including community members, community health workers, and providers (Vedam et al, 2019). One of six women experienced one or more forms of mistreatment with higher frequencies by women of color when compared to white women (Vedam et al., 2019).

Utilizing a bivariable logistical regression analysis for measuring mistreatment and referencing white women responses, indigenous women reported the highest incidences (2.98, CI 95%: 1.73 – 5.13), followed by Hispanic women (2.04, CI 95%: 1.42 – 2.93), and non-Hispanic black women (1.77, CI 95%: 1.31 – 2.40) (Vedam et al., 2019). Other statistically significant indicators of maternity care mistreatment included lower levels of SES, Caesarean section births, physician care provider in a hospital setting, first time mothers, and age (Vedam et al., 2019). Comparatively using women respondents between the ages of 31 and 39, women ages 17 and 25 experienced the highest rate of mistreatment (1.71, CI 95%: 1.08 – 2.69), followed by 26 through 30 years of age (1.15, CI 95%: .88 – 1.49), and over 40 (1.04, CI 95%: .62 – 1.74) (Vedam et al., 2019). Mistreatment was further worsened through unexpected provider interventions resulting in patient and clinician disagreements about care delivery (Vedam et al., 2019). The researchers postulated that patient experiencing degrees of mistreatment experience short-term pain and suffering along with longer-term effects of mental health, declining family relationships, and fear associated with subsequent pregnancies (Vedam et al., 2019). The study further emphasized prior research suggesting the need for enhanced education and training of health care providers on effective processes for managing vulnerable populations (Howell, 2018; Vedam et al., 2019).

Sharma et al. (2022) studied the impact of cardiovascular health (CVH) and SDOH on maternal health outcomes. The authors hypothesized with over 33% of pregnancy deaths attributed to cardiovascular disease combined with previous research regarding the association of SDOH on maternal health outcomes, there was a correlation between the two variables (Sharma et al., 2022). Utilizing the National Health Interview Study from 2013 through 2017, the researchers isolated the responses from the adult sample core questionnaire in determining the correlation between suboptimal CVH and SDOH from attributing 38 factors within six domains (Sharma et al., 2022). Data for 1433 survey respondents was evaluated, average age of 28.8 years (+/- 5.5 years) with 13% non-Hispanic Black women (Sharma et al., 2022). CVH was assigned a binary score of 0 for no presence and 1 for existence based on self-reported information encompassing different CVH factors (Sharma et al., 2022). SDOH were scored based on six domains including economic stability, education level, food accessibility, health care services, physical environment, and social support (Sharma et al., 2022). using a Bayesian regression model, the researchers tested the relationship between CVH as the dependent variable and cardiovascular risk factors, SDOH as the independent variables, adjusting for age, race/ethnicity (Sharma et al., 2022).

High level analysis revealed over 50% of women during their pregnancy reporting the highest level of SDOH factors also had suboptimal CVH with greater than two factors (Sharma, et al., 2022). Overall, 38.4% (CI 95%: 33.9 – 43) of women had suboptimal CVH, and 51.7% (CI 95%: 47 – 56.3) scoring in the highest or fourth quartile for SDOH (Sharma et al., 2022). Risk factors correlating to SDOH at the fourth quartile verses the first quartile were suboptimal CVH (2.05, CI 95%: 1.46 – 2.88), smoking (8.37, CI 95%: 3 – 23.43), obesity (1.54, CI 95%: 1.17 – 2.03), and low physical activity levels (1.19, CI 95%: 1.01 – 1.42) (Sharma et al., 2022). Comparatively pregnant women to non-pregnant women had higher levels of insufficient physical activity and obesity, however non-pregnant had higher prevalence of hypertension, diabetes, cholesterol levels, and smoking (Sharma et al., 2022). Within the fourth quartile for SDOH statistically significant for pregnant was low physical exercise (63.1, CI 95%: 58.5 – 67.6) hyperlipidemia (9.9, CI 95% 5.6 – 14.3), smoking (11.8, CI 95%: 8.5 – 15), and obesity (39, CI 95%: 34.1 – 43.9) (Sharma, et al., 2022). Age was also significant factor for pregnant women (38.4, CI 95%: 33.9 – 43) to have suboptimal CVH (Sharma et al., 2022). The authors concluded the need for providers to implement a risk assessment tool for monitoring the various associated factors impacting CVH during pregnancy along with a public health comprehensive interventional strategy (Sharma et al., 2022).

***COVID-19 effects***

Saccone et al. (2020) during the first months of the pandemic conducted a cross-sectional study of 100 pregnant women in China March through April 2020. Requirements for interested participants in the self-administered were a current singleton pregnancy and no past history of post-partum related depression, however no age or gestational period limitations (Saccone et al., 2020). The survey had three components: measuring the psychological impact of COVID-19 using the Impact of Event Scale Revised (IES-R); evaluating anxiety using the Spielberger State-Trait Anxiety Inventory (STAI); and a self-assessment of measuring anxiousness regarding the epidemic, possibility of vertical transmission to the fetus (Saccone et al., 2020). The IES-R was a 22 questionnaire with a Likert scale zero to four, with the higher the score the greater the psychological impact (Saccone et al., 2020). The STAI utilized six questions with a scoring range 20 to 80, the higher numbers reflecting greater anxiety levels (Saccone et al., 2020). A visual analog scale (VAS) ranging from one to 100 for the respondent's self-measuring anxious level (Saccone et al., 2020).

The researchers conducted a univariate comparison of the two components of the survey utilizing a Chi-Square test and further utilized a *t*-test for analyzing the comparisons between the groups at 95% confidence (Saccone et al., 2020). Overall, the respondents using the IES-R averaged 36.9% (=/-10.1) moderate psychological impact with 53% at a severe rating (Saccone et al., 2020). The results of the STAI found 45.2% (+/- 14.6) with anxiety symptoms and 68% above the normal standard score (Saccone et al., 2020). The VAS score average was at the 43 markers (+/-26.9) with 46% scoring over 50 reflecting their concerns with vertical transmission of COVID-19 to their fetus (Saccone et al., 2020). The authors further segmented data by gestational periods first through third semesters for all three indicators (Saccone et al., 2020). Overall, women in their first trimester had statistically higher psychological concerns ($p < .01$, 42.9%, CI 95% +/-17), anxiety ($p < .01$, 58.7%, CI 95% +/- 16.8) than their peers for the other gestational periods (Saccone et al., 2020). A healthy pregnancy is contingent upon a mother's mental and physical health; therefore, anticipatory psychological interventions within the first trimester is essential (Saccone et al., 2020).

**COVID 19 Pandemic**

The World Health Organization (WHO) declared COVID-19 a global public health emergency on January 30, 2020 (HHS, 2020; Musiimenta et al., 2022). COVID-19 further highlighted the inherent health inequities existing within the U.S. health care system, presenting new challenges for health care providers in providing accessible and appropriate care within vulnerable communities (Blumenthal et al., 2020; Villar et al., 2021). Medical services specifically in rural areas and inner cities were drastically reduced due to resource reallocations addressing the pandemic combined with workforce shortages (HHS, 2020; Sharma, Burd, & Liao, 2020). Significantly disproportionate percentages of minority populations were further impacted by COVID-19 due to job losses, limited insurance coverage, SDOH indications, and higher incidences of acquiring the virus (HHS, 2020; Musiimenta, et al., 2022; Villar, et al., 2021).

The CDC reported that the number of maternal deaths per 100,000 live births increased the first years of the pandemic, 2019 and 2020, with increases greatest for

Black and Hispanic women (Villar et al., 2021). HHS (2020) concurred describing how COVID-19 negatively impacted maternal mortality and morbidity rates in areas with racially and ethnically diverse patient populations attributed to delays of perinatal and postnatal services (CDC, 2021; Kotlar et al., 2021; Mor et al., 2021). Sharma, Burd, and Liao (2020) further validated the CDC and HHS findings through a preliminary compilation review of COVID-19 related manuscripts reporting maternal health challenges reflecting preliminary higher rates for preterm births and stillborn rates. Increasing SMM risks associated with COVID-19 are further compounded by the impact on mental health with COVID-19 indiscriminately affecting people based on race and gender (HHS, 2020; Pawar, 2020).

### *Maternal Health*

Kotlar et al. (2021) referenced several contributing factors affecting maternal health outcomes specific to COVID-19 due to the reduced access to prenatal care, health care infrastructure limitations, public health policy changes, and job loss. Mor et al. (2021) sought to understand clinical effects of the COVID-19 on perinatal mortality and morbidity in Israel due to the limited documented knowledge on how COVID-19 impacted pregnant women. The scope of the study was a retrospective cohort study conducted at Shamir Medical Center located in Zerifin, Israel. The research involved outcome comparisons between two groups, the study cohort representing COVID-19 time period of February through April 2020 and control group outcomes from the same time period during 2017, 2018, 2019 (Mor et al., 2021). The sample size for the study group was 1,556 women and the control group 4,564 women. The research approach was executed utilizing SAS data analysis for producing normal distribution summaries for the continuous factors and Chi-Square or Fisher's teat for categorial variables, both using confidence intervals (CI) set at 95%, statistical significance, $p < .05$. The data disclosed the perinatal emergency department daily labor admissions declined significantly during COVID-19 comparatively to pre-COVID, (48.6 /+12.2, 57.8+/-14.4, $p < .001$) and stillborn rates statistically increased by 2.5% during COVID, ($p = .037$, 6/1556, 5/4564) (Mor et al., 2021). There was no significant difference in complications by gestational age, premature delivery, post-date deliveries, Caesarean section (C-section) rates, or intrapartum fetal death (Mor et al., 2021). The authors utilized Poisson modeling in understanding the impact of COVID-19 infection for pregnant women, ($p <.05$). Pregnant women with the COVID-19 infection are at a higher risk than not infected pregnant women for pre-eclampsia ($p < .051$. CI 95%: 1.27-2.43), severe infections ($p < .05$, CI 95%: 3.38, 1.63-7.01,), ICU admission ($p < .05$, CI 95%: 5.04, 3.13-8.10,) (Mor et al., 2021). Mor et al. (2021) suggested the higher incidence of SMM associated with COVID-19 was a result of the imposed regulatory lockdowns and fears of contracting the virus, however noted the need for additional research due to the limitations of their study.

Musiimenta et al. (2022) utilized randomized trial surveys on women discharged post-partum from Mbarara Regional Reference Hospital (MRRH), Uganda. MRRH is a rural hospital and the 50 patients surveyed had a median age of 28 years with 84% completing school at a primary education level (Musiimenta et al., 2022). During COVID-19, maternal health morbidity and mortality increased 10.4 percent in Uganda; the authors seeking insight on how the pandemic affected accessibility to post-natal medical services (Musiimenta et al., 2022). The authors conducted a mixed method design utilizing a telephone survey for addressing different quantitative and qualitative factors associated with maternal health complications. Participants reported that 84% had missed post-partum appointments, 92% experienced some level of financial distress, 86% encountered food insecurity, and 88% had symptoms of stress (Musiimenta et al., 2022). Further investigation revealed several causes for the post-partum outcomes citing transportation challenges, fear of contracting COVID-19, and delays at the health care facility (Musiimenta et al., 2022). The authors postulated with the multi-faceted barriers associated with accessible maternal health service, further research into the utilization of remote resources available through a patients mobile device could mitigate potential problems (Musiimenta et al., 2022). Further research and implementation of accessible resources would need to be conducted with governmental policy support.

### *SMM*

Villar et al. (2021) investigated the effects of COVID-19 infections during pregnancy that were associated with SMM. The research involved a large scale, multination prospective cohort study across 43 institutions located within 18 countries (Villar et al., 2021). The purpose was to identify significant complications associated with the pandemic on maternal and neonatal outcomes. 706 patients with COVID-19, 1,424 patients without COVID-19 were compared during March through October 2020 addressing the research question, to what extent does COVID-19 in pregnancy alter the risks of adverse maternal and neonatal outcomes compared with pregnant individuals without COVID-19 (Villar et al., 2021). The researchers examined three unweighted indices for measuring symptoms and correlations with COVID-19: overall maternal morbidity and mortality; severe neonatal mortality; and severe perinatal maternal morbidity and mortality (Villar et al., 2021). Utilizing Poisson modeling for developing incident rates (CI 95%, $p < .05$) pregnant women with COVID-19 infection had significantly relative risk for pre-eclampsia (1.76%, CI 95%: 1.27-2.43), severe infections (3.3%, CI 95%: 1.63-7.01), ICU admissions (5.04%, CI 95%: 3.13-8.10), MMR (22.23%, CI 95%: 2.88-172), and preterm birth (1.59%, CI 95%: 1.30-1.94) (Villar, et al., 2021). Women without COVID infection higher relative risk of MMR (1.24%, CI 95%: 1.00.154), and pre-eclampsia (1.63%, CI 95%: 1.01,2.63) (Villar et al., 2021). Contrary to other studies evaluating the effects of the pandemic on pregnant women, those with COVID-19 had higher rates of c-sections than those without and demonstrated an intrauterine infection transmission rate of 12.1% (Villar et al., 2021). The results suggest the increased need for adherence for health care providers to evidence-based guidelines to prevent pregnant women from contracting COVID-19 (Villar et al., 2021). Limitations with the study were associated with provider reporting biases.

Ashish et al. (2020) studied the effects of the COVID-19 pandemic response on intrapartum care, stillbirths, and neonatal mortality outcomes in Nepal through a prospective observational study. Nepal pregnant women at nine hospitals, pre and during the COVID-19 pandemic, January through May 2020 with a sample size of 10,543 live births with observable health care worker practices (Ashish et al., 2020). The researchers developed a data collection tool evaluating quality of care factors and health care worker's performances through independent clinical observations (Ashish et al., 2020). The objective of the study was to identify how health care service reductions during the pandemic impacted maternal health outcomes. Investigators evaluated demographic attributes, obstetrician accessibility, health care workers performance, and quality outcome factors using a general linear model (Ashish et al., 2020).

A significant decline in appointment attendance was observed among the more disadvantaged ethnic group Madhesi during lockdown (*n* = 1228, 17.1%) (Ashish et al., 2020). The mean live births decreased during this time period with a statistically significant increase in still birth ($p$ =.0022), decreases in fetal heart rates ($p < .0001$), and breastfeeding ($p$ = .00332) (Ashish et al., 2020). One positive outcome as a result of COVID-19 was an improved health care worker compliance in hand hygiene procedures (Ashish et al., 2020). A decrease in use of health facilities was noted weeks before COVID-19 was a identified a global pandemic, indicating a heightened fear of disease transmission that deferred women from seeking care at health facilities (Ashish et al., 2020). During the COVID-19 lockdown in Nepal, reduced utilization of health care facilities further decreased due to the national mandated transportation restrictions and isolation precautions (Ashish et al., 2020). The researchers raised additional questions on how federal and local policies regarding strict lockdowns impacted low- and medium-income communities on accessing medical services (Ashish et al., 2020).

Wei et al. (2021) designed a meta-analysis study using comparison data for calculating the summary odds ratio or weighted mean differences at CI 95%. The investigators conducted a systematic search of MEDLINE, Embase, ClinicalTrials. gov, medRxiv and Cochrane databases 2020 through January 2021, identifying observational studies with comparative data for COVID-19 infected pregnant women (Wei et al., 2021). 42 studies were evaluated reporting outcomes for 438,548 pregnant women (Wei et al., 2021). This research addressed limited studies to date on the impact of COVID-19 virus. on pregnant women and fetus, comparing women with COVID-19 during pregnancy experiencing pre-eclampsia, pre-term births, stillbirths, gestational diabetes, and other related complications. Results associated with this study contained similar findings to other investigations or contradicting outcomes.

Researchers found COVID-19 in pregnancy is associated with preeclampsia (1.33%, CI 95%: 1.03-1.73), stillbirths (2.11%, CI 95%: 1.13-3.90) and preterm births (1.82%, CI 95%: 1.38-2.39) compared with patients not infected with COVID-19 (Wei et al., 2021). In addition, symptomatic COVID-19 infections or side-effects were associated with an increased risk of C-section deliveries and preterm births when compared with asymptomatic COVID-19 (Wei et al., 2021). Severe COVID-19 cases were strongly associated with pre-eclampsia (4.16%, CI 95%: 1.55-11.15), gestational diabetes (1.99%, CI 95%: 1.09-3.64), preterm births (4.29%, CI 95%: 2.41-7.63), and low birth weight (1.89%, CI 95%: 1.14-3.12) (Wei et al., 2021). Limitations identified by the authors per their study include unadjusted effect sizes overvaluing potential risks between COVID-19 and maternal health complications (Wei et al., 2021). The clinical significance of two outcomes, admission to ICU and preterm birth could not be medically correlated to COVID-19 (Wei et al., 2021).

### *Healthcare Workers*

Vanhaecht et al. (2021) studied the effect of COVID-19 on health care workers' mental health and physical resiliency. The authors proposed the pandemic further exacerbated health care workers experiences with job stress and burnout compromising their capacity for delivering high quality patient care (Vanhaecht et al., 2021). Researchers used a cross-sectional online survey with a zero to 10 Likert scale for scoring (Vanhaecht et al., 2021). Participation for 4,509 health care workers in Flanders, Belgium was conducted on a volunteer basis with answers deidentified for confidentiality

(Vanhaecht et al., 2021). The survey period was April through May 2020 with 40.6% paramedics, 33.4% nurses, 13.4% physicians, and 12.2% management soliciting feedback on impact of how COVID-19 on their mental health, teamwork, quality of care and patient safety (Vanhaecht et al., 2021). The research question was measuring the effect of COVID-19 on positive and negative mental health for health care workers.

The data designed used a logit model analysis with odds ratio, CI 95% (Vanhaecht et al., 2021). All symptoms were more pronounced than pre-COVID, with an overall 12-fold odds increase (12.24%, CI 95%: 11.11-13.49) (Vanhaecht et al., 2021). Statistically significant compared to pre-COVID-19, stress increased from 25.1% to 57.5% and knowledge deficits 10% to 23.4% (Vanhaecht et al., 2021). Hypervigilance increased by 12.4% and the strongest mental health risks were associated with female nurses between the ages of 30 and 49 years (Vanhaecht et al., 2021). The investigators hypothesized women of childbearing age incur greater work/life demands, requiring multitasking capabilities (Vanhaecht et al., 2021). The recommendations from the study stressed the importance of hospital leadership during COVID-19 and other stressful circumstances in implementing support programs for targeted risk groups (Vanhaecht et al., 2021).

### *Literature Review Summary*

The organizational challenges for hospital executive in effectively addressing the ongoing quality, patient safety, workforce, and fiscal issues were compounded over the past three years following the World Health Organization's recognition of COVID-19 as a global pandemic (HHS, 2020; Musiimenta et al., 2022; Wei et al., 2021). The literature review conducted for this study examined the impact of COVID-19 on SMM rates comparatively between Magnet and non-Magnet designated hospitals required a comprehensive review of four important foundational factors: Donabedian, Magnet, SMM, and COVID-19. Donabedian's classic quality conceptual model, maintaining that structure drives processes which produce outcomes, supports the complimentary ANCC Magnet framework (American Nurses Association, n.d.). Donabedian and Magnet both provide based on evidenced-based models that can be used for promoting positive organizational behaviors and ameliorate patient outcomes (Berwick & Fox, 2016; Haller et al., 2018; McHugh et al., 2013). The revised Magnet model focuses on outcomes, representing a significant shift from structure and process evaluation to greater emphasis on the importance of empirical evidence for improved performance relating to nursing care practices (Amaral & Vidinha, 2014; Haller et al., 2018). Several studies on Magnet designated organizations outperforming non-Magnet hospitals in nurse working indicators, patient mortality and morbidity outcomes, hospital performance metrics, and patient engagement (Drenkard, 2019; Friese et al., 2015; Haller et al., 2018; McHugh et al., 2013; Kutney-Lee et al., 2015). Poor maternal health outcomes in morbidity and mortality are a national health crisis for the U.S. which was further worsened in 2020 with the COVID-19 pandemic (Dagher & Linares, 2022; HHS, 2020; Howell, 2018). SMM is a strong predictor of mortality (HHS, 2020; Howell, 2018; St Pierre et al., 2015) with significant higher negative incidences of both outcomes found in racial and ethnic minority populations (Dagher & Linares, 2022; Mishkin et al., 2021). COVID-19 caused detrimental effects for maternal health care access, especially in poorer and rural communities (HHS, 2020; Mishkin et al., 2021). Notably, NJ incidences for poor maternal health outcomes is prevalent for non-Hispanic Black women living in poor or rural communities (Hutchinson-Colas et al., 2022; Publication of the Office of the First Lady, Trenton, New Jersey, 2020). Further research is needed utilizing empirical data for understanding the clinical quality effects on maternal morbidity rates during the COVID pandemic for Magnet and non-Magnet hospitals in NJ (Kotlar et al., 2021; Villar et al., 2021).

## Definitions

- *Magnet designation:* Magnet program designation is based on evidenced-based research promoting nursing excellence in all aspects of patient care (Graystone, 2019; Kutney-Lee et al., 2015) through the advancement of five core components: transformational leadership; structural empowerment; exemplary professional practice; new knowledge, innovations, and improvements; and empirical outcomes (Abuzied et al., 2022).
- *Severe maternal morbidity (SMM):* Unintended complications associated with the labor and delivery process resulting in considerable short-term or long-term poor outcomes affecting a woman’s health (HHS, 2020). The CDC established 21 ICD-10 indicators of SMM which are utilized to monitor maternal health outcomes (CDC, 2022)
- *Antepartum:* period before giving birth and usually includes pregnancy-related exams and tests (Nayeri et al., 2018)
- *Chronic disease:* defined within the health care industry as medical conditions that last for a person greater than one year and require a cadence of medical intervention and/or interfere with daily activities (CDC, 2022)

- *COVID-19 pandemic:* the Coronavirus disease 2019 (COVID-19) was recognized as a global pandemic in March 2020 is caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (Wei et al., 2021).
- *Health disparities:* reflect how socially disadvantaged people experience inherent compromised healthy lives due to higher incidences of preventable chronic disease, violence, or injury (CDC, 2022)
- *International classification of diseases (ICD):* the global standard for disease classification including morbidity and mortality causation (WHO, 2021)
- *Intrapartum:* portion of pregnancy that occurs during labor, beginning as labor initiates and ends following the third stage of labor (Nayeri et al., 2018)
- *Maternal health:* refers to the health status of a woman throughout the duration of conception, pregnancy, childbirth, and the postnatal period (WHO, 2021)
- *Maternal mortality rates (MMR):* the WHO defines MMR as deaths of pregnant women or within 42 days of the end of pregnancy, from any cause related to or aggravated by the pregnancy or lack of clinical, health management (HHS, 2020)
- *Post-partum:* period after the birth of the baby (Nayeri et al., 2018)
- *Social determinants of health (SDOH):* environmental conditions including where people are born, reside, learn, work, play, and worship that correlate to a person's wellness status, activity levels, morbidity and mortality outcomes, and potential health risks (HHS, n.d.)

## Assumptions

Inherent with any investigative study are presumptions by the researcher for being true or correct and cannot directly validate or verify (Simon & Goes, 2013). The assumption for this study was the HCUP information utilized from participatory hospitals administrative claims data was accurately coded and data inputted correctly reflecting all SMM complications for comparison purposes.

## Scope and Delimitations

The scope of this research was limited to determining if there was a statistically significant difference between Magnet ANCC designated hospitals and non-Magnet hospitals SMM rates in NJ. It was also limited to a specific compare period of available data during COVID-19, for 2021. The limitation to the study was that results are limited to the population and demographics of NJ which may not be generalizable to other part of the country or world.

## Significance, Summary, and Conclusion

This study was significant in that it will add to the growing body of knowledge and positive social change in understanding if Magnet designated hospitals have statistically significantly different SMM outcomes during extreme public health conditions similar to the recent COVID-19 pandemic. The evidence collected and analyzed in this study may provide health care leaders with the knowledge needed to implement quality indicators consistent with Magnet status.

The intent of this study was to determine if there is a statistically significant relationship between Magnet designated hospitals in mitigating SMM outcomes during the COVID-19 pandemic within the state of NJ. A review of the literature on the different variables and topics reveals that Magnet organizations perform better than non-Magnet hospitals in managing patient outcomes, with limited data specific to maternal health complications or SMM. The results of this research may provide health care leaders with the business case for investing and adopting the structured approach, infrastructure, framework associated with Magnet designation. The correlation of how observed patient outcomes are affected by a combination of patient behaviors and other attributes including nursing care practices may reveal a method in reducing complications especially for vulnerable populations associated with pregnancy.

Section two incorporated the study variables into the research design and rationale, methodology inclusive of population sampling, a data analysis plan, threats to validity, and ethical procedures required for establishing the investigatory study.

# Section 2: Research Design and Data Collection

## Introduction

The purpose of this quantitative, quasi experimental retrospective study, using secondary data, was to evaluate if there is a statistically significant relationship between Magnet versus non-Magnet designated NJ hospitals for SMM rates during the COVID pandemic, in NJ during 2021. Magnet designation for hospitals is synonymous with high-quality patient care (Abuzied, 2022). The Magnet recognition program provides organizations a strategic roadmap for promoting nursing excellence embodied through the five model components of transformational leadership; structural empowerment; exemplary professional practice; new knowledge, innovations, and improvements; and empirical outcomes (Abuzied et al., 2022; American Nurses Association, n.d.). The CDC defines severe maternal morbidity as “unexpected outcomes of labor and delivery that results in considerable short- or long-term consequences to a woman's well-being” (CDC, 2021). Currently the CDC utilizes 21 ICD-10 complications associated with SMM, collected from administrative hospital discharge data (CDC 2021).

Section 2 of the proposal provides an overview of the research design and rationale, data analysis methodology including collection technique with quality appraisal, threats to validity, and ethical validations.

## Research Design and Rationale

Magnet designation status is the independent variable (IV). The dependent variable (DV) in this study is SMM. The two moderating variables affecting the relationship between the IV and DV were the target population of NJ hospitals divided into two independent groups, those with current Magnet designation and those without

Magnet designation, and the time period of the COVID pandemic, calendar year 2021. A quasi-experimental research design was selected as the empirical approach for determining the causal impact of Magnet status on SMM rates in NJ during calendar year 2021, with non-random groups assigned based on where the patient received maternal health services. Quasi-experiments provide a reliable design in the health care environment for quickly assessing the relationship between an intervention and outcome for improving patient quality care, without requiring randomization (Schweizer et al., 2016).

## Methodology

### Population

The Independent Variable target population was determined by segmenting the 72 acute-care NJ hospitals by Magnet and non- Magnet designation status during 2021 per the ANCC data base https://www.nursingworld.org/organizational-programs/Magnet/find-a-Magnet-organization/ (American Nurses Association, n.d.). The ANCC data base is available to the public and provides visibility to Magnet designated sites by state (American Nurses Association, n.d.). In 2021, 37 of 72 NJ hospitals had Magnet designation. The total NJ hospital population was further refined isolating the hospitals with labor and delivery services. In 2021, 49 NJ hospitals provided maternal health services with 29 achieving Magnet status (NJ Department of Health, 2024).

The target population for the Dependent Variable were females ages 12 through 55 years old with a diagnosis or procedure indicating an acute hospital delivery in NJ during 2021, which equated to 83,192. Within that population, 85 patients were coded with a SMM during labor and delivery.

**Sampling and Sampling Procedures**

The sampling strategies for collecting secondary data information for the IV required accessing the ANCC Magnet database and sorting by state to identify the NJ hospitals with Magnet designation in 2021 https://www.nursingworld.org/organizational-programs/Magnet/find-a-Magnet-organization/ (American Nurses Association, n.d.). The NJ Department of Health internet site provided supplementary information for the sample, defining which NJ hospitals provided labor and delivery services in 2021 (NJ Department of Health, 2024) and this was cross-referenced with the ANCC Magnet designation information for sample inclusion (American Nurses Association, n.d.). Both the ANCC database for visibility to Magnet designated sites (American Nurses Association, n.d.) and the NJ Department of Health website for NJ hospital services are publicly accessible.

The secondary data set utilized for this study was collected through Healthcare Cost and Utilization Project (HCUP) website, https://hcup-US.ahrq.gov/as reported by the NJ state inpatient databases (SID) (Agency for Healthcare Research and Quality, n.d.). The NJ SID includes all inpatient discharges by calendar year from hospitals in NJ including discharges from residents and non-residents of the state who obtained in-patient treatment at a NJ hospital (NJ SHAD, 2022; Agency for Healthcare Research and Quality, n.d.). The overall population retrieved from the HCUP data set for 2021, inclusive of women between the ages of 12 and 55 years who had a labor and delivery diagnosis code was 83,192. Per the NJ Department of Health website, https://www-doh.state.nj.U.S./doh-shad/topic/Births.html the state of NJ averages 100,000 births per year (NJ SHAD, 2022). Although the HCUP website provided the public access to aggregated trending maternal health information with no special permissions or requirements, gaining access to the patient-level, detailed information required requesting data through the online HCUP central distributor website, https://www.hcup-U.S.ahrq.gov/tech_assist/centdist.jsp (Agency for Healthcare Research and Quality, 2022).

Acquiring the HCUP deidentified hospital files necessitated the researcher registering for a user account, completing the HCUP data utilization authorization (DUA) training program, electronically submitting a data request with a statement of intended use, and payment for files (Agency for Healthcare Research and Quality, 2022). The files were mailed to my home on CD discs, followed by an email providing the passwords to unzip/extract and decrypt the secure HCUP database products ordered (Appendix B).

A G*Power, version 3.1.9.4, available at https:// https://g-power.apponic.com/ was used to perform a power analysis using an alpha (α) err prob = 0.05, power set a .8, and the effect size set at .5; G*Power determined the recommended minimal sample size for this study was 64 for the Research Question .

## Operationalization of Variables

### *Magnet Designation*

The operational definition for the IV was defining if a hospital had Magnet designation. The Magnet designation status. (IV) was determined using the ANCC current list of NJ Magnet designated hospitals containing the hospital name, address, original designation year as well as redesignation as appropriate (American Nurses Association, n.d.). Within the data set, the AHA cross-reference information was used for manipulating the de-identified hospital identifiers in determining the hospital name which were then coded as categorical variables within the dataset as Magnet status = 1 and non-Magnet status = 0. Based on the coded data, 63,272 patients received obstetric services at a NJ Magnet facility and 19,190 delivered at a non-Magnet hospital totaling 83,192.

***SMM***

The standard definition for SMM is set and governed by the CDC (CDC, 2016a). The CDC 21 indicators and corresponding ICD-10 administrative codes used in identifying delivery hospitalizations with SMM are: acute myocardial infarction; aneurysm; acute renal failure; adult respiratory distress syndrome; amniotic fluid embolism; cardiac arrest/ventricular fibrillation; conversion of cardiac rhythm; disseminated intravascular coagulation; eclampsia; heart failure/arrest during surgery or procedure; puerperal cerebrovascular disorders; pulmonary edema/acute heart failure; severe anesthesia complications; sepsis; shock, sickle cell disease with crisis; air and thrombotic embolism; blood products transfusion; hysterectomy; temporary tracheostomy; and ventilation (see Appendix A) (CDC, 2016a). Sorting the HCUP data file using the 21 ICD-10 SMM administrative codes isolated the number of SMM outcomes. The operational definition for the DV in this study was SMM rates. SMM rates are a continuous variable comprised of a composite outcome, calculated using the number of maternal health administrative coded complications, the number of total live births, and an incidence factor of 10,000. Each NJ hospital SMM rate was calculated by the HCUP number of in-hospital deliveries with specific SMM or corresponding diagnoses in the numerator (total number of SMM), the total number of the individual in-patient hospital deliveries in the denominator (live births by facility), with a multiplier of 10,000 [(Number of SMM by facility/Total individual hospital live births) * 10,000].

### *Data Analysis Plan*

The Statistical Package for Social Science (SPSS) Version 27 was used for analyzing data associated with ICD-10 coded SMM data for calendar year 2021 acquired from the HCUP website. Prior to identifying SMM outcomes, segmenting the NJ hospitals by Magnet status was required, and further refining the list by those hospitals offering maternity services. Once the population demographics were established, hospital information was matched to each patient record and coded for Magnet, non-Magnet designation status. by adding a column within the SPSS data file. In addition, the HCUP database required data cleaning, including removing excluded patients from study per the parameters of the designated population: women, ages 12 to 55 years, with labor and delivery administrative codes associated with their inpatient stay.

The research question for this study was: What is the relationship between Magnet and non-Magnet designated hospitals for addressing SMM rates in NJ hospitals during COVID-19? The null hypothesis indicates there was no statistically significant relationship between Magnet designation and non-Magnet designation in SMM outcomes for NJ hospitals during the recent COVID-19 pandemic.  The alternative hypothesis states there was a statistically significant relationship between Magnet designation and non-Magnet designation for SMM outcomes for NJ hospitals during the recent COVID-19 pandemic.

An independent, two-tailed *t*-test was the inferential statistical method used for evaluating the hypothesis comparing the population means of Magnet and non-Magnet hospitals using individual composite SMM rate scores for each hospital. SMM rates were calculated by site, dividing the live births for 2021 by the total number of SMM both numbers specific to that hospital and multiplying by 10,000. All four assumptions for a *t*-test were reviewed prior to any additional analysis, including independent samples, normal data distribution, homogeneity of variances, and appropriate sample size (Albright & Winston, 2020). Results from the *t*-test were interpreted by reviewing several outputs from the SPSS analysis tool. A normality test validated basic assumption of a parametric test ensuring the continuous variable, DV, analyzed had a normal distribution. The *p*-value or probability signified a statistical significance between the two means. The Levene's Test for Equality Variances verifies whether the two groups of SMM rates have the same variance within the populations and is used to test the null hypothesis of comparable samples. The effect size using Cohen's provides the practical significance of the results by measuring the magnitude of the differences between the means of the two groups.

**Threats to Validity**

Internal and external validity are two concepts that reflect whether the results of an investigative study are "trustworthy and meaningful" (Andrade, 2018; Cuncic, 2022). Internal validity threats refer to the structure of the study and how well a study was conducted (Cuncic, 2022). Threats to external validity are differences between experimental conditions and the universal translatable applicability of the results (Cuncic, 2022). A potential main threat to internal validity for this study was the dependability of the individual hospital administrative coding process for determining the existence of a SMM condition. The main threat to external validity was the geographic selection of the sample. The state of NJ is comprised of a unique, distinct population consisting of different racial, cultural, socioeconomic, and political attributes; the results may not have applicability outside the State of NJ.

**Ethical Procedures**

Publicly available, deidentified secondary data was used for this investigative study. Permission to conduct the study was obtained from Walden University's Institutional Review Board, approval 09-26-23-0747915. Walden University's Institutional Review Board (IRB) approval was required prior to accessing and analyzing data to ensure the study methodology meets the institute's ethical standards. There was no collection of data utilized directly from human subjects. Magnet status information was accessed through the ANCC website for determining the NJ hospital Magnet status in 2021. SMM data was accessed using the procured HCUP data files. Accessing data through the HCUP database entailed a formal application process, data training (DUA), and submitting payment (Healthcare Cost and Utilization Program, 2022). Patient identifiers were eliminated in the HCUP dataset pursuant to CMS national standards for protecting personal health information (CDC, 2023). Therefore, the data analysis efforts were focused on identifying SMM and calculating rates based on Magnet or non-Magnet status.

Post-study, the HCUP data will remain stored on a secured CD drive. Any related SPSS data analysis from this study will be stored on a separate secured jump drive for ensuring the integrity of the information. All drives will be locked down and only accessible me for a seven-year period, whereafter the file will be destroyed, ensuring the integrity of the information.

## Summary

The purpose of this quantitative quasi experimental retrospective study was to examine the relationship between Magnet and non-Magnet designated hospitals for SMM outcomes in the state of NJ during the recent COVID-19 pandemic. Section two reviewed the population sampling methodology, including 72 NJ acute care hospitals with 51 percent achieving Magnet designation, further refined by to 49 NJ acute care hospitals with obstetric services comprised of 29 Magnet hospitals. The patient population subset for this study within the HCUP data set was 83,192 women between the ages of 12 and 55 receiving obstetric care at a NJ acute care facility during 2021. SMM rates were defined by the number of coded CDC established ICD-10 21 administrative codes and calculated by dividing the individual SMM count by the attributed hospital number of annual births multiplied by 10,000. Magnet designation was coded as a categorial variable which was used to compare the SMM rates between the two populations. SPSS was the statistical software utilized for analyzing the data and determining if the two-population means were statistically significantly different. A potential threat for the internal validity of this study was the inter-reliability between hospitals for administrative SMM coding and the limited scope examining patients only from NJ.

Section 3 includes the presentation of the results and findings, including an introduction, the data collection process of secondary data set, the results, and a summary.

Section 3: Presentation of the Results and Findings

## Introduction

The purpose of this quantitative, quasi experimental retrospective study, accessing secondary data, was to evaluate if there was a statistically significant relationship between Magnet versus non-Magnet designated NJ hospitals for SMM rates during the COVID pandemic, in NJ , for the year of 2021. Data availability to support the research inquiries provided the framework for the data collection and analytic methodologies. The research question was: What is the relationship between Magnet and non-Magnet designated hospitals for addressing SMM rates in NJ hospitals during COVID-19? The null hypothesis for RQ there was no statistically significant relationship between Magnet designation and non-Magnet designation in SMM outcomes for NJ hospitals during the recent COVID-19 pandemic with the alternative hypothesis stating there was a statistically significant relationship between Magnet designation and non-Magnet designation for SMM outcomes for NJ hospitals during the recent COVID-19 pandemic.

Section three includes the collection and analysis of secondary quantitative data sets, the results and evaluating statistical assumptions, and summary.

## Data Collection of the Secondary Data Set

The timeframe for the data collection for all variables was calendar year 2021. The ANCC website provided a complete list of NJ hospitals that achieved and/or maintained Magnet designation for 2021 (American Nurses Association, n.d). The HCUP provided the deidentified inpatient discharge information including ICD-10 coding information for comorbidities from all NJ acute care facilities in 2021 (Healthcare Cost and Utilization Program, 2022). The overall response rate withing the HCUP database reflected 100 percent NJ in-patient volumes coded by the respective organizations. HCUP also provided the American Hospital Association (AHA) linkage files, containing hospital-level files designed to supplement the redacted data elements (Agency for Healthcare Research and Quality, 2022 ). Due to the inability to link the AHA hospital references with the HCUP files for years 2016 through 2020, (Agency for Healthcare Research and Quality, 2020), the scope for this study was limited to evaluating Magnet and non-Magnet sites SMM outcomes in 2021.

The baseline descriptive statistics for this population, were NJ Magnet and non-Magnet hospitals with maternity services and women 12 to 55 years of age with administrative codes for an in-patient delivery. Data was collected for this research study for the IV was accessed from the ANCC, a publicly available site which requires no additional permission, affording the user to view Magnet designated hospitals. The ANCC website provides users the ability to search Magnet designation by year and state, revealing 37 out of 72 acute care NJ hospitals had Magnet status in 2021. Of the 72 NJ in-patient facilities, 49 hospitals provide maternity services, with 29 of those organizations deemed Magnet recognition (American Nurses Association, n.d.). Utilizing Magnet status segmentation for number of patients resulted in 76% of patients delivering at a Magnet hospital, and 23.9% at a non-Magnet facility, with 10 patients not coded with a hospital location.

The demographics for SMM complications were identified utilizing the CDC ICD-10 coding for diagnostics and/or the Current Procedural Terminology (CPT-4) for procedural provided services (CDC, 2022). A preliminary analysis of all NJ facilities providing obstetric services for 83,182 patients in 2021 resulted in 85 administrative

SMM coded outcomes or a rate of 10.22 per 10,000 deliveries. The SMM coded conditions were air and thrombotic embolism, amniotic fluid, eclampsia, respiratory distress, and sepsis . One confounding result from the baseline analytics contradicted CDC (2021) findings that blood products transfusion present as the largest percentage of SMM during labor and delivery. Only four NJ hospitals coded for SMM blood transfusion totaling 1,445 with 1,442 coded from one facility. Due to the unreliability of the data, blood transfusions was excluded from the analysis of comparing overall mean SMM rates within this research study. Notably, the data retrieved from the ANCC for Magnet designation and HCUP for SMM rates represents 100% of the available population for both variables.

## Results

### Descriptive Statistics

The patient population for this study represented women ages 12 through 55 years with an in-patient delivery administrative code in NJ during the calendar year 2021. Table 1 represents the descriptive statistical data output for the study, outlining the results for the study population segmented by Magnet and non-Magnet facilities. Within the 72 acute-care hospitals in NJ, 49 health care facilities provide labor and delivery services, (State of NJ Department of Health, 2021) and within that group, 59% or 29 hospitals had Magnet designation in 2021 (Appendix C) (American Nurses Association, n.d.).

**Table 1.**

*NJ 2021 Hospital Births by Magnet Designation*

| | Number of Births | Percentage |
|---|---|---|
| Non-Magnet | 19910 | 23.9 |
| Magnet | 63272 | 76.1 |
| Total | 83192 | |

*Note.* Per Definitive Healthcare (2023) 80 percent of the top 10 NJ hospitals by net patient revenue were Magnet designated facilities.

The Pew Research Center (2023) noted the average age for first time births increased from 25.6 years in 2011 to 27.3 years in 2021. The data for this study pertaining to mother's age mirrored the national trends as displayed in Figures 1 and 2 respectively for Magnet designated hospitals ($M$ = 31.19 , $SD$ = 5.363, $n$ = 63,272 ) and non-Magnet hospitals ($M$ = 29.72, $SD$ = 5.860 , $n$ = 19,910 ). While the Magnet average age was slightly higher than the non-Magnet hospital average age, the 31 to 40 age spans had the highest percentage of birth rates in 2021 for all NJ hospitals. NJ consistently has higher birth rates for older women when compared to the national ages (NJ SHAD, 2023).

**Figure 1.**

*NJ Magnet Hospitals Maternal Health Population Age Groups in 2021*

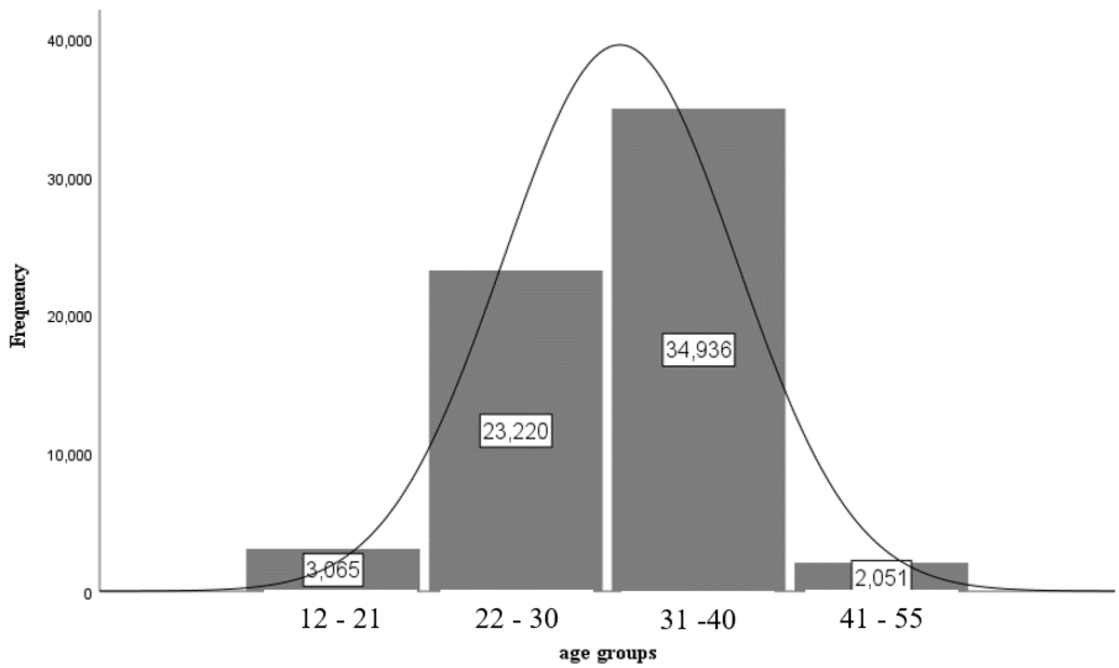
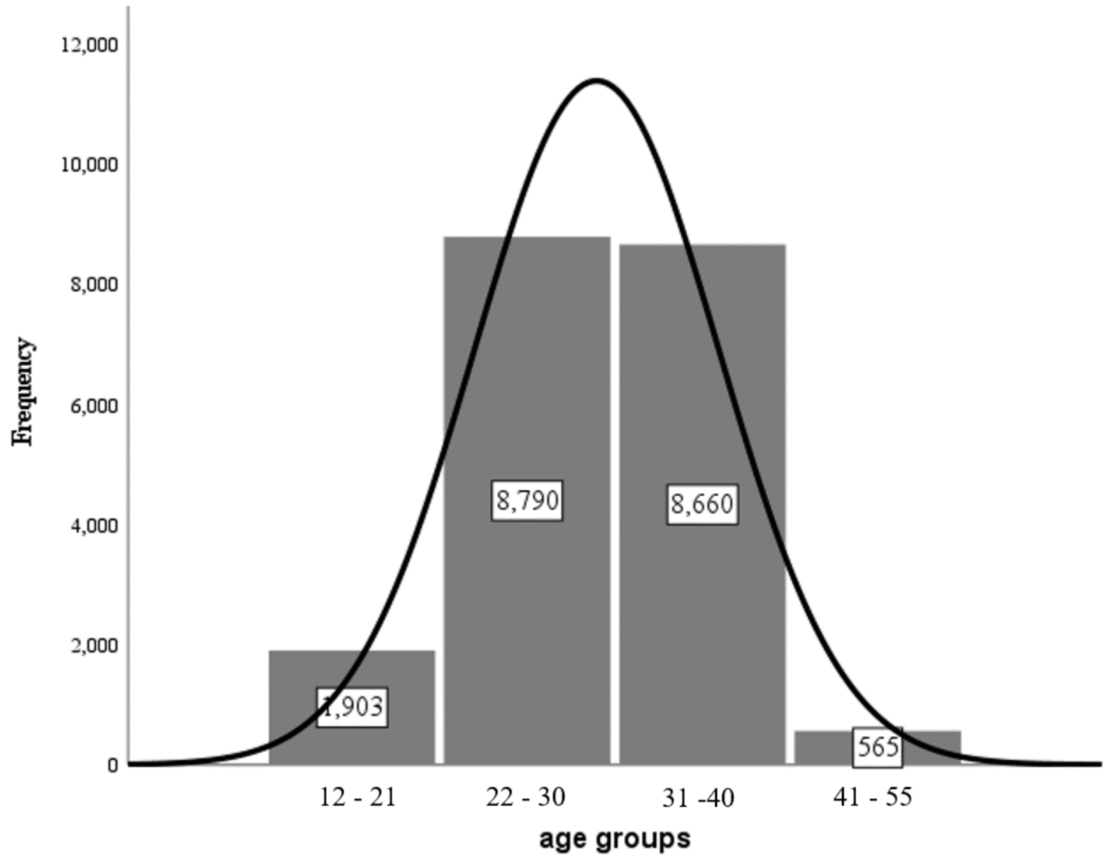


**Figure 2.**

*NJ non-Magnet Hospitals Maternal Health Population Age Groups in 2021*




In addition to patient age, ethnicity is another demographic variable available through the HCUP database for understanding the different populations. In NJ, ethnicity is denoted by the patient as a self-reported data element and in 2021, 74.5% of patients designated their ethnicity as other or did not provide an answer. Tables 2 and 3 reflect the demographics for magnet and nonmagnet facilities respectively, with the non-Magnet facilities indicating a higher percentage of minority populations than the Magnet hospitals.

**Table 2.**

*Magnet NJ Hospitals Maternal Health Population Reported Ethnicity in 2021*

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Other/Not Reported | 46412 | 73.4 | 76.9 | 76.9 |
| | White | 5082 | 8.0 | 8.4 | 85.3 |
| | Black | 320 | .5 | .5 | 85.8 |
| | Hispanic | 7099 | 11.2 | 11.8 | 97.6 |
| | Asian | 1450 | 2.3 | 2.4 | 100.0 |
| | Total | 60363 | 95.4 | 100.0 | |
| Missing | System | 2909 | 4.6 | | |
| Total | | 63272 | 100.0 | | |

**Table 3.**

*Non-Magnet NJ Hospitals Maternal Health Population Reported Ethnicity in 2021*

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Valid | Other/Not Reported | 12046 | 60.5 | 66.5 | 66.5 |
| | White | 1351 | 6.8 | 7.5 | 74.0 |
| | Black | 140 | .7 | .8 | 74.8 |
| | Hispanic | 3036 | 15.2 | 16.8 | 91.5 |
| | Asian | 1532 | 7.7 | 8.5 | 100.0 |
| | Total | 18105 | 90.9 | 100.0 | |
| Missing | System | 1805 | 9.1 | | |
| Total | | 19910 | 100.0 | | |

The literature review also identified several other demographic statistics relevant to understanding the maternal health population including marital status, patient preferred language, and primary insurance coverage (Daw et al., 2020; Njoku et al., 2023; Vedam et al., 2019; Wang et al., 2020). Review and analysis of the HCUP data set resulted in additional information collected with no significant identifiable trends (Appendix E).

In 2021, NJ Magnet hospitals submitted 66 administrative SMM codes, with non-Magnet facilities attributed with 19 SMM codes for a total of 85 SMM. Calculating the SMM rate per 10,000 births for this study's inferential testing was based on the hospital total SMM attributed by site by dividing total number of births by the annual total live births multiplied by 10,000 (MD App, 2020; Spronk et al., 2019). Overall, comparatively in NJ, the larger obstetric hospital programs in terms of annual births are Magnet designated facilities. For Magnet hospitals, 72.4% of the 29 hospitals (21) had an ICD-10 coded SMM including some of the largest maternal health facilities for annual births. The percentage for non-Magnet facilities was lower, with 45% of 20 hospitals (9) having a coded SMM. Therefore, as reflected in Table 4, although the number of SMM's was greater in the Magnet organizations however, due to higher annual birth volumes, the overall rate was statistically significantly better than non-Magnet hospitals.

**Table 4.**

*NJ 2021 Magnet and non-Magnet Hospitals SMM Outcome Rates per 10,000 births*

| Status | Number SMM Outcomes | Number of Births | Rate Per 10,000 |
|---|---|---|---|
| Magnet Facilities | 66 | 63,272 | 10.43115438 |
| Non-Magnet Facilities | 19 | 19,919 | 9.538631457 |

29 NJ Magnet and non-Magnet hospitals reported administrative coded SMMs in 2021. The 20 remaining NJ Magnet and non-Magnet facilities did not report SMM occurrences in 2021, therefore the SMM rate for these hospitals was zero (Appendix F).

**Hypothesis Testing**

The inferential analysis utilized in this study was an independent two-tailed *t*-test for determining if there was statistically significant difference between Magnet and non-Magnet designated hospitals' mean SMM rates. A *t*-test is a parametric hypothesis test that compares the differences between two population means. Prior to doing the *t*-test analysis there are four assumptions that need to be met:

1. The dependent variable need to be measured at an interval or ratio level. SMM rates never fall below zero and are measured at a Ratio level. therefore, this assumption was met.

2. The independent or group variables are numerical, Magnet=1, Non-Magnet =0. Therefore, this assumption was met.

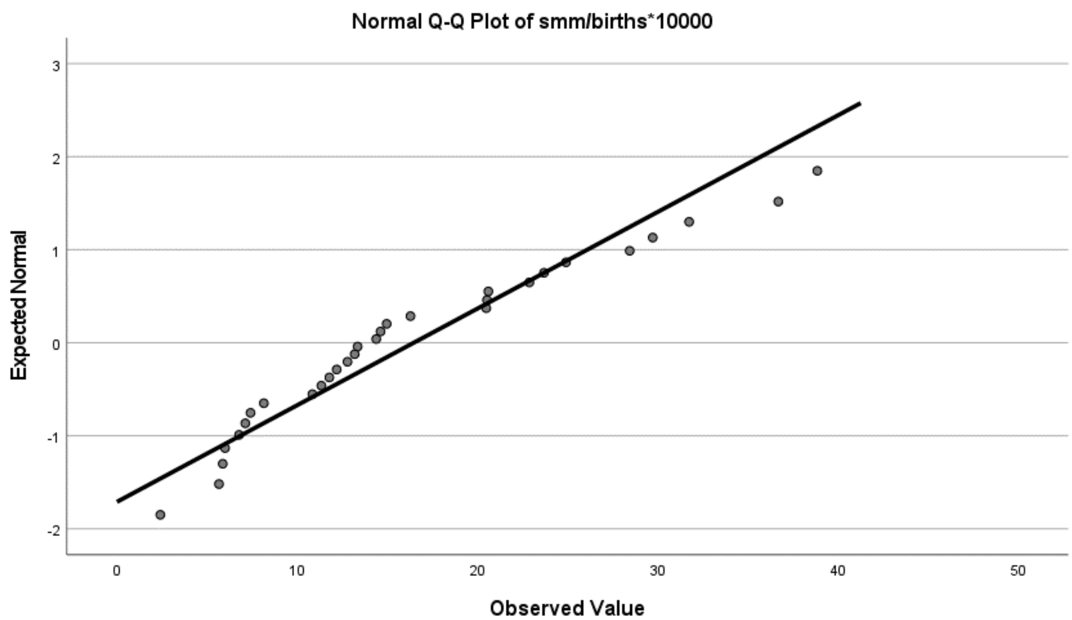
3. There is a homogeneity of variance. This is measured by Levene's test. If the *p*-value or significance of the Levene's test is >.05 then the variances are not significantly different than each other. As shown in Table 10, ($F_{1,28}$ =.583, $p$ = .451), the assumption of homogeneity of variances was met.

4. There is a normal distribution of data. As shown in Figure 3, this was measured by a Q-Q plot. If the data is normally distributed the points will fall on the 45-degree reference line. This assumption was met.

Validating all parametric assumptions were met, the analyses proceeded with an independent two-tailed *t*-test analysis.

**Figure 3.**

*Q-Q Plot of SMM Rates (DV)*




An independent samples, two-sided *t*-test was conducted using SPSS to evaluate if there was a statistically significant difference between Magnet designated and non-Magnet designated hospitals mean SMM rates. As represented in Tables 5 and 6, even though the Magnet hospitals number of SMM is numerically higher in non-Magnet facilities, the results of the independent two-tailed *t*-test showed that the non-Magnet SMM rates ($M$ = 22.93, $SD$ = 10.06, $n$ = 9) and the Magnet SMM rates ($M$ = 13.69, $SD$ = 8.19, $n$ = 21) was statistically significant [$t(28) = 2.649$, $df = 28$, $p = .013$]. Statistical significance was determined through a small *p*-value (.013) indicating that a greater than 95 percent that the probability Magnet facilities had lower SMM mean rates than non-Magnet hospitals. Furthermore, comparison of the *t*-value (2.649) was greater than the expected *t*-values in *t*-value distribution table (2.048), determining a significant difference between the two groups. Therefore, the conclusion based on the statistical analysis rejected the null hypothesis which suggested that there was no statistical difference between Magnet and non-Magnet facilities.

**Table 5.**

*Group Statistics SMM Rates between Magnet and non-Magnet Hospitals*

| | Magnet code | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| SMM/births* 10000 | non-Magnet | 9 | 22.93 | 10.06 | 3.3537800 |
| | Magnet | 21 | 13.69 | 8.19 | 1.7863635 |

**Table 6.**

*Independent Two-Sided t-Test*

*Independent Samples Test*

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Significance | | | | 95% Confidence Interval of the Difference | |
| | | F | Sig. | t | df | One-Sided p | Two-Sided p | Mean Difference | Std. Error Difference | Lower | Upper |
| SMM/births* 10000 | Equal variances assumed | .583 | .451 | 2.649 | 28 | .007 | .013 | 9.25 | 3.49 | 2.0951367 | 16.3981239 |
| | Equal variances not assumed | | | 2.433 | 12.77 | .015 | .030 | 9.25 | 3.79 | 1.0226123 | 17.4706483 |

**Summary**

The purpose of this quantitative, quasi-experimental, retrospective study was to investigate the relationship of Magnet designation on severe maternal morbidity rates in NJ during calendar year 2021. Based on the independent two-tailed *t*-test comparing the mean SMM rates for Magnet and non-Magnet facilities during the COVID-19 pandemic, 2021, the alternative hypothesis was accepted, concluding there was a statistically significant difference between Magnet and non-Magnet designated hospitals for SMM rates.

# Section 4: Application to Professional Practice and Implications for Social Change

## Introduction

The purpose of this quantitative, quasi-experimental, retrospective study was to determine if there was a statistically significant relationship between Magnet and non-Magnet designation (IV) and SMM rates (DV) in the state of NJ, the year 2021. An independent sample, two-tailed *t*-test was the inferential statistical analysis used to determine the significant differences for Magnet hospitals SMM rates compared to non-Magnet hospitals morbidity rates in NJ during the COVID-19 pandemic. The findings rejected the null hypothesis, supporting the alternative hypothesis that there is a statistically significant relationship difference between Magnet designation and non-Magnet designation for mean SMM outcome rates at NJ hospitals during COVID-19. Over the last 20 years, peer-reviewed studies have verified that the Magnet designation provides caregivers with a comprehensive structure and process for positively impacting patient outcomes (Huseman et al., 2022; Mezzina et al., 2021). The Commonwealth Fund (2021) estimates that 50,000 to 60,000 women each year experience an unexpected complication or severe maternal morbidity event during labor or delivery. The recent COVID-19 pandemic created a significant disruption in medical services, presenting challenging circumstances for health care providers in delivery timely, effective patient care (Haileamlak, 2021; Huseman et al., 2022; Mezzina et al., 2021). The nature of this study was to investigate if magnet designation affected maternal health complications during a global health crisis.

## Interpretation of the Findings

The findings of this study suggested statistically significant difference between Magnet and non-Magnet designated hospitals for SMM rates ($p$ = .013) during the COVID-19 pandemic in the state of N.J. An independent sample, two-tailed $t$-test was conducted to compare SMM rates in Magnet designated and non-Magnet designated hospitals. There was a significant difference in the scores for Magnet hospitals ($M$ =13.69, $SD$ = 8.19) and non-Magnet hospitals ($M$ = 22.93, $SD$ = 10.06); $t(28) = 2.649$, $p$ = .013. These results suggest that Magnet designation does have an effect on SMM rates. Specifically, the results indicate that when an organization attains Magnet designation the SMM rates decrease.

The core Magnet tenants, consisting of transformational leadership, structural empowerment, exemplary professional practice, new knowledge, innovations and improvements, and empirical quality outcomes (American Nurses Credentialing Center, 2019), continue to be associated with better patient outcomes (Kutney-Lee et al., 2015; Melnyk et al. 2020). During the recent pandemic, organizations were required to effectively evaluate structures and processes relating to patient care and quickly adjust for the challenges associated with a public health emergency (Hartman et al., 2021; Huseman- Maratea et al., 2022; Mezzina, Agbozo, & Hileman, 2021; Mohammadinia et al., 2023). A lack of overall preparedness throughout the health care industry combined with continuous changing regulatory mandates from the local and national agencies required creativity on the part of all caregivers (Huseman- Maratea et al., 2022; Mohammadinia et al., 2023). This study suggests that the constructs of the Magnet framework, primarily structural empowerment and transformational leadership may have provided organizational flexibility within magnet designated hospitals in managing SMM rates (Abuzied et al., 2022; Hartman et al., 2021; Huseman-Maratea et al., 2022; Mezzina et al., 2021).

Donabedian's conceptual theory of structure, process, and results guided this study for understanding the alignment of Magnet status in hospitals for SMM outcome rates. using Donabedian's quality model helped to define and further clarify the postulated relationship between Magnet designation and SMM rates (Walden University, 2024). When a hospital recognizes the importance of having an organizational focus on structure and process, through staff empowerment the results are realized through improved patient outcomes (American Nurses Association, n.d.; Melnyk et al., 2020; Mezzina et al., 2021; Tossaint et al., 2021). The findings within this investigation supported the assumptions that magnet designation positively impacts SMM outcomes.

## Limitations of the Study

There are several limitations of this study relating to data integrity and geographical limitations. The dependence of evaluating maternal health complications within this study was directly affected by the accuracy of the administrative claims coding materials. Although HHS adopted standard practice sets in accordance with the Health Insurance Portability and Accountability Act (HIPAA) defining specific codes for addressing different health care processes including billing, public health outcomes, and research (CMS, 2022) determining the parameters for segmenting the administrative claims data was challenging. The HCUP data set demonstrated a lack of standardization between the NJ hospitals in the utilization of the International Classification of Diseases, 10th addition (ICD-10) and Current Procedural Terminology (CPT-4) coding practices.

Despite previous research by Callaghan et al. (2012) and Getahun et al. (2013) recommending standardized definitions for coding maternal health indictors, inconsistencies in defining the primary diagnosis and supportive diagnosis exist. Additionally, the data utilized for this research project was collected from the NJ SID which may specifically represent the regional characteristics specific to that state and limits applicability to general SMM outcomes of hospitals across the U.S.

## Recommendations

Based on the research through this study, there are several recommendations for additional future investigations. The findings through the data analysis further confirm that NJ Magnet designated hospitals are associated with better patient SMM outcomes. However, due to the disproportionate percentage of magnet designated hospitals in NJ, 51 percent as compared to the national average of 10%, presents an opportunity for further research in Magnet and nonmagnet hospitals' SMM rates within other geographic regions. The lack of consistent, standard definitions for patient and hospital level maternal health data may impede health care providers in how their patient care delivery processes impact patient outcomes (Aydin et al., 2020; Hudson, 2012; Werlau et al., 2020). A recommendation for a further study replicating this research design but utilizing a structured data-surveillance plan within magnet and nonmagnet hospitals focused on collecting SMM outcomes (Bouvier-Colle et al., 2012; Gellar et al., 2018; Kilpatrick et al., 2016;).

Finally, the preliminary literature search resulted in multiple sources and studies identifying racial/ethnic disparities as a covariant for impeding access to quality maternal health care therefore directly impacting outcomes (Bomela, 2020; Crear-Perry et al., 2021; Vendem, et al., 2019; Wang, et al., 2020; WHO, 2019). A future research study is expanding the findings of this study design in understanding if a patient's race impacts their ability to access a Magnet facility and experiencing SMM rates (CDC, 2021; Kotlar, et al.,2021; Moretal et al., 2021).

**Professional Practice**

In 2001, the Institute of Medicine (IOM) (2001) published their recommendations for comprehensive changes in the U.S. health care system. The structure released by the IOM established six domains for improving overall patient care: safe, effective, patient-centered, timely, efficient, and equitable (Corrigan, 2004; IOM, 2001). Over the last 25 years, despite local and national strategies specifically for improving maternal health outcomes, HHS recently released their findings signaling a continued opportunity for understanding factors associated with SMM outcomes (HHS, 2023). The results of this study will add to a growing body of knowledge indicating how Magnet designation improves patient outcomes statistically significantly better than hospitals without Magnet recognition. In addition to encouraging hospital leaders in applying Magnet principles within their organization developing for improving SMM outcomes, there continues to be a need for a standard process in collecting and understanding data associated with SMM (CDC, 2021; Gellar et al., 2018).

**Positive Social Change**

Within the Walden University definition for positive social change, is the commitment for advanced development of communities, individuals, and diversity cultures (Walden University, 2023). The ability for a researcher to influence change depends on how the study findings can impact positive growth within society (Walden

University, 2023). Both the U.S. Healthy People 2030 goals (HHS, n.d.) and the Agency for Healthcare Research and Quality (2019) recognize the inverse correlation between safe, effective patient outcomes and the failure of a health care provider in addressing maternal health challenges. The Magnet recognition program promotes and empowers clinicians through multi-disciplinary teams in creating patient-centric care delivery plans (Abuzied et al., 2022;  American Nurses Association, n.d). The results of this research demonstrates how the core Magnet tenants and designation can effectively reduce the risk of SMM.

## Conclusion

Given the evidence through this study of how Magnet designated hospitals have better SMM outcomes than non-Magnet facilities, then more hospitals should consider applying for Magnet status. Magnet designation is a complex, lengthy process requiring a strategic focus at all levels within the organization. However, the investment and support in promoting a Magnet culture may improve a hospital's quality patient outcomes.

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# Appendix A: Severe Morbidity Indicators and Corresponding ICD-10-CM/PCS Codes during Delivery Hospitalization

*The table below includes the list of 21 indicators and corresponding ICD codes used to identify delivery hospitalizations with SMM*

| **Severe Maternal Morbidity Indicator** | **DX or PR** | **ICD-10** |
|---|---|---|
| 1. Acute myocardial infarction | DX | I21.01, I21.02, I21.09, I21.11, I21.19, I21.21, I21.29, I21.3, I21.4, I21.9, I21.A1 and I21.A9<br>I22.0, I22.1, I22.2, I22.8, I22.9 |
| 2. Aneurysm* | DX | I71.00 – I71.03, I71.1, I71.2, I71.3, I71.4, I71.5, I71.6, I71.8, I71.9, I79.0 |
| 3. Acute renal failure | DX | N17.0, N17.1, N17.2, N17.8, N17.9, O90.4 |
| 4. Adult respiratory distress syndrome | DX | J80, J95.1, J95.2, J95.3, J95.821, J95.822, J96.00, J96.01, J96.02,<br>J96.20, J96.21, J96.22, R09.2 |
| 5. Amniotic fluid embolism | DX | O88.11x*, O88.12 (childbirth), O88.13 (puerperium)<br>* x=1st, 2nd and 3rd trimester |
| 6. Cardiac arrest/ventricular fibrillation* | DX | I46.2, I46.8, I46.9, I49.01*, I49.02**<br>* Ventricular fibrillation<br>** Ventricular flutter |
| 7. Conversion of cardiac rhythm | PR | 5A2204Z, 5A12012 |
| 8. Disseminated intravascular coagulation | DX | D65, D68.8, D68.9, O72.3*<br>*see comments for pregnancy related codes |

| | | |
|---|---|---|
| 9. Eclampsia | DX | O15.00, O15.02, O15.03, O15.1, O15.2, O15.9<br>O14.22 – HELLP syndrome (HELLP), second trimester, O14.23 – HELLP syndrome (HELLP), third trimester<br>HELLP syndrome is not included currently (ranges in severity, more research is needed) |
| 10. Heart failure/arrest during surgery or procedure | DX | I97.120, I97.121, I97.130, I97.131, I97.710, I97.711 |
| 11. Puerperal cerebrovascular disorders | DX | I60.0x, I60.1x, I60.2, I60.3x, I60.4, I60.5x, I60.6, I60.7, I60.8, I60.9;<br>I61.1, I61.2, I61.3, I61.4, I61.5, I61.6, I61.8, I61.9;<br>I62.0x, I62.1, I62.9;I63.0xx, I63.1xx, I63.2xx, I63.3xx, I63.4xx , I63.5xx, I63.6, I63.8, I63.9;<br>I65.0x, I65.1, I65.2x, I65.8, I65.9;<br>I66.0x, I66.1x, I66.2x, I66.3, I66.8, I66.9;<br>I67.0, I67.1, I67.2, I67.3, I67.4, I67.5, I67.6, I67.7, I67.8xx, I67.9;<br>I68.0, I68.2, I68.8;<br>O22.51, O22.52, O22.53, I97.810, I97.811, I97.820, I97.821, O87.3<br>674.0x – no crosswalk |
| 12. Pulmonary edema / Acute heart failure | DX | J81.0, I50.1, I50.20, I50.21, I50.23, I50.30, I50.31, I50.33, I50.40, I50.41, I50.43, I5$^{0}$·9 |

| | | |
|---|---|---|
| | | (-) Add 5th character: 0=unspecified 1=acute 2=chronic 3=acute on chronic<br>0=unspecified – keep since it is commonly used among health care providers terminology in medical records |
| 13. Severe anesthesia complications | DX | O74.0 , O74.1, O74.2, O74.3,<br>O89.01*, O89.09, O89.1, O89.2<br>*O89.01 Aspiration – decided to keep due to difficulties of separation from “Aspiration Pnuemonitis” |
| 14. Sepsis | DX | O85,[a]O86.04, T80.211A, T81.4XXA, T81.44, T81.44XA, T81.44XD, T81.44XS<br>or<br>severity: R65.20<br>or A40.0, A40.1 , A40.3 , A40.8, A40.9, A41.01, A41.02, A41.1, A41.2, A41.3, A41.4, A41.50, A41.51, A41.52, A41.53, A41.59, A41.81, A41.89, A41.9, A32.7 |
| 15. Shock | DX | O75.1, R57.0, R57.1, R57.8, R57.9, R65.21, T78.2XXA, T88.2XXA , T88.6XXA, T81.10XA, T81.11XA, T81.19XA |

| | | |
|---|---|---|
| 16. Sickle cell disease with crisis | DX | D57.00 , D57.01, D57.02, D57.211, D57.212, D57.219, D57.411, D57.412, D57.419, D57.811, D57.81[2,] D57.819 (5th digit: unspecified, acute chest syndrome or splenic sequestration) |
| 17. Air and thrombotic embolism | DX | I26.01, I26.02, I26.09, I26.90, I26.92, I26.99 O88.011-O88.019, 088.02, O88.03, O88.211-O88.219, O88.22, O88.23, O88.311-O88.319, O88.32, O88.33, O88.81, O88.82, O88.83 * I26.0 – Pulmonary embolism with acute cor pulmonaleexternal icon (acute right ventricle heart failure) |
| 18. Blood products transfU.S.ion | PR | 99.0x à 160 ICD-10-PCS codes The most common 30233H1 Transfusion of Nonautologous. Whole Blood into Peripheral Vein, Percutaneous. Approach 30233K1 Transfusion of Nonautologous. Frozen Plasma into Peripheral Vein, Percutaneous. Approach 30233L1 Transfusion of Nonautologous. Fresh Plasma into Peripheral Vein, Percutaneous. Approach |

30233M1 Transfusion of Nonautologous. Plasma Cryoprecipitate into Peripheral Vein, Percutaneous. Approach
30233N1 Transfusion of Nonautologous. Red Blood Cells into Peripheral Vein, Percutaneous. Approach
30233P1 Transfusion of Nonautologous. Frozen Red Cells into Peripheral Vein, Percutaneous. Approach
30233R1 Transfusion of Nonautologous. Platelets into Peripheral Vein, Percutaneous. Approach
30233T1 Transfusion of Nonautologous. Fibrinogen into Peripheral Vein, Percutaneous. Approach
30240H1 Transfusion of Nonautologous. Whole Blood into Central vein, open approach
30240K1 Transfusion of Nonautologous. Frozen Plasma into Central vein, open approach
30240L1 Transfusion of Nonautologous. Fresh Plasma into Central vein, open approach
30240M1 Transfusion of Nonautologous. Plasma Cryoprecipitate into Central vein, open approach

30240N1 Transfusion of Nonautologous. Red Blood Cells into Central vein, open approach
30240P1 Transfusion of Nonautologous. Frozen Red Cells into Central vein, open approach
30240R1 Transfusion of Nonautologous. Platelets into Central vein, open approach
30240T1 Transfusion of Non-Autologous. Fibrinogen into Central vein, open approach
30243H1 Transfusion of Nonautologous. Whole Blood into Central vein, percutaneous. approach
30243K1 Transfusion of Nonautologous. Frozen Plasma into Central vein, Percutaneous. approach
30243L1 Transfusion of Nonautologous. Fresh Plasma into Central vein, percutaneous. approach
30243M1 Transfusion of Nonautologous. Plasma Cryoprecipitate into Central vein, percutaneous. approach
30243N1 Transfusion of Nonautologous. Red Blood Cells into Central vein, percutaneous. approach

| | | |
|---|---|---|
| | | 30243P1 Transfusion of nonautologous. Frozen Red Cells into Central vein, percutaneous. approach 30243R1 Transfusion of nonautologous Platelets into Central vein, percutaneous. approach 30243T1 Transfusion of nonautologous Fibrinogen into Central vein, percutaneous. approach 30233N0 Transfusion of Autologous. Red Blood Cells into Peripheral Vein, Percutaneous. Approach 30233P0 Transfusion of Autologous. Frozen Red Cells into Peripheral Vein, Percutaneous. Approach 30240N0 Transfusion of Autologous. Red Blood Cells into Central vein, open approach 30240P0 Transfusion of Autologous. Frozen Red Cells into Central vein, open approach 30243N0 Transfusion of Autologous. Red Blood Cells into Central vein, percutaneous. approach 30243P0 Transfusion of Autologous. Frozen Red Cells into Central vein, percutaneous. approach |
| 19. Hysterectomy | PR | 0UT90ZZ, 0UT94ZZ, 0UT97ZZ, 0UT98ZZ, 0UT9FZZ |

| | | |
|---|---|---|
| 20. Temporary tracheostomy* | PR | 0B110Z4, 0B110F4, 0B113Z4, 0B113F4, 0B114Z4, 0B114F4 |
| 21.Ventilation | PR | 5A1935Z, 5A1945Z, 5A1955Z |

*Notes:* For all pregnancy related codes O00-O9A:

1. are only applicable to maternity patients aged 12 – 55 years inclusive

2. U.S.e a code under Z3A (Z3A.20-Z3A.42) to document the exact week during the pregnancy

3. *Due to rare prevalence, the following indicators may be combined for reporting purposes: 1) Acute myocardial infarction and aneurysm; 2) cardiac arrest/ventricular fibrillation and conversion of cardiac rhythm; and 3) temporary tracheostomy and ventilation

# Appendix B: HCUP Data Authorization Letter

**From:** HCUP-U.S. <hcup-U.S.@norc.org>
**Sent:** Monday, May 22, 2023 3:52 PM
**To:** [redacted]>
**Subject:** HCUP Central Distributor Order #2023S200009: Information about your order

Greetings [redacted],
This email provides the passwords to unzip/extract and decrypt the secure HCUP database products you recently ordered. Details confirming your order with shipment status. are contained in a separate email.

| **Database** | **Password** |
|---|---|
| State Inpatient Databases -- New Jersey -- 2016 | SID2016YERP2W |
| State Inpatient Databases -- New Jersey -- 2017 | SID2017SQPWBB |
| State Inpatient Databases -- New Jersey -- 2018 | SID2018UUEAEJ |
| State Inpatient Databases -- New Jersey -- 2019 | SID2019DPGGDN |
| State Inpatient Databases -- New Jersey -- 2020 | SID2020ZF17JE |
| State Inpatient Databases -- New Jersey -- 2021 | SID2021QRT8BM |

HCUP databases are delivered in compressed, encrypted “zip” or “exe” format requiring a password to extract the product.
**IMPORTANT!** You mU.S.t U.S.e a third-party zip utility such as SecureZIP®, 7-zip, ZIP Reader, WinZip, SecureZIP® for Mac, StuffIt Expander®, or Keka. Attempts to extract files Using the built-in zip or exe utilities in Windows (Windows Explorer) or Mac (Archive Utility) will produce an error message warning of incorrect password and/or file or folder errors. Note: encryption software and operating system utilities are evolving rapidly; older versions of zip software may not be effective with newer operating systems, and vice versa. In particular, newer versions of Mac may experience difficulties with any utility other than SecureZIP. See the Purchasing FAQ for more information.
Kind regards,
HCUP Central Distributor Team

Please note: The HCUP Central Distributor began transitioning to a new online system on March 10, 2023. All data requests and payments are being processed manually and will take additional time to process and fulfill. We expect the new system to be available in Summer 2023. Thank you for your patience during the transition.

Ref:MSG0008978_Xd1Dtc68rSNtXX4kRVFN

Appendix C: Magnet Designated NJ Hospitals 2021

| Facility Name | Facility City |
|---|---|
| ATLANTICARE REGIONAL MEDICAL CENTER - MAINLAND CAM (NJ10101) | POMONA |
| CAPITAL HEALTH MEDICAL CENTER - HOPEWELL (NJ11104) | PENNINGTON |
| CENTRASTATE MEDICAL CENTER (NJ11302) | FREEHOLD |
| CHILTON MEDICAL CENTER (NJ11401) | POMPTON PLAINS |
| COOPERMAN BARNABAS MEDICAL CENTER (NJ10710) | LIVINGSTON |
| ENGLEWOOD HOSPITAL (NJ10202) | ENGLEWOOD |
| HACKENSACK UNIVERSITY MEDICAL CENTER (NJ10204) | HACKENSACK |
| HOLY NAME MEDICAL CENTER (NJ310008) | TEANECK |
| INSPIRA MEDICAL CENTER ELMER (NJ310069) | ELMER |
| INSPIRA MEDICAL CENTER MULLICA HILL (NJ10803) | MULLICA HILL |
| INSPIRA MEDICAL CENTER VINELAND (NJ310032) | VINELAND |
| JEFFERSON WASHINGTON TOWNSHIP HOSPITAL (NJ10802-1) | TURNERSVILLE |
| JERSEY CITY MEDICAL CENTER (NJ10904) | JERSEY CITY |
| JERSEY SHORE UNIVERSITY MEDICAL CENTER (NJ11303) | NEPTUNE |
| MONMOUTH MEDICAL CENTER (NJ11304) | LONG BRANCH |
| MORRISTOWN MEDICAL CENTER (NJ11403) | MORRISTOWN |
| OCEAN UNIVERSITY MEDICAL CENTER (NJ310052) | BRICK |
| OVERLOOK MEDICAL CENTER (NJ12005) | SUMMIT |
| PENN MEDICINE PRINCETON MEDICAL CENTER (NJ11103) | PLAINSBORO |
| RARITAN BAY MEDICAL CENTER (NJ310039) | PERTH AMBOY |
| RIVERVIEW MEDICAL CENTER (NJ11305) | RED BANK |
| ROBERT WOOD JOHNSON UNIVERSITY HOSPITAL (NJ11202) | NEW BRUNSWICK |
| ROBERT WOOD JOHNSON UNIVERSITY HOSPITAL SOMERSET (NJ11802) | SOMERVILLE |
| SAINT PETER'S UNIVERSITY HOSPITAL (NJ11205) | NEW BRUNSWICK |
| SOUTHERN OCEAN MEDICAL CENTER (NJ11504) | MANAHAWKIN |
| ST JOSEPH'S UNIVERSITY MEDICAL CENTER INC (NJ11605) | PATERSON |
| VALLEY HOSPITAL (NJ10211) | RIDGEWOOD |
| VIRTUA MOUNT HOLLY HOSPITAL (NJ10301) | MOUNT HOLLY |
| WEST JERSEY HOSPITAL (NJ310022) | VOORHEES |

*Note*. Source American Nurses Association, (n.d).

Appendix D: Data Element Descriptions

| National Inpatient Sample (NIS) variable | Variable description | Variable values | NJ SID exception |
|---|---|---|---|
| AGE | Patient age at admission | Ages 12 through 55 | None |
| ADMISSIONHR | Time of patient admission | 0 (midnight) through 2300 (11:00 PM) | None |
| AMONTH | Admission month | 1-12 admit month<br>Blank (missing)<br>A (invalid) | None |
| ATYPE | Admission type | 1 Emergency<br>2 Urgent<br>3 Elective<br>4 Newborn<br>5 Delivery (coded in 1988-1997 data)<br>5 Trauma (beginning 2003)<br>6 Other<br>Missing<br>A Invalid | New Jersey does not separately classify deliveries |
| CPT 1-6 | Services and procedures classification | | None |
| DMONTH | Discharged Month | 1-12 Discharged Month | None |
| DSHOSPID | Data source hospital number | The hospital identifier used by the American Hospital Association | None |

| | | | |
|---|---|---|---|
| | | (AHAID and IDNUMBER), and | |
| HISPANIC | Hispanic ethnicity (uniform) | 0 Not Hispanic<br>1 Hispanic, White<br>2 Hispanic, Black<br>3 Hispanic, Other race<br>4 Hispanic, Unspecified race<br>. Missing<br>.A Invalid | None |
| I10_DX_Admitting (1-3) | Admitting ICD-10-CM Diagnosis Code | Admission Diagnosis code | None |
| I10_DXn (1-6) | ICD-10-CM Diagnosis | Diagnosis code | None |
| MARITALST'TU.S.UB04 | Patient's marital status., UB-04 standard coding | I Single<br>M Married<br>A Common Law<br>B Registered Domestic Partner<br>S Separated<br>X Legally Separated<br>D Divorced<br>W Widowed<br>U Unmarried (single or divorced or widowed) | A Common Law<br>B Registered Domestic partner/ life partner<br>D Divorced<br>I Single<br>M Married |

| | | | |
|---|---|---|---|
| | | Blank Unknown | S Separated<br>U Unmarried<br>W Widowed<br>X Legally separated<br>Blank Missing |
| MEDINCSTQ | Median household income state quartile for patient ZIP Code | 1 First quartile<br>2 Second quartile<br>3 Third quartile<br>4 Fourth quartile<br>. Missing | None |
| PAY1 (1-4) | Expected (primary) payer, uniform | 1 Medicare<br>2 Medicaid<br>3 Private insurance<br>4 Self-pay<br>5 No charge<br>6 Other<br>. Missing<br>A Invalid | None |
| PrimLang | Primary language of patient | State specific coding | |
| TOWN | Patient town of residence | State specific coding | |

*Note:* This table was accessed from the HCUP U.S.er support website, Agency for Healthcare Research and Quality. (2020).

Appendix E: Descriptive Statistics NJ Maternity Patient Demographics

*NJ Hospital Maternal Health Population Marital Status, Magnet and Non-Magnet Hospitals Year 2021*

| | | .00 | 1.00 |
|---|---|---|---|
| | | Non-Magnet | Magnet |
| Patient's marital status, UB-04 standard coding | unknown | 2306 | 846 |
| | domestic partner | 38 | 218 |
| | divorce | 135 | 348 |
| | single | 9651 | 17770 |
| | married | 7591 | 43692 |
| | separated | 54 | 100 |
| | unmarried | 30 | 75 |
| | widowed | 12 | 37 |
| | legally separated | 93 | 186 |

*Note:* Reference Appendix D for marital status. for the UB04 patient claim submission for service  (Agency for Healthcare Research and Quality, 2020

*NJ Hospital Maternal Health Population Preferred Language, Magnet and Non-Magnet Hospitals Year 2021*

| | | .00 | 1.00 |
|---|---|---|---|
| | | Non-Magnet | Magnet |
| Primary language of patient | | | |
| | Missing | 6 | 63 |
| | Arabic | 40 | 200 |
| | Bengali | 12 | 70 |
| | Chinese | 10 | 82 |
| | French Creole | 73 | 50 |
| | English | 13968 | 55426 |
| | French | 21 | 22 |
| | Gujarti | 3 | 106 |
| | Hindu | 17 | 152 |
| | Korean | 4 | 177 |
| | Other Language | 2646 | 811 |
| | Portugese | 58 | 229 |
| | Spanish | 3019 | 5603 |
| | Telugu | 0 | 82 |
| | Turkish | 9 | 79 |
| | Urdu | 21 | 89 |

*Note*: Reference Appendix D for data element descriptors (Agency for Healthcare Research and Quality, 2020

*NJ Hospital Maternal Health Population Primary Health Insurance, Magnet and Non-Magnet Hospitals Year 2021*

| | | .00 | 1.00 |
|---|---|---|---|
| | | Non-Magnet | Magnet |
| Primary expected payer (uniform) | Medicare | 64 | 157 |
| | Medicaid | 7602 | 17020 |
| | Private | 10258 | 41808 |
| | Self Pay | 710 | 1204 |
| | No Charge | 478 | 404 |
| | Other/Missing | 787 | 2582 |

*Note*. Per AHRQ database, these are the reported payors for the UB04 patient claim submission for service (Agency for Healthcare Research and Quality, 2020)

Appendix F: De-identified NJ Hospitals by Magnet Status and Number of SMM

| Magnet status | Hospital Coded Identifier | Magnet Coding (IV) | Number SMM (factor for deriving DV) |
|---|---|---|---|
| no | 10N | 0 | 0 |
| no | 11N | 0 | 0 |
| no | 12N | 0 | 0 |
| no | 13N | 0 | 0 |
| no | 14N | 0 | 0 |
| yes | 22Y | 1 | 0 |
| yes | 23Y | 1 | 0 |
| yes | 24Y | 1 | 0 |
| yes | 25Y | 1 | 0 |
| no | 15N | 0 | 0 |
| no | 16N | 0 | 0 |
| yes | 26Y | 1 | 0 |
| no | 17N | 0 | 0 |
| no | 18N | 0 | 0 |
| yes | 27Y | 1 | 0 |
| no | 19N | 0 | 0 |
| yes | 28Y | 1 | 0 |
| no | 20N | 0 | 0 |
| yes | 29Y | 1 | 0 |
| yes | 21Y | 1 | 1 |
| yes | 20Y | 1 | 1 |
| yes | 17Y | 1 | 1 |
| yes | 15Y | 1 | 1 |
| yes | 14Y | 1 | 1 |
| no | 9N | 0 | 1 |
| yes | 8Y | 1 | 1 |
| no | 7N | 0 | 1 |
| no | 5N | 0 | 1 |
| no | 4N | 0 | 1 |
| yes | 18Y | 1 | 2 |
| no | 8N | 0 | 2 |
| yes | 13Y | 1 | 2 |
| no | 6N | 0 | 2 |
| yes | 4Y | 1 | 2 |
| yes | 1Y | 1 | 2 |

| | | | |
|---|---|---|---|
| no | 2N | 0 | 2 |
| yes | 19Y | 1 | 3 |
| yes | 16Y | 1 | 3 |
| yes | 10Y | 1 | 3 |
| yes | 7Y | 1 | 3 |
| yes | 3Y | 1 | 3 |
| no | 1N | 0 | 3 |
| yes | 5Y | 1 | 4 |
| yes | 6Y | 1 | 5 |
| yes | 11Y | 1 | 6 |
| no | 3N | 0 | 6 |
| yes | 12Y | 1 | 7 |
| yes | 9Y | 1 | 7 |
| yes | 2Y | 1 | 8 |