

THE IMPACT OF SCHOOL NURSES ON STUDENT HEALTH AND EDUCATION
OUTCOMES

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ABSTRACT

Nakia Charmaine Best: The Impact of School Nurses on Student Health and Education Outcomes
(Under the direction of Debbie Travers)

Background: School nurses intervene with students, families, and school staff to maintain or improve the health and academic success of students. To display school nurse impact on student health and success, their work must be identified and measured. Although some data on school nursing services exist, datasets are disparate, not standardized. Examining the impact of school nurses on student health and education outcomes is necessary to illustrate the need for students to have access to a school nurse each day.

Purpose: This is a three-manuscript dissertation. Chapter 2 presents an integrative review of the literature that explores school nurse interventions, activities, and student health and education outcomes. Chapter 3 presents the results that describe trends in data for North Carolina public schools of school nurse health services and programs, utilized by grade level. Chapter 4 examines the impact of school nurse-to-student ratios, and health services and programs on student outcomes.

Methods: Chapter 2 is an integrative review that uses the Framework for 21st Century School Nursing Practice to explore school nurse interventions and activities, and student outcome measures. Chapter 3 presents results of longitudinal repeated measures study that used generalized linear modeling and Poisson regression to test the effect of time and grade on trends of school nurse health services and programs in North Carolina public schools, stratified by grade level. Chapter 4 used generalized linear modeling with a gamma distribution to estimate

the association between school nurse-to-student ratios and health services and programs on the outcomes of students with asthma and diabetes.

Results: Over time, more students were identified with various health conditions, and had more orders for health care procedures to be conducted in the school setting. Also, lower school nurse-to-student ratios were associated with some improved student health and education outcomes in students with asthma and diabetes.

Conclusions: School nurses do have an impact on student outcomes. There is an identified need to find determine the impact of school nurse interventions on school nurse sensitive indicator.

I dedicate this work to my family. Thank you for loving and supporting me, and understanding when I needed time to write. Thank you for reminding me often of who I am, and whose I am.

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Ralph Best (Daddy), Helen Best (Mommy), and N’kengie Best (Sis)

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TABLE OF CONTENTS

LIST OF TABLES	xiii
LIST OF FIGURES	xiv
LIST OF ABBREVIATIONS.....	xvi
CHAPTER 1: DISSERTATION PROPOSAL	1
Background and Significance	1
Aims	6
Conceptual Framework.....	6
Prepared Manuscripts.....	10
REFERENCES	12
CHAPTER 2: EXPLORING SCHOOL NURSE INTERVENTIONS AND HEALTH AND EDUCATION OUTCOMES: AN INTEGRATIVE REVIEW	16
Overview	16
Background	16
Framework for 21st Century School Nursing Practice	17
Methods.....	18
School Nurse Interventions and Activities	20
Outcome Measures	25
School Nurse Interventions Linked to Outcomes	28
Discussion	30
School Nurse Interventions and Activities	31
Health and Education Outcome Measures.....	32
School Nurse Interventions Linked to Positive Outcomes	34

Limitations	36
Implications for School Nursing Practice and Future Research	36
Conclusion	37
REFERENCES	38
CHAPTER 3: SCHOOL NURSE HEALTH SERVICES AND PROGRAMS IN NORTH CAROLINA PUBLIC SCHOOLS FROM 2006 TO 2016	50
Introduction.....	50
Methods.....	51
Study Design.....	51
Participants and Procedures	51
Instruments	52
Variables	52
Data Analysis	54
Results.....	55
Sample	55
Identified Health Conditions.....	58
Health Education Presentations and Programs	61
Health Counseling	63
Health Care Procedures	65
School Nurse Case Management	69
Discussion	70
Conclusion	76
REFERENCES	77
CHAPTER 4: THE IMPACT OF NORTH CAROLINA SCHOOL NURSE RATIOS AND SCHOOL NURSE HEALTH SERVICES AND PROGRAMS ON STUDENT HEALTH AND EDUCATION OUTCOMES FROM 2011-2016.....	81

Introduction.....	81
Methods.....	83
Study Design.....	83
Participants and Procedures.....	83
Data Source.....	84
Variables	84
Data Analysis	87
Results.....	89
Sample	89
Identified Health Conditions.....	91
Health Education Presentations, Programs, and Training	92
Health Counseling	92
Health Care Procedures	93
School Nurse Case Management.....	94
Impact of School Nurse-to-Student Ratios and School Nurse Health Services and Programs.....	95
Discussion.....	96
Conclusion	100
REFERENCES	102
CHAPTER 5: DISCUSSION.....	105
Aim 1: Published in Journal of School Nursing (Best, Oppewal, & Travers, 2018).....	106
Sample for Aims 2 and 3	109
Aim 2: Manuscript to Be Submitted to Journal of School Health	110

Aim 3: Manuscript to be Submitted to North Carolina Medical Journal.....	111
Future Implications for Practice and Research	112
APPENDIX A: LIST OF VARIABLES AND DESCRIPTIONS	117

LIST OF TABLES

Table 2.1. School Nurse Interventions and Activities Categorized by Framework Principles.....	47
Table 2.2. Outcome Measures Categorized by Framework Principle	48
Table 2.3. Links Between School Nurse Interventions and Student Outcomes	49
Table 3.1. LEA Characteristics School Years 2006-2016 (N=115)	55
Table 3.2. School Nurse Full Time Equivalents and School Nurse-to-Student Ratios School Years 2006-2016.....	56
Table 3.3. School Nurse Educational Preparation and National Certification School Years 2006-2009 and 2013-2016.....	57
Table 3.4. Health Education Presentations and Programs in all LEA (N=115)	62
Table 4.1. Local Education Agency Characteristics School Years 2011-2016 (N=115).....	89
Table 4.2. School Nurse Full Time Equivalents and School Nurse-to-Student Ratios School Years 2011-2016.....	90
Table 4.3. School Nurse Educational Preparation and National Certification School Years 2013-2016.....	91
Table 4.4. Students with Asthma, Type 1 Diabetes, and Type 2 Diabetes 2011-2016.....	91
Table 4.5. Health Education Presentations, Programs, and Training in all LEAs (N=115).....	92
Table 4.6. Asthma and Diabetes One-to-One Counseling 2011-2016.....	93
Table 4.7. Asthma and Diabetes Health Care Procedures 2011-2016.....	94

LIST OF FIGURES

Figure 2.1. PRISMA diagram showing search and screening process, and selection of studies for inclusion in review.....	46
Figure 3.1. N.C. average nurse-to-student ratios and school nurse FTEs from 2006 to 2016	56
Figure 3.2. School nurses with Bachelor of Science in Nursing from 2006-2009 and 2013-2016	57
Figure 3.3. School nurses with national school nurse certification 2006-2009 and 2013-2016	58
Figure 3.4. Mean count of students with health conditions	58
Figure 3.5. Mean count of students with asthma	59
Figure 3.6. Mean count of students with type 1 diabetes.....	60
Figure 3.7. Mean count of students with type 2 diabetes.....	60
Figure 3.8. Mean count of all one-to-one health counseling sessions	63
Figure 3.9. Mean count of one-to-one asthma health counseling sessions.....	64
Figure 3.10. Mean count of one-to-one diabetes health counseling	65
Figure 3.11. Mean count of all health care procedures.....	66
Figure 3.12. Mean count of students with nebulizer treatment orders.....	67
Figure 3.13. Mean count of students with glucagon injection orders	68
Figure 3.14. Mean count of students with insulin pump orders.....	68
Figure 3.15. Mean count of students with glucose monitoring orders.....	69
Figure 3.16. Mean count of students with insulin injection orders.....	69
Figure 3.17. LEAs with formal case management programs 2007 and 2016 (N=115).....	70
Figure 4.1. Student asthma and diabetes outcomes	87
Figure 4.2. Asthma and diabetes related education programs and procedures	89
Figure 4.3. Average nurse-to-student ratios and school nurse full-time equivalents 2011 to 2016	90

Figure 4.4. LEAs with structured school nurse case management program 2011-2016 (N=115).....	95
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LIST OF ABBREVIATIONS

ADN	Associate Degree in Nursing
ANA	American Nurses Association
AAP	American Academy of Pediatrics
BA	Bachelor of Art
BS	Bachelor of Science
BSN	Bachelor of Science in Nursing
CDC	Centers for Disease Control and Prevention
DIKW	Data, information, knowledge, wisdom
DPH	Division of Public Health
EOY	End of year
FTE	Full-time equivalents
GEE	Generalized estimated equations
GLM	Generalized linear model
HIV	Human immunodeficiency virus
ICS	Inhaled corticosteroid
LEA	Local education agency
NASN	National Association of School Nurses
NHLBI	National Heart, Lung, and Blood Institute
N.C.	North Carolina
NCDHSS	North Carolina Department of Health and Human Services
NCES	National Center for Education Statistics
NCGA	North Carolina General Assembly
PED	Program Evaluation Division

PRISMA	Preferred reporting items for systematic reviews and meta-analyses
U.S.	United States
SNCM	School nurse case management
STI	Sexually transmitted infection
WCH	Women's and Children's Health Section

CHAPTER 1: DISSERTATION PROPOSAL

Background and Significance

School nursing was established by Lillian Wald in 1902, when she and her colleagues provided evidence to the New York School Education Administration that nurses were needed in schools to combat communicable diseases (Maughan, 2003; National Association of School Nurses [NASN], 2012). In one month, Lina Rogers, the first school nurse, administered 893 treatments, visited 137 homes, provided health education to students and families, and was able to help 25 students return to school. Under her leadership, 12 nurses were employed to offer care across the city. Within one year, absenteeism was reduced by 90% (Vessey & McGowan, 2006). The school nurse role has expanded over the years, but has kept the same goals in mind: keep students safe, healthy, and in school so that they can learn.

School nursing is defined as a specialized practice of public health nursing that advances the well-being, academic success and lifelong achievement and health of students (American Nurses Association [ANA] & NASN, 2011). School nurses take on different roles that depend on the school setting (rural, suburban, or urban), needs of the student population (age group, chronic health conditions, mental health, special needs), and available resources and services (NASN, 2012a). Access to a school nurse varies by state and school district policy. NASN recommends nurse-to-student ratios to be at minimum one school nurse to 750 students (NASN, 2015). In North Carolina the current average nurse-to-student ratio is 1:1,112, 48% higher than the recommended ratio of 1:750 (North Carolina Department of Health and Human Services [NCDHSS], 2016).

The scope of school nursing practice includes: facilitation of normal student development and positive response to interventions; promotion of a healthy and safe environment through provision of education to students and school staff; interventions for acute and chronic illnesses through quality health care, case management services and public health tasks (immunization compliance, health promotion, disease surveillance); and collaboration with others (students, parents, families, school staff, community, health care providers) to promote student/family self management and advocacy, and decrease health-related barriers that affect student learning (American Academy of Pediatrics Council on School Health, 2016; NASN, 2016).

The ability to learn is directly related to a child's health status. By providing health care and follow-up within the school environment, full-time school nurses play a vital role in keeping children healthy, in school and ready to learn (NASN, 2012a). The traditional view of a school nurse consists of someone to provide health screenings and take care of acute issues (e.g. nose bleeds, fever, vomiting). However, the role of the school nurse serves a pivotal role that includes much more to meet student health needs. School nurses are positioned to meet student health needs through a variety of services for actual and potential health problems. School nurses develop school health service policies and programs that are evidence-based and student-centered, and provide community health education and disease prevention. School nurse interventions also include medication administration, screenings, disease surveillance, and routine treatments and procedures (Maughan, Duff, & Wright, 2016)

Emotional and intellectual disabilities, and chronic illnesses impact a student's ability to learn and can lead to poor school performance and absenteeism (NASN, 2012a, 2012b). Students with disabilities and chronic illnesses have complex medical problems that often require health services provided by school nurses including complicated treatments, health care plans and

emergency action plans, or other accommodations (NASN, 2012a, 2012b).

There has been an increase in the number of children and adolescents with chronic health conditions (CHCs) needing care during the school day over the past few decades. This is due to improved case finding by school nurses, and an increased number of students with special needs that were once confined to medical settings now being educated in local school districts. Critical support services provided by key health care providers like school nurses are needed to keep them in school and help them be academically successful (NASN, 2012b).

Chronic health conditions such as asthma, diabetes, mental health concerns, and obesity can affect a child's school attendance and performance, well-being, and place undue stress on the entire family (McElfresh & Merck, 2011; NASN, 2016; Office of Adolescent Health, 2016). In the 2011-2012 school year, approximately 16.4 percent of students in NC were reported to have at least one chronic health condition (Child and Adolescent Health Measurement Initiative, 2013).

School nursing is a multidimensional professional career path with a broad scope of roles and responsibilities, that allows nurses to support all facets of student and school staff health including emotional, mental, physical, and social (NASN, 2012a). School nurse support is pivotal to assist students in being successful learners. The extensive services school nurses provide in the non-medical setting differentiates school nursing from other specialties, and places them in a unique place to have a positive, effective impact on student performance, school absenteeism, graduation rates, and collaboration between school and community members (Fateau, 2010; NASN, 2012a).

Anecdotal stories about a school nurse providing services to students that positively impacted their lives and school performance, such as offering a influenza vaccine clinic, teaching

a child how to calculate their insulin dose, or administering a life-saving dose of epinephrine for an allergic reaction, have been told in local newspapers, blogs, and news reports. These interventions and activities may be thought of as positive actions that are effective in keeping a child from getting sick, missing school, alert and performing well on a test, or alive so that they may return to school. In spite of anecdotal evidence on school nurses' positive impact on student health and educational outcomes, there is little published literature regarding how school nurse effectiveness is defined, which approaches have been used to measure school nurse effectiveness, and the "best" evidence-based indicators of school nurse effectiveness. It is vital that evidence based research is conducted to continuously improve school nursing practice and interpret the importance of school nursing to stakeholders (Sheetz, 2012).

While some data on school nursing services do exist, the datasets are disparate and not collected in a standardized format. In North Carolina, school nurses and nurse supervisors that represent all public schools in the state's 115 local education agencies (LEAs) complete an annual survey related to health services they provide in schools each year. In the immediate past school year (2015-2016) there were 1,459,852 public school students enrolled in public schools. The data does not include students enrolled in charter schools (77,791 in 2015-2016 school year), but does represent 95% of the total students enrolled in the North Carolina public school system. Data are collected using a survey instrument developed by school health nurse consultants and data specialists in NC Division of Public Health's Children and Youth Branch. The State School Nurse Consultant has reported 100% participation from all LEAs in North Carolina. The data are submitted to the North Carolina Department of Health and Human Services (DHHS) Division of Public Health (DPH) for the N.C. Annual End of School Year (EOY) Report of School Health Services and Programs. The end of year report includes two sections, a staffing form, and a

screening form. Section One and Staffing-Form A, due in January of each year, includes demographic information for school nursing staff, funding, employers, vaccination clinics, and school health policies/protocols. Section Two and Screening Worksheet-Form B, due in June of each year, includes health education, concerns, counseling, outcomes, and total numbers of students screened, referred, and who have secured a health care provider (e.g. vision, hearing).

After the annual NC school health survey data are compiled, significant findings are summarized by the State School Health Nurse Consultant in the North Carolina Annual Report of School Health Services and results are made available on the DHHS/DPH Women's and Children's Health Section (WCH) Facts and Figures website (NCDHHS, 2016). Data for 2006/2007 through 2015/2016 school years have been preserved in Microsoft Access and Microsoft Excel files, but due to lack of human resources, a longitudinal analysis of these data has never been conducted. It is not known if the many services and programs offered by school nurses are producing the desired effect since evidence cannot be provided.

There are many factors that affect the health and educational success of students (e.g. social determinants, school environment, parenting, school leadership, poverty, school nurses). To demonstrate the contributions of nurses on students' health and success in school, factors that reflect school nursing's impact must be identified and measured. Specifically, there is a need for school nurse-sensitive outcome measures that distinguish between effects of school nursing interventions and other effects (Bergren, 2011; NASN, 2016). Therefore, the purpose of this dissertation research is to measure school nurse impact on student health and education outcomes using aggregated population level data from the annual NC school health survey.

Aims

Aim 1. Determine the state of the science on the links between school nurse interventions and activities, and the health and education outcomes of school children.

Aim 2. Describe patterns in data for public North Carolina elementary, middle, and high schools for years 2006-2016:

2a. School nurse health services and programs patterns

2b. Most common health services and programs by grade level.

Aim 3. Examine the impact of North Carolina school nurse-to-student ratios and programs and services on health and education outcomes of school children.

Conceptual Framework

The nursing profession has historically been challenged with making nursing work visible. Acute care nurses have had to contend with preserving documentation of nursing activities and knowledge, and distinguishing the importance of their work in improving patient outcomes from other disciplines. Acute care nurses have also been challenged to develop ways to quantify nursing work, capture nursing care that is delivered but is difficult to quantify, and identify nurse sensitive indicators and outcomes (Bergren, 2011; Clark & Lang, 1992; Pearson, 2003; Ronquillo, Currie, & Rodney, 2016). Nurses in the school setting are also tasked with proving their impact on the health and education outcomes of school aged children, but there is little evidence available on school nurses (Bergren, 2011; Maughan et al., 2014). How can school nurses operationalize their work to make it more visible and be counted? The data, information, knowledge, wisdom (DIKW) framework has been instrumental in making nursing work in other settings visible (Nelson & Staggers, 2014, 2015; Ronquillo, et al., 2016). Because the focus of this dissertation is to move school nursing in North Carolina from data to wisdom, Nelson's

Data-to-Wisdom Continuum is appropriate to address the gap in how data on school nurses and student outcomes are managed and shared.

In 1989, Ramona Nelson and Irene Joos built upon previous definitions of the data, information, and knowledge continuum and extended the work of Bruce Blum, Judy Graves, and Sheila Corcoran, to include the concept of wisdom. The framework is comprised of four major concepts: data, information, knowledge, and wisdom (Nelson, 2002; Nelson & Staggers, 2014, 2015).

Data are the basic foundational layer in the Data-to-Wisdom framework. Data are symbols that represent objects, events, and their properties. Data are products of observation, discrete facts, with no structure or relationships between them (Ackoff as cited in Rowley, 2006; Blum, 1986). Therefore, a single piece of data (a datum) has little to no inherent meaning. Data come in the form of numbers, words, sentences, or pictures. Alone, a number that is supposed to represent a “grade” or “absence” has no meaning until it is organized because it is unprocessed and uninterpreted (Blum, 1986; Gee et al., 2012; Matney et al., 2011).

Information allows the processed data elements to be put into context (i.e. data + meaning). Information is a product of structured data that has been interpreted and processed (Blum, 1986; Gee et al., 2012; Matney et al., 2011). As data are processed into information, they increase in value and meaning. For example, a local education agency’s (LEA) number of students with “improved grades” or “decreased number of absences,” provides structure for the data, and can be used to produce information for longitudinal comparisons of student outcomes.

Knowledge is the application of data and information. Knowledge is developed from interpreted and integrated information that forms and identifies relationships, patterns, experience, and rules to increase understanding (Gee et al., 2012; Matney et al., 2011; Nelson &

Staggers, 2014). Knowledge in the context of North Carolina schools could be gained by identifying the patterns and relationships between school nurse support and interventions and student educational outcomes (e.g. 10 middle school students in two rural LEAs have achieved Asthma Outcomes *Improved grades* and *Decreased number of absences*; the school nurses working in these LEAs incorporated school nurse care management to manage students with chronic health conditions, and implemented one-to-one health counseling and asthma health education programs for students, staff, and parents).

Wisdom builds on understanding and applying the appropriate use of knowledge, while integrating compassion, to manage and solve human problems or needs. Reaching wisdom implies ethics, choosing what is important and distinguishing between alternatives, and includes use of experience, creativity, and intelligence. Wisdom uses knowledge to establish and achieve goals (Birely et al., 2000; Matney et al., 2011; Nelson & Staggers, 2014). The potential for wisdom to be developed can occur through change in school health policy by providing knowledge to school nurses and other school health professionals.

The major concepts (and their activities as described above) build upon one another and have “fuzzy” boundaries, represented by the overlapping circles. The bidirectional arrows represent how the concepts are interrelated and connect to one another. The curved arrows that appear to be in movement demonstrate the constant flux (i.e. continuous change or movement) between and within the concepts. “What is information in one context may be data in another” (Nelson & Staggers, 2014, p.27). With each level of the framework, there is an increased level of critical thinking. As one moves up the continuum, there are increased interactions and interrelationships within and between the concepts, which creates increased complexity (Matney et al., 2011; Nelson, 2002; Nelson & Staggers, 2014).

The DIKW framework has been used in a variety of studies pertaining to computerized information systems (Tully et al., 2013), nursing practice (Looman et al., 2012; Matney, Maddox, & Staggers, 2014; Matney, 2015), and theory building (Gee et al., 2013; Matney, 2015).

Nelson's Data-to-Wisdom Continuum will guide this study. My purpose in studying school nursing in North Carolina public schools is to understand the types of health services and programs school nurses provide, the types of health and education outcomes for students with chronic and/or complex health care needs as a result of school nurse intervention, the common health services and programs provided to students by grade level (Kindergarten-5th grade, 6th-8th, 9th-12th), and the impact of school nurse-to-student ratios on health and education outcomes.

First, I will access the *data* from the NC Division of Public Health/School Health Unit, which has been collected by school nurses for the N.C. Annual Local Education Agency (LEA) End of School Year (EOY) Report of School Health Services and Programs. The data are currently saved in Microsoft Access and Excel files. This follows Nelson's Data-to-Wisdom Continuum, as the data are available as numbers, words, and sentences. These data has been named, collected, and organized through questions school nurses have answered for the report (Blum, 1986; Gee et al., 2012, Matney et al., 2011; Nelson and Staggers, 2014).

Next, I will conduct analyses to process these data into *information* to increase value and meaning. I will begin to interpret the information using statistical analyses (Blum, 1986; Gee et al., 2012, Matney et al., 2011; Nelson and Staggers, 2014). As I interpret the annual survey information, the results from my analyses will guide *knowledge* as I identify and describe patterns and relationships to increase understanding of the impact of school nursing in North Carolina public schools (Gee et al., 2012, Matney et al., 2011; Nelson and Staggers, 2014). From

the knowledge gained I anticipate providing the state school nursing consultant supervisor with suggestions for changes to the survey questions and data collection, trends and patterns of school nurse health programs and services, student health and education outcomes, and the impact of nurse-to-student ratios on these programs and services and health and education outcomes. In turn, the state school nursing consultant supervisor and staff will be able to provide consultation to LEAs based on the study findings.

The data, information, and knowledge acquired in this study and the products of this study (publications and presentations) will contribute to the development of *wisdom* to change public and school health policy. This study will also assist the school nursing profession to reach wisdom by providing knowledge on how to improve measurement of the effect of school nurse programs and services and student health and education outcomes to North Carolina and national school nurse leaders, and others in the school nursing community.

Prepared Manuscripts

This is a three-manuscript dissertation. The manuscript-style dissertation consists of five chapters: Chapter 1 is an introduction to the role of the school nurse and challenges with lack of standardized data that represent the school health and the impact school nurses have on student outcomes. Chapters 2, 3, 4 are three manuscripts that correspond to each specified aim of the study. Chapter 2, Manuscript 1, “Exploring School Nurse Interventions and Health and Education Outcomes: An integrative Review,” is a review on the state of the science of the links between school nurse interventions and activities, and the health and education outcomes of school children. This review was published in the *Journal of School Nursing*; the version of the manuscript that was accepted by the journal is provided. Chapter 3, Manuscript 2, “School Nurse Health Services and Programs in North Carolina Public Schools from 2006 to 2016,” describes health services and programs provided by school nurses, and the most common health services

by grade level (elementary, middle, high school) in NC public schools. Chapter 4, Manuscript 3, “The Impact of North Carolina School Nurse Ratios and School Nurse Health Services and Programs on Student Health and Education Outcomes from 2011 to 2016. Chapter 5 is a synthesis of the three manuscripts’ results with a focus on future implications for practice and research.

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CHAPTER 2: EXPLORING SCHOOL NURSE INTERVENTIONS AND HEALTH AND EDUCATION OUTCOMES: AN INTEGRATIVE REVIEW

Overview

School nurses intervene with students, parents, and school staff to advance the health and academic success of students. We conducted an integrative literature review of published research to describe types of school nurse interventions, and health and education outcome measures; and to examine how school nurse interventions were linked to student outcomes. Sixty-five studies met the inclusion criteria. We used the National Association of School Nurses' Framework for 21st Century School Nursing Practice to categorize school nurse interventions, and health and education outcome measures. The majority of interventions were categorized under the care coordination principle, most commonly, motivational interviewing and counseling. In 17 studies, school nurse interventions were linked to improved student outcomes. Most studies (80%) were descriptive. To advance school nursing science, researchers can build on this foundation with more rigorous research methods to evaluate the impact of school nurse interventions and activities on student health and education outcomes.

Background

School nurses intervene to advance the well-being, health, academic success, and lifelong achievement of students (National Association of School Nurses [NASN], 2016a, 2017b). School nurses promote a healthy and safe environment by providing education, interventions for acute and chronic illnesses, public health activities; and case management services to promote self-management and advocacy, and decrease health-related barriers that affect student learning (American Academy of Pediatrics (AAP) Council on School Health, 2016; NASN, 2017b).

While previous studies have *described* school nurse roles and metrics for measuring student health and education outcomes (Johnson, Bergren, & Westbrook, 2012; Selekman, Wolfe, & Cole, 2016; Stock, Larter, Kieckehefer, Thronson, & Maire, 2002), NASN (2016c) has called for research studies to *determine the impact of* school nurse interventions on student outcomes, and the impact of school nurse interventions on nurse sensitive indicators (e.g. attendance, health office visits, immunization rates). The purpose of this integrative literature review was to explore empirical research findings for links between school nurse interventions and activities, and the health and education outcomes of school children. We used three questions to guide this process:

1. What types of school nurse interventions and activities are described in the literature?
2. What health and education outcome measures are described in the literature?
3. How are school nurse interventions linked to positive outcomes?

Framework for 21st Century School Nursing Practice

In 2016, NASN published the final version of a conceptual framework to explain key principles of school nursing and components that help focus the care school nurses provide in their practice. The *Framework for 21st Century School Nursing Practice* is student-centered and takes the student's family and community into consideration. The key principles of the Framework are: Care Coordination, Leadership, Quality Improvement, and Community/Public Health. These principles, each comprised of specific components, are nonhierarchical and overlapping, and surrounded by the Standards of Practice principle. Standards of practice are a foundation for the evidence-based, quality, and competent care school nurses provide (NASN, 2016b). We used the Framework principles and components to categorize the school nurse interventions/activities, and health and education outcomes.

Methods

This review was conducted according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses (Moher, Liberati, Tetzlaff, Altman, & PRISMA Group, 2009). Studies were identified by searching: PubMed, Cumulative Index of Nursing and Allied Health, PsycINFO, Academic Search Premier, Education Resources Information Center, and Social Work Abstracts databases. This was conducted in consultation with an expert nursing reference librarian to ensure we conducted an exhaustive literature search. To identify the most current articles we originally searched each database for studies published between January 1, 2011 and December 31, 2016; we then conducted and updated search on July 30, 2017 to capture additional articles from January 1, 2017 to July 30, 2017. Key search terms included a combination of *school nurse, school nursing, health or education outcomes, chronic or acute disease, medication administration, allergies, health education or knowledge, and screening*.

Included were studies that reported empirical findings, published in English in peer-reviewed journals, and were conducted in the United States (U.S.). Only studies describing health services provided by school nurses, perspectives of school nurses, or perspectives of the school nurse role on health and education outcomes of school-aged children were included.

The search process is illustrated in Figure 2.1. The search identified 799 potentially relevant records and an additional 16 records were identified through snowballing. Of these, 109 were duplicates. Titles and abstracts were screened (n=706) to determine whether or not they were relevant and 501 were excluded. The remaining records were accessed to review the entire text of each article (n=205) for eligibility, of which, 140 were excluded. Studies that were excluded did not include a school nurse in the intervention/activity (e.g. consulting physician or nurse practitioner) (n=77), were conducted in countries other than the U.S. (n=12), or did not clearly identify who conducted the interventions and activities (n=7). School nurse guideline

information, recommendations, commentaries (n=39), and literature reviews (n=5) were also excluded. Sixty-five research studies were included in this review.

We used an iterative process to develop a template to extract appropriate data (Whittemore & Knafl, 2005). Studies were assessed to ensure they addressed at least one of the research questions and for appropriateness of participants, sampling, measurement, data collection, findings, and their relevance to one another. Each author independently reviewed potential studies, and discussions on coding resolved all discrepancies. We categorized each study by which, if any, of the four Framework principles they addressed. Some studies were categorized under more than one component, because they included more than one intervention or activity.

Results

The 65 studies included in the literature review consisted of 50 (77%) quantitative studies, nine (14%) mixed-methods studies, and six (9%) qualitative studies. The majority (80%) used a descriptive design (n=52). Quasi-experimental (n=6), experimental (n=6), and correlational (n=1) designs were also used. Half (n=33) of the studies were published between 2015-2017. Research sites included public, private, and charter schools in Massachusetts (n=10), national studies (n=9), North Carolina (n=7), and Missouri (n=5). The location of two studies was not reported. The remaining studies were conducted in 18 other states.

Characteristics of school nurses, students, and schools varied among the 65 studies. School nurses ranged from 23 to 71 years old, had practiced as registered nurses from one to 45 years, and as school nurses from one to 31 years. The majority were female, Caucasian, and held at least a baccalaureate degree. Nine studies also reported if school nurses held a national or state school nurse certification. Student participants in the included studies ranged from five to 19

years old. Participating students were predominantly male, and Caucasian or African American. Nine studies were conducted in elementary schools, one in a middle school, and seven in high schools. The entire K-12 population was included in 15 studies, while the pre-K population was included in eight studies. Eight studies included a combination of school populations: elementary and middle schools (n=4), and middle and high schools (n=4). Sample size ranges varied for participant type: 28 to 4,437 (students), six to 2,049 (school nurses), and 64-72 (parents). One study included 11 student/parent dyads. Socioeconomic status was not consistently documented: 10 studies documented the percentage of students that received free or reduced lunch (range reported 0% to 80%), five studies documented type of insurance (43%-82% Medicaid/public insured), four studies documented family annual income (mean \$61,000-70,000; 73% over 80,000; 52.8% less than \$50,000), and one study documented mean percentage of students living below poverty level (23.4%).

School Nurse Interventions and Activities

Sixty-one (94%) studies were categorized under each Framework principle: care coordination (n=36), community/public health principles (n=17), leadership (n=12), and quality improvement (n=2) (examples are cited in Table 2.1). Some studies were categorized under more than one component, because they included more than one intervention or activity. The remaining four studies did not include school nurse interventions or activities. They assessed perceptions of the school nurse role, barriers present in the school setting, and differences in outcomes based on full or part time employment.

Care coordination principle. In just over half of the studies (55%), school nurses coordinated care to meet student and family goals, needs, and expectations (NASN, 2016b). School nurse interventions and activities aligned with components of the care coordination principle, including: chronic disease management (n=11), collaborative communication (n=10),

motivational interviewing/counseling (n=7), direct care (n=5), case management (n=5), and student care plans (n=2).

School nurses engaged in chronic disease management including: group asthma education (Mickel, Shanovich, Evans, & Jackson, 2017), individual education on epinephrine pens and ensuring students carried unexpired pens (Spina, McIntyre, & Pulcini, 2012), and management of students' asthma, diabetes, and anaphylaxis emergencies (Allen, Henselman, Laird, Quinones, & Reutzell, 2012). Eight studies explored school nurse experiences with chronic disease reporting (Rivkina et al., 2014), providing disease management for students with weight-related health issues (Powell, Engelke, & Neil, 2017; Quelly, 2013; Steele et al., 2011), and students diagnosed with asthma (Garwick, Svavarsdottir, Seppelt, Looman, & Orlygsdottir, 2015; Krenitsky-Korn, 2011), seizure disorders (Terry, Patel, Cohen, Scherzer, & Kline, 2016), and food allergies (Morris, Baker, Belot, & Edwards, 2011).

School nurses communicated collaboratively with parents/guardians (n=9) to: collect student health data (Bergren, 2016; Rivkina et al., 2014), obtain consent for ophthalmology consultation (Diao et al., 2016), provide human papillomavirus (HPV) and meningococcal vaccine information (Rhodes, Draper, Woolman, & Cox, 2017), explain immunization compliance (Swallow & Roberts, 2016); and to discuss adolescent dating violence incidents (Khubchandani, Telljohann, Price, Dake, & Hendershot, 2013), asthma treatments (Krenitsky-Korn, 2011), and weight management (Lee & Kubik, 2015; Stalter, Kaylor, Steinke, & Barker, 2011). School nurses communicated with school staff (n=3) to collect student health data (Bergren, 2016), discuss asthma diagnosis and treatments (Krenitsky-Korn, 2011), and to develop a plan for students with symptoms of female athlete triad syndrome (Kroshus, Fischer, & Nichols, 2015). School nurses also communicated with health care providers (n=2) to collect

student health data and discuss asthma treatments (Bergren, 2016; Krenitsky-Korn, 2011), and with students (n=1) about HPV and meningococcal vaccines (Rhodes et al., 2017).

School nurses used individual counseling interventions to support children with anxiety (Muggeo, Stewart, Drake, & Ginsburg, 2017) and weight-related health issues (Pbert et al., 2013, 2016; Schroeder, Jia, Wang, & Smaldone, 2017); group counseling for children with disabilities (Vessey & O'Neill, 2011), and a motivational interviewing intervention to encourage students diagnosed with asthma to take their daily administration of inhaled corticosteroids (ICS) (Blaakman, Cohen, Fagnano, & Halterman, 2014; Halterman et al., 2011).

School nurses provided direct care for students including: direct observation of students taking asthma preventive and emergency medications (Krenitsky-Korn, 2011), treatment for headaches (e.g. provide snacks/drinks, water/electrolytes, over the counter medications) (Lazdowsky et al., 2016), primary care for adolescent dating violence victims (Khubchandani et al., 2013), assessing the need for and providing epinephrine injections for (food) allergic reactions (Szychliński et al., 2015), and student health assessments (Hill & Hollis, 2012).

School nurses implemented case management action plans for students with asthma (Carpenter, Lachance, Wilkin, & Clark, 2013; Engelke, Swanson, & Guttu, 2014; Moricca et al., 2012) and diabetes (Engelke, Swanson, Guttu, Warren, & Lovern, 2011; Peery, Keehner Engelke, & Swanson, 2012). School nurses also implemented care plans for students returning to school after a concussion diagnosis (Blackwell, Robinson, Proctor, & Taylor, 2017) and emergency action plans for students with food allergies (Pulcini, Marshall, & Naveed, 2011).

Community/public health principle. The foundation of school nursing practice is community and public health (NASN, 2016b). Seventeen studies focused on community and public health under the screenings/referral/follow-up (n=12), health education (n=2), surveillance (n=2) components, and under the overall umbrella of the community/public health principle (n=1). The majority of studies included screenings/referrals/follow-up on a variety of topics including: anxiety (Allison, Nativio, Mitchell, Ren, & Yuhasz, 2014; Muggeo et al., 2017), body mass index (Lee & Kubik, 2015; Stalter, Chaudry, & Polivka, 2011), depression (Allison et al., 2014), somatic symptoms (e.g. headache, nausea, heart racing) and general functioning (home, school, peers) (Muggeo et al., 2017), psychiatric evaluations and referrals to the emergency department (Grudnikoff, Taneli, & Correll, 2015), vision (Kemper, Helfrich, Talbot, & Patel, 2012), hearing (Sekhar et al., 2014), posture (Magee, Kenney, & Mullin, 2012), alcohol use (Lunstead, Weitzman, Kaye, & Levy, 2016), female athlete triad syndrome (Kroshus et al., 2015), acanthosis nigricans (Scott & Hall, 2012), and adolescent dating violence (Khubchandani et al., 2013).

Health education studies involved sex education including a curriculum on human immunodeficiency virus (HIV) and sexually transmitted infections (STI) (Borawski et al., 2015), (Rasberry et al., 2015). Surveillance, a key component of the public health principle, is the systematic collection, analysis, and interpretation of health-related data (NASN, 2016b). Surveillance studies included school nurses reporting data for a statewide asthma surveillance program (Medaglia, Knorr, Condon, & Charleston, 2013) and school nurse visit data for influenza-like illness, fever-flu, allergy, asthma, diarrhea, and vomiting syndromes (Wilson et al., 2014). Lastly, Schaffer, Anderson, & Rising (2016) used the Public Health Intervention Wheel framework to define how school nurses conduct public health interventions.

Leadership principle. School nurses serve as leaders in school settings, requiring ongoing engagement to advance knowledge and skills (NASN, 2016b). Of the 12 studies categorized in the leadership principle, all fit the lifelong learner component with various professional development topics: asthma (n=4), food allergies (n=2), adolescent relationship abuse (n=1), biological event preparedness (n=1), concussions (n=1), maltreatment (n=1), weight-related health issues (n=1), and students with disabilities (n=1).

School nurses attended continuing education on the overall health of students diagnosed with asthma, and training to conduct assessments, use equipment (e.g. peak flow meters), and implement action plans (Carpenter et al., 2013; Francisco, Rood, Nevel, Foreman, & Homan, 2017; Putman-Casdorff & Pinto, 2011; Staudt, Alamgir, Long, Inscore, & Wood, 2015). Other studies included education for school nurses about: food allergies (Chokshi, Patel, & Davis, 2015), adolescent relationship abuse and how to integrate discussions of healthy/unhealthy relationships in each student encounter (Raible et al., 2017), school preparedness for biological events (Rebmann, Elliott, Artman, VanNatta, & Wakefield, 2016), how to support students as they return to the classroom (i.e. return to learn) after concussions (Wing, Amanullah, Jacobs, Clark, & Merritt, 2015), recognizing children at risk for maltreatment (Jordan, MacKay, & Woods, 2017), and improving communication with families on weight-related health issues through a web-based tutorial (Steele, Wu, Cushing, & Jensen, 2013). School nurses also assisted with creating an education module about food allergies for school staff (White et al., 2016), and provided recommendations for education on collaboration with interdisciplinary staff, as well as conducting mandated screenings to provide care for students with disabilities (Singer, 2013).

Quality improvement principle. School nurses use continuous quality improvement (QI) and documentation/data collection components in their daily practice to systematically measure outcomes to understand which of their interventions and activities have the greatest impact on student health and school readiness (NASN, 2016b). School nurses used Plan-Do-Study-Act (PDSA) cycles to test various strategies to increase immunization compliance (Davis, Varni, Barry, Frankowski, & Harder, 2016). Bergren (2016) conducted a survey to assess the feasibility of school nurses' ability to collect school nurse generated student health and education data.

Outcome Measures

Thirty-five studies (61%) included outcome measures, of which, 28 measured health outcomes, two measured education outcomes, and five measured both health and education outcomes. Health and education outcome measures were categorized under each Framework principle: care coordination (n=18), community/public health (n=16), quality improvement (n=6), and leadership (n=3) (examples are cited in Table 2.2).

Care coordination principle. Eighteen studies included care coordination components: chronic disease management (n=10), case management (n=4), student care plans (n=2), direct care (n=1), and student-centered care (n=1). School nurse management of chronic disease was used to explore health outcome measures. Five studies addressed health outcome measures in children diagnosed with asthma: overall asthma and medication knowledge (Francisco et al., 2017; Mickel et al., 2017), health care cost savings, number of days with/without asthma symptoms, quality of life, activity limitations, readiness to change stages, student perceptions about asthma, and asthma management barriers (Francisco et al., 2017; Halterman et al., 2011; Krenitsky-Korn, 2011; Quaranta & Spencer, 2016). Spina et al. (2012) and Szychliński et al. (2015) measured the number of students with available epinephrine pens, number of times

epinephrine administered, types of personnel available to respond to emergencies, reasons epinephrine was not administered, and types of school communities that do not have epinephrine available. The number of emergent events, 911 calls, and deaths were addressed in children diagnosed with asthma, diabetes, and food allergies (Allen et al., 2012). Weight management outcome measures included decreased body mass index, body fat percentage, waist circumference, and blood pressure; improved dietary behaviors, and increased physical activity (Pbert et al., 2013, 2016).

In four studies, school nurses implemented case management plans with individualized goals and measured health outcomes of children diagnosed with chronic illnesses: decreased asthma-related symptoms and number of urgent care visits (Carpenter et al., 2013), parent and teacher perceptions of child's asthma/diabetes self-management, improved asthma/diabetes-related quality of life (Engelke et al., 2014; Peery et al., 2012), and ability to attain case management goals (Engelke et al., 2014, 2011). Two studies investigated the prevalence of student care plans for food allergies and asthma emergencies (Pulcini et al., 2011; Rivkina et al., 2014). Lazdowsky et al. (2016) explored the types of school nurse actions and student/family perceptions of the direct care school nurses provided for management of headaches. Lastly, Vessey et al. (2011) measured how school nurses provided student-centered care through support groups to improve resilience in students with disabilities affected by teasing and bullying.

Community/public health principle. School nurses conducted surveillance (n=7), and provided screenings/referrals/follow-up (n=6) and health education (n=5) during their practice. School nurses conducted surveillance and documented decreased days absent (partial or full days) from school, tardiness, and time out of class (Bergren, 2016; Carpenter et al., 2013; Engelke et al., 2014; Krenitsky-Korn, 2011; Moricca et al., 2012; Muggeo et al., 2017;

Rodriguez et al., 2013). Bergren (2016) also assessed school nurse data collection on the number of times students were dismissed from school early or sent back to class after health office visits. Types of screenings, referrals, and follow-up included: screenings for depression and anxiety (Allison et al., 2014; Muggeo et al., 2017), physical symptoms and overall functioning related to anxiety (Muggeo et al., 2017), parental satisfaction with BMI notification letter (Lee & Kubik, 2015), number of students confirmed for postural curvature during screening (Magee et al., 2012), emergency department referrals for psychiatric evaluation (Grudnikoff et al., 2015), and the number of students who received follow-up eye exams after screening (Kemper et al., 2012). Studies examined if sexual health and STI/HIV education by school nurses improved sex-related cognitive mediators (i.e. knowledge, efficacy, beliefs, intentions) (Borawski et al., 2015) and increased immunization compliance (Swallow & Roberts, 2016). Studies also described the willingness of students to talk to school nurses about HIV/STI testing (Rasberry et al., 2015) and the influence of school nurse knowledge, attitudes, and perceptions of role as opinion leaders on their practice regarding HPV prevention (Rosen, DiClemente, Shepard, Wilson, & Fehr, 2016; Rosen, Goodson, Thompson, & Wilson, 2015).

Quality improvement principle. Six studies applied QI principles under the meaningful health/academic outcomes (n=4), CQI (n=1), and documentation/data collection (n=1) components to measure: decreased concentration problems, improved memory and behavior in class (Muggeo et al., 2017), improved academic performance in students diagnosed with asthma and anxiety (Engelke et al., 2014; Krenitsky-Korn, 2011; Moricca et al., 2012; Muggeo et al., 2017); assess how nurses collected school nurse generated data on school health visits and medication administration (Bergren, 2016), and study the implementation of school systems immunization inventories (Davis et al., 2016).

Leadership principle. In three studies, under the lifelong learner component, school nurses attended education sessions to increase identification of students with food allergies, the number of epinephrine devices available in school (Chokshi et al., 2015), school nurse knowledge of asthma (Francisco et al., 2017), and percentage of asthma action plans distributed to students (Staudt et al., 2015).

School Nurse Interventions Linked to Outcomes

School nurse interventions in 17 of the 65 research studies (26%) were linked to positive changes in student health or education outcomes. Our literature review did not reveal any research studies that described school nurse interventions linked with negative student outcomes. There were studies that did not result in positive outcomes (e.g. intervention improved dietary behaviors but did not decrease student BMI or waist circumference). Interventions were categorized under: care coordination (n=11), community/public health (n=3), leadership (n=2), and quality improvement (n=1) principles. Examples of these studies are shown in Table 2.3.

Care coordination principle. The majority of school nurse interventions were categorized under the care coordination components: motivational interviewing/counseling (n=5), case management (n=4), chronic disease (n=1), and collaborative communication (n=1).

Student counseling led by school nurses was associated with: improved dietary behaviors in overweight and obese students ($p<.05$) (Pbert et al., 2013, 2016); improved quality of life, and increased symptom free days and motivation to take medications in students diagnosed with asthma ($p<.05$) (Halterman et al., 2011). School nurse-led student counseling was also associated with strengthened resilience ($p<.007$) and management of teasing and bullying ($p<.001$) in students with disabilities (Vessey & O'Neill, 2011), and decreased child anxiety and concentration problems ($p<.05$) (Muggeo et al., 2017).

Case management processes implemented by school nurses were associated with improved health and education of students diagnosed with asthma and diabetes. Over 90% of students met case management goals that were primarily facilitated by the school nurse's work to establish a safe school environment (e.g. developed emergency action plans, individual health plans, staff trained in care) (Engelke et al., 2014, 2011). Students improved meeting self-management case management goals including: following a prescribed diet (93%), self-administration/receive insulin according to plan (84%), and self-management of insulin regimen (83%) (Engelke et al., 2011). Students also had improved quality of life scores ($p<.05$) and lower symptom and treatment problems ($p<.01$) (Engelke et al., 2014, 2011). Engelke et al. (2014, 2011) found that between 58-69% students met the goal to decrease the number of health-related absences, while Moricca et al. (2012) found the average days missed due to illness dropped from 5.8 days to 3.7 days ($p=.003$). There was also improved parent ($p=.05$) (Engelke et al., 2014; Peery et al., 2012) and teacher (Peery et al., 2012) perception on child self-management. Engelke et al. (2014) found that students who met the goal of improving psychosocial support from family, had the largest average gain in grade point average ($M=.53$) ($p=.03$).

Students diagnosed with asthma improved their knowledge about their chronic disease after one group asthma education session taught by school nurses; this improvement was sustained a month after the intervention ($p<.001$) (Mickel et al., 2017). Collaborative communication between school nurse and parents using a letter (to report children's height, weight, BMI, and healthy eating and physical activity tips), improved reporting of limiting snacks and sweetened drinks ($p<.001$) and decreased time watching television/playing video games ($p=.005$) among parents of overweight children (Lee & Kubik, 2015).

Community/public health principle. At the 12-month follow-up, a HIV/STI prevention curriculum taught by school nurses and health education teachers was linked to sustained improved outcomes for student beliefs and efficacy related to sexual health ($p<.05$) (Borawski et al., 2015). Visual acuity (Kemper et al., 2012) and postural (Magee et al., 2012) screenings conducted by school nurses led to outside referrals with health care providers and diagnosis and treatment of refractive error, scoliosis, and kyphosis.

Leadership principle. Under the lifelong learner component, educational interventions for school nurses were linked to decreased student allergic reactions from 15% to 0% ($p=.014$); increased mean number of epinephrine devices per school ($p<.001$) (Chokshi et al., 2015), health care cost savings, weekly ICS doses (6.5 to 8.2 doses), and improved student attitudes ($p<.001$) (Francisco et al., 2017).

Quality improvement principle. School nurses conducted monthly Plan-Do-Study-Act cycles to test strategies to complete/track immunization inventories and decrease number of students with incomplete (provisionally admitted) immunization records. This continuous quality improvement initiative increased the number of systems in place to track immunizations ($M=12.63$ to 14.88 , $p=.03$) and decreased the number of students provisionally admitted ($M=35.71$ to 11.86 , $p=.02$) (Davis et al., 2016).

Discussion

We used the recently published *Framework for 21st Century School Nursing Practice* as our lens for examining how school nurses impact health and education outcomes of school children. The Framework's principles and components provided an effective structure for categorizing the many school nurse interventions and activities, and health and education outcome measures identified in the literature review. To our knowledge this is the first integrative review to use the Framework as a guide for examining the links between school nurse

interventions and student outcomes. During the development of the Framework some school nurses voiced that they did not understand how to use it in their practice, but feedback during the NASN 2016 Annual Conference revealed many school nurses were already using aspects of the Framework to guide their school nurse practice. The studies included in this review showed that all of the Framework's principles (Care Coordination, Leadership, Quality Improvement, and Community/Public Health) are reflected in current research, which is indicative of how school nurses are prioritizing their daily practice, using a variety of interventions and activities to help students manage their chronic conditions, provide direct care, and collaborate with partners in the community (Maughan, Duff, & Wright, 2016; NASN, 2016b). This literature review offers validation, through the included studies, that school nurses can use the Framework to guide student-centered care, collect standardized data, and develop evidence-based interventions for students, school staff, and families.

School Nurse Interventions and Activities

Using the Framework, a little over half of the interventions and activities school nurses carried out were categorized as care coordination, which is consistent with what is known about healthcare provided by school nurses. School nurses are an integral part of not only the medical/nursing community, but also the educational community. This supports school nurse collaboration with professionals in both fields, and the opportunity to coordinate student healthcare with their medical home, school, and family (McClanahan & Weismuller, 2015; NASN, 2017b). Chronic disease management was the most common component used under the care coordination principle. As the number of children with chronic diseases increases, it is imperative that school nurses are available to students to help them manage their chronic health conditions, and provide direct care and case management (Leroy, Wallin, & Lee, 2017; NASN, 2017a). Interestingly, the majority of studies under chronic disease management focused on

school nurse experiences and perceptions, while only a few involved school nurse interventions. Understanding school nurse experiences and perceptions provides rich description about school nurse activities from qualitative research (Merriam & Tisdell, 2015), yet more studies are needed to measure the impact of school nurse interventions on student management of their chronic conditions (NASN, 2016c). There is also opportunity to expand research that includes care coordination components that were not discovered during this review: education, interdisciplinary teams, nursing delegation, student self-empowerment, and transition planning.

School nurse interventions and activities categorized under the Community/Public Health principle were found to be the next most common. This was an expected finding because the practice of school nursing is grounded in community/public health (NASN 2016a, 2016b; Schaffer et al., 2015). Most of the Community/Public Health studies were categorized under the screenings/referrals/follow-up component. Performing screenings, referrals, and follow-up are critical secondary prevention strategies that assist school nurses to keep students safe, healthy, and ready to learn by recognizing health issues before there are complications (AAP Council on School Health, 2016; NASN, 2016b, 2017b). Of note, many of the studies in the screening component examined different types of screenings reflecting diverse health issues among school aged children. There is considerable opportunity for conducting research studies in components of the community/public health principle, as these were not reflected in our literature review: access to care, cultural competency, disease prevention, environmental health, health equity, health promotion, outreach, risk reduction, social determinants of health, Healthy People 2020.

Health and Education Outcome Measures

Half of the studies included in this review addressed various health outcome measures, with a little over half categorized under care coordination, in particular, the chronic disease management component. Previous studies have found that school nurses deliver care that

improves health and education outcomes of students with chronic health conditions, and can provide care coordination, health education, and decrease long-term health issues while meeting the needs of students and their families (Leroy, Wallin, & Lee, 2017;NASN, 2017a, 2017b). Few studies included education outcome measures. The small number of studies measuring education outcome measures was surprising given the priority of keeping children in school, ready to learn, and positive correlation between health and academic success (Engelke et al., 2009; NASN, 2017b). Measuring education outcomes is pivotal to understanding how school nursing practice relates to student academic achievement (Selekman et al., 2016) and gives vital information for school nurse leaders, stakeholders and decision makers to use for local resource and budget decisions that may impact the health of students (Endsley, 2017; Taras, 2014). Not surprisingly, researchers were more likely to measure absenteeism related outcomes than academic performance outcomes. This is consistent with previous studies because although school nurses influence academic performance, so do other education and health professionals (Maughan, 2003).

Several studies in the review included similar health or education outcomes, but definitions and measurements were not standardized. Decreasing asthma symptoms was important but was measured in various ways including number of days with symptoms, without symptoms, and percentage of students who met goals for decreasing symptoms. Researchers who measured perceptions and improvement in asthma knowledge designed custom surveys for their studies. To determine epinephrine pen availability in schools, researchers measured mean epinephrine devices per school and number of students with available epinephrine pens. Education outcomes were also measured using a variety of methods. Absenteeism was measured by partial or full days absent, being tardy to class, and time out of class; and academic

performance was measured by grade point average and standardized test scores. We recommend standardization of definitions for outcome measures to promote development of standardized datasets. Also, standardizing how student outcomes are measured can improve the understanding of how school nurse interventions influence student health and academic success (Johnson et al., 2017; Selekman et al., 2016). *Step Up & Be Counted!* aims to accomplish this through standardized data points and reporting structure (Johnson et al., 2017; Leroy et al., 2017; Maughan et al., 2014).

School Nurse Interventions Linked to Positive Outcomes

Our literature review revealed that only 1 in 4 of the studies explored links between school nurse interventions and student outcomes. Most of these studies were categorized under the care coordination principle, the principle that had the greatest number of studies that met the inclusion criteria for this literature review. School nurse interventions with positive student outcomes benefitted school-aged children with life threatening diseases like asthma and diabetes and children with serious health conditions that could have debilitating consequences such as being obese, anxious, or bullied by others. In addition to positive outcomes linked to nursing case management for chronic diseases, positive outcomes were associated with school nurse interventions involving nurse-led education and support groups, screening, and immunization tracking. Articulating the value of school nursing interventions grounded in evidence and linked to positive health and/or education outcomes is a powerful tool for school nurses. School nurses who can discuss research studies with linkages between positive student outcomes and nursing interventions to stakeholders will be better positioned to advocate for and leverage needed resources to improve child health including additional school nurses and reimbursement for school nursing services.

This literature review reveals the need for more studies that move beyond description and examine relationships between school nurse interventions and health and education outcomes. Most of the studies included in this review used descriptive designs to describe characteristics and findings of their projects, which is consistent with previous findings (Lineberry & Ickes, 2015; Stock et al., 2002). Designing more robust and rigorous correlational and experimental research studies will advance the science of school nursing and health of school children. School nurses can partner more strategically with nurse researchers from schools of nursing to identify relevant practice problems and outcomes and work together on analytical research designs that build on descriptive studies. Graduate nursing students can conduct their research in the field of school nursing by collaborating with practicing school nurses. Encouraging dialogue about research studies that did not find positive student outcomes will also advance school nursing practice as researchers and school nurses work together to critique school nurse interventions, outcome measures, and study designs. Strategies for facilitating such dialogue might include presentations, round table or panel discussions at conferences, a blog for sharing studies not submitted for publication, and studies accepted for publication that did not find positive outcomes but will further lessons learned from conducting the research studies.

This review revealed diverse school nursing interventions that related well to the Framework. It also revealed inconsistent use of definitions and measures of school nurse interventions and activities and student outcomes. Creating a database of school nursing interventions with standard definitions and outcome measures can advance school nursing science by helping researchers learn from each other, which will also build opportunity for more sophisticated analysis of results from multiple studies. In addition, school nurse researchers can

be encouraged to replicate studies to explore more robust findings as they work to conduct research studies with more advanced and robust research methods.

Limitations

There are some limitations in this review. The limiters and key search terms we used may have missed published research. We made a strong effort to avoid this by consulting with an expert nursing reference librarian to ensure an exhaustive search. We limited the review of literature to studies published January 2011- July 2017 and it is possible that we excluded some key studies published earlier. Our goal was to capture the most current research.

Implications for School Nursing Practice and Future Research

The *Framework for 21st Century School Nursing Practice* offers an evidenced-based foundation to guide school nurses to provide clinically competent, high quality, student-centered care. School nurses can use the framework and the findings of this review to assess and evaluate their daily practice through the lens of the key principles and components. Similarly they can use the framework to identify gaps in the care they provide with students, families, staff members, and community members, and to identify gaps in lifelong learning needs of school nurses. This review also identified evidence of school nurse interventions and activities that have successfully impacted student outcomes. This review will help school nurses recognize that they are improving health and education outcomes of students, and that they have a valuable role with advancing school nursing science by collaborating on research studies with researchers and other school nurses. Identifying and building on studies that are most similar, such as studies that fit under the care coordination principle, will further the science by adding evidence to better inform school nursing practice. This can help students stay healthy and safe in the school environment, and ready to learn successfully.

This review supports the need to strengthen the state of the science of school nursing research with studies using more rigorous methodology in order to determine the impact that evidence based school nurse interventions have on student outcomes. Like previous literature review findings (Lineberry & Ickes, 2015; McClanahan & Weismuller, 2015; Stock et al., 2002), most of the studies examined in this review used descriptive designs, which highlights the need for school nurse studies with more robust research methods and rigorous designs (e.g., quasi-experimental and experimental). School nurses and nurse researchers also need to contribute to the development of standardized definitions and tools to measure school nurse interventions, activities, and student health and education outcomes (Cowell, 2015; McClanahan & Weismuller, 2015). With the paucity of quality improvement studies in the literature, future research will need to include components of the quality improvement principle. Development of a standardized national school health dataset that represents students and school nurses and data collection, can help school nurses understand which interventions and activities have the greatest impact and are most effective on student health and education outcomes.

Conclusion

In this review, the *Framework for 21st Century School Nursing Practice* provided an effective lens to identify school nurse interventions and activities, health and education outcome measures, and school nurse interventions linked to positive student outcomes in the research literature. To date, research studies are limited in the types of school nurse interventions, student health conditions, study designs and outcome measures. There is also a lack of standardization in how outcomes are measured. Researchers can move school nursing science forward by building on current descriptive studies, expanding the number of interventions and types of study designs, replicating studies, using standardized definitions and measures, and exploring links between interventions and outcomes.

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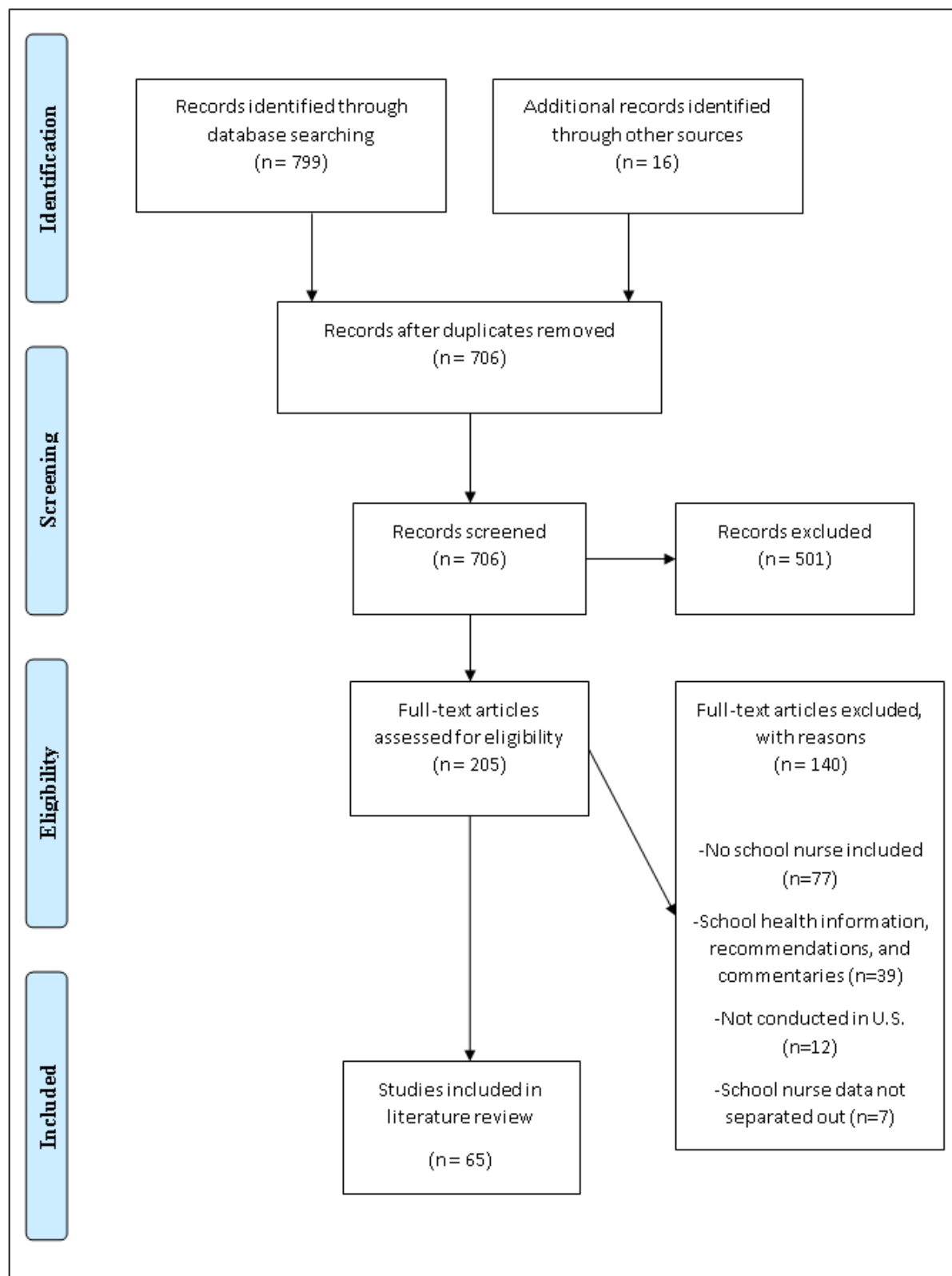


Figure 2.1. PRISMA diagram showing search and screening process, and selection of studies for inclusion in review

Table 2.1. *School Nurse Interventions and Activities Categorized by Framework Principles*

Framework Principle	Components	Authors	SN Interventions and Activities Examples in Literature
Care Coordination	Case Management	Engelke et al. (2011, 2014) Carpenter et al. (2013)	- Implement case management process for students with asthma and diabetes - Implement asthma action plans
	Chronic Disease Management	Spina et al. (2012) Allen et al. (2012) Garwick et al. (2015) Terry et al. (2016)	- Individual education on epinephrine pen and periodic checks for pen - Manage emergencies for students diagnosed with asthma food allergies, diabetes - Manage care for children diagnosed with asthma and seizures
	Collaborative Communication	Rivkina et al. (2014) Bergren (2016)	- Communication with school staff, parents/guardians
	Direct Care	Krenitsky-Korn (2011) Szychliński et al. (2015) Lazdowsky et al. (2016)	- Medication admin for asthma - Administer epinephrine injection for food allergy reactions - Treatments for student headaches
	Motivational interviewing/counseling	Vessey & O'Neill (2011) Pbert et al. (2013, 2016) Blaakman et al. (2014) Muggeo et al. (2017)	- Group SN led support for children with disabilities - Individual counseling for weight-related health issues, asthma, anxiety
	Student Care Plans	Pulcini et al. (2011) Blackwell et al. (2017)	- Emergency plans for food allergies - Manage return to learn plans for students with concussions
	Lifelong Learner	Rebmann et al. (2016) Francisco et al. (2017) Jordan et al. (2017) Raible et al. (2017)	- SN education on preparedness for biological events, asthma, maltreatment, adolescent relationship abuse
	Continuous Quality Improvement	Davis et al. (2016)	- Conduct Plan, Do, Study, Act cycles on strategies for school health immunization systems
	Documentation/Data Collection	Bergren (2016)	- Collect SN generated data
	Health Education	Borawski et al. (2015) Rasberry et al. (2015)	- Teach curriculum on sexual health topics
Leadership	Screenings/Referral/Follow-up	Kemper et al. (2012) Allison et al. (2014) Muggeo et al. (2017)	- Conduct screenings: vision, depression, anxiety
	Surveillance	Medaglia et al. (2013) Schaffer et al. (2016)	- Conduct asthma surveillance - Record SN visit data to conduct surveillance
Quality Improvement			
Community/Public Health			

Table 2.2. *Outcome Measures Categorized by Framework Principle*

Framework Principle	Components	Authors	Health Outcome Examples	Education Outcome Examples
Care Coordination	Case Management	Perry et al. (2012) Engelke et al. (2014)	- Symptom days - Quality of life	
	Chronic Disease Management	Halterman et al. (2011) Francisco et al. (2017)	- Symptom free days - Health care cost savings - Medication knowledge	
	Direct Care	Mickel et al. (2017) Lazdowsky et al. (2016)	- Types of school nurse actions for headaches	
	Student Care Plans	Pulcini et al. (2011)	- Action plans on file	
	Student-centered Care	Vessey & O'Neill (2011)	- Resilience	
Leadership	Lifelong Learner	Chokshi et al. (2015)	- Increased identification of students with food allergies	
Quality Improvement	Continuous Quality Improvement	Davis et al. (2016)	- School immunization systems inventory score	
	Documentation/Data Collection	Bergren (2016)	- Feasibility of collecting school nurse generated data	
	Meaningful Health/Academic Outcomes	Engelke et al. (2014) Muggeo et al. (2017)		- Improved or maintained grade point average - Decreased concentration problems
Community/Public Health	Health Education	Rosen et al. (2015, 2016)	- Influence of knowledge, attitudes on SN practice	
	Screenings/Referral/Follow-up	Allison et al. (2014) Muggeo et al. (2017)	- Positive depression screen - Somatic symptom score	
	Surveillance	Carpenter et al. (2013) Rodriguez et al. (2013) Bergren (2016)		- Days absent due to asthma - Number of days absent because of illness - Days absent overall

Table 2.3. *Links Between School Nurse Interventions and Student Outcomes*

Framework Principle	School Nurse Interventions	Authors	Positive Student Outcome Examples
Care Coordination	Asthma Case Management	Engelke et al. (2014)	<ul style="list-style-type: none"> - Decreased health-related absences - Increased grade point average - Fewer asthma symptoms
	Diabetes Case Management	Engelke et al. (2011)	<ul style="list-style-type: none"> - Students followed prescribed diet - Students self-managed insulin regimen - Increased extracurricular activities
	Nurse-led support group for children with disabilities	Vessey & O'Neill (2011)	<ul style="list-style-type: none"> - Strengthened resilience - Fewer bothersome peer interactions
Leadership	Education for nurses to improve identification of children with food allergies and student asthma control	Chokshi et al. (2015) Francisco et al. (2017)	<ul style="list-style-type: none"> - Decreased allergic reactions - Increased student-specific injectable epinephrine devices - Improved school nurse asthma knowledge - Improved student medication knowledge - Improved student asthma attitudes
Quality Improvement	Immunization tracking improvement via monthly cycles of Plan-Do-Study-Act	Davis et al. (2016)	<ul style="list-style-type: none"> - Improved tracking of immunization status - Decreased number of students provisionally admitted
Community/Public Health	HIV/STI prevention education by nurses	Borawski et al. (2015)	<ul style="list-style-type: none"> - Improved impulse control, condom technical skills - Decreased belief that condoms interfere with sexual enjoyment

HIV=human immunodeficiency virus, STI=sexually transmitted infection

CHAPTER 3: SCHOOL NURSE HEALTH SERVICES AND PROGRAMS IN NORTH CAROLINA PUBLIC SCHOOLS FROM 2006 TO 2016

Introduction

Health services offered in schools can aid students with acute/emergency care, preventive care, and management of their chronic health conditions (Centers for Disease Control and Prevention [CDC], 2017). School health services can positively impact student health outcomes such as quality of life and symptom days, as well as education outcomes such as attendance and grades. School health services can also be implemented to address social determinants of health such as access to quality health care, healthy food, and safe environments (CDC, 2018; National Association of School Nurses [NASN], 2016a).

School nurses are instrumental in delivering health services to school aged children (Maughan, Bobo, Butler, & Schantz, 2016). School nurses have a vital role in supporting all facets of student health including physical, emotional, mental, and social. School nurses coordinate and provide health services that support improvement and maintenance of student health and academic success. School nurses accomplish this through direct care, program and policy development, education for school staff and students, health promotion and prevention, care coordination between student, family, school, and medical home; and quality improvement activities (e.g. data collection, documentation, measuring meaningful outcomes) (NASN, 2016b).

In an integrative review of empirical research that explored school nurse interventions and activities and how they impact student outcomes, we found that over half of school nurse interventions and activities focused on care coordination (Best, Oppewal, & Travers, 2018). School nurses implement many care coordination health services in their daily practice,

including: school nurse-led case management, chronic disease management, collaborative communication with other school and medical professionals, counseling, education, and student care plans (Best et al., 2018; Maughan et al., 2016). There is a gap in the availability of data that capture the health and well-being of children who attend school (Bergren et al., 2016). This includes school nurse health services data. The purpose of this study was to describe patterns in health services and programs provided by school nurses, including stratification by elementary, middle and high school-aged students, in North Carolina public schools between 2006 and 2016. I focused on asthma and diabetes in this study, consistent with the major health issues identified in my integrative literature review.

Methods

Study Design

This research was a longitudinal repeated measures analysis of school health services data as reported to the Children and Youth Branch of the North Carolina Division of Public Health.

Participants and Procedures

The sample was collected during school years 2006/2007 through 2015/2016. School nurses representing all 115 North Carolina public school districts (local education agencies [LEAs]) reported data on relevant variables each school year. School nurses were defined as registered nurses who served individual students full-time or part-time and did not work solely as administrators. Students were defined as school aged children enrolled in public elementary (K-5th grades), middle (6th-8th grades), and high (9th-12th grades) schools. Average school nurse/student ratios were based on full-time equivalents (FTE positions budgeted for school nurses) that worked in the school districts. This study was determined to be exempt by the University of North Carolina at Chapel Hill Institutional Review Board.

Instruments

We used data from the N. C. Annual End of School Year School Health Services and Programs Survey, developed by data specialists and school health nurse consultants in the N. C. Division of Public Health's Children and Youth Branch. Since the 1996-1997 school year, the N. C. Division of Public Health has collected school health data for the survey and disseminated findings of school health services as reported by school nurses. All 115 LEAs electronically submitted data for each school year included in the study (2006-2016), yielding a 100% return rate. Not all questions were relevant to each school district; if the district did not provide all services and programs, or collect all the data included in the survey, some questions were not applicable. Due to this, each question did not have a response from all school districts. Throughout the 10-year study period, various questions were deleted or added to the survey, based on North Carolina school nursing policy or program changes. As such, results were not available for each variable for all school years. We obtained the data through a data use agreement with the NC Division of Public Health/School Health Unit. Data were aggregated by school district and all school nurse identifiers were removed prior to obtaining the data.

We also used financial and business services data from the NC Department of Public Instruction to obtain annual summaries of NC public school information. Information for school years 2013-2014 and 2014-2015 were unavailable.

Variables

Sample characteristics. LEA information included: number of public schools (available 2006-2013 and 2015-2016) and number of students in school each school year (available for 2006-2016). LEA information did not include charter or private schools. School nurse information included: educational preparation (highest degree earned- diploma in nursing, associate degree in nursing, bachelor's degree, master's degree, doctorate) and national school

nurse certification. Educational preparation and national school nurse certification were available between 2006-2009 and 2013-2016.

Identified health conditions. School nurses reported the number of individual students with one or more identified health condition (e.g. asthma, cardiac, cystic fibrosis, diabetes) that required action at school (e.g. available medication, health care plan, accommodations). We analyzed the number of students with identified health conditions, and specifically identified those with asthma, type 1 diabetes, and type 2 diabetes. Identified health conditions data were available for the entire sample period of 2006-2016.

Health education presentations and programs. School nurses reported number of times group presentations were provided and what health topics the education addressed, asthma-specific staff and student asthma education programs, and staff generalized and intensive training on diabetes care. Health education presentations and programs data were analyzed for the entire sample period of 2006-2016.

Health counseling. School nurses served as health counselors and worked on a one-to-one basis with students to address a variety of health needs (e.g. asthma, diabetes, injury recovery, puberty/reproductive health). In the survey, school nurses reported the total number of counseling sessions, regardless of the topic(s) covered at each session. We analyzed the total number of students that received any type of health counseling, and also looked specifically at health counseling for asthma and diabetes. The overall measurement of counseling sessions was available for the entire 10-year study period; however, asthma and diabetes counseling were added to the survey starting in the 2009/2010 school year.

Health care procedures. School nurses reported the number of students with health care provider orders for specialized care procedures that were performed in the school setting. We analyzed the number of students with orders for any procedure as well as specific procedures related to asthma (nebulizer treatment, pulse oximeter) and diabetes (blood glucose monitoring, glucagon injection, insulin injection, and insulin pump). The number of health care procedures performed in the schools each year was available for years also 2006-2016, with the exception of glucagon injection (2006-2014) and pulse oximeter (2009-2016).

School nurse case management. School nurses reported formal nurse-managed programs for students with chronic or complex health conditions. The number of LEAs with school nurse case management programs was available between 2007-2016.

Data Analysis

We computed descriptive statistics (means, standard deviations, frequencies, proportions) for all health services and programs, nurse demographics, and school system/LEA characteristics at the different timepoints and overall. Next, we created longitudinal graphical displays (mean profiles, histograms of the counts) to identify patterns in the health services and programs data and to inform subsequent modeling decisions.

We evaluated differences in health services and programs by grade level and school year by a generalized linear model (GLM) for longitudinal data analysis using a generalized estimated equations (GEE) approach (Diggle, Heagerty, Liang, & Zeger, 2002). We then fit a separate Poisson regression model with the log link to each non-negative discrete (count) health services and programs variable. These models included time (entered as a categorical variable) and grade as fixed effects; an exchangeable correlation structure was assumed. Each model was evaluated for overdispersion. When it occurred, overdispersion was managed by applying a scaling factor to the covariance matrix.

We performed all analyses using SAS software version 9.4 (SAS Institute, Inc., Cary, NC, USA). All tests were two-tailed, and a p -value ≤ 0.05 was considered statistically significant. No adjustment was made for multiplicity.

Results

Sample

Local education agencies (LEAs). The study sample included 115 LEAs (school districts) (Table 3.1). Between 2006 and 2016, the number of public schools across all LEAs increased from 2,304 to 2,434. The number of students who attended public schools in North Carolina increased from 1.39 million to 1.46 million.

Table 3.1. *LEA Characteristics School Years 2006-2016 (N=115)*

Variable	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011
Number of Public Schools	2,304	2,354	2,399	2,422	2,425
Number of Students	1,386,363	1,404,957	1,410,497	1,402,269	1,409,895
Variable	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
Number of Public Schools	2,412	2,418	2,418	2,434	2,434
Number of Students	1,417,458	1,427,281	1,434,180	1,433,592	1,459,852

Note. * Missing data.

School nurse characteristics. The number of school nurse FTEs and average school nurse-to-student ratios are provided in Table 3.2. The number of school nurse FTEs increased from 1,034 to 1,318, a 27% increase. The average school nurse-to-student ratio decreased from 1:1,340 to 1:1086, a 19% improvement. Trends for nurse-to-student ratios and school nurse FTEs can be seen in Figure 3.1.

Table 3.2. *School Nurse Full Time Equivalents and School Nurse-to-Student Ratios School Years 2006-2016*

Variable	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011
School Nurse FTEs	1,034	1,147	1,169	1,183	1,174
Average School Nurse/Student Ratio	1,340	1,225	1,207	1,185	1,201

Variable	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
School Nurse FTEs	1,202	1,212	1,236	1,288	1,318
Average School Nurse/Student Ratio	1,179	1,177	1,160	1,112	1,086

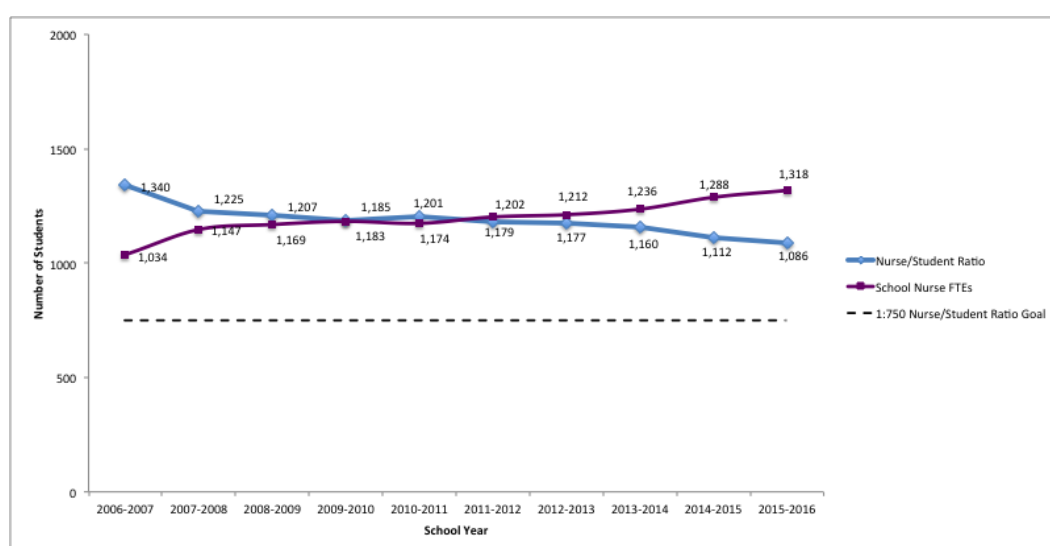


Figure 3.1. N.C. average nurse-to-student ratios and school nurse FTEs from 2006 to 2016

Additional school nurse characteristics were available for school years 2006/2007 through 2008/2009 and 2013/2014 through 2015/2016 (Table 3.3). These additional school nurse characteristics were unavailable between school years 2009/2010 and 2012/2013. Between 2006 and 2016, the percentage of school nurses with at least a Bachelor of Science in Nursing (BSN) increased from 65% to 75% (Figure 3.2), and the percentage of school nurses with any type of baccalaureate education preparation (BSN, BS, BA) increased from 71% to 79%.

Table 3.3. *School Nurse Educational Preparation and National Certification School Years 2006-2009 and 2013-2016*

Variable	2006-2007	2007-2008	2008-2009	2013-2014	2014-2015	2015-2016
School nurses included in report, n	854	1226	1261	1292	1353	1357
Highest degree, n (%)						
Diploma	34 (4)	42 (3.3)	41 (3.3)	22 (1.7)	17 (1.3)	13 (1.0)
ADN	142 (16.6)	186 (14.7)	177 (14)	128 (9.9)	130 (9.6)	124 (9.1)
BSN	554 (64.9)	835 (66)	853 (67.6)	953 (73.8)	1003 (74.1)	1018 (75.0)
BS		68 (5.4)	58 (4.6)	48 (3.7)	54 (4.0)	44 (3.2)
BA	50 (5.9)	18 (1.4)	19 (1.5)	16 (1.2)	13 (1.0)	14 (1.0)
Masters	55 (6.4)	79 (6.2)	95 (7.5)	89 (6.9)	91 (6.7)	90 (6.6)
Doctorate	12 (1.4)	2 (0.2)	3 (0.2)	2 (0.2)	--	--
Unknown	--	--	3 (0.2)	--	--	--
Missing	7 (0.8)	9 (0.7)	11 (0.9)	34 (2.6)	45 (3.3)	54 (4.0)
National school nurse certification, n (%)	474 (55.5)	509 (40.2)	578 (45.8)	660 (51.1)	689 (51)	699 (51.5)

Note. ADN-associate degree in nursing, BSN-bachelor of science in nursing, BS-bachelor of science, BA-bachelor of arts

Note. Percentages may not equal 100% due to rounding.

Note. --No school nurse data reported for characteristic.

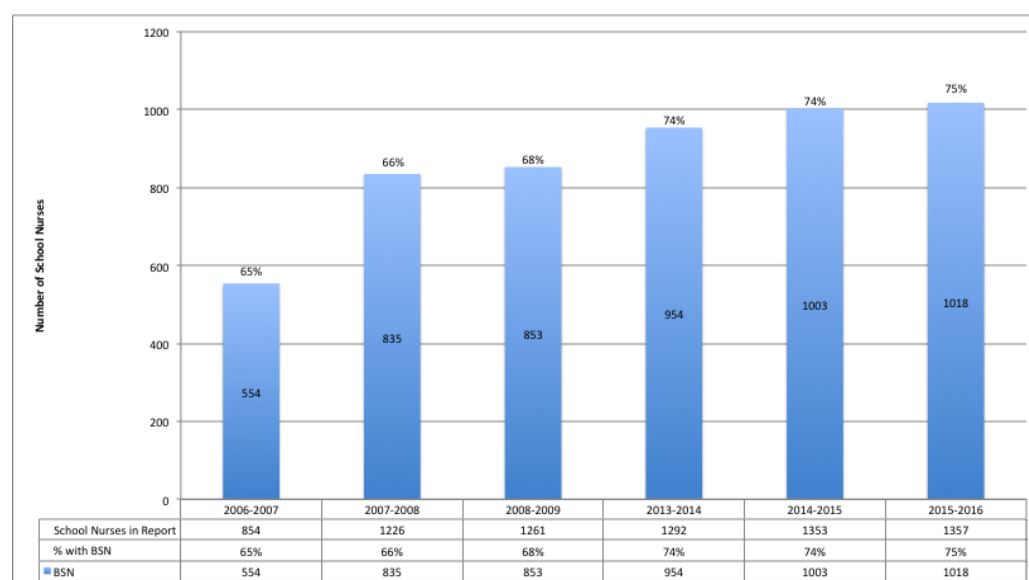


Figure 3.2. School nurses with Bachelor of Science in Nursing from 2006-2009 and 2013-2016

The number of school nurses that held national school nurse certification increased from 474 to 699, but the percentage of certified school nurses decreased (56% to 52%) (Figure 3.3).

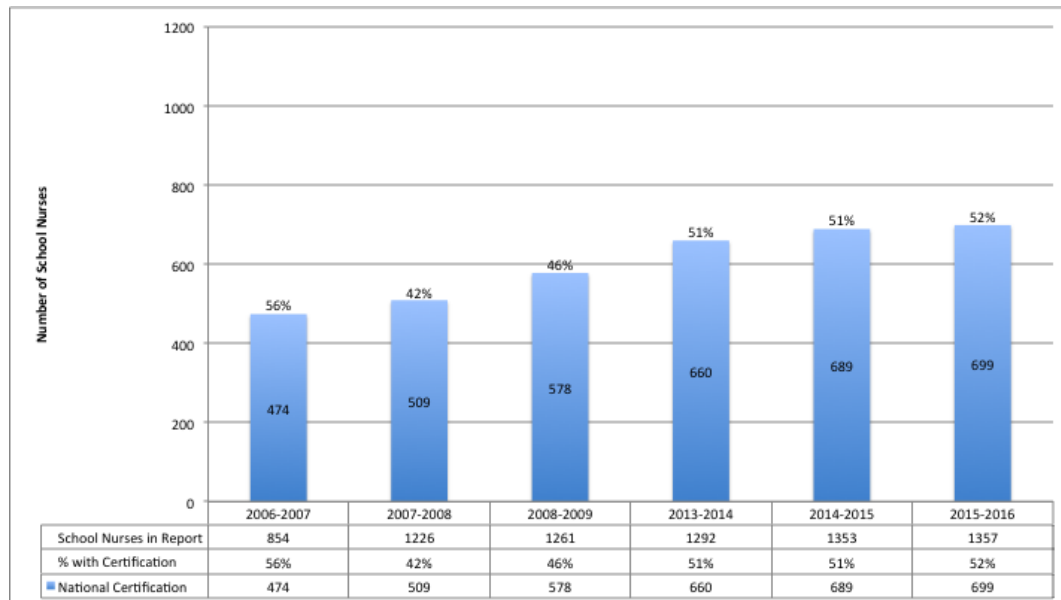


Figure 3.3. School nurses with national school nurse certification 2006-2009 and 2013-2016

Identified Health Conditions

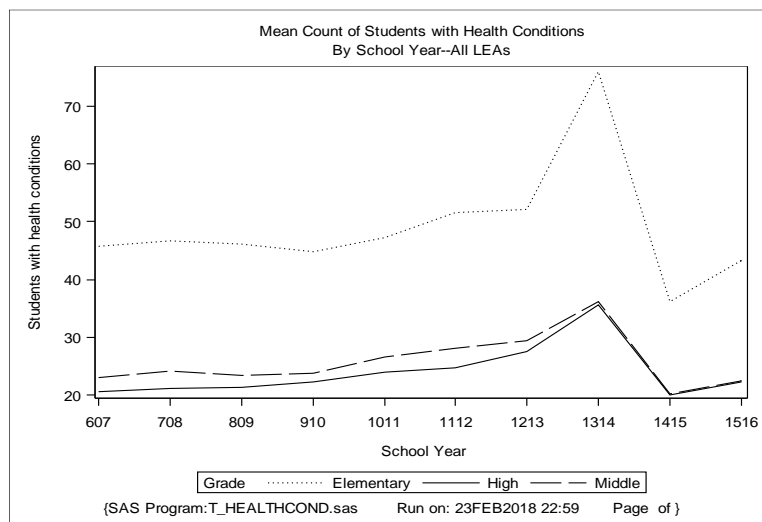


Figure 3.4. Mean count of students with health conditions

All identified health conditions. Over time there were significantly more students identified with health conditions (Figure 3.4; $\chi^2 = 42.21$, $df = 9$, $p < .0001$). There were significantly more students in elementary school identified with health conditions than middle and high school students ($\chi^2 = 43$, $df = 2$, $p < .0001$).

Asthma. There were significantly more students with asthma over time (Figure 3.5; $\chi^2 = 28.31$, $df = 9$, $p = .0008$). We also found significantly more students identified in elementary school with asthma than students in middle and high schools ($\chi^2 = 39.95$, $df = 2$, $p < .0001$).

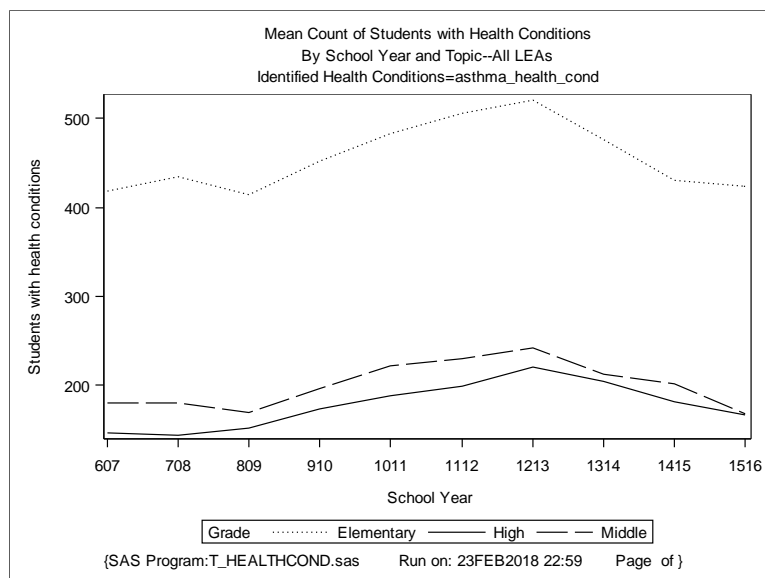


Figure 3.5. Mean count of students with asthma

Diabetes. There were significant differences over time ($\chi^2 = 19.44$, $df = 9$, $p = .0217$) and by grade ($\chi^2 = 36.29$, $df = 2$, $p < .0001$) for type 1 diabetes (Figure 3.6). Significant differences between grades ($\chi^2 = 26.97$, $df = 2$, $p < .0001$) were found for type 2 diabetes (Figure 3.7).

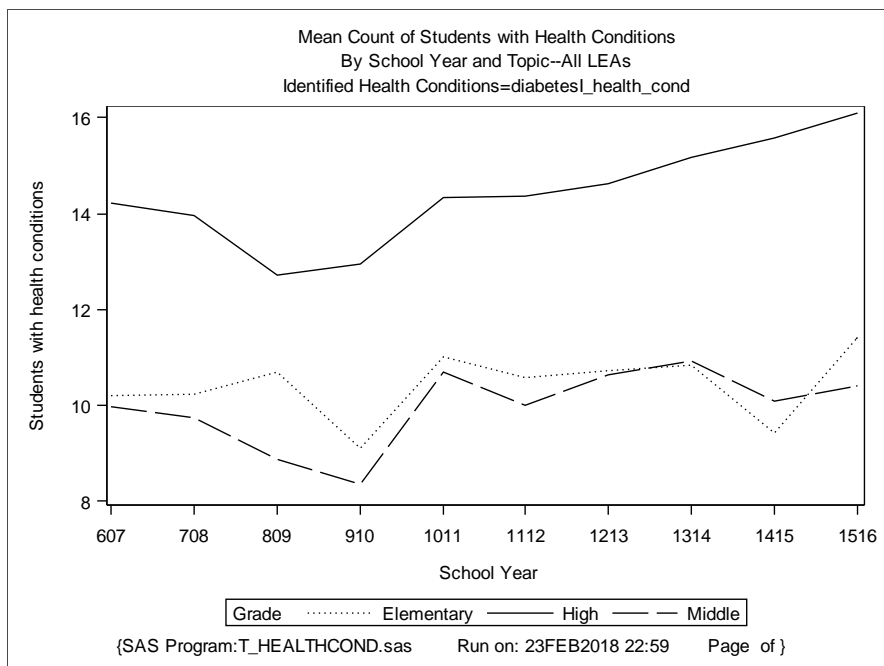


Figure 3.6. Mean count of students with type 1 diabetes

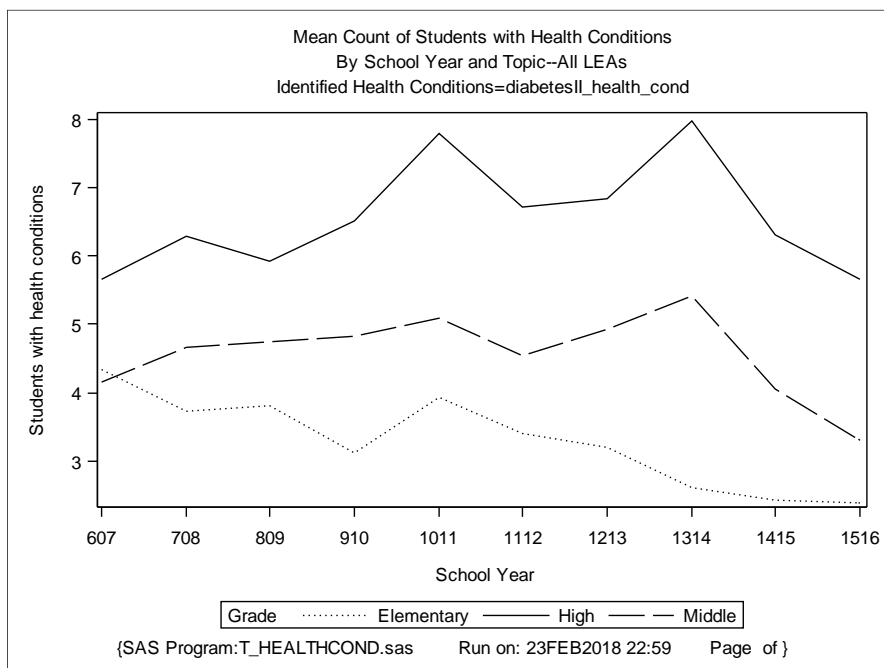


Figure 3.7. Mean count of students with type 2 diabetes

Health Education Presentations and Programs

Group presentations. Over the 10-year period, the mean number of group presentations school nurses taught in all LEAs decreased from 232 (*SD* 490.9) to 212.8 (*SD* 331.0). Since 2007, 94-99% of LEAs have offered group diabetes management presentations (Table 3.4).

Asthma programs. School nurses reported if the LEA offered asthma education programs for staff and students. The number of LEAs for which school nurses provided staff asthma education programs decreased from 49 (43%) to 38 (33%). Student asthma education programs decreased from 53 (46%) LEAs to 30 (26%) LEAs (Table 3.4).

Diabetes training. Generalized and intensive diabetes training for school staff were reported from 2009-2016; during that time, the number of LEAs that offered generalized training programs increased from 105 (91%) to 114 (99%). LEAs with at least two school staff intensively trained on diabetes care increased from 111 (97%) to 114 (99%) (Table 3.4).

Table 3.4. *Health Education Presentations and Programs in all LEA (N=115)*

	2006- 2007	2007- 2008	2008- 2009	2009- 2010	2010- 2011	2011- 2012	2012- 2013	2013- 2014	2014- 2015	2015- 2016
Group presentations (all topics), mean (SD)	232 (490.9)	226 (477)	263 (504)	248.4 (423.1)	251 (497)	211 (383.9)	210.3 (381)	212 (328.9)	218.3 (347.2)	212.8 (331)
Group presentations (diabetes), n (%)	--	113 (98.3)	112 (97.4)	113 (98.3)	114 (99.1)	110 (95.7)	111 (96.5)	108 (93.9)	112 (97.4)	111 (96.5)
Staff education (asthma), n (%)	49 (43)	41 (36)	43 (37.4)	48 (42)	45 (39.1)	50 (43.5)	36 (31.3)	42 (36.5)	37 (32.2)	38 (33)
Student education (asthma), n (%)	--	53 (46.1)	51 (44.3)	46 (40)	43 (37.4)	33 (29)	31 (27)	31 (27)	26 (22.6)	30 (26.1)
Staff generalized training (diabetes), n (%)	--	--	--	105 (91.3)	108 (94)	110 (96)	113 (98.3)	112 (97.4)	113 (98.3)	114 (99.1)
Staff intensive training (diabetes), n (%)	--	--	--	111 (97)	113 (98.3)	114 (99.1)	113 (98.3)	113 (98.3)	114 (99.1)	114 (99.1)

Note. --Question not asked during these school years.

Health Counseling

One-to-one health counseling sessions. Over the 10-year study period, we found significant differences in health counseling of all topics by school year (Figure 3.8; $\chi^2 = 24.39$, $df = 9$, $p = .0037$) and grade ($\chi^2 = 28.37$, $df = 2$, $p < .0001$). Over time, there were fewer health counseling sessions provided. We found more health counseling sessions were provided for elementary school students than middle and high school students.

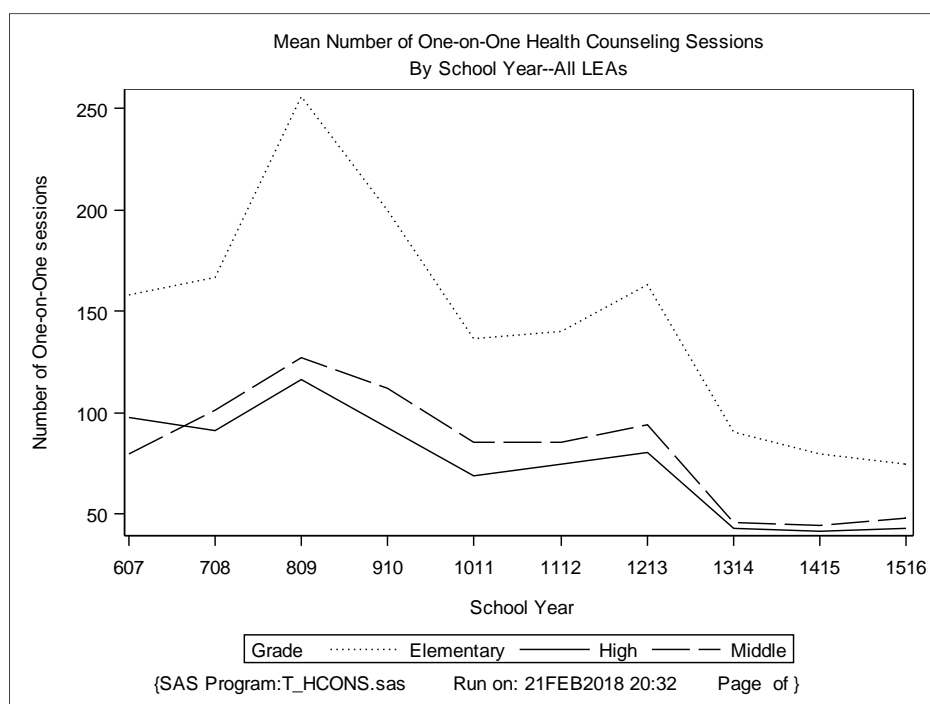


Figure 3.8. Mean count of all one-to-one health counseling sessions

Asthma health counseling sessions. Elementary school students received significantly more asthma health counseling sessions than middle and high school students (Figure 3.9; $\chi^2 = 17.51$, $df = 2$, $p = .0002$). We found no significant difference in the number of asthma health counseling sessions over time.

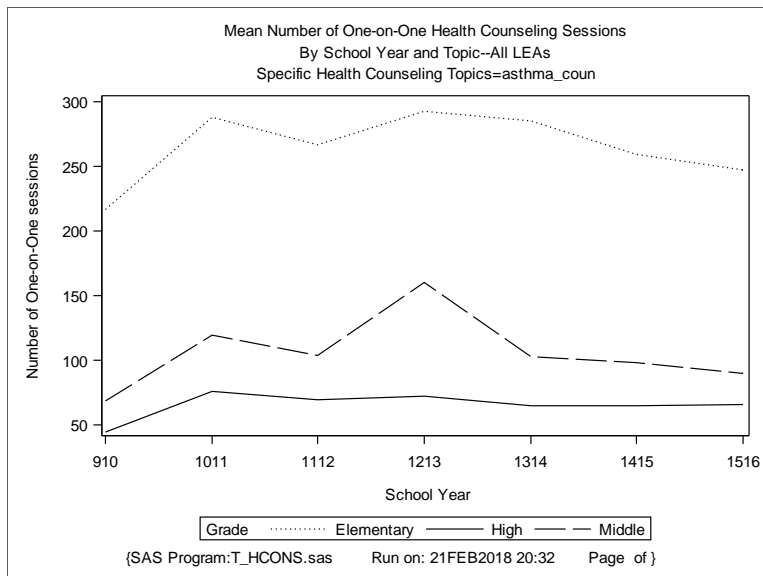


Figure 3.9. Mean count of one-to-one asthma health counseling sessions

Diabetes health counseling sessions. There were significant differences over time (Figure 3.10; $\chi^2 = 17.11$, $df = 6$, $p = .0089$) and grade ($\chi^2 = 11.87$, $df = 2$, $p = .0026$) for diabetes counseling. Compared to the 2009/2010 school year, there was an increase in diabetes counseling sessions during the 2015/2016 school year. Elementary students generally received more diabetes counseling sessions.

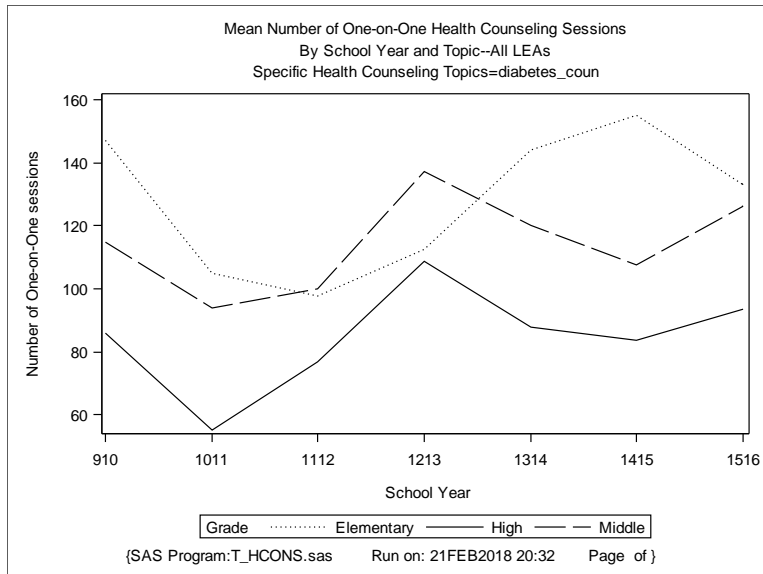


Figure 3.10. Mean count of one-to-one diabetes health counseling

Health Care Procedures

All health care procedures. There were significant differences over time ($\chi^2 = 36.80$, $df = 9$, $p < .0001$) and grade ($\chi^2 = 27.44$, $df = 2$, $p < .0001$) in health care procedure orders in NC public schools, and also more procedure orders written for elementary school students than middle and high school students (Figure 3.11).

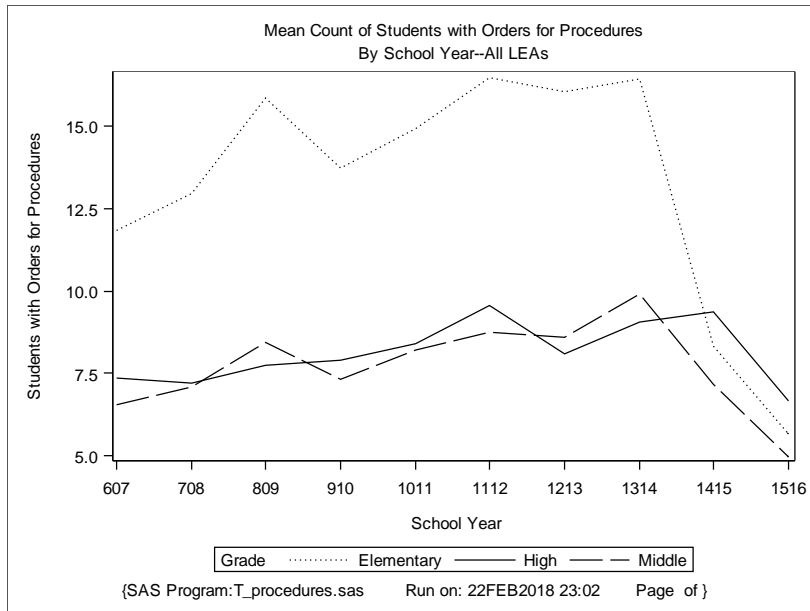


Figure 3.11. Mean count of all health care procedures

Asthma health care procedures. We found elementary school students had significantly more nebulizer treatment orders than middle and high school students (Figure 3.12; $\chi^2 = 23.79$, $df = 2$, $p < .0001$). We found no significant difference in school years for nebulizer orders. We also found no significant difference over time or by grade level for students with pulse oximeter orders (data not shown).

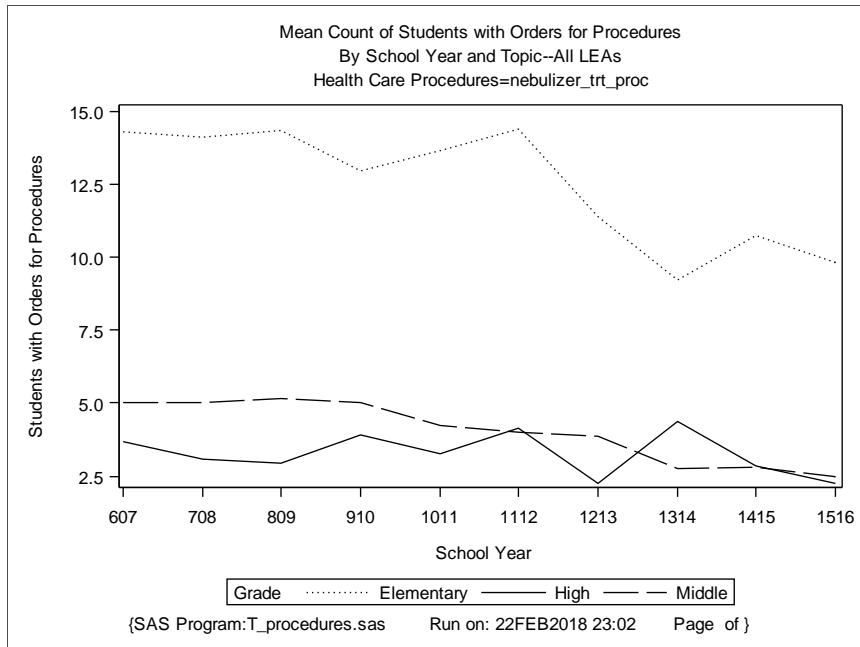


Figure 3.12. Mean count of students with nebulizer treatment orders

Diabetes health care procedures. We found that over time there was a significant increase in orders for glucagon injections (Figure 3.13; $\chi^2 = 25.12$, $df = 7$, $p = .0007$) and insulin pumps (Figure 3.14; $\chi^2 = 21.33$, $df = 9$, $p = .0113$). Elementary school students had more glucagon injection orders ($\chi^2 = 15.20$, $df = 2$, $p = .0005$), while more high school students had orders for insulin pumps ($\chi^2 = 28.94$, $df = 2$, $p < .0001$).

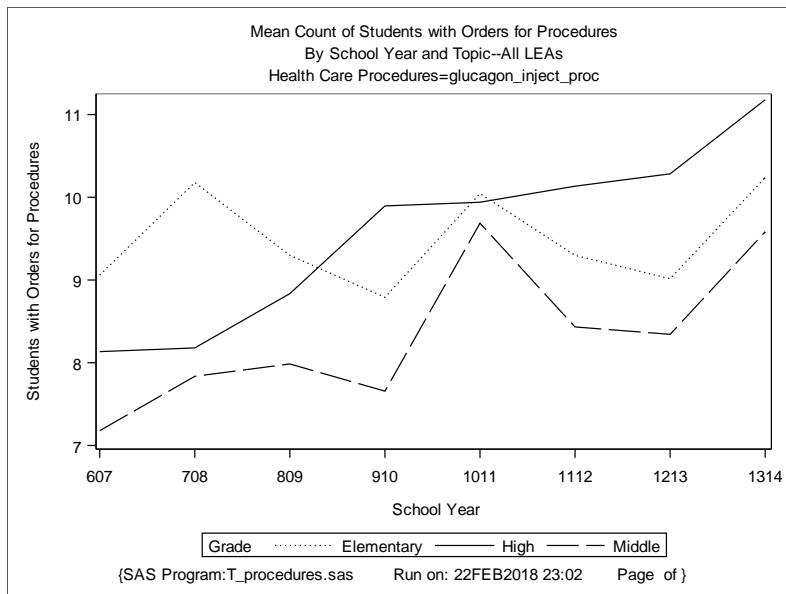


Figure 3.13. Mean count of students with glucagon injection orders

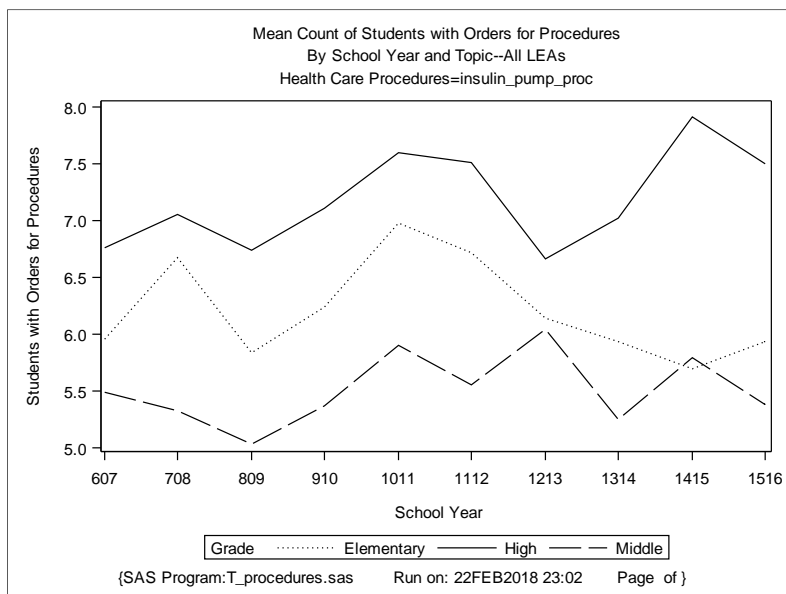


Figure 3.14. Mean count of students with insulin pump orders

Significantly more high school students had orders for glucose monitoring (Figure 3.15; $\chi^2 = 45.24$, $df = 2$, $p < .0001$) and insulin injections (Figure 3.16; $\chi^2 = 38.77$, $df = 2$, $p < .0001$). There were no significant differences over time for glucose monitoring or insulin injection orders.

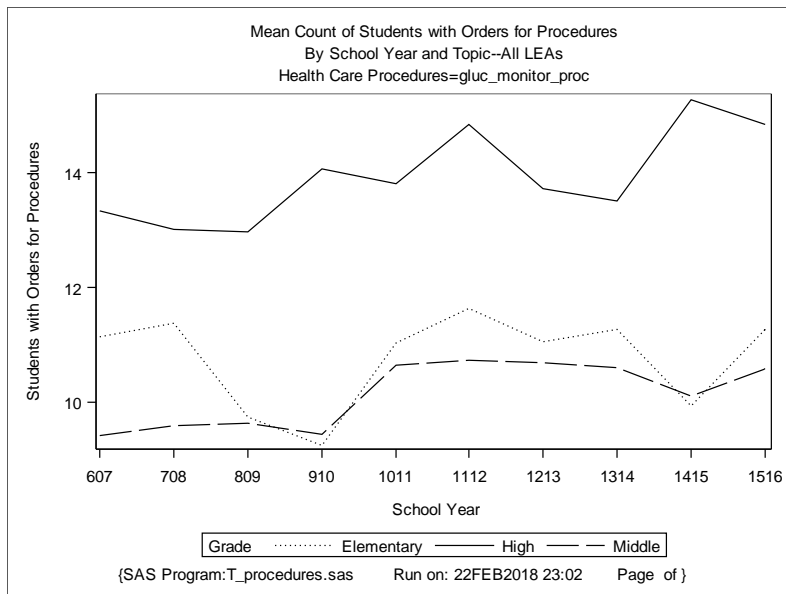


Figure 3.15. Mean count of students with glucose monitoring orders

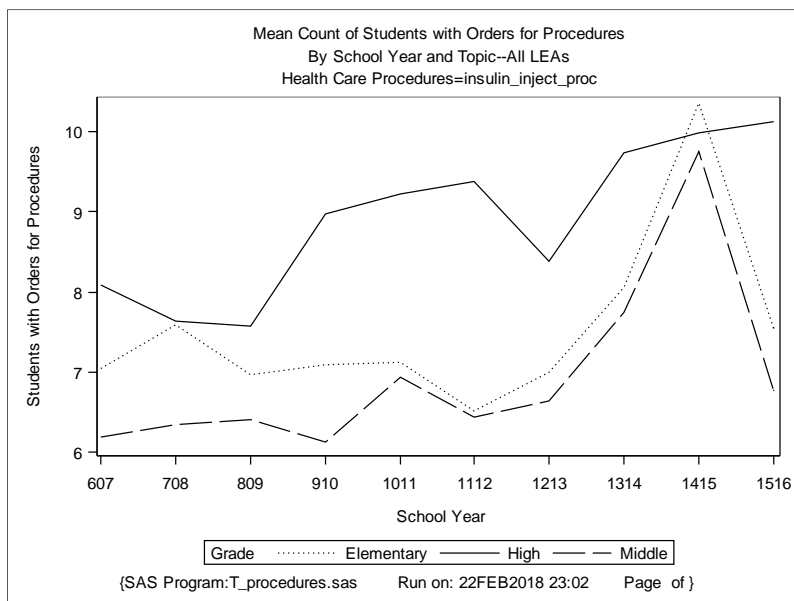


Figure 3.16. Mean count of students with insulin injection orders

School Nurse Case Management

Between 2007 and 2016, the number of LEAs that reported incorporating a formal school nurse case management program for students with chronic or complex health conditions increased from 22 (19.1%) to 55 (48%) (Figure 3.17).

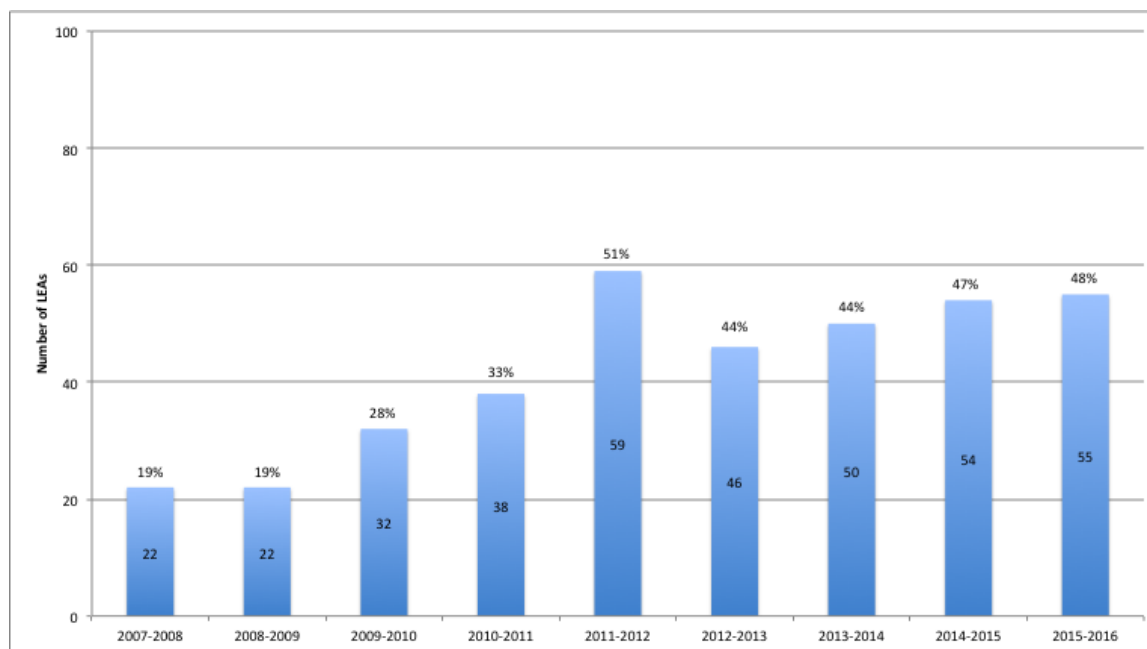


Figure 3.17. LEAs with formal case management programs 2007 and 2016 (N=115)

Discussion

The purpose of this study was to describe the health services and programs provided under the direction of school nurses in North Carolina's public schools between 2006-2016. The sample included all 115 school districts in North Carolina, one of the country's largest state public school systems. North Carolina saw a 5% increase (1.39 million to 1.46 million) in the student enrollment for public elementary, middle, and high schools between 2006 and 2016. We found improved school nurse-to-student ratios and number of nurses with baccalaureate educational preparation. We found significant differences over the 10-year study period in: students with all health conditions that required action in the school setting, students with asthma, and students with type 1 diabetes; all health counseling and diabetes health counseling; and orders for all health care procedures, glucagon injections and insulin pumps. We also found significant differences between grades in: all health conditions, asthma, type 1 diabetes, and type 2 diabetes; all health counseling, asthma health counseling, and diabetes health counseling; all

health care procedures; and orders for nebulizer treatments, glucagon injections, insulin pumps, glucose monitoring, and insulin injections.

There was a steady increase in LEAs that offered staff and student diabetes education, and formal school nurse case management programs, until 2011-2012. During the 2011/2012 school year, the SNCM results may have been inflated due to a change in how the school nurses were asked to report data, causing an unexpected spike up to 59 (51%) LEAs. During the 2012/2013 school year, the number of LEAs with SNCM programs decreased to 46 (44%), but rose each year after.

From the 2006/2007 school year to the 2015/2016 school year, the average school nurse-to-student ratio decreased from 1:1,340 to 1:1,086, a 19% improvement. This may be attributed to the increase in the number of school nurse full time equivalents from 1,034 to 1,318, a 27% increase. The North Carolina 2015/2016 average school nurse-to-student ratio of 1,086 was slightly above the national average of 924-1,072 students reported in the 2015 NASN National Survey (Mangena & Maughan, 2015). In 2004, the NC State Board of Education set a goal to reach a 1:750 school nurse-to-student ratio by 2014, which has been the historically acknowledged ratio recommendation (NASN, 2015). In the 2006/2007 school year, 31 (27%) LEAs met this goal. By the 2015/2016 school year, 46 (40%) LEAs met the 1:750 school nurse-to-student ratio (North Carolina Department of Health and Human Services, 2007; North Carolina General Assembly/Program Evaluation Division [NCGA/PED], 2017). The National Association of School Nurses, National Association of State School Nurse Consultants, and American Academy of Pediatrics no longer support the caseload model, which focuses on ratios determined by acuity of the student population. It is now recommended that every student have daily access to a school nurse (American Academy of Pediatrics, 2016; Combe et al., 2015;

NASN, 2015). This approach embraces the school nurse workload model, which takes into account not only nurse caseload/ratios, but also social determinants, student achievement, and collaboration with families, health care providers, and school staff (Combe, et al., 2015). In the 2015/2016 school year, 5 of 115 (4%) of North Carolina's public school districts met this recommendation (NCGA/PED, 2017).

In the 2015/2016 school year, seventy-five percent of school nurses included in the study held a BSN degree. The increase from 2006/2007 (65%) to 2015/2016 (75%) may have been driven, in part, by the Future of Nursing: Campaign for Action's efforts to meet the Institute of Medicine's 2010 recommendation to increase the proportion of nurses with a baccalaureate degree (or higher) in nursing to 80% by 2020. North Carolina school nurses are well on their way to contributing to this goal, exceeding the 2016 national rate of employed nurses with a baccalaureate (or higher) degree in nursing of 54% (Future of Nursing: Campaign for Action, 2017). NASN recommends that every school-aged child have access to a registered nurse who has a minimum of a BSN (NASN, 2016c). According to NASN, 51% of school nurses in the U.S. have a BSN, which North Carolina has also exceeded.

There was a spike in students with health conditions in 2013/2014. We did not find a change in how school nurses were instructed to answer this question on the survey, but students enrolled in schools between 2010/2011 and 2013/2014 were found to have significantly more identified health conditions, in particular, asthma. Identified health conditions decreased in school years 2014/2015 and 2015/2016, but the decrease was not significant to the regression model. On average, 56,725 elementary students across all school districts were identified with asthma during each of these school years. School nurses manage chronic health conditions through direct patient care, case management programs, and coordinating care and resources for

students and families to improve health outcomes and academic success (Leroy, Wallin, & Lee, 2017; NASN, 2017). Asthma is a leading chronic illness with possible long-term consequences, affecting over 10 million children in the United States (Engelke, Swanson, & Guttu, 2014; McClanahan & Weismiller, 2015). With a national prevalence rate of 8.4%, asthma is one of the leading causes of school absenteeism (CDC, 2017b; National Association of Chronic Disease Directors [NACCD], 2016). In 2013, there were 13.8 million missed school days reported among children with asthma aged 5-17 years (CDC, 2015).

Although not significant, we found an increase in the number of students identified with diabetes. In a longitudinal study (2002-2012) across five United States study centers, researchers analyzed trends of type 1 and type 2 diabetes among children ages 0-19 years. They found that type 1 diabetes rates increased by 1.4% each year (from 19.5 to 21.7 cases per 100,000 children; $p = .03$), and type 2 diabetes rates increased by 7.1% each year (from 9 to 12.5 cases per 100,000 children; $p < .001$) (Mayer-Davis et al., 2017).

Although more students were identified with asthma than diabetes, more LEAs offered staff diabetes education (96%) than staff asthma education (37%). This may be explained by North Carolina state policy change when the Legislature enacted the Care of Students with Diabetes Act (Session Law 2002-103/Senate Bill 911 and Session Law 2009-563/Senate Bill 738) to address school children with diabetes (Diabetes North Carolina, n.d.). These laws required the North Carolina State Board of Education to adopt guidelines recommended by the American Diabetes Association. Adopted guidelines include staff training for teachers and other school staff to support students with diabetes, and individual health care plans after request by a student's parent or guardian (North Carolina Session Law of 2002). This is a positive step to address the needs of students with diabetes. However, if this causes school nurses to be more

focused on diabetes management than asthma management, school nurses will also need to address ways to improve student and staff access to asthma education since asthma continues to be a leading cause of chronic absenteeism (NACDD, 2016).

Elementary school students received more individual asthma health counseling sessions than middle and high school students. This was an expected finding due to more elementary students being identified with asthma than middle and high school students. Also, because of their young age, elementary school students may require more encounters with the nurse to receive health education. Uncontrolled asthma has been associated with reduced quality of life and increased health care utilization (Lozier, Zahran, Bailey, 2018). Structured education focused on self-management, combined with group presentations and family involvement, is beneficial to controlling asthma symptoms (National Heart, Lung, and Blood Institute [NHLBI], 2007). Asthma education has been found to improve quality of life, increase confidence in asthma self-management, and reduce health services utilization and days out of school (Cicutto, To, & Murphy, 2013; Guevara et al., 2003; McGhan, et al., 2010). Managing chronic health conditions such as asthma requires students to develop a solid knowledge base and skill set, which can be assessed and developed during individualized health counseling sessions with the school nurse (Carpenter, LaChance, Wilkin, & Clark, 2013; NHLBI, 2007).

Between school years 2008/2009 and 2013/2014, there was a steady increase in orders for health care procedures to be provided in schools in North Carolina. I did not find a change in how school nurses were instructed to answer the question, but this can conceivably be explained by the increase in student enrollment and increase in students identified with health conditions. The increase in health care procedures may also be due to the increase in preterm survival rates, and an increase in children with chronic health conditions (NASN, 2012). There was a steep

decrease in health care procedure orders between 2014-2016. This may be due to incomplete data for epinephrine auto injector orders. As expected, elementary school students had more orders for nebulizer treatments for asthma. However, considering the numbers of students identified with asthma, I expected to find more numbers of students with orders for nebulizers. This may be due to asthma medication guidelines that recommend the use of inhaled corticosteroids (ICSs) as the preferred treatment for persistent asthma (Hsu, Sircar, Herman, & Garbe, 2018). Because medications through nebulizer are considered alternative treatments, students may not be prescribed them as often as the preferred asthma treatment of ICSs (Hsu et al., 2018; NHLBI, 2007). Student enrollment in North Carolina public schools included more students in grades K-5 (~680,000), than grades 6-8 (~340,000) and 9-12 (~435,000). Also, more students enrolled in elementary school were identified with asthma than middle and high school students.

We expected to find that high school students would have more diabetes health care procedure orders (i.e. glucagon injections and insulin pumps) because they were identified (in health conditions) with type 1 and type 2 diabetes more than elementary and middle school students. This was true for insulin pump orders. Insulin pumps provide a child with flexibility in meal times and how they administer insulin. Insulin pumps are also beneficial to a child's quality of life and ease apprehension about hypoglycemic episodes (Abdullah, Pesterfield, Elleri, & Dunger, 2014; American Diabetes Association, 2013; Mueller-Godeffroy, Treichel, & Wagner, 2009).

Strengths of this study include the use of a longitudinal data set that represents 1.5 million public school students in one of the largest school systems in the United States. These data provided a rich source of population-based information about school nurse health services

provided to students enrolled in public elementary, middle, and high schools in North Carolina. The survey used for this study had a 100% participation rate by all 115 North Carolina school districts. To our knowledge, this is the first study that has been conducted using this data set to describe trends in school nurse health services and programs provided to public school students in all 115 of North Carolina's school districts.

Conclusion

This study captures the health and well-being of school aged children in North Carolina's public schools. Understanding what health conditions are common can assist school nurses in understanding what school health services and programs students may benefit from. Our study findings suggest that further attention needs to be directed toward asthma-related health services, particularly for elementary school students. As North Carolina works toward reaching the recommended 1:750 school nurse-to-student ratio, future research should include examination of the data for possible links between school nurse-to-student ratios, health services and programs, and health and education outcomes of students attending North Carolina's public schools.

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CHAPTER 4: THE IMPACT OF NORTH CAROLINA SCHOOL NURSE RATIOS AND SCHOOL NURSE HEALTH SERVICES AND PROGRAMS ON STUDENT HEALTH AND EDUCATION OUTCOMES FROM 2011-2016

Introduction

The American Academy of Pediatrics (AAP) and National Association of School Nurses (NASN) recommend that school children have daily access to a full-time school nurse to ensure the health of these students (American Academy of Pediatrics & Council on School Health, 2016; National Association of School Nurses, 2016). The ability to learn is directly related to a child's health status. By providing health care and follow-up within the school environment, full-time school nurses play a vital role in keeping children healthy, in school, and ready to learn (NASN, 2016). School nurses implement school health service policies and programs that are evidence-based and student-centered, and provide community health education and disease prevention. School nurse interventions also include medication administration, screenings, disease surveillance, routine treatments and procedures, and care coordination to help students and families meet their goals (Maughan, Duff, & Wright, 2016).

School nurse support is pivotal to assist students in being successful learners. The extensive services school nurses provide in the non-medical setting differentiates school nursing from other specialties, and places them in a unique place to have a positive, effective impact on student performance, school absenteeism, graduation rates, and collaboration between school and community members (Fateau, 2010; NASN, 2017a). Yet, school nurse positions are often vulnerable when school district budgets need to be tightened, leading to higher school nurse-to-student ratios (Daughtry & Engelke, 2017; Maughan et al., 2018).

Determination of adequate school nurse staffing is a complex process and has been historically measured using school nurse-to-student ratios. Previous work has shown that when school nurse-to-student ratios are lower, school nurses were more likely to identify children with chronic illnesses and provide more services for students with asthma and diabetes (Fateau, 2010; Maughan, 2009). Inadequate school nurse staffing can lead to serious consequences. When a school nurse is not in the building, a decline in a student's health status may go unidentified, and appropriate care may be delayed or not be provided (Malone & Bergren, 2010). Circumstances such as these may contribute to student deaths (Dolatowski et al., 2015). Inadequate staffing can also lead to inconsistent care of students, lost teaching time in the classroom, unnecessary early dismissal from class, and increased school nurse turnover (Dolatowski et al., 2015; Hill & Hollis, 2012).

In 2016, the North Carolina General Assembly Program Evaluation Division (PED) was directed to evaluate school nurse health services in North Carolina public schools (North Carolina General Assembly/Program Evaluation Division [NCGA/PED], 2017). This evaluation addressed school nurse staffing levels, school nurse roles and responsibilities, and how North Carolina and its 115 school districts (local education agencies [LEAs]) fund school nurses. The PED found that during the 2015-2016 school year, 46 of 115 school districts achieved the State Board of Education's recommended 1:750 school nurse-to-student ratio. They also found that only five school districts (4%) had a school nurse in every school (NCNA/PED, 2017).

In an integrative literature review, we found that 80% of studies on school nurse interventions and activities and student health and education outcomes were descriptive, and only one in four studies included interventions linked to change in student outcomes. Also, definitions and measurement of health and education outcomes were not standardized (Best,

Oppewal, & Travers, 2018). The demand for additional school nurses has increased to meet the needs of the growing population of students who have chronic/complex health conditions, but with the lack of intervention studies, standardization of data points and definitions for outcome measures, and school nurse datasets, it is difficult to understand how school nurse interventions influence health and academic success. The purpose of this study was to examine the impact of North Carolina school nurse-to-student ratios and school nurse health services and programs related to asthma and diabetes, on student health and education outcomes.

Methods

Study Design

This research was a longitudinal repeated measures analysis of school health services data as reported to the Children and Youth Branch of the North Carolina Division of Public Health.

Participants and Procedures

The sample was collected during school years 2011/2012 through 2015/2016. School nurses representing all 115 North Carolina public school districts reported data on relevant variables each school year. School nurses were defined as registered nurses who served individual students full-time or part-time and did not work solely as administrators. Students were defined as school-aged children enrolled in public elementary (K-5th grades), middle (6th-8th grades), and high (9th-12th grades) schools. Average school nurse/student ratios were based on full-time equivalents (FTE positions budgeted for school nurses) that worked in the school districts. This study was determined to be exempt by the University of North Carolina at Chapel Hill Institutional Review Board.

Data Source

We used data from the N. C. Annual End of School Year School Health Services and Programs Survey, developed by data specialists and school health nurse consultants in the N. C. Division of Public Health's Children and Youth Branch. Since the 1996-1997 school year, the N. C. Division of Public Health has collected school health data for the survey and disseminated findings of school health services as reported by school nurses. All 115 LEAs electronically submitted data for each school year included in the study (2011-2016), yielding a 100% return rate. Not all questions were relevant to each school district; if the school district did not provide all services and programs, or collect all the data included in the survey, some questions were not applicable. Due to this, each question did not have a response from all school districts. We obtained the data through a data use agreement with the NC Division of Public Health/School Health Unit. Data were aggregated by school district and all school nurse identifiers were removed prior to obtaining the data.

We also used financial and business services data from the NC Department of Public Instruction to obtain annual summaries of NC public school information.

Variables

Sample characteristics. LEA information included: number of public schools, number of students in school each school year, number of school nurse full-time equivalents (FTE), and average school nurse-to-student ratios (available between 2011 and 2016). LEA information did not include charter or private schools. School nurse information included: educational preparation (highest degree earned- diploma in nursing, associate degree in nursing, bachelor's degree, master's degree, doctorate) and national school nurse certification (available between 2013-2016).

Identified health conditions. LEAs reported the number of individual students with one or more identified health condition (e.g. asthma, cardiac, cystic fibrosis, diabetes) that required action at school (e.g. available medication, health care plan, accommodations). In this study we focused on two of the most common health conditions addressed in school settings, asthma and diabetes (Best, Oppewal & Travers, 2018). We analyzed the number of students with asthma, type 1 diabetes, and type 2 diabetes. Identified health conditions data were available for the entire sample period of 2011-2016.

Health education presentations, programs, and training. LEAs reported number of times group presentations were provided and health topics the education addressed. Asthma education program for school staff and students, group diabetes management presentations, generalized diabetes training for school staff, and intensive diabetes training for at least 2 school staff were reported. We created a dichotomous (yes/no) variable for each health education presentation, program, and training, which were available for the entire sample period of 2011-2016.

Health counseling. LEAs reported one-to-one health counseling between school nurses and students to address a variety of health needs (e.g. asthma, diabetes, injury recovery, puberty/reproductive health). We included health counseling for asthma and diabetes in our analyses. Health counseling data were available for the entire sample period of 2011-2016.

Health care procedures. LEAs reported health care provider orders for specialized care procedures that were performed in the school setting. Of particular relevance for this study, were the asthma (nebulizer treatment) and diabetes (blood glucose monitoring, insulin injection, insulin pump) related health care procedures. These data were available for years 2011-2016.

School nurse case management (SNCM). LEAs reported the presence of structured school nurse-managed programs for students with chronic or complex health conditions. We created a dichotomous (yes/no) variable. School nurses answered yes, if one or more school nurses in the LEA provided SNCM. LEAs also reported the number of students that received structured case management. The number of LEAs with school nurse case management programs and number of students that received SNCM were available between 2011 and 2016.

Student outcomes. We included interventions provided by school nurses that were delivered as part of structured school nurse case management programs for chronic or complex health conditions, in particular, asthma and diabetes. Each chronic health condition included measurable health and education outcomes (Figure 4.1). Each student did not have all outcomes as part of their care; outcomes were chosen on an individual basis. The number of students in all grades (elementary, middle, and high school combined) for whom an outcome was measured and number of students that demonstrated improvement in an outcome, were available between 2011 and 2016. In the analysis, outcome measures were expressed as percent improvement and computed as the ratio of number of students that demonstrated improvement in each outcome to the number of students in which the outcome was measured.

Asthma Outcomes
Health Outcomes Consistently verbalized accurate knowledge of the pathophysiology of their condition Consistently demonstrated correct use of asthma inhaler and/or spacer Accurately listed his/her asthma triggers Remained within peak flow/pulse oximeter plan goals Improved amount and/or quality of regular physical activity Education Outcomes Improved grades Decreased number of absences
Diabetes Outcomes
Health Outcomes Consistently verbalized accurate knowledge of the pathophysiology of their condition Demonstrated improvement in ability to correctly count carbohydrates Improved skill in testing own blood glucose Showed improvement in HbA1c (if measured and available) Consistently (90% of time) calculated accurate insulin dose Improved ability to deliver insulin dose Education Outcomes Improved grades Decreased number of absences

Figure 4.1. Student asthma and diabetes outcomes

Data Analysis

We computed descriptive statistics (means, standard deviations, median, frequencies, proportions) for all health services and programs, school nurse demographics, LEA characteristics, and health outcomes at the different timepoints and overall. Next, we created longitudinal graphical displays (mean profiles, histograms of the counts) to identify patterns in the health services, programs, and outcomes data, and to inform subsequent modeling decisions.

To estimate the association of school nurse-to-student ratio with each asthma and diabetes outcome, we employed a generalized linear model (GLM) (McCullagh & Nelder, 1989) assuming a gamma distribution with log link relating each health outcome of interest to a

corresponding set of predefined predictors (Figure 4.2). The gamma model was chosen in view of the continuous non-negative skewed nature of the outcome variables data.

For each asthma outcome, we fitted at least two models. First, we tested the effect of school nurse-to-student ratio on the outcome of interest in a model that incorporated a fixed effect term for time. Next, we fitted a fully adjusted multivariate model that included additional terms for asthma-related school nurse health services, programs and procedure covariates (Figure 4.2). We assessed the effect of the interaction between nurse-to-student ratio and time, and dropped this term if it did not impact the model in a significant manner. Overall model adequacy and distributional assumptions were evaluated by residual analysis and by the deviance test for goodness of fit.

The same Gamma regression modeling strategy outlined above was repeated for the analysis of each diabetes outcome. Covariates included in these diabetes outcomes models are specified in figure 4.2. We performed all analyses using SAS software version 9.4 (SAS Institute, Inc., Cary, NC, USA). All tests of hypothesis were two-tailed, and a p -value ≤ 0.05 was considered statistically significant. No adjustment was made for multiplicity.

Asthma-related Covariates
Asthma education program for staff (group)
Asthma education program for students (group)
Asthma counseling (individual)
Nebulizer treatment health care procedure
School nurse case management (SNCM)
Total numbers of students that received SNCM
Diabetes-related Covariates
Generalized diabetes training for staff
Intensive diabetes training
Diabetes education for students, parents, or staff (group)
Diabetes counseling (individual)
Glucose monitoring, insulin injection, insulin pump health care procedures
School nurse case management (SNCM)
Total numbers of students that received SNCM

Figure 4.2. Asthma and diabetes related education programs and procedures

Results

Sample

Local education agencies characteristics. The study sample included 115 school districts. Between 2011 and 2016, the number of public schools across all LEAs increased from 2,412 to 2,434, and the number of students who attended public schools in North Carolina increased from 1.42 million to nearly 1.46 million (Table 4.1).

Table 4.1. *Local Education Agency Characteristics School Years 2011-2016 (N=115)*

Characteristic	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
Number of Public Schools	2,412	2,418	2,418	2,434	2,434
Number of Students	1,417,458	1,427,281	1,434,180	1,433,592	1,459,852

School nurse characteristics. The number of school nurse FTEs and average school nurse-to-student ratios are provided in Table 4.2. The number of school nurse FTEs increased from 1,202 to 1,318, a 10% improvement. The average school nurse-to-student ratio decreased

from 1:1,179 to 1:1086, an 8% improvement. Trends for school nurse FTEs and school nurse-to-student ratios can be seen in Figure 4.3.

Table 4.2. *School Nurse Full Time Equivalents and School Nurse-to-Student Ratios School Years 2011-2016*

Variable	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
School Nurse FTEs	1,202	1,212	1,236	1,288	1,318
Average School Nurse/Student Ratio	1,179	1,177	1,160	1,112	1,086

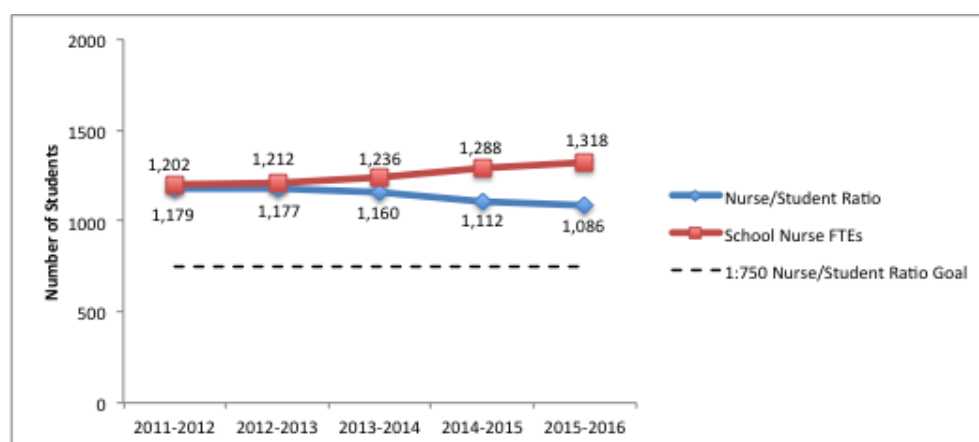


Figure 4.3. Average nurse-to-student ratios and school nurse full-time equivalents 2011 to 2016

Additional school nurse characteristics were available for school years 2013-2016 (Table 4.3). Between 2013 and 2016, the percentage of school nurses with at least a Bachelor of Science in Nursing (BSN) increased from 74% to 75%, and the percentage of school nurses with any type of baccalaureate education preparation (BSN, BS, BA) was maintained at 79%. The percentage of school nurses that held national school nurse certification was maintained at 52%.

Table 4.3. *School Nurse Educational Preparation and National Certification School Years 2013-2016*

Variable	2013-2014	2014-2015	2015-2016
School nurses included in report, n	1292	1353	1357
Highest degree, n (%)			
Diploma	22 (1.7)	17 (1.3)	13 (1.0)
Associate degree in nursing	128 (9.9)	130 (9.6)	124 (9.1)
Bachelor of Science in Nursing	953 (73.8)	1003 (74.1)	1018 (75.0)
Bachelor of Science	48 (3.7)	54 (4.0)	44 (3.2)
Bachelor of Arts	16 (1.2)	13 (1.0)	14 (1.0)
Masters	89 (6.9)	91 (6.7)	90 (6.6)
Doctorate	2 (0.2)	--	--
Unknown	--	--	--
Missing	34 (2.6)	45 (3.3)	54 (4.0)
National school nurse certification, n (%)	660 (51.1)	689 (51)	699 (51.5)

Note. Percentages may not equal 100% due to rounding.

Note. --No school nurse data reported for characteristic.

Identified Health Conditions

As shown in Table 4.4, between 2011 and 2016 the number of students with asthma ranged from 86,717 and 112,123, the number of students with type 1 diabetes ranged from 3,710 and 4,011, and the number of students with type 2 diabetes ranged from 507 and 1,186.

Table 4.4. *Students with Asthma, Type 1 Diabetes, and Type 2 Diabetes 2011-2016*

Asthma	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
Elementary	57,718	59,908	54,273	49,534	48,763
Middle	25,724	27,487	23,794	22,891	19,321
High	22,100	24,728	23,034	20,681	18,633
Total	105,542	112,123	101,101	93,106	86,717
Type 1 Diabetes	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
Elementary	1,132	1,105	1,074	981	1,188
Middle	1,060	1,095	1,126	1,048	1,052
High	1,567	1,624	1,655	1,681	1,771
Total	3,759	3,824	3,855	3,710	4,011
Type 2 Diabetes	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
Elementary	218	163	34	102	100
Middle	350	369	146	271	225
High	618	629	327	517	498
Total	1,186	1,161	507	890	823

Health Education Presentations, Programs, and Training

Since 2011, 94 to 97% of LEAs have offered group diabetes management presentations (Table 4.5). The number of LEAs for which school nurses provided staff asthma education programs decreased from 50 (44%) to 38 (33%). Student asthma education programs decreased from 33 (29%) LEAs to 30 (26%) LEAs. The number of LEAs that offered generalized training programs increased from 110 (96%) to 114 (99%). The number of LEAs with at least two school staff intensively trained on diabetes care ranged from 113 (98%) to 114 (99%) (Table 4.5).

Table 4.5. *Health Education Presentations, Programs, and Training in all LEAs (N=115)*

	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
Group presentations (diabetes), n (%)	110 (95.7)	111 (96.5)	108 (93.9)	112 (97.4)	111 (96.5)
Staff education (asthma), n (%)	50 (43.5)	36 (31.3)	42 (36.5)	37 (32.2)	38 (33)
Student education (asthma), n (%)	33 (29)	31 (27)	31 (27)	26 (22.6)	30 (26.1)
Staff generalized training (diabetes), n (%)	110 (96)	113 (98.3)	112 (97.4)	113 (98.3)	114 (99.1)
Staff intensive training (diabetes), n (%)	114 (99.1)	113 (98.3)	113 (98.3)	114 (99.1)	114 (99.1)

Health Counseling

During the 5-year study period between 44,413 and 57,695 students received asthma health counseling each school year, and between 28,335 and 37,246 students received diabetes health counseling (Table 4.6).

Table 4.6. *Asthma and Diabetes One-to-One Counseling 2011-2016*

Asthma Counseling	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
Elementary	29,624	33,312	32,180	29,543	27,464
Middle	10,701	16,969	10,903	10,404	9,958
High	7,054	7,414	6,826	6,749	6,991
Total	47,379	57,695	49,909	46,696	44,413

Diabetes Counseling	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
Elementary	10,653	11,698	14,406	16,448	13,428
Middle	10,004	14,132	12,479	11,296	12,883
High	7,678	11,416	9,126	8,955	10,093
Total	28,335	37,246	36,011	36,699	36,404

Health Care Procedures

During the 5-year study period between 1,116 and 1,920 students had orders for nebulizer treatments each school year, between 3,748 and 3,932 students had orders for blood glucose monitoring, between 2,239 and 2,928 students had orders for insulin injection, and between 1,685 and 1,733 students had orders for an insulin pump (Table 4.7).

Table 4.7. *Asthma and Diabetes Health Care Procedures 2011-2016*

Nebulizer Treatment	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
Elementary	1,441	1,126	893	977	863
Middle	252	232	162	184	150
High	227	130	215	156	103
Total	1,920	1,488	1,270	1,317	1,116
Blood Glucose Monitoring	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
Elementary	1,234	1,150	1,116	1,063	1,162
Middle	1,106	1,122	1,145	1,071	1,121
High	1,575	1,551	1,487	1,681	1,649
Total	3,915	3,823	3,748	3,815	3,932
Insulin Injection	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
Elementary	664	693	757	953	702
Middle	637	658	752	946	657
High	938	880	983	1,029	1,053
Total	2,239	2,231	2,492	2,928	2,412
Insulin Pump	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016
Elementary	558	534	493	479	487
Middle	472	520	510	510	463
High	668	646	688	744	735
Total	1,698	1,700	1,691	1,733	1,685

School Nurse Case Management

In the 2011/2012 school year, 59 (51%) LEAs reported incorporating a structured school nurse case management (SNCM) program for students with chronic health conditions. During the 2012/2013 school year, the number of LEAs with structured SNCM programs dropped to 46 (44%). However, there has been a steady increase to 55 (48%) LEAs with structured SNCM programs (Figure 4.4).

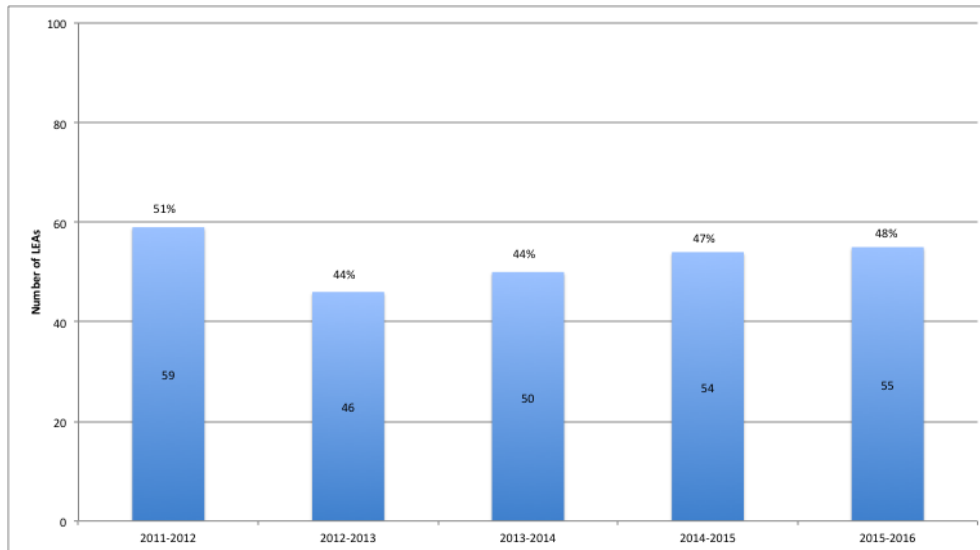


Figure 4.4. LEAs with structured school nurse case management program 2011-2016 (N=115)

Impact of School Nurse-to-Student Ratios and School Nurse Health Services and Programs

Asthma outcomes. In the model adjusted for time, lower school nurse-to-student ratios were associated with improvement in student ability to accurately list their asthma triggers (parameter estimate = .9999, 95% confidence interval [CI .9999, 1.0000], $p = .0392$). In the model adjusted for asthma covariates (staff and student asthma education, asthma counseling, SNCM, nebulizer treatment orders), the association between lower school nurse-to-student ratio and ability to accurately list asthma triggers disappeared. However, in the model adjusted for asthma covariates, lower school nurse-to-student ratios were associated with improvement in decreased number of absences (parameter estimate = .9999, 95% CI [.9998, 1.0000], $p = .0452$). We found no significant impact on other asthma outcomes.

Diabetes outcomes. In the model adjusted for time, lower school nurse-to-student ratios were associated with improvement in verbalized accurate knowledge of diabetes pathophysiology (parameter estimate = .9994, 95% CI [.9989, .9998], $p = .0043$), improvement in skill in testing blood glucose (parameter estimate = .9994, 95% CI [.9988, .9999], $p = .0253$),

and decreased number of absences (parameter estimate = .9996, 95% CI [.9992, 1.0000], $p = 0.0457$). In the model adjusted for diabetes covariates (staff diabetes training, diabetes counseling, SNCM; glucose monitoring, insulin injection, insulin pump orders), the relationship between lower school nurse-to-student ratios improvement in verbalized accurate knowledge of diabetes pathophysiology weakened, but continued to be significant (parameter estimate = .9994, 95% CI [.9989, .9998], $p = .0098$). The relationship between lower school nurse-to-student ratios and improvement in skill in testing blood glucose was stronger in the model adjusted for diabetes covariates (parameter estimate = .9993, 95% CI [.9986, .9999], $p = .0182$). There was also a new association between lower school nurse-to-student ratios, and improved ability to correctly count carbohydrates (parameter estimate = .9993, 95% CI [.9988, .9999], $p = .0229$). We found no significant impact on other diabetes outcomes.

Discussion

Our findings indicate that lower school nurse-to-student ratios were associated with increased percentages of students with improved health and education outcomes. We found that, when adjusted for time, lower school nurse-to-student ratios were associated with improvement in several health outcomes including students being able to accurately list asthma triggers, consistently verbalize knowledge of diabetes pathophysiology, and test their own blood glucose. When we adjusted the model for diabetes covariates, both diabetes outcomes (consistently verbalize knowledge of diabetes pathophysiology and test their own blood glucose) remained significant, and a new relationship between lower school nurse-to-student ratios and correctly counting carbohydrates was significant. Our findings are consistent with previous research that suggests when school nurse-to-student ratios were decreased, asthma and other health conditions were more likely to be identified, immunization requirements were more likely to be met, and

provision of services to children with asthma, diabetes, and depression increased (Fateau, 2010; Maughan, 2009).

The number of NC public school students identified with asthma decreased between 2011 and 2016. This was a surprising finding, but was consistent with the U.S. childhood asthma prevalence trends. There was a steady rise in the prevalence of childhood asthma between 1980 and 2009. It was then followed by a plateau, and eventual decline in 2013 (Akinbami, Simon, & Rossen, 2016). Across the country, the prevalence rate of asthma in children decreased from 9.5% in 2011 to 8.4% in 2015 (Centers for Disease Control and Prevention [CDC], 2016).

In NC schools over time, I found that the number of students identified with type 1 diabetes increased and the number of students identified with diabetes type 2 decreased. This was unexpected, because the prevalence and incidence of type 1 and type 2 diabetes in the U.S. have increased in children under the age of 20 (CDC, 2017a). Previous research found there were significant increases particularly among children of minority racial and ethnic groups (Mayer-Davis et al., 2017). Without knowing the racial and ethnic makeup of the North Carolina public school students, it is difficult to ascertain if this is related to the unexpected finding.

North Carolina public school nurses provided asthma and diabetes training and group education for staff and students, individual asthma and diabetes counseling for students, and school nurse case management for students with chronic/complex health conditions. The drop in number of LEAs with asthma education, asthma health counseling sessions, and nebulizer treatment orders may be explained by the decrease in numbers of students in this study that were identified with asthma.

There was a decrease in the number of LEAs with structured school nurse case management programs between the 2011-2012 and 2012-2013 school year. We discovered the

2011-2012 SNCM results may have been inflated due to a change in how the school nurses were asked to report data. Since the 2012-2013 school year, SNCM programs have steadily increased. School nurses have a pivotal role in managing chronic health conditions.

School nurses provide health services for students with chronic health conditions, including direct care (procedures, medications), case management (structured case management, individual health plans, emergency care plans), and assisting students and families with accessing resources (health insurance, find medical home) (CDC, 2017b; NASN, 2017b). North Carolina school nurses provide direct care to students, but also provide vital training to staff so that they can assist in providing direct care when school nurses are not in the building. Previous studies have found that when school nurses were assigned to fewer schools they were able to provide more direct care (Engelke, Swanson, Guttu, Warren, & Lovern, 2011). School nurse-led counseling for students with asthma has been associated with improved quality of life, increased symptom free days, and motivation to take medications (Halterman et al., 2011). Previous studies also found that case management implemented by school nurses was associated with students meeting case management goals to establish a safe environment, administer insulin, manage insulin regimen, and decrease symptom/treatment problems (Engelke, et al., 2011; Engelke, Swanson, & Guttu, 2014). Students who participated in school nurse case management programs were able to meet goals, including: decreased number of health-related absences and fewer days missed due to asthma (Engelke, et al, 2011; Moricca et al., 2012).

In the model adjusted for time, lower school nurse-to-student ratios were associated with improvement in decreased school absences among students with diabetes. Our results also indicated that lower school-nurse-to-student ratios were associated with improvement in decreased number of absences in students with asthma when the model was adjusted for asthma

covariates. Our findings are consistent with previous studies that found lower school nurse-to-student ratios were associated with lower absenteeism rates (Jacobsen, Meeder, & Voskuil, 2016; Michael, Merlo, Basch, Wentzel, & Wechsler, 2015). As the number of students diagnosed with chronic health conditions has increased, there has also been a substantial increase in absenteeism (Jacobsen et al., 2016). Students with chronic health conditions are at risk for high absenteeism and poor academic performance (NASN, 2017b), which can have long-term effects on a child's life, into adulthood (National Collaborative on Education and Health, 2015). When school nurses are available to assist students with managing their chronic health condition, students have increased time in the classroom and decreased absenteeism (CDC, 2017). By improving student health, school nurses advance student academic success (NASN, 2017a).

National school nurse staffing recommendations have shifted. The work of school nurses historically focused on ratios (Combe et al., 2015). With little evidence to support the previously recommended 1:750 school nurse-to-student ratio, it is now recommended that students have daily access to a full-time school nurse (AAP, 2016; Combe et al., 2015; Dolatowski et al., 2015). To achieve adequate school nurse staffing for the increasing student population, North Carolina will need to take into account social determinants of health (e.g. safe environment, income, housing, transportation), student achievement, and collaboration with families, health care providers, and school staff to ensure students are healthy, safe, and in school learning (Combe, et al., 2015; NASN, 2017a).

As the number of students attending North Carolina's public schools continues to grow, so does the demand for students to have access to a school nurse. During the 2016/2017 school year, the average school nurse-to-student ratio was 1:1,072. North Carolina did not meet the state's goal of a 1:750 school nurse-to-student ratio by 2014, nor did it meet the current NASN

and AAP recommendation of at least one full-time school nurse per school. Only five school districts (4%) met this goal. To meet student needs, it will be necessary for the North Carolina State Board of Education to address school nurse staffing levels and develop a long-term plan to fund additional positions. To meet these goals, the NC Program Evaluation Division estimated an annual cost between \$45 million and \$79 million to fund additional school nurse positions (NCGA/PED, 2017).

Our study has several strengths, including the 100% participation rate in the survey by all 115 North Carolina school districts, and the use of a data set that represents 1.5 million public school students in one of the largest school systems in the United States. These data provided population-based information about school nurse health services provided to students that attended traditional public schools in North Carolina over a 5-year time span.

This study is not without limitations. Although all school districts participated in the survey, not all questions pertained to each district, and some questions were not answered for other unknown reasons. This study does not include all school nurse health services provided by school nurses in North Carolina. Future studies are needed to determine which school nurse health services and programs may be most beneficial and cost efficient to students with asthma, diabetes, and other chronic health conditions. Also, future research can study other health services provided by school nurses, such as health office visits and screenings (vision, hearing, weight).

Conclusion

In this study we found associations between school nurses (lower school nurse to student ratios) and improvements in students' health and education outcomes. School nurse-provided health services and programs are essential for students to improve or maintain their health and well-being. School nurses and the health services they provide for students are key to keeping

students healthy, in a safe school environment, and in the classroom ready to learn.

Understanding how school nurse-to-student ratios impact student health and education outcomes is key to meeting student needs.

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CHAPTER 5: DISCUSSION

In the 2016-2017 school year, 1.5 million children attended public schools in the State of North Carolina (NC) (North Carolina Department of Public Instruction, 2017). The current North Carolina school nurse-to-student ratio is one nurse for every 1,072 students (NC Child & North Carolina Institute of Medicine, 2018). This is aligned with the US average school nurse ratio, but does not meet the NC State Board of Education's goal of 1:750. Nor does the ratio allow NC to provide a school nurse for every school, as the National Association of School Nurses, American Academy of Pediatrics, and American Academy of Nursing recommend (American Academy of Pediatrics & Council on School Health, 2016; Maughan, et al., 2018; National Association of School Nurses [NASN], 2017a). As the NC student population continues to grow, so will the need for additional school nurses to ensure each student has daily access to a full-time school nurse (Maughan, et al., 2018; National Center for Education Statistics [NCES], 2016). Despite the current North Carolina school nurse-to-student ratios, I found that school nurses are improving student health and education outcomes.

School nursing is a multidimensional specialized practice with a broad scope of roles and responsibilities, grounded in community/public health. School nurses provide health services and support to keep children healthy, in school, and ready to learn (NASN, 2017a). School nurse support is pivotal to assist students in being successful learners. School nurses are in a unique position to bridge health care and education, and have a positive impact on student academic performance, school absenteeism, and graduation rates (Fateau, 2010; NASN, 2017a). There are many factors that affect the health and educational success of students, including social

determinants, school environment, parenting, school leadership, poverty, and school nurses. To demonstrate the contributions of nurses to student health and success in school, it is imperative that factors reflecting school nursing's impact be identified and measured (Bergren, 2011).

While some data on school nursing services do exist, the datasets are disparate and not collected in a standardized format. In North Carolina, school nurses and nurse supervisors representing all public schools in the state's 115 local education agencies (LEAs) complete an annual survey related to health services they provide in schools. The purpose of this dissertation was to explore empirical school health research literature for links between school nurse interventions and activities, and health and education outcomes of school children; describe the health services and programs provided by school nurses in North Carolina public schools; and examine the impact of school nurse-to-student ratios and school nurse health services on student health and education outcomes. My dissertation was comprised of three manuscripts, one manuscript for each study aim.

Aim 1: Published in Journal of School Nursing (Best, Oppewal, & Travers, 2018)

Determine the state of the science on the links between school nurse interventions and activities, and the health and education outcomes of school children.

The *Framework for 21st Century School Nursing Practice* was used in an integrative review to explore empirical findings for links between school nurse interventions and activities, and the health and education outcomes of school children (Best, Oppewal, & Travers, 2018). The *Framework for 21st Century School Nursing Practice* specifies key principles of school nursing, and components that focus the practice of school nurses. The key principles are: care coordination, leadership, quality improvement, and community/public health. Standards of practice ground the framework and serve as the foundation for quality, evidence-based care provided by school nurses (NASN, 2016a). I used the framework's key principles and

components to categorize school nurse interventions and activities, and health and education outcome measures identified in the literature. This was the first literature review to use the framework to examine links between school nurse interventions and student outcomes (Best, et al., 2018).

Sixty-five studies met the inclusion criteria and were included in the literature review. All four key principles are reflected in current literature, which represents school nursing practice and the interventions and activities they use to provide direct care, help students manage their chronic conditions, and collaborate with school staff and community partners (Best, et al., 2018; Maughan, Duff, & Wright, 2016). The majority (n=52, 80%) used a descriptive design. This finding supports the need for more rigorous school nursing research to determine the impact of school nurse interventions on student outcomes (Lineberry & Ickes, 2015; McClanahan & Weismuller, 2015).

Thirty-six studies were categorized under care coordination. Care coordination, which includes chronic disease management and collaborative communication, is integral to school nursing practice. As the number of students with chronic diseases, such as asthma and diabetes, increases, it will be vital for school nurses to be available to students while they are attending school. More studies are needed to examine the impact of school nurse interventions on student management of their chronic conditions (NASN, 2016b).

Seventeen studies were categorized under community/public health. School nurses provide key prevention strategies, such as health screenings, referrals, and follow-up, to recognize health issues before complications arise. Many of the community/public health components were not reflected in the literature (e.g. environmental health, health equity, social determinants), providing ample opportunity to conduct novel research.

Thirty-five studies included outcome measures, with thirty-three comprised of care coordination components. Chronic disease management was a prevalent component explored in the literature. School nurses deliver integral care for students with chronic health conditions; this may reduce long-term health issues, and help meet the needs of students and families (Leroy, Wallin, & Lee, 2017; NASN, 2017b). Very few studies focused on educational outcome measures, despite the importance of understanding how school nurse practice impacts academic performance and absenteeism (Selekman, Wolfe, & Cole, 2016).

Only 17 (26%) studies included interventions that were linked to student outcomes. Studies included school nurse interventions that resulted in positive outcomes for students with asthma and diabetes, as well as students dealing with weight management, anxiety, and bullying. School nurse interventions that were associated with positive outcomes included health screenings, immunization tracking, and nurse-led education and support groups (Best et al., 2018).

Health and education outcome definitions and measurements were not standardized across studies, which made comparison difficult. For example, researchers defined decreased asthma symptoms as 1) the number of days with symptoms, 2) the number of days without symptoms, and 3) the percentage of students who met goals for decreasing symptoms (Francisco, Rood, Nevel, Foreman, & Homan, 2017; Halterman et al., 2011; Krenitsky-Korn, 2011; Quaranta, & Spencer, 2016). Researchers who measured perception and improvement in asthma knowledge did not measure knowledge in the same manner, designing custom surveys for each particular study (Francisco et al., 2017; Mickel, Shanovich, Evans, & Jackson, 2017). Standardization of definitions and development of standardized data sets can improve the understanding of the influence of school nurse interventions on student outcomes. *Step Up & Be*

Counted!, a national initiative for all school nurses to collect uniform data for all of their students, aspires to accomplish this by using standardized data points and reporting structure, but there is still work to be done (Johnson et al., 2017; Maughan et al., 2014). The results reported in this review addressed Aim 1 by synthesizing existing literature on the links between school nurse interventions and activities, and the health and education outcomes of school children. I found evidence that school nurse interventions and activities contribute positively to student outcomes, but more research needs to be done to move school nursing science forward.

Sample for Aims 2 and 3

I conducted a secondary data analysis of aggregated cross-sectional population level data to explore trends in the data over a 10-year period. I also examined the effect of school nurse-to-student ratios and health services and programs on health and education outcomes. I obtained approval from the University of North Carolina at Chapel Hill Institutional Review Board for this research. Data on the 115 NC school districts, school nurses, students (elementary, middle, high school), and school health services and programs were collected from 2006-2016 through the NC Annual End of School Year School Health Services and Programs Survey. Between 2006 and 2016, the number of schools increased 5.6% (2,304 schools to 2,433) and the number of students increased 5% (1,386,363 students to 1,459,852). Average school nurse full-time equivalents increased from 1,340 to 1,318, and the average school nurse-to-student ratio improved, decreasing from 1:1,340 to 1:1,086. In the last year of the study data, 75% of school nurses had at least a Bachelor of Science in Nursing and 52% held national school nurse certification.

Aim 2: Manuscript to Be Submitted to Journal of School Health

Describe trends in data for public North Carolina elementary, middle, and high schools for years 2006-2016: School nurse health services and programs and most common health services and programs by grade level.

This study's findings clearly point to an increase in students with all health conditions, including asthma and type 1 diabetes. School nurses provided increased numbers of diabetes health counseling. School nurses were responsible for increased numbers of overall health care procedures, glucagon injection orders, and insulin pump orders. I found significant differences between grades in: all health conditions, asthma, type 1 diabetes, and type 2 diabetes; all health counseling, asthma health counseling, and diabetes health counseling; all health care procedures; and orders for nebulizer treatments, glucagon injections, insulin pumps, glucose monitoring, and insulin injections. I found that more students in elementary school were identified with all health conditions and asthma, while more high school students were identified with type 1 and type 2 diabetes. I found that school nurses provided more health counseling (all types of health counseling, asthma, and diabetes) sessions for elementary school students. School nurses were responsible for more health care procedure orders for elementary school students, including all health care procedures, nebulizer treatments, and glucagon injections. School nurses were responsible for more health care procedure orders (insulin pumps, glucose monitoring, and insulin injections) for high school students.

School districts were consistently compliant with staff training on diabetes, and there was an increase in the number of LEAs that offered staff and student diabetes education and formal school nurse case management programs. With the number of students in the US with asthma and diabetes increasing, it is likely that the numbers in North Carolina will continue to rise. This study identifies the necessity for school nurses to improve case finding of students at risk for

health conditions, such as asthma and diabetes, and to begin school nurse case management and health counseling as soon as possible.

Aim 3: Manuscript to be Submitted to North Carolina Medical Journal

Examine the impact of North Carolina school nurse-to-student ratios and programs and services on health and education outcomes of school children with asthma and diabetes for school years 2011-2016.

I found that, over the 5-year study period, lower school nurse-to-student ratios were associated with improvement in students with asthma being able to accurately list asthma triggers. When controlling for asthma-related school nurse health services (asthma education, asthma health counseling, nebulizer treatment orders, school nurse case management), lower school nurse-to-student ratios were also associated with more students with decreased school absences.

Lower school nurse-to-student ratios were associated with improvement in students with diabetes being able to consistently verbalize knowledge of diabetes pathophysiology, test their blood glucose, and decreased school absences. When controlling for diabetes-related school nurse health services (diabetes training for staff, diabetes education, diabetes health counseling, orders for glucose monitoring, insulin injections, and insulin pumps, and school nurse case management), students continued to show improvements in consistently verbalizing knowledge of diabetes pathophysiology and testing their blood glucose, and also had improvements in correctly counting carbohydrates.

My study findings are consistent with previous studies that found when school nurses were assigned to fewer schools, they were able to provide more direct care (Engelke, Swanson, Guttu, Warren, & Lovern, 2011). Lower school nurse-to-student ratios have also been associated with lower student absenteeism rates (Jacobsen, Meeder, & Voskuil, 2016; Moricca et al., 2015).

School nurse led-health counseling has been associated with improved student quality of life, more symptom free days, and motivation to take medications (Blaakman, Cohen, Fagnano, & Halterman, 2014; Halterman et al., 2011). School nurse case management interventions have been associated with students successfully meeting case management goals, including maintenance of a safe environment, management and administration of insulin, and decreased symptoms related to their chronic illness. My findings demonstrate the need for school nurses to be responsible for fewer students to be able to address student health needs, provide impactful health services for students and training for school staff, and promote healthy behaviors to improve the health and well-being of students with chronic illnesses.

Future Implications for Practice and Research

The key principles and components of the Framework for the 21st Century School Nursing Practice can guide school nurses in assessing and evaluating their daily practice, and identifying gaps in the care and education/training they provide students, families, and school staff. School nurses can also identify gaps in their own learning needs, which will be beneficial to the students, families, and school staff they encounter.

In my review of 65 studies on school nurse interventions and activities on student health and education outcomes, I identified the need for more research on how school nurse practice impacts students as well as the need for standardized school health data to facilitate research and reporting. Such research will increase the evidence base needed to inform improvements in school nursing practice. Given that the majority of the studies to date are descriptive, there is a clear need for research that utilizes more rigorous methodology to identify the impact of school nurse interventions on students managing their chronic health conditions. To address the lack of studies focused on the impact of school nurse interventions on education outcomes, future research should include determining the impact of school nurse interventions on identified school

nurse sensitive indicators such as school attendance and returning to class/early dismissal from school. This research focused on two common chronic health conditions, asthma and diabetes. Future studies should include other chronic or complex health conditions including severe allergies, seizures, obesity, and mental health issues. Other research studies could include determining which school nurse health services and programs for students with chronic health conditions are most beneficial by conducting a cost-benefit analysis.

I used Nelson's Data-to-Wisdom Continuum as a framework to examine school nursing in North Carolina and address the lack of data that capture how school nurse health services and programs impact student health and education outcome measures. First, I accessed data sources that were archived in Microsoft Access and Excel, and Adobe Acrobat portable document format (PDF) files. These data were named, collected, and organized through questions school nurses answered for the survey. Through data analysis, I processed these data into information to increase their value and meaning. I used descriptive statistics, generalized linear modeling, Poisson regression, and Gamma distribution to interpret the information. Interpretation of the information (i.e. results from analysis) guided knowledge as I identified patterns and relationships. This enabled me to increase the understanding of the impact of school nursing in North Carolina public schools.

The data, information, and knowledge acquired in this study have the potential to contribute to the development of wisdom about management of school nurse-generated data and the impact of school nursing on the improvement of student outcomes. I will provide growing recommendations for changes to the annual school nurse survey questions that can help distinguish if questions are not answered because they are not applicable to a school district, or for other unknown reasons. This can assist the NC state and regional school nurse consultants

understand which responses need to be clarified. As wisdom emerges, there are also more opportunities to drive school nursing policy. Publishing the dissertation manuscripts and presenting findings provide me with the opportunity to influence school nursing policy on a state and national level. The results from data across 10 school years representing school nurse health services in North Carolina have valuable implications to assist North Carolina and national school nurse leaders with improving the use of data to examine the impact of school nurses on student outcomes. This dissertation research can contribute to wisdom that demonstrates the essential role school nurses play in keeping students healthy, in school, and ready to learn.

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APPENDIX A: LIST OF VARIABLES AND DESCRIPTIONS

Variables	Instrument	LEA/Grade Level	Reported Data
LEA	Department of Public Instruction	LEA	
Number of public schools		LEA	Number of public school-does not include charters
Average daily membership		LEA	Number of days students are in membership at school divided by number of days in a school year
School Nurse	End of School Year School Health Services and Programs Survey	LEA	
Highest degree earned		LEA	Options: Diploma, Association Degree, Bachelor of Arts, Bachelor of Science, Bachelor of Science in Nursing, Master's, Doctorate of Nursing Science, Doctorate of Philosophy
National Certification		LEA	Yes/No
Identified health conditions	End of School Year School Health Services and Programs Survey	LEA	Total number of individual students w/1 or more chronic health conditions
Number of individual students with any particular identified health condition that requires some degree of action at school		Grade level (K-5, 6-8, 9-12)	Options: Allergies (severe), Asthma, Autistic disorders, Blood disorders, Cancer, including leukemia, Cardiac condition, Cerebral palsy,, Chromosomal/genetic conditions, Chronic encopresis, Concussion Chronic infectious diseases, Cystic fibrosis, Diabetes Type 1, Diabetes Type 2, Eating disorders, Emotional/behavior and/or psychiatric disorder, Fetal alcohol syndrome, Gastrointestinal disorders, Hearing loss, Hemophilia, Hydrocephalus, Hypertension, Hypo/hyperthyroidism, Metabolic conditions or endocrine disorders, Migraine headaches, Multiple sclerosis, Muscular dystrophy, Obesity (>95 th % BMI), Orthopedic disability (permanent), Other, neurological condition, Other neuromuscular condition, Renal/adrenal/kidney condition, Rheumatological conditions, Seizure disorder/epilepsy, Sickle cell anemia, Sickle cell trait, Spina bifida, Traumatic brain injury, Visually impaired (uncorrectable)
HEALTH CARE SERVICES AND PROGRAMS			
Health education presentations/programs (group)	End of School Year School Health Services and Programs Survey	LEA	Number of times all topics covered
Topics covered			Alcohol and drug abuse, tobacco, allergies, blood borne pathogens, cancer prevention, diabetes management, reproductive health, violence prevention, dental health, health careers, infection prevention/control, pest prevention/control, nutrition, physical activity, personal hygiene, injury prevention
Asthma education and care		LEA	Education for staff? (Yes/No) Students? (Yes/No)
Diabetes education		LEA	School/system offer generalized diabetes training to school staff system wide? Have at least 2 staff persons intensively trained on diabetes care in each school where students with diabetes are enrolled? (Yes/No)
Health counseling (one-on-one)	End of School Year School Health Services and Programs Survey	Grade level (K-5, 6-8, 9-12)	Number of health counseling sessions: ADD/ADHD, asthma, child abuse/neglect, chronic illness, depression, diabetes, hygiene, illness/injury recovery, mental health issues, nutrition, pregnancy, puberty/reproductive health, seizure disorders, severe allergies, substance abuse including tobacco use/prescription abuse, suicidal ideation, violence/bullying

Variables	Instrument	LEA/Grade Level	Reported Data
Health care procedures	End of School Year School Health Services and Programs Survey	Grade level (K-5, 6-8, 9-12)	Number of students who have orders for each procedure: blood glucose monitoring, clean intermittent catheterization, central venous line monitoring, Dressing change/Wound care, Insulin injection, Insulin pump, Nebulizer treatment, Oxygen therapy, Pulse oximeter, Respiratory care, Shunt care, Tracheal suctioning/trach care, Stoma care (other than trach), Tube feeding, Reinsertion of feeding tube, Vagal nerve stimulator
School nurse case management for chronic and/or complex health care	End of School Year School Health Services and Programs Survey	School level	School nurse management approach incorporated? Yes/No
OUTCOMES			
Asthma outcomes	End of School Year School Health Services and Programs Survey	K-5, 6-8, 9-12	Number of students included in outcome, number of students demonstrating improvement
Health outcomes: Consistently verbalize accurate knowledge, demonstrate correct use of asthma inhaler and/or spacer, list his/her asthma triggers, remain within peak flow/pulse oximeter plan goals			
Education outcomes: Improved grades, decreased number of absences			
Diabetes outcomes	End of School Year School Health Services and Programs Survey	K-5, 6-8, 9-12	Number of students included in outcome, number of students demonstrating improvement for each outcome
Health outcomes: Consistently verbalize accurate knowledge, demonstrate improvement in ability to count carbohydrates, improved skill in testing own blood glucose, improvement in HbA1c, consistently calculate insulin dose, improved ability to deliver insulin dose			
Education outcomes: Improved grades, decreased number of absences			