Title
Examining the Use of Mobile Medical Clinics in the United States and Southern California

Author
Coaston, Angela Suzanne

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Examining the Use of Mobile Medical Clinics in the United States and Southern California

by
Angela Coaston

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Approved:

DocuSigned by:
Soo-Jeong Lee — Soo-Jeong Lee
FB69E18FB56642F...
Chair

DocuSigned by:
Caroline Stephens — Caroline Stephens

DocuSigned by:
Johnson , Julene

DocuSigned by:
Sandra J. Weiss — Sandra J. Weiss
29B9816487EE497...

Committee Members

Dedication

I'd like to dedicate this dissertation to my late sister and brother-n-law, Melanie Jo Clark and Charles C. Clark. You invested so much of your lives in my nursing career and education. You were my inspiration to serve those who do not trust healthcare, and you trusted me to lead you and respect you in your health journey. Rest in Heaven: † January 17, 2019 and March 27, 2020. Additionally, to my husband, Zac Jr. and to my children, Ashley, Zacharia, Zac III, and Zacqueline (Zacky), the loves of my life.

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To my parents, Harlen and Marlen Burton, may you rest in heaven †, thank you for training and teaching me to love God, others and myself and how to share the gospel of Christ to everyone through love.

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Contributions

Author Note from Chapter 2

Angela Coaston[1], Soo-Jeong Lee[1], Julene Johnson[2], Sandra Weiss[1], Caroline Stephens[1,4]

[1]University of California San Francisco, School of Nursing, Department of Community Health Systems, San Francisco, CA.

[2]University of California San Francisco, School of Nursing, Institute for Health & Aging

[3]University of California San Francisco, School of Nursing, Department of Epidemiology and Biostatistics, San Francisco, CA.

[4]University of Utah, College of Nursing, Gerontology Interdisciplinary Program, Salt Lake City, UT

This manuscript has been formatted for, and submitted to, *Population Health Management.*

Author Note from Chapter 3

Angela Coaston[1], Soo-Jeong Lee[1], Julene Johnson[2], Sandra Weiss[1], Thomas Hoffmann[3], Caroline Stephens[1,4]

[1]University of California San Francisco, School of Nursing, Department of Community Health Systems, San Francisco, CA.

[2]University of California San Francisco, School of Nursing, Institute for Health & Aging

[3]University of California San Francisco, School of Nursing, Department of Epidemiology and Biostatistics, San Francisco, CA.

[4]University of Utah, College of Nursing, Gerontology Interdisciplinary Program, Salt Lake City, UT

This manuscript has been formatted for submission to *BMC Public Health*

Author Note from Chapter 4

Angela Coaston[1], Caroline Stephens[1,4], Julene Johnson[2], Sandra Weiss[1], Thomas Hoffmann[3], and Soo-Jeong Lee[1]

[1]University of California San Francisco, School of Nursing, Department of Community Health Systems, San Francisco, CA

[2]University of California San Francisco, School of Nursing, Institute for Health & Aging, San Francisco, CA

[3]University of California San Francisco, School of Nursing, Department of Epidemiology and Biostatistics, San Francisco, CA

[4]University of Utah, College of Nursing, Gerontology Interdisciplinary Program, Salt Lake City, UT

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Abstract

Examining the Use of Mobile Medical Clinics in the United States and Southern California

Angela Coaston

Background & Significance: Mobile medical clinics have been an underrecognized source of care delivery for vulnerable and marginalized populations for decades; however, little is known about their post-Affordable Care Act impact. The overall goal of this dissertation was to describe predisposing, enabling, and need factors associated with mobile medical clinic use and to examine the effect of frequency of clinic use on chronic illness control.

Methods: Guided by the Andersen Behavioral Model of Healthcare Service Use, this dissertation comprises three separate studies. The first study is an integrative review that synthesizes the current state of the science of mobile clinic research since 2010, identifies the gaps in knowledge, and discusses how those gaps might be addressed. The second is a retrospective cohort study of adults seeking care aboard medical clinics in Southern California between January 1, 2018 to December 31, 2019 (N = 411) and examines their predisposing, enabling and need factors associated with mobile medical clinic use and the relationship between mobile clinic utilization and presence and control of diabetes and hypertension. The third study leverages a subsample of regular mobile clinic users (N = 218) from the parent cohort to examine the association between frequency of mobile clinic visits and control of diabetes and hypertension.

Result: Findings from the integrative review revealed mobile medical clinic use and services vary across the United States. Mobile clinics are used to address chronic illness in both children and adults, and services are particularly targeted towards underserved and uninsured populations. Evidence suggests that adults of all ethnicities benefit from their use, and regular and high utilizers of these clinics experience improved chronic illness outcomes. Findings from the retrospective cohort study of Southern California mobile clinic users (*N* = 411) revealed the majority of the patients are female (68%), married (47%), Hispanic (78%), with a mean age of 50 (range 42–57, SD = 11). Uninsured individuals account for 38% of mobile clinic users. Nearly all mobile clinic patients report a home address (98%) while only 2% indicate homeless housing status. In the adjusted zero-truncated negative binomial regression model, race/ethnicity was associated with the frequency of mobile clinic utilization, with Hispanics having almost twice as many visits than Whites (IRR = 1.68, 95% CI 1.14–2.48). Chronic illness and comorbidities were also significant factors in mobile clinic utilization. Patients with hypertension and diabetes had 1.61 and 1.22 times the rate of mobile medical clinic visits than those without those chronic conditions, respectively (Hypertension: IRR = 1.61, 95% CI 1.36–1.92; diabetes: IRR = 1.22, 95% CI 1.02–1.45). Findings from the retrospective cohort study of regular mobile clinic users suggest that patients with hypertension who were regular users of mobile clinics experienced an increase in hypertension control over time. As number of visits increased, hypertension control increased. However, the trajectory of hemoglobin A1c control over time among regular mobile clinic users did not differ by the frequency of clinic visits.

Discussion and Conclusion: Mobile clinics serve as an important system of health care delivery, especially to vulnerable populations, those who are both insured and uninsured, and those with uncontrolled chronic illness. Evidence in the literature highlights the quality of care, cost effectiveness, and health outcome benefits of mobile medical clinics in the United States. The study findings showed that patients with chronic illness had higher rates of visits than those without chronic illness. Further, among those who were regular users of mobile clinics, patients with hypertension experience better hypertension control over time with more frequent clinic

visits. However, for individuals with diabetes who used mobile medical clinics regularly, their number of visits had no significant effect on hemoglobin A1c control over time.

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Chapter 1: Introduction

Problem Statement

Lack of access to timely and appropriate healthcare places individuals at high risk for poor health outcomes, including increased emergency department (ED) visits, hospital readmissions, and delayed diagnosis and management of chronic diseases (Yu et al., 2017). Nonetheless, 28.9 million adults (ages 18-64)— three million in California alone—are still unable to access healthcare in the United States because they are uninsured (Kaiser Family Foundation, 2019; Kelch & Gallardo, 2017). According to a study by the Kaiser Family Foundation (2019), 45% of uninsured adults reported that they remained uninsured because the cost of coverage was too high and 1 in 5 uninsured adults went without needed medical care due to cost.

Over the past few decades, mobile medical clinics have contributed to the health of underserved populations (Khanna & Narula, 2016), who are marginalized by geographic, social, and/or structural barriers, such as minoritized individuals excluded from adequate services and who encounter barriers to accessing healthcare services. (Gibson et al., 2014; Yu et al., 2017). Mobile clinics are "customized vehicles that travel to the heart of communities, both urban and rural, and provide prevention and healthcare services where people work, live, and play" (Hill et al., 2014, p.1). Mobile clinics are an effective strategy for increasing access to healthcare and reducing health disparities for communities. Mobile medical clinics have a considerable impact on people with limited or no access to healthcare. However, there is a significant gap in knowledge about use of mobile medical clinics in adults with chronic illness, particularly post-implementation of the Affordable Care Act (ACA) which afforded approximately 31 million Americans access to health insurance coverage (Issue Brief HP-2021-13,2021).

Background and Significance

Access to healthcare, including insurance coverage, healthcare services, and timely care, is an important determinant of health. However, in the United States, millions of people are unable to access healthcare (Medical Economics®, 2014). Even with the Patient Protection and Affordable Care Act (ACA) providing subsidies that lower insurance costs, offering Medicaid-expansion programs and supporting delivery methods designed to lower the cost of care (U.S. Department of Health & Human Services, 2018), still, in 2017, 28 million people did not have health insurance (Berchick et al., 2018). Of the 62 million who were unable to access primary care services, 43% were low-income and 28% lived in rural areas (Medical Economics®, 2014).

Social determinants of health are conditions in the environment where people live, work, play, and pray. They affect a wide range of health and quality of life outcomes and risks (Office of Disease Prevention and Health Promotion [ODPHP], 2021). Barriers to healthcare access leads to unmet health needs, delays in receiving appropriate care, and preventable hospital admissions (Clarke et al., 2017). Lack of insurance is one of the most formidable barriers to accessing healthcare (Institute of Medicine, 2002).

Quality healthcare is essential to achieve health equity and increase one's quality of life. Limited access to care impacts each individual's ability to reach their full potential, negatively affecting their quality of life. According to the 2019 Kaiser Foundation Hospital report, Southern California performs worse on several indicators of residents' access to care compared to the state as a whole. For example, two cities in San Bernardino County, Fontana and Ontario, have lower rates of primary care visits (66.6% and 66.8%, respectively) compared to the rest of the state (72.9%). Additionally, the prevalence of diabetes is higher in the Fontana (11.5%) and Ontario (10.2%) service regions compared to the rest of California (7.3%). In addition, the prevalence of obesity is higher in the Fontana and Ontario service region (35.7% and 32.1%, respectively) compared to the rest of California (29.6%) (Annual Report, 2019). These San Bernardino County residents also report more poor physical health days per month, with Fontana residents reporting 4.4 days per month and Ontario residents reporting 4.3 days per month, compared to the 3.7 days per month reported by residents in the rest of the state (Kaiser Foundation Hospital, 2019).

More than 2,000 mobile clinics currently operate in the United States, providing an estimated 5 to 6.5 million visits annually to more than 2.1 million uninsured and 2.3 million publicly insured persons (Malone, 2020). Historically, mobile medical clinics have served the most vulnerable populations in the nation, providing quality healthcare access to migrant workers, women in need of prenatal care, children with asthma, and minorities with HIV (Yu et al., 2017). These clinics are well-positioned to provide needed healthcare services to diagnose and treat chronic diseases that disproportionately affect these populations (Collective Research Network of Mobile Clinics, 2013). Research suggests that mobile clinics can improve quality of life of care recipients and save millions of dollars by reducing unnecessary emergency department visits (Hill et al., 2016). In addition, mobile clinics reduce hospital readmissions, further curtailing healthcare costs. However, little is known about the use of mobile medical clinics in Southern California and the effect of mobile medical clinic use frequency on chronic illness outcomes in individuals who seek care aboard these clinics on wheels.

Specific Aims and Hypotheses

The overall goals of this dissertation study is to investigate the current state of the science of mobile medical clinics nationally, to identify gaps in the literature, to examine predisposing, enabling and need factors associated with mobile medical clinic use and the relationship between mobile clinic utilization and presence and control of diabetes and hypertension, and to examine the association between frequency of mobile clinic visits and control of diabetes and hypertension. The specific research aims and hypotheses for this dissertation are as follows:

Specific Aim 1: Review the state of the current literature about mobile medical clinics in the United States (Chapter 2). The review was designed to critique the existing research, to identify the gaps in knowledge, and to discuss how the gaps might be addressed. Specifically, this review aimed to determine (a) descriptive characteristics of populations served by mobile medical clinics in the United States, (b) utilization patterns of individuals who seek care aboard mobile medical clinics, and (c) health outcomes of individuals with chronic disease.

Specific Aim 2: Describe visit frequency among adults who utilize mobile clinics by sociodemographic and health characteristics (e.g., age, sex, ethnicity, insurance status, zip code, Charlson Comorbidity Index score) and presence and control of chronic illness (i.e., diabetes: hemoglobin A1c $< 6.5\%$ and hypertension: blood pressure $< 140/90$ mmHg) (Chapter 3).

Hypothesis 1: Use of mobile clinics will differ by sociodemographic and health characteristics and presence and control of chronic illness.

Hypothesis 2: The prevalence of controlled diabetes and/or hypertension will differ by sociodemographic characteristics.

Specific Aim 3: Examine the relationship between mobile clinic utilization and presence of chronic illness, controlling for sociodemographic and health characteristics (Chapter 3).

Hypothesis 3: Patients with chronic illness (i.e., diabetes and hypertension) will have a higher number of mobile clinic visits compared to those without chronic illness, controlling for sociodemographic and health characteristics.

Specific Aim 4: Among those who receive regular mobile clinic care (3+ visits in a year), examine the association between frequency of visits and controlled chronic illness status (e.g., hemoglobin A1c <6.5% and blood pressure < 140/90 mmHg), after adjustment for patient sociodemographic and health characteristics (Chapter 4).

Hypothesis 4: Adults with well-controlled diabetes or hypertension will use mobile clinics more frequently than those without well-controlled diabetes or hypertension, after adjusting for sociodemographic and health characteristics.

Theoretical Framework

This study was guided by the Andersen's Behavioral Model (ABM), which is one of the most frequently used frameworks for explaining and predicting patient utilization of healthcare services and related outcomes (Andersen, 1973, 1995, 2008; Andersen & Newman, 1995). It uses a broad systems perspective and posits that health services use is a function of a complex and interrelated set of societal factors, system factors, and individual factors that are associated with people's decisions to seek care.

The underlying premise of the ABM is that people's use of health services is a function of their predisposition to use services, factors which enable or impede use, and their need for care (Andersen, 1973, 1995, 2008; Andersen & Newman, 1995). Its feedback loop provides a holistic perspective of the health determinants that can influence access to healthcare. Understanding health services use is best accomplished by focusing on contextual and individual determinants. This feedback loop shows that health outcomes can affect subsequent enabling and need characteristics of the individual and their utilization of health services.

Specifically, predisposing characteristics are most distal to service use and include demographic characteristics such as age, gender, race, ethnicity, and health beliefs, which influence engagement towards healthcare utilization. Enabling factors, or factors that are required for services to take place, include individual income and wealth, education, insurance, transportation and access to regular sources of care, which allow or impede an individual's ability to use healthcare services. Enabling resources also include health facility and provider access, as well as health policies for reimbursement services. Need characteristics, which are most proximal to service use, are medical conditions that prompt the importance of medical care. The presence of chronic illnesses, such as diabetes, hypertension and depression, are classified as need characteristics. Figure 1.1 provides an overview of the adapted ABM conceptual framework, guiding this dissertation study that will examine the effects of predisposing, enabling, and need variables on mobile medical clinic utilization and chronic illness biomarkers.

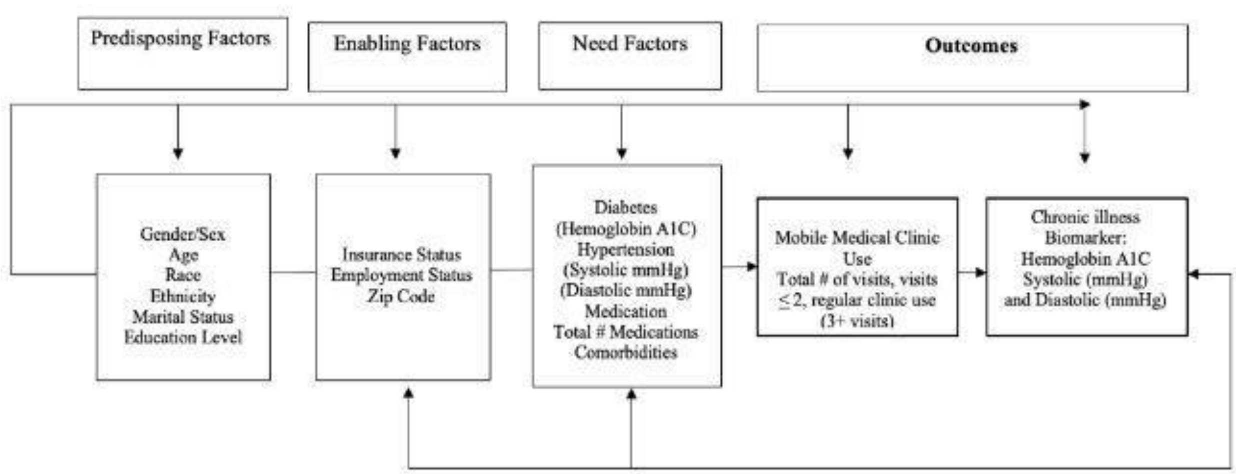

Figure 1.1 Conceptual Framework: Andersen's Behavioral Model

Organization of the Dissertation

This dissertation consists of five chapters. Chapter 1 provides an introduction and background on access to healthcare and mobile medical clinic use in adults with chronic illness and describes the dissertation study's purpose and specific aims. Three studies were conducted to achieve the study aims and are presented in Chapters 2, 3, and 4, which were formatted for publication in the journal which it was or will be submitted

Chapter 2, “Mobile Medical Clinics in the United States Post-ACA: An Integrative Review,” reviews the current state of the literature regarding mobile medical clinics in the United States. The review was designed to critique the existing research, to identify the gaps in knowledge, and to discuss how the gaps might be addressed. Specifically, this review aimed to describe the characteristics, utilization patterns, and health outcomes of populations served by mobile medical clinics in the United States.

Chapter 3 includes the manuscript, “Factors Associated with Mobile Medical Clinic Use: A Retrospective Cohort Study.” This retrospective study analysis leveraged data from a clinic in Southern California. The aims for this study were to (a) describe visit frequency among, adults who utilize mobile clinics as a function of sociodemographic variables, health characteristics, and the presence and control of chronic illness; and (b) to examine the relationship between mobile clinic utilization and the presence of chronic illness, controlling for sociodemographic and health characteristics.

The aforementioned study contributed to the final study presented in Chapter 4 entitled “Examining the Association Between Frequency of Mobile Clinic Visits and Chronic Illness Control” The objective of this study was to examine the association between visit frequency and controlled chronic illness status after adjustment for patient sociodemographic and health characteristics. In Chapter 5, findings are summarized and synthesized from the three studies and implications and future directions are discussed.

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Chapter 2:

Mobile Medical Clinics in the United States Post-ACA:

An Integrative Review

Abstract

Despite changes brought about by the 2010 Affordable Care Act (ACA), millions of individuals are still unable to access healthcare in the United States (U.S.). Mobile medical clinics have been an invisible force of care delivery for vulnerable and marginalized populations for decades; however, little is known about their impact post-ACA. The purpose of this paper is to review and critique the state of the current literature about mobile medical clinics in the U.S. since 2010, identify the gaps in knowledge, and discuss how the gaps might be addressed. Guided by the Anderson Behavioral Model, we followed Whittemore and Knafl's integrative review methodology. The search was conducted in 6 databases and delivered 1,934 results; 341 articles were removed as duplicates. Following the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines, 2 independent reviewers screened and adjudicated the remaining titles, abstracts and full-texts, yielding twelve articles in the final review. The Mixed Methods Appraisal Tool (MMAT) was used to evaluate the quality of the articles. Studies revealed variation in quality, study design and location; and diversity of chronic diseases and populations addressed (e.g., children with asthma, complementary alternative medicine use with children, adults with diabetes and hypertension, patients with chronic disease with an emphasis on the patient experience, and utilization patterns in migrant farmers). Mobile medical clinics provide care for prevention, treatment and management of chronic illness in high-risk adults and children and the wide geographic spread of these studies confirm their broad use across the United States. Mobile clinics provide a return on investment through emergency room avoidance, decreasing hospital length of stay and improving chronic disease management. Children with Asthma experienced a reduction in emergency department visits and adults with hypertension experienced significant reduction in blood pressure.

Introduction

Despite changes brought about by the Affordable Care Act (ACA) in 2010, millions of vulnerable individuals are still unable to access healthcare in the U.S.[1] Access to healthcare includes insurance coverage, healthcare services, and timely care. In 2017, 28 million individuals were without health insurance and of the 62 million who were unable to access primary care services, 43% were low-income and 28% lived in rural areas.[3] Lack of access to timely and appropriate healthcare places these individuals at high risk for poor health outcomes.[2]

Evidence suggests that mobile medical clinics are one effective strategy for increasing healthcare accessibility and reducing health disparities for such communities marginalized by geographic, social, and/or structural barriers.[4] In fact, mobile medical clinics have been an invisible force of care delivery for vulnerable and marginalized populations across the nation for decades.[5,6] They have driven to the doorsteps of communities to provide access to quality healthcare for migrant workers, women in need of prenatal care, children with asthma, and minorities with HIV. [7-11] With over 2,000 mobile clinics currently operating in the U.S., providing an estimated 5 to 6.5 million visits annually and serving over 2.8 million individuals who are uninsured, they are uniquely positioned to provide the needed healthcare services to diagnose and treat chronic diseases that disproportionately impact these populations (See Figure 2.1). The terms, vulnerable, marginalized and underserved will be used interchangeable and are defined as minoritized individuals excluded from adequate services and who encounter barriers to accessing healthcare services.

Such mobile clinics are an important, yet understudied, health delivery model that has high potential to improve health outcomes, decrease health system costs, and minimize health disparities for vulnerable and underserved populations. Thus, it is critical to better understand how mobile medical clinics address access to health care utilization for vulnerable individuals and how they serve to improve health outcomes and reduce health disparities in the United States. Little is known about their impact post-ACA including descriptive characteristics, utilization patterns, and health outcomes of individuals who seek care aboard mobile medical clinics.

The purpose of this integrative review is to review the state of the current literature about mobile medical clinics in the United States, to critique the existing research, to identify the gaps in knowledge, and to discuss how the gaps might be addressed. The specific aims of this review are to determine (a) descriptive characteristics of populations served by mobile medical clinics in the United States, (b) utilization patterns of individuals who seek care aboard mobile medical clinics, and (c) health outcomes of individuals with chronic disease.

Conceptual Framework

The Anderson Behavioral Model (ABM) is one of the most frequently used frameworks for explaining and predicting patient utilization of healthcare services and related outcomes.[12-14] It uses a broad systems perspective and posits that health services use is a function of a complex and interrelated set of societal factors, system factors, and individual factors that are associated with people's decisions to seek care**.** The underlying premise of the ABM is that people's use of health services is a function of their *predisposition* to use services, *factors which enable or impede use*, and their *need for care.*[12-14]

The ABM aligns perfectly with studying individuals and populations' use of mobile medical clinics as an access point for care. This model was originally developed to guide research studies that explain and predict utilization patterns of health systems use and therefore is very useful for examining utilization patterns for mobile medical clinics in the United States.

Specifically, *predisposing characteristics* include demographic characteristics such as age, gender, race, ethnicity, and health beliefs, which influence engagement towards healthcare utilization. *Enabling factors* include individual income and wealth, education, access to regular sources of care which allow or impede an individual's ability to use healthcare services, insurance, and transportation. Enabling resources also include health facility and provider access as well as health policies for reimbursement services. *Need characteristics* are medical conditions which prompt the necessity for medical care. The presence of chronic disease such as diabetes, asthma, and hypertension are classified as need characteristics.

Method

This review followed Whittemore and Knafl's (2005) integrative review methodology, allowing for a broad exploration of mobile medical clinics, the phenomenon of interest, and incorporation of both quantitative and qualitative studies.[15] A mobile medical clinic was defined as vehicles (e.g. vans, trucks, recreational vehicles) which were converted to clinics and provided primary care, preventative care, and/or health care screening.

Literature Search

The current review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines.[16] Under the guidance of a university librarian, a systematic search of the research literature was initiated using the following databases with numbers in parentheses representing the total for each search out of 1,934 results: PubMed (n= 981), Web of Science (n=445), EMBASE (n=235), CINAHL (n=133), Sociological Abstracts (n=17), and Social Services Abstracts (n= 123). A combination of keywords was used to ensure maximum results of relevant articles. The search strategy had a single concept, which was mobile clinics; however, six terms were used: mobile health clinic(s), mobile health unit(s), mobile health van(s), mobile medical clinic(s), mobile medical unit(s), and mobile medical van(s) (See Table 2.1). Non-English articles were excluded. Only studies in the United States were included.

Articles identified by the search strategy went through additional screening according to the inclusion and exclusion criteria. The following inclusion criteria were used:

- Quantitative, qualitative, and mixed-method studies, systematic reviews and meta-analysis that included mobile medical and mobile health clinics, units, and vans.
- Studies that included primary care management, preventative care, and health screening for chronic disease aboard mobile clinics, units, and vans.
- Peer-reviewed articles published from 2010 to 2021.

The exclusion criteria were as follows:

- Editorials, case reports, and non-scientific evaluative literature.
- Studies involving specialty clinic services (e.g. mobile dental, HIV, mammography, ophthalmic).
- Studies outside of the United States.
- Articles dated prior to 2010.

After gathering potential articles to be included in this review, all articles were entered into Endnote X8 and imported into Covidence, a web-based software platform used to streamline the systematic review process.[17] Once imported, Covidence software was used to identify and remove the duplicates then organize the articles for initial screening. Titles and abstracts were screened for initial eligibility. For specificity, full-text articles were read to determine eligibility and the reason for exclusion was documented on the PRISMA Flow Diagram (See Figure 2.2). All initial publications were screened for eligibility by two reviewers. Both reviewers had to reach a consensus regarding the entry on the inclusion and exclusion of the article and the data was entered into the data form. If there was a question about an article, the article was discussed until an agreement was reached to include or exclude the article in the study. The bibliographies of key articles were hand-searched; however, no new articles were found.

Data Evaluation

The Mixed Methods Appraisal Tool (MMAT; version 2018) was used to evaluate the quality of all included articles.[18] As a critical appraisal tool, the MMAT was used to assess the quality of the mixed studies, including qualitative, quantitative, and mixed-method studies. Five categories were used to appraise the studies, including qualitative research, randomized controlled trials, non-randomized studies, quantitative descriptive studies, and mixed-methods studies. Each of the categories was evaluated according to the MMAT quality criteria.

Data Analysis

Evaluation data were entered into the data quality assessment form (See Table 2.2). Primary sources were divided into subgroups: qualitative, quantitative randomized control trial, quantitative non-randomized control trial, and quantitative descriptive studies. This initial subgroup classification was based on study type, chronology, settings, and sample characteristics. Further, ABM was used to organize the variables of interest including predisposing factors, enabling factors, and need factors. This approach provided succinct organization of the literature, facilitating a systematic comparison of the primary sources (See Table 2.3 & Table 2.4). Data were compared across primary sources to identify patterns, themes, and relationships. Variables and important themes were identified.

Results

The search in six different databases relating to mobile medical clinic utilization in the United States since 2010 delivered 1,934 results. In total, 341 articles were removed because they were identified as duplicates. After screening titles, abstracts, and full-texts on relevance for the research aim, 12 articles were included in the present integrative literature review (See Figure 2.3). Most of the full-text articles were excluded due to study dates outside our search criteria, studies that were international, or studies that were not on mobile clinics. Other reasons for exclusion were articles that followed an evaluative design, were editorials, or were pilot studies.

Quality of Included Articles

After assessing the quality of the articles with the MMAT, most of the articles were found to be of fair to good quality. One article was found to be of poor quality due to no aim or research question, measurements were unclear, and only demographic data were reported.[19] Since it did not meet the MMAT quality standards, it was excluded from the final results. In many of the studies, confounders were not taken into consideration regarding the correlation found between chronic disease and enabling factors such as income, insurance status, and healthcare access. Confounding variables are variables that "compete with the exposure of interest in explaining the outcome of a study".[20, p.10.] Such variables may mask an actual association or mistakenly demonstrate an obvious association between treatment and outcome when no real association between them occurs.[20] Other reasons for lower quality were small sample sizes and decreasing generalizability in the results. A detailed table of the quality assessment of the included articles can be found in the Quality assessment table based upon MMAT (See Table 2.2).

General Findings in the Selected Articles

The selected articles were screened for predisposing factors, enabling factors, and need factors. The main findings are summarized in Tables 2.3 and 2.4. Twelve articles represented 12 studies but only data from 7 unique mobile clinic entities. For example, 3 articles utilized the same setting data from The Family Van [8,11,21] and two articles utilized data from the Community Health Care Van.[22,23]

Articles were published from 2010 to 2019, with most of the articles being recent (2017 to 2019). Various study designs were among the included articles: two qualitative studies, [9,21] one randomized controlled trial,[24] five quantitative non-randomized studies,[25,26,27] and four quantitative descriptive studies.[11,19,22,23,28,29] Studies varied broadly, with sample sizes ranging from 25 participants to greater than 8,000. Data sources ranged from primary data collected on small convenience samples, archived medical records, return on investment analysis using Centers for Medicare and Medicaid Services Market Basket rates, and healthcare utilization and prescription claims records.

The overall aim of the studies with respect to mobile medical clinic use was diverse. Articles studied the access to, the effects of, the experience of, the return on investment of, and the accessibility and utilization patterns of mobile medical clinic use. Nevertheless, most often the use of mobile or Breathmobile (asthma management) clinics or the outcomes of such use were investigated.

The selected articles were from different geographical regions throughout the United States. (See Figure 2.2): Georgia, [29] California,[26] Massachusetts,[8,11,21,22] Maryland, [22,23] and Texas.[25,28] All studies but one were conducted in an urban setting, and the remaining study was located in a rural setting.[28]

A few types of mobile clinics were represented: three were Breathmobiles [24, 26,28] one studied a mobile farm clinic,[29] and the others were studies of mobile health clinics or vans. All clinics provided free healthcare services for the uninsured except one whose participants were Medicaid insured.[26] All of the articles that involved Breathmobiles reported children with asthma as their population of focus.[24,26,28] One mobile clinic focused on the pediatric population.[25] However, all of the other mobile clinics reported care for adult underserved populations.[8,11,21,22,23,27,29]

The selected articles also showed diversity of chronic diseases and populations that were addressed: three articles reported on patients with asthma,[24,26,28] one on complementary alternative medicine use with children,[25] one on diabetes,[27] one on hypertension,[11] and four articles reported on patients with chronic disease in general with an emphasis on the patient experience,[8,21] one on varied diseases in migrant farmers,[29] and determinants of utilization patterns.[22,23]

Predisposing Factors

Each of the studies except one reported descriptive characteristics including, age, gender and race/ethnicity.[28] The age for the pediatric population served by Breathmobiles ranged between ages 4 to 7 years.[24,26] The other pediatric study population mean age was 8.4.[25] The adult populations served by mobile clinics varied with a mean age from 33 to 56.8 for all studies. All but two studies reported a majority of male participants ranging from 53% to 87%. Race/Ethnicity was reported in all studies except one.[28] Six studies reported a high percentage of Blacks served on mobile medical clinics. Hispanics and Whites were the second highest ethnic groups who utilized mobile medical clinics (See Table 4). The remaining four studies reported a majority of Hispanic,[25,26] Mexican,[29] or Central American[27] participants.

Enabling Factors

Income, insurance, education and a regular source of care were common enabling factors noted across all studies. All studies included low-income participants, many of whom were also uninsured or publicly insured. For example, in two studies, 100% of the participants had no insurance.[25,27] Other studies showed that 52% of the participants on the Family Van were publicly insured while 55% of participants using the Community Health Care Van had no insurance.[22, 23] Two articles that studied patient mobile clinic utilization patterns reported frequent healthcare utilization among inner city populations who used mobile medical clinics as a regular source of care. The studies reflected that foreign-born participants had significantly higher rates of visits than the average American-born person (3.42 additional visits on average; $p<.001$) and those with hypertension had 1.09 additional visits on average ($p<.009$; Gibson, 2017). Fewer visits were reported among those who did not complete high school (0.26 fewer visits; $p <.001$).[23] Only 4 of the 12 studies reviewed reported on educational level of the mobile clinic patients. Most studies found 64-69% of patients had at least a 12th grade education,[11] however the mobile clinic sample in the Luque study (2012) had a mean of 5.5 (SD =1.7) years of education.

Need Factors

Chronic diseases, such as asthma and hypertension, were the most common need factors examined in mobile clinic outcome studies. Three studies examined the influence of mobile clinics on populations with asthma. Two Breathmobile studies reported a decrease in emergency department (ED) utilization as a result of their services rendered as a usual place of access to care. Children with asthma who received care at the Breathmobile had a 52% reduction in ED visits compared to 13% for those in the usual care cohort ($p= <.05$; Morphew et.al.,2017). For example, Mophew et. al (2017) used healthcare utilization and prescription claims, as well as asthma medication ratios (AMR) and ED utilization as quality indicators. Findings revealed the Breathmobile group, compared with a usual care group, improved in their AMR and had fewer ED visits (AMR >.50, 49% ED Visits, P<.05). Specifically, investigators found an AMR of greater than .50 was associated with 49% fewer ED visits.[23] Morphew et al's study was the only study that used AMR as an indicator for improved asthma outcomes. Furthermore, there was only one Breathmobile that examined the return on investment (ROI) of the clinic services on asthma.[28] This study found that there was a significant economic impact resulting in an "average return of $1.32 and community ROI of $1.45 with an estimated benefit of $445,123.00 and cost avoidance of $263,853.01".[28]

Eakin et al (2012) conducted a randomized control trial (RCT) evaluating the effects of four interventions on asthma: Breathmobile services only, facilitated asthma communication intervention (FACI) only, or both Breathmobile and FACI on asthma outcomes versus standard care. This study showed that these services resulted in only a slight decrease in self-reported emergency department utilization for the Breathmobile and FACI group at 6 months (Incident rate ratio [IRR]=.23 p=.08). Overall, for this RCT, "these community-based intervention strategies did not result in any significant improvements in asthma management or asthma morbidity among low-income preschool children".[24]

Only one study focused on hypertension, examining the association of a mobile clinic use with cost savings for lowering blood pressure and emergency department use.[11] This study used a data set of 5,900 patients who made greater than 10,000 visits to a mobile clinic over a two-year period. There was an average reduction in blood pressure of 10.7 mm/kg and 6.2 mm/kg in systolic and diastolic blood pressure, respectively. Return on investment, based upon the estimated saving from reduced relative risk of stroke and myocardial infarction through blood pressure reduction and savings from emergency department avoidance, was calculated to be $1.3 million.[11]

Another study measured type 2 diabetes in adults who were provided continuous access to medication through a mobile clinic. This was the only study that explored the relationship between continuous access to medication via a mobile clinic and biomarkers such as, hemoglobin A1c (HbA1c), low-density lipoprotein (LDL), systolic blood pressure (SBP), and diastolic blood pressure (DBP).[27] In addition to diabetes, 95.4% of the participants had comorbid conditions and received medications for hypertension and/or dyslipidemia. Significant pre- to post-intervention positive effects were noted on HbA1c (−0.69 +/- 1.8%, 95% CI [−1.14, −0.25], t (64) = −3.11, p = .003), LDL (−13.9 +/- 37.4 mg/d. 95% CI [−23.1, −4.6], t (64) = −2.99, p = .004) and SBP (−4.5 +/- 15.8 mmHg, 95% CI [−8.4, −0.59], t (64) = −2.30, p = .025). There was no significant change in DBP. This was the only study to highlight that in addition to gaining a regular and sustainable source of necessary medications via the mobile clinic, this underserved population also benefited from a consistent source of care.[27]

Other Factors

Two articles representing one study population were qualitative pieces that narrated the voices of patients who received preventative health and/or chronic disease management aboard a mobile clinic. Both articles reflected the responses of 25 participants.[8,21] Key themes from these studies included: providers communicating understandably, providers creating a culture of respect and inclusivity, and providers having diverse knowledge of the community. In addition, participants indicated services were expeditious, free, and multiple services were provided on site. Finally, the clinic location was important; it parked in proximity to their residence.[8]

The second article, using the same study data, provided a story-telling process in which a narrative of generosity emerged during the analysis. The voices of those who received care aboard this mobile clinic expressed that there was a sense of welcome and this welcoming environment stimulated patient health behaviors and empowered a "pay it forward" attitude overall.[21]

Another retrospective cohort study reported the use of complementary and alternative medicine (CAM) on uninsured children receiving care aboard a mobile clinic.[25] Among 250 uninsured children included in this study, 64 (25.6%) were taking CAM. Although similar to the other mobile clinic services, this study uniquely reported on CAM use among children who sought free services and underscored the importance of health providers inquiring about CAM use in the pediatric population. Interestingly, prayer was considered a CAM and 15% of children along with 17% of parents reported they used prayer as a form of therapy. Finally, one mobile clinic study described the health outcomes of migrant farmers. This study found that the most common chronic conditions reported by this group included hypertension, musculoskeletal disorders, and eye problems. This was the only study with the aim of understanding the occupational hazards of this population.[29]

Discussion, Strengths and Limitations

Guided by ABM, this integrative review was organized by predisposing characteristics, enabling factors, need characteristics. The elements of the model provided a clear way to describe and to underscore common factors in mobile medical clinics use. The results of the current review suggest a clear need for mobile medical clinics for a variety of services that target high-need and vulnerable populations. The wide geographic spread of these studies confirms their broad use across the United States. There is significant indication that mobile clinics provide a return on investment through emergency room avoidance, decreasing hospital length of stay and improving chronic disease managment.[30] Considerable attention has been given to calculating the return on investment of these clinics. Growing evidence supports the use of mobile medical clinics in the United States post-ACA. Literature reviews as well as qualitative and quantitative studies highlight the quality of care, cost effectiveness, and health outcome benefits of mobile medical clinics.

Children and middle-aged adults with lower income and at least a high school education are the most likely to use mobile medical clinics. Also, people with chronic disease who are undocumented and have unstable housing seem to benefit from accessing mobile medical clinics, especially those in urban settings. All ethnic groups benefit from utilization of mobile clinics; however, Blacks and Hispanics are the most likely ethnic groups to seek care aboard mobile clinics.

The current review had several limitations to consider. While a systematic approach was employed to search and select articles, this was not a systematic review. Consequently, it is possible that bias existed in the search process. Nevertheless, a clear methodological approach was used to conduct this integrative review. Multiple databases were searched to reach saturation of the present literature under review. To minimize bias, a second reviewer participated in the initial review. A software program called Covidence was used to provide organization and collaboration for the screening, abstract, title, and full-texted review.

Second, the aims of the studies reviewed differed greatly. A major limitation of this review was that mobile clinics vary in their services and populations served, and only two used a framework to guide the study. Although most of the studies included specific objectives, confounders were not included in most. Hence, it was difficult to determine the quality of many of the studies included in this review. However, MMAT was used to assess the quality of studies reviewed.

Two studies did not meet the quality assessment criteria; however, the content of one such study was compelling and necessary to include in this literature review. For example, one study by Hill (2014) synthesized data collected from the Mobile Health Map, an online platform where mobile clinics across the United States aggregate their data to capture the scope, value, and geographic spread of the clinic services.[30] According to this study, 1,500 mobile clinics received 5 million visits from uninsured or publicly insured persons throughout the nation. Common barriers to care for low-income and minority communities included getting an appointment, transportation/distance, insurance or cost requirement, and lack of trust with providers. This study showed that mobile clinics combat these barriers by driving to the communities in need, providing free services, and providing culturally and linguistically appropriate services.[30]

Implications for Future Research & Policy

The persistent utilization of mobile medical clinics for the past few decades has contributed to the need for rigorous investigation of the collective impact these clinics on wheels have made on individuals and communities at large. An increasing body of knowledge is emerging that validates the ideas and assumptions that mobile medical clinics are accomplishing their mission to provide cost-effective healthcare and to meet the healthcare access needs of underserved individuals and populations across the nation. [31,32]

The current review revealed that there are still significant knowledge gaps about current utilization patterns and health outcomes for adults who access this form of healthcare delivery in communities around the nation. Future studies should include randomized control trials that provide interventions for specific chronic conditions guided by conceptual frameworks such as ABM or Social Determinants of Health to better understand the predisposing, enabling, and need factors associated with health outcomes of underserved populations seeking access to healthcare aboard mobile medical clinics. This knowledge will continue to aid in identifying populations who will benefit most from specific interventions to reduce negative health conditions, as well as evaluate evidence-based interventions implemented aboard mobile clinics measuring their impact over time. Understanding the patient characteristics and health outcomes of individuals served on mobile medical clinics may provide researchers, policy makers and health systems leaders the necessary data needed to guide clinical practice interventions in unconventional spaces, to support non-traditional delivery models, and to leverage policy development and change for health care access for vulnerable populations.

Conclusion

Research demonstrates that mobile medical clinics are mostly used by vulnerable populations. There is indication that mobile clinics provide a return on investment through emergency room avoidance, decreasing hospital length of stay and improving chronic disease managment.[30] Suggested directions for interventions are to target underserved populations who live with specific chronic disease using an evidence-based intervention that can be implemented with both a control group and an experimental group. This approach could improve the generalizability of the impact this model of care has on populations living with chronic disease and solidify the validity of the utilization of mobile medical clinics in the United States as a sure source of access to quality care. Furthermore, foundational studies have been conducted to support evaluating the return on investment[7,10,33,34] and determining utilization patterns.[22] These methodologies can be further tested in future research to add to the literature validating the impact and value of mobile clinics on chronic disease management and population health in the United States. Results of future studies could support health systems, policy makers and healthcare providers seeking scientifically sound strategies and models of care that are effective in hard-to-reach communities.

Understanding how mobile medical clinics bridge the gap in health care can inform effective community-clinical linkages which are critical for reducing health disparities, improving population health and increasing quality of care.[35] As the importance of social determinants of health and community-clinical connections are recognized, mobile medical clinics are positioned to inform policy, to improve chronic disease health outcomes, and to advance health equity among vulnerable populations[35]

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Figure 2.1 Mobile Health Map United States
[https://Mobile Health Map United States]()

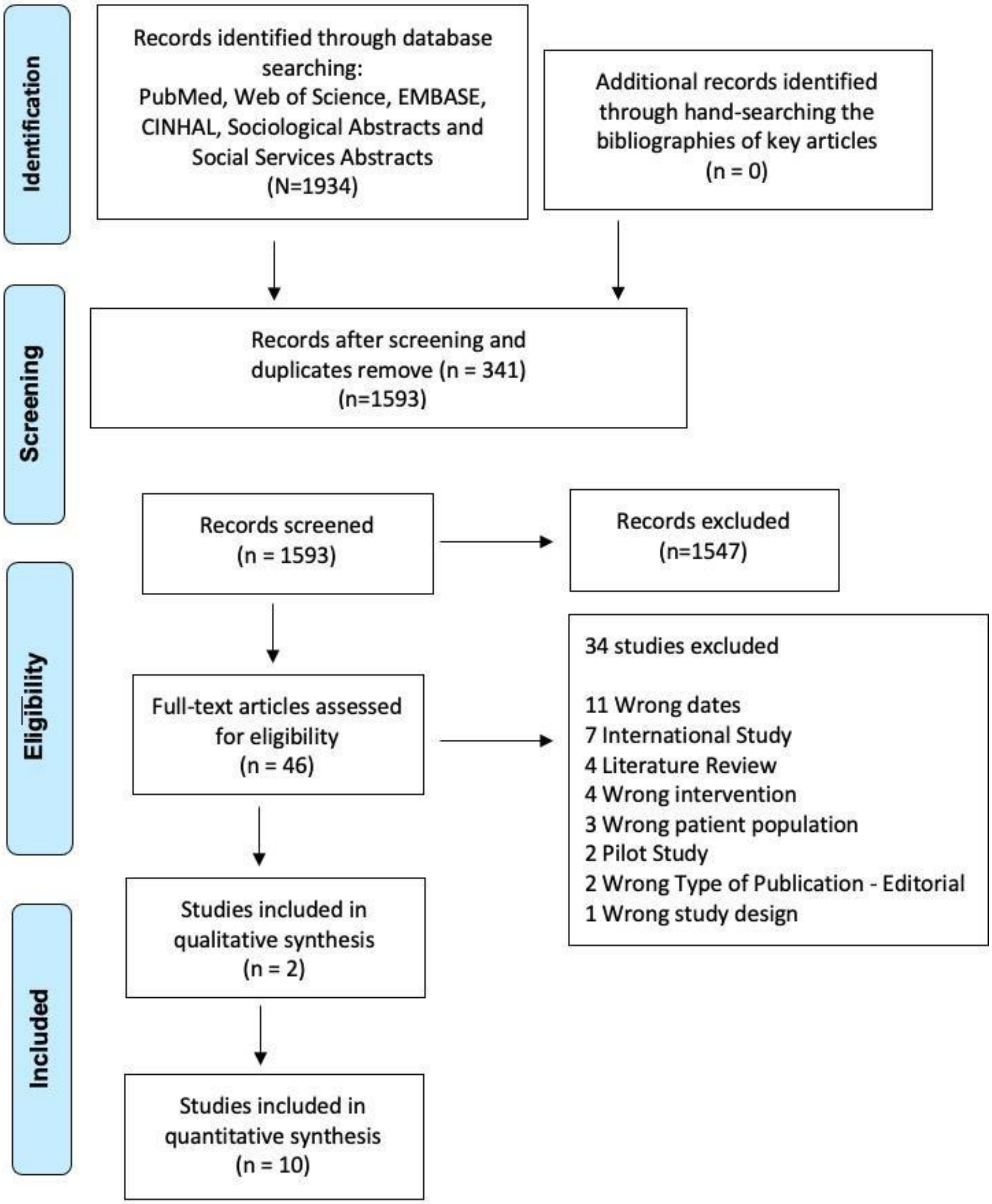

Figure 2.2 PRISMA 2009 Flow Diagram

Table 2.1 Search Terms

PUBMED	
Search Terms	
1.	"mobile van"[All Fields] OR "mobile vans"[All Fields] OR "mobile clinic"[All Fields] OR "mobile clinics"[All Fields] OR "Mobile medical clinic"[All Fields] OR "mobile medical clinics"[All Fields] OR "Mobile medical unit"[All Fields] OR "mobile medical units"[All Fields] OR "mobile medical van"[All Fields] OR "mobile medical vans" [All Fields] OR "mobile health clinic"[All Fields] OR "mobile health clinics"[All Fields] OR "mobile health van"[All Fields] OR "mobile health vans"[All Fields] OR "mobile health unit"[All Fields] OR "mobile health units"[mh] (("2010/01/01"[PDAT] : "3000/12/31"[PDAT]) AND English[lang])
Web of Science	
Search Terms	
2.	"mobile van" OR "mobile vans" OR "mobile clinic" OR "mobile clinics" OR "Mobile medical clinic" OR "mobile medical clinics" OR "Mobile medical unit" OR "mobile medical units" OR "mobile medical van" OR "mobile medical vans" OR "mobile health clinic" OR "mobile health clinics" OR "mobile health van" OR "mobile health vans" OR "mobile health unit" OR "mobile health units" AND [excluding]: PUBLICATION YEARS: (2007 OR 1995 OR 1976 OR 2006 OR 1994 OR 1974 OR 2005 OR 1993 OR 1972 OR 2004 OR 1992 OR 1971 OR 2003 OR 1991 OR 1970 OR 2002 OR 1990 OR 1969 OR 2001 OR 1989 OR 1966 OR 2000 OR 1981 OR 1965 OR 1999 OR 1979 OR 1950 OR 1998 OR 1978 OR 1928 OR 2009 OR 1997 OR 1977 OR 1927 OR 2008 OR 1996) AND TOPIC: (United States
EMBASE	
Search Terms	
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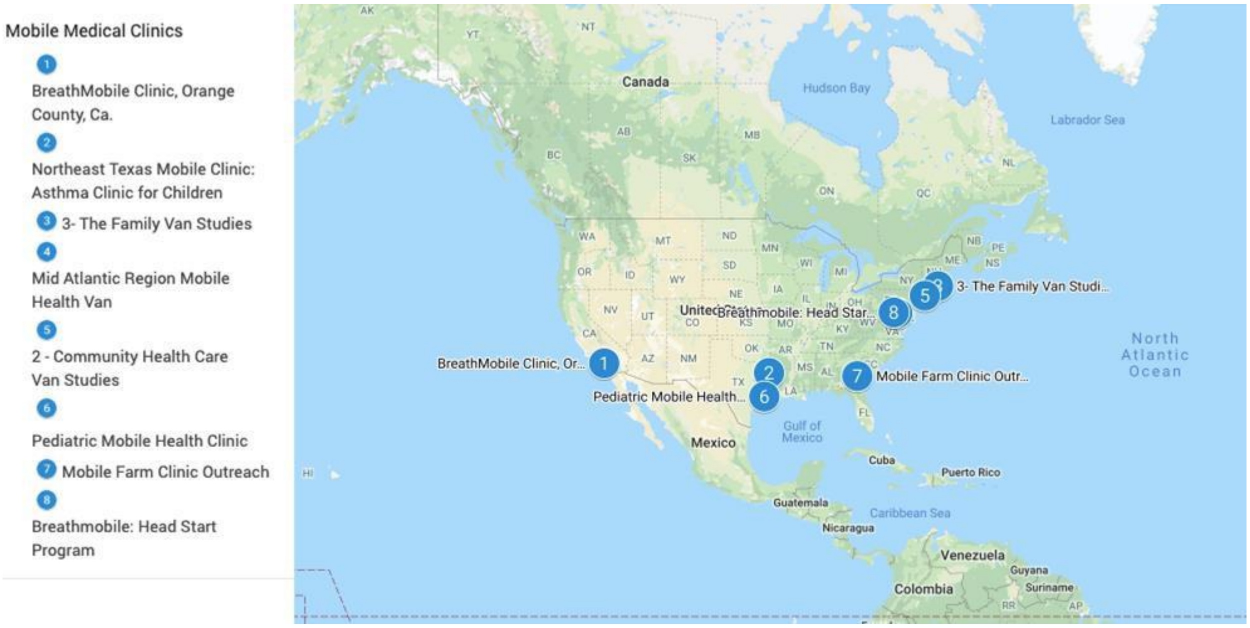

Figure 2.3 Mobile Medical Clinic Studies Post-ACA

Table 2.2 Quality Assessment of Study

	Name/year published	Screening questions for all types		Category of study and methodological quality criteria key ✓= yes, ✕= no, can't tell = ■			
				1. Qualitative			
		S1. Are there clear research questions ?	S2. Do the collected data allow to address the research questions?	1.1 Is qualitative approach appropriate for answer the research question?	1.2. Are the qualitative data collection methods adequate to address the research question?	1.3. Are the findings adequately derived from the data?	1.4. Is the interpretation of results sufficiently substantiated by data?
1	Bouchelle et al., 2017	✓	✓	✓	✓	✓	✓
2	Carmack, et. al., 2017	✓	✓	✓	✓	✓	✓
				2. Quantitative randomized controlled trials			
		S1. Are there clear research questions ?	S2. Do the collected data allow to address the research questions?	2.1. Is randomizatio n appropriately performed?	2.2. Are the groups comparable at baseline?	2.3. Are there complete outcome data?	2.4. Are outcome assessors blinded to the intervention provided
3	Eakin, et. al., 2012	✓	✓	✓	✓	✓	x
				3. Quantitative nonrandomized			
		S1. Are there clear research questions ?	S2. Do the collected data allow to address the research questions?	3.1. Are the participants representativ e of the target population?	3.2. Are measurements appropriate regarding both the outcome and intervention (or exposure)?	3.3. Are there complete outcome data?	3.4. Are the confounder s accounted for in the design and analysis?
4	Misra et al, 2017	✓	✓	✓	✓	✓	X
5	Morphew, et. al., 2017	✓	✓	✓	✓	✓	X
6	Toulouse, C. & Kodadek, M. 2016	✓	✓	✓	✓	✓	✓

Table 2.2 (continued)

	Name/year published	Screening questions for all types		Category of study and methodological quality criteria key ✓= yes, ✕= no, can't tell = ■			
				4. Quantitative descriptive			
		S1. Are there clear research questions?	S2. Do the collected data allow to address the research questions?	4.1. Is the sampling strategy relevant to address the research question?	4.2. Is the sample representative of the target population?	4.3. Are the measurements appropriate?	4.4. Is the risk of nonresponse bias low?
7	Gibson, et. al., 2014	✓	✓	✓	✓	✓	X
8	Gibson, et. al., 2017	✓	✓	✓	✓	✓	X
9	Orsak et. al., 2018	✓	✓	✓	✓	✓	X
10	Nall et. al., 2019	X	X	✓	✓	X	X
11	Luque, et. al., 2012	✓	✓	✓	✓	✓	✓
12	Song, et. al.,2013	✓	✓	✓	✓	✓	✓
				5. Mixed methods			
		S1. Are there clear research questions ?	S2. Do the collected data allow to address the research questions?	5.1. Is there an adequate rationale for using a mixed methods design to address the research question?	5.2. Are the different components of the study effectively integrated to answer the research question?	5.3. Are the outputs of the integration of qualitative and quantitative components adequately interpreted?	5.4. Are divergences and inconsistencies between quantitative and qualitative results adequately addressed?
		n/a	n/a	n/a	n/a	n/a	n/a

Table 2.3 Study Characteristics and Findings

	Name/year published	Study description and sample size	Disease and measurement	Mobile medical clinic use findings	Limitations
1	Bouchelle et al., 2017	Grounded theory study of patients in The Family Van, a Boston-based Mobile Health Clinic. 25 patients were interviewed from June-July 2014.	Emerging patterns revealed three relational and three structural factors most significant to participants' experience of care on The Family Van.	• Providers communicate understandably • Providers create a culture of respect and inclusivity • Providers are divers with knowledge of the community • Preventative health and chronic disease management • Expeditious, free and multiple services • Location – parked in proximity to their residence.	The study participants were self-selected sample which may skew the data toward more positive or negative accounts of MHC experiences
2	Carmack, et. al., 2017	Narrative theorizing study that asked patients in The Family Van in Boston the following question: How do patients narrate their experiences with a mobile health clinic? 25 patients were interviewed after a mobile health clinic visit during summer of 2014	Semi-structured individual interviews were used to examine patients storied experiences of the mobile health clinic. This study is part of a larger project examining mobile health clinic patient decision making, expectations, and recommendations of care.	A narrative of generosity emerged during the analysis process as a way to make sense of the common themes and was used to show the connections between the themes. Creating a sense of welcome Activating patient health behaviors Empowering a "Pay it Forward" Attitude	Limited sample to 25 who agreed to participate. Interviews were conducted in the field limiting deep responses. The voice of The Van staff was missing.
3	Eakin, et. al., 2012	Randomized control trial testing the effectiveness of two community-based interventions. Children with Asthma were randomized into one of four groups; Breathmobile alone, Facilitated Asthma Communication Intervention (FACI), Breathmobile + FACI, verses standard care from 66 Head Starts in Baltimore, MD. N = 321	The primary study outcomes were measured by Symptom Free Days (SFD). Secondary outcomes included acute health care utilization (Emergency Department visits and hospitalizations), number of oral steroid bursts, proportion of children on asthma controller medication, and caregiver's asthma-related quality of life (measured with Pediatric Asthma Caregiver's Quality of Life Questionnaire, PACQLQ)	There was a slight improvement in SFD at 6 months in the Breathmobile + FACI group. Otherwise these community-based intervention strategies did not result in any significant improvements in asthma management or asthma morbidity amongst low-income preschool children.	Generalizability of the results to the larger population is not possible because data was not collected on nonparticipants

Table 2.3 (continued)

	Name/year published	Study description and sample size	Disease and measurement	Mobile medical clinic use findings	Limitations
4	Misra et al, 2017	Survey, self-report study in Houston, Texas aboard the Texas Children's Mobile Clinic Program from September to December 2011. N = 250 uninsured subjects were enrolled.	Self-Report Survey consisted of 28 questions available in English and Spanish about Complementary (CAM) and Alternative Medicine use among uninsured/underserved children.	CAM use is significant in an uninsured population who seeks care on a mobile medical clinic. However, families do not generally discuss CAM use with their provider, therefore because CAM use can affect allopathic therapies, providers must ask about CAM use in this population.	This study targeted uninsured children. Most were immigrants influenced strongly by their families, making this study less generalizable.
5	Morphew, et. al., 2017	Retrospective cohort study using healthcare utilization and prescription claims records from January 2011 – June 2014 in Orange County, California N = 164. Breathmobile group N=72 and Usual Care (UC) Group N= 92)	An Asthma Medication Ratio (AMR) of at least .05 reflects emergency department utilization and is an effective metric for assessing quality of care provided to asthmatic patients.	Breathmobiles proved to be more effective then UC in increasing the percent of patients who achieved >0.50. The AMR difference was reflected in the 52% reduction in ED visits post year in the BM cohort compared with the 13% in the UC cohort.	Far fewer patients were selected for this study than previous studies, restricting the study to low-socieoeconomic status Hispanic patients which may have affected generalizability and the power to detect significant clinical meaningful differentials in the reduction of health resources between both groups post intervention.
6	Toulouse, C., & Kodadek, M., 2016	Retrospective pre-post exploratory study to examine the relationship between continuous access to medical and physiologic outcomes in adults with a diagnosis of diabetes. Mobile Health Van (MHV) operating in Mid-Atlantic Region. Archived medical records were accessed from January 2006 – December 2010. N= 65 met the inclusion criteria.	Diabetes, Hypertension and Dsylipidemia One documented measure of HbA1c in the 12-month period prior to the start of prescription procurement program (PPP) and one documented measure in the 12-month period after the start of PPP. Other measures include Low density lipoprotein (LDL) and Blood Pressure in uninsured adults with diabetes	Access to medication through PPP resulted in a. regular and essential source of medications for patents to manage their chronic disease. HbA1c, LDL and Systolic Blood Pressure was all significantly reduced from the pre- to the post-intervention period. HbA1c went from 8.9 t0 8.26, LDL went from 108.8mg/dl to 94.8mg/dl, and systolic BP 130 to 123. There was no significant change in diastolic blood pressure.	Archived medical records may be incomplete or illegible, resulting in inaccurate interpretation of the data. High level of missing data was not expected. Without a control group the generalizability of this study is limited.

Table 2.3 (continued)

	Name/year published	Study description and sample size	Disease and measurement	Mobile medical clinic use findings	Limitations
7	Gibson, et. al., 2014	Longitudinal retrospective study of patients served in New Haven, Connecticut by the Community Health Care Van (CHCV) from January 2004 – December 2012, N = 8404.	Client characteristics with group comparison Client stratification based on CHCV utilization Spatial pattern using Geographic Information Science (GIS) environment with Hot Spot Analysis	Factors beyond geographic proximity or a lack of health insurance influence clients to travel and seek care by a Mobile Medical clinic.	The study's data is from a clinical database that is comprised of a series of cross-sectional interviews that only assess when the client choose to utilize care, it is therefore difficult to know other sources of care before, during or after care was utilized by the mobile clinic. Homeless individuals were not able to be geocoded therefore the person reporting homelessness may have been underestimated.
8	Gibson, et. al., 2017	Longitudinal retrospective study of patients served in New Haven, Connecticut by the Community Health Care Van (CHCV) from January 2004 – December 2012 – 9-year period, N = 9,716. Multiple Site 4 Mobile clinics. Electronic Health Records (EHR) were accessed and 1300 clients were excluded due to incomplete information, N=8,415 included.	Explore utilization patterns and to understand if certain populations rely on mobile medical clinics and identify the role of MMCs with the enactment of the Affordable Care Act. Chronic Diseases Asthma, Hypertension, Diabetes, Mental illness were noted from the HER	Description of clients Service utilization Patterns in utilization frequency Negative binomial regression was used to model the impact of specific indicators on visitation. CHCV visitation was positively associated with being foreign-born (additional 3.4 visit on average, $p<0.001$), injection drug use, (additional 1.69 visits on average, $p<0.001$) and having hypertension (additional 1.09 visits on average, $p<0.001$)	The CHCV HER comprises of a series of cross-sectional encounters, so information collection is contingent upon the completeness of provider-patient visit information. Further, there was no way to track successful linkage to further care.
9	Orsak et. al., 2018	A study examining the return on investment (ROI) of the Breath of Life Mobile Pediatric Asthma Clinic (BOLMPAC), Head Start in Northeast, Texas during state fiscal years 2015 – 2016.	Examining the reduced cost attributed to preventable emergency room visits, inpatient admission, school absenteeism, cost of education and parent work absenteeism related to Asthma.	The Breath of Life Mobile Pediatric Asthma Clinic (BOLMPAC) cost for 2015 and 2016 together was $538,031.69. It provided an average ROI of $1.32 and community ROI of $1.45. Estimated benefits were $445,125.00 and cost avoidance were $263,853.01.	Three different providers worked for the clinic during the study period which could have created inconsistency in coding and billing. Reimbursement may differ from state to state thus impacting generalizability.

Table 2.3 (continued)

	Name/year published	Study description and sample size	Disease and measurement	Mobile medical clinic use findings	Limitations
10	Nall et. al., 2019	Description of the implementation of a long-acting reversible contraception program (LARC) in a free primary care mobile clinic in central Florida. N = 23 Women were referred for the IUD or implant insertion since the launch of the clinic in 2016.	Prevention of unintended pregnancy for low income women in Central Florida	The University of Florida Mobile Outreach Clinic (MOC) provided free medical services to uninsured and underserved citizens of Gainesville, Florida. Data collected from the electronic medical record indicate 3,231 clinic visits, provided to 1,971 unique patients in 2017.	Low participation. This descriptive article lacks research rigor. Only descriptive statistics were provided.
11	Luque, et. al., 2012	Observational study. Cross-sectional survey administered to a convenience sample of N = 100 farmworkers in 2010 in the state of Georgia. Phase 2 (2009 – 2012) of the study included the mobile farm clinic database was accessed and analyzed in data from (2009 – 2012). A comparison between the self-report survey data collected and the actual medical diagnosis from the medical charts.	California Agricultural Workers Health Survey (CAWHS) – Access to healthcare, Eye injuries, Skin problems, Use of PPE, pesticide exposure, musculoskeletal injuries, depression, diabetes and hypertension. Marin-Gamba Bidemensional Acculturation Scale for Hispanics – To assess language acculturation PHQ-2 – To assess mental health.	The combined data from the survey research and the medical record reviewed identified hypertension, musculoskeletal problems, eye problems and skin problems as the most common physical ailments. Although this study did use mobile clinics, its' main objective was to conduct an occupational health needs assessment of migrant farmworkers to inform future intervention research on occupational health and safety for migrant farmworker population.	The convenience sample was biased towards willing participants in the interview after they received health screenings. Because the data was self-reported, social desirability biases may have been introduced especially for safety questions. The phase 1 data and phase 2 data were not linked, therefore because some farmers may have returned to the same farm each year, the diagnosis categories might be overinflated.
12	Song, et. al.,2013	A longitudinal study examining the effects of screening and counseling provided on Blood Pressure on The Family Van, in Boston, Massachusetts, N = 5,900, patients who made a total of 10,509 visits from January 2010 – June 2012.	Demographic, socioeconomic, and blood pressure (Systolic and Diastolic) between two groups: returners (n=1,134) and nonreturners (n= Return on Investment was estimated using financial expenditure reports for the period of January 2010 – 2012.	Patient population and emergency department avoidance – 2,851 patients reported they would have gone to an emergency department if the mobile clinic had not been available. Effect on Blood Pressure = n=237; Average systolic reduction of 10.7 mmHg and diastolic reduction of 6.2mmHg. Return on Investment – Estimated total savings of about $1.4 Million from the 2,851 avoided emergency department visits.	Study lacked a comparison group. There were a number of confounding factors that could not be adjusted for in the absence of a control group. Self-selection bias Small number of blood pressure sample compared to the population limiting generalizability. The measure of avoided emergency room visits was based upon patient response lending to a possible reporting bias.

Table 2.4 Study Findings Comparing Mobile Medical Clinic Use by Population within the Andersen Behavioral Model of Health Care Use

	Name/Year Published	Predisposing	Enabling	Need
		- Age - Gender - Race/Ethnicity - Education	- Income - Insurance - Regular Source of Care - Transportation - Nearby health facilities	- Chronic Disease presence - Severity - Comorbidities
1	Bouchelle et al., 2017	44% - Younger than 50 16% - Between 50 -60 40% - Greater than 65 40% - Female **60% - Male** **Education** **30% - Black** 20% - Hispanic 12% - White Education Not Reported	**12% - No insurance** 28% - Private Insurance 52% - Public Insurance	Patients living in underserved communities have greater difficulty accessing care due to a number of barriers including cultural differences, poor communication, a perceived absence of patient-centered care, and lack of diversity among medical professionals.
2	Carmack, et. al., 2017	40% - Female **60% - Male** 53% - Ages 19 – 72 68% - Spoke English **30% - Black** 20% - Hispanic 12% - White Education Not Reported	15 participants visited The Family Van for the 1st time. 10 participants were returners.	The Family Van is a 40 -foot van that sets up on the corner of an underserved area. Free services provided, creating a communitive space where staff and patients can feel comfortable to discuss health issues.
3	Eakin, et. al., 2012	336 families consented 95% completed the questionnaire. 321 were randomized. **Mean age = 4 years** **53% - Male** 47% - Female **97% - African American** Education: Head Start	40% - < $10,000 30% $10, 000 - $19,000 70% Low Income 87% Medical assistance 8% Private Pay 4% Self-pay/Cash	100% Asthma diagnosis 100% Head Start Program participant
4	Misra et al, 2017	50% - Male 50% Female Mean Age – 8 Mean Age of Mother – 33 Mean Age of Father – 36 3% - Black 92% - Hispanic 1% - White Mother's Education 14% - Primary School 32%- Secondary School 36%- High School 18%- College Father's Education 24% - Primary School 27%- Secondary School 37%- High School 12% - College	100% - Uninsured 76% - Annual Income <$40,000 6% - Annual Income > $40,000	8% - Chronic Medical Condition 30% - with a medical home 85% Up to Date with Vaccinations 12% - Taking prescription medication Most common CAM Therapies used included: 54% - Chamomile 26% Vitamins 15% - Prayer 15% Garlic 14% Green Tea & Yerba Buena

Table 2.4 (continued)

	Name/Year Published	Predisposing	Enabling	Need
5	Morphew, et. al., 2017	Mean Age in both groups = 7 **Male 65% and 59%** 100% Hispanic Education not reported	Low- Socioeconomic status Resource utilization - ED days (any) - BM – 36%, UC – 24% - Ed days (>2) - BM – 8%, UC – 8% - IP days (any) - BM – 8%, UC – 11% - OCS fills (any) - BM – 99%, UC – 99% - OC fills (>2) - BM – 92%, UC – 94%	100% - High-risk Asthma HEDIS AMR 47.2% - BM Cohort 50% - UC Cohort 86% - BM Cohort with >1 Controller Medication 80% - UC Cohort with >1 Controller Medication
6	Toulouse, C. & Kodadek, M., 2016	**35% - Male** **65% - Female** 54% - English Speaking 45% Spanish Speaking **Mean Age – 50** 17% - Black **11% Mexico** **38% Central America** 8% White Education – Not reported	**100% - Uninsured** 100- Below 200% federal poverty level Years patient (Usual Source of Care) 29% - 0-1 Year 17% - 1 – 3 Years 28% - 3- 5 Years 26% - 5+ Years	Diabetes Comorbid conditions: 6% - Hypertension (HTN) 22% - Dyslipidemia (DLD) Depression (DEP) 57% - HTN + DLD
7	Gibson, et. al., 2014	**56% – Male** 44% - Female **41% Black** 35% Hispanic 23% White **39% Foreign Born** 12% undocumented Median Age – 35 years old 69.6% - Education – High School or higher 27.7%- Less than High School	68% - Unemployed **55% - Lack of health insurance** 34% - Unstable Housing 1% - Homeless	14% - 20% Hypertension 2% - 9% Diabetes 24% - 37% Mental illness (Varied across sites) CHCV clients are highly vulnerable having unstable housing, drug use, medical comorbid conditions such as mental illness, SUD and HIV
8	Gibson, et. al., 2017	**56% – Male** 44% - Female **40% - Black** 34% - Hispanic 26% - White 38% - Foreign Born 11% - Undocumented **Median Age – 35 years old** 28% - Less than High School education 67% - High School Education or Higher	55%- Assisted Income **55% - Uninsured** 46% - Insured 66%- Stable Housing 33% - Unstable Housing 10% - Homeless 68% - Unemployed 32% - Employed	20% - Asthma 19% - Hypertension 9% - Diabetes 25% - Mental illness CHCV clients are highly vulnerable having unstable housing, drug use, medical comorbid conditions such as mental illness, SUD and HIV
9	Orsak et. al., 2018	Pediatric Asthma Clinic Head Start Program and School Aged Children Grades K – 12th.	Rural regions with small metropolitan statistical areas	Asthma Free services This study followed a pilot study of the BOLMPAC which demonstrated efficacy by decreasing total missed school days and emergency room visits.

Table 2.4 (continued)

	Name/Year Published	Predisposing	Enabling	Need
10	Nall et. al., 2019	N=18 for total Patients of MOC LARC 28% Age 18 -24 33% Age 25-34 33% Aged 35 – 44 38% Black 28% Hispanic 28% White	89% Uninsured 11% Medicaid 28% Income Below $10,000 22% Income Between $10,000 - $14,000 22% Income Between $20,000 - $29,000	Unintended pregnancy Patients to express satisfaction Record of continuation of the use of the IUD or Implant would be necessary.
11	Luque, et. al., 2012	Phase 1: **87% - Male** 13% Female **70% - Spanish Speaking Only** **93% Mexican** Phase 2: **89% - Male** 10% - Female **Mean age – 33** Phase 2: **90% - Male** 10% - Female 99% Spanish Speaking **97 % Migrant Farmworker** 88% Country of Birth Mexico **Education – Mean 5.5 +/- 1.7**	Phase 1: None reported Phase 2: None reported	Phase 1: - 10% - Diabetes - 25% - Hypertension - 11% - Musculoskeletal Problems - 12% - Eye problems - 5% - Skin Problems - 7% - Depressions Phase 2: - 12% Back pain - 11 % Hypertension - 11% Musculoskeletal - 9% Gastrointestinal - 7% Eye Problems - 7% Skin Problems - 5% Tinea, fungal skin infection
12	Song, et. al.,2013	Returners: (n=1,134) **Mean Age = 56.8** **49% Male** **68% Black** **14% Hispanic** 11% White 16% - less than 12th grade **64% - 12th grade** 20% - more than 12th grade Non-Returners (n=4689) **Mean Age = 49** **57% Male** **61% Black** **19% Hispanic** 13% White 21% - less than 12th grade **56% - 12th grade** 22% - more than 12th grade	Returners **27% Private Pay** 13% Medicare **10% Uninsured** 4% Homeless Non-Returners 24% Private Pay 11% Medicare **11% uninsured** 5% Homeless	Blood Pressure change in returning patients 143/88 to 129/78 Comorbid conditions included Diabetes (14%) and Hypercholesterolemia (3%)

*predisposing (age, gender, marital status, ethnicity and family size), enabling (education level, travel time to the nearest health facility, medical expense per capita, and health insurance coverage), and need factors (chronic disease)

Chapter 3:

Factors Associated with Mobile Medical Clinic Use:

A Retrospective Cohort Study

Abstract

Background: Mobile medical clinics have been used for decades to provide primary and preventive care to underserved populations. While several studies have examined their return on investment and impact on chronic disease management outcomes in the Mid-Atlantic and East Coast regions of the United States, little is known about the characteristics and clinical outcomes of adults who receive care aboard mobile clinics on the West Coast region. Guided by the Anderson Behavioral Model, this study describes the predisposing, enabling, and need factors associated with mobile medical clinic use among mobile medical clinic patients in Southern California and examines the relationship between mobile clinic utilization and presence and control of diabetes and hypertension.

Methods: We conducted a retrospective cohort study of 411 adults who received care in four mobile clinic locations in Southern California from January 1, 2018 to December 31, 2019. Data were collected from patient charts on predisposing (e.g., sex, race, age), enabling (e.g., insurance and housing status), and need (e.g., chronic illness) factors based on Andersen's Behavioral Model. Zero-truncated negative binomial regression was used to examine the association of chronic illness (hypertension and diabetes) with number of clinic visits, accounting for potential confounding factors.

Results: Over the course of the 2-year study period, 411 patients made 1790 visits to the mobile medical clinic. The majority of patients were female (68%), Hispanic (78%), married (47%), with a mean age of 50 (SD=11). Forty-four percent had hypertension and 29% had diabetes. Frequency of mobile clinic utilization was significantly associated with chronic illness. Patients with hypertension and diabetes had 1.22 and 1.61 times the rate of mobile medical clinic visit than those without those conditions, respectively (IRR = 1.61, 95% CI, 1.36-1.92; 1.22, 95% CI, 1.02–1.45).

Conclusions: Mobile clinics serve as an important system of health care delivery, especially for adults with uncontrolled diabetes and hypertension.

Keywords: mobile clinics, utilization, access to health care, chronic disease, Andersen's Behavioral Model

Background

Mobile medical clinics are custom-made vehicles (e.g., vans, trucks, recreational vehicles) converted to healthcare clinics that travel to the heart of communities where people work, live, play, and pray.[1] Over the past few decades, mobile medical clinics have contributed to the health of underserved populations, who are marginalized by geographic, social, and/or structural barriers[3,4] by providing primary care, preventative care, and/or health care screening.[2] They are an effective strategy for increasing access to health care and reducing health disparities for communities. In addition, an increasing body of knowledge shows that mobile medical clinics are accomplishing their mission to provide cost-effective healthcare for underserved populations across the nation.[5,6]

Foundational studies on mobile medical clinics have been conducted in the Mid-Atlantic and east coast regions of the United States. These studies evaluated the effectiveness of mobile medical clinics by calculating and investigating their return on investment,[7–10] evaluating chronic disease management outcomes,[11,4] and identifying utilization patterns.[3] Results suggest that mobile medical clinics are a model for high-quality, cost-effective health care delivery for improving health outcomes in underserved areas. However, variations in region, populations, and healthcare service patterns across the nation underscore the need to understand how mobile medical clinics impact healthcare access, healthcare utilization, health outcomes, and cost. Although there are a reported 120 mobile health clinics providing services in California, with 70 licensed by the state as a primary care clinic,[12] no studies to date have described the demographic characteristics, healthcare utilization patterns, and chronic illness (e.g., diabetes, hypertension) health outcomes of adults served by primary care mobile medical clinics operating in the western region of the United States.

Applying theoretical models of health services utilization to vulnerable populations, such as mobile clinic patients, can be particularly helpful in identifying the unique challenges they face in obtaining needed services and maintaining or improving their health status.[13] Andersen's Behavioral Model is one of the most frequently used frameworks for explaining and predicting patient utilization of healthcare services and related outcomes.[14–16] Guided by Andersen's Behavioral Model, this study examined the characteristics, mobile clinic utilization, and clinical outcomes of adults who receive care aboard Well of Healing Mobile Medical Clinic, which is a no-cost, faith-based primary care mobile medical clinic in Southern California.[17]

The aims of this study were to: 1) describe visit frequency among adults who utilize mobile clinics by sociodemographic and health characteristics (e.g., age, sex, ethnicity, insurance status, zip code, Charlson Comorbidity Index score) and presence and control of chronic illness (i.e., diabetes: hemoglobin A1c < 6.5% and hypertension: blood pressure < 140/90 mmHg); and 2) examine the relationship between mobile clinic utilization and presence of chronic illness, controlling for sociodemographic and health characteristics. We hypothesized that the use of mobile clinics will differ by sociodemographic and health characteristics and presence and control of chronic illness and that the prevalence of controlled diabetes and/or hypertension will differ by sociodemographic characteristics. We also hypothesized that patients with chronic illness (i.e., diabetes and hypertension) will have a higher number of mobile clinic visits compared to those without chronic illness, controlling for sociodemographic and health characteristics.

Methods

Study Design & Sampling

This study was a retrospective cohort study analyzing data retrieved from chart reviews of adult patients who visited four mobile clinic locations in Southern California from January 1, 2018 to December 31, 2019. The study inclusion criteria included adults 26 years and older who visited the clinic at least one time during the 2-year study period. As chronic illnesses were the outcome of interest, this study included only adult patients over age 26 – an approach consistent with other mobile clinic studies. [14,18] Exclusion criteria included those who visited the clinic once but left without being seen by a health care provider: and people 25 years and younger. After conducting an initial patient chart review, a total of 425 patients were identified as eligible for the study. Upon further review, 14 patients were excluded from the study because they left without being seen by a provider. Hence, 411 patients were included in the study.

Study Setting

San Bernardino County is one of the largest counties in California. Many areas suffer from poverty-related disparities, including food deserts, high rates of crime, unemployment, and homelessness.[19] San Bernardino County residents experience higher levels of diabetes and hypertension compared to residents in the rest of the state of California (diabetes: 11% vs 9%; hypertension: 32% vs 28%).[19] Additionally, 36% of adults in San Bernardino County are obese, compared with California's obesity rate of 27.9%.[19]

The Well of Healing Mobile Medical Clinic is a primary care clinic that opened its doors in 2004. It is licensed as a “free” clinic by the California Department of Public Health for San Bernardino County. It is a non-denominational faith-based clinic operated by ministry volunteer physicians and nurses.[17] This clinic on wheels drives into four communities: Fontana, Ontario, Muscoy and San Bernardino. Clinic services are offered once a month at each of the clinic locations. For continuity of care, patients and volunteers are assigned to one of the four sites. The sites are set up at a local church in each of these communities. Patients are served on a first come, first serve basis; no one is turned away. First, patients are assessed by a nurse. Then, they are given a private examination by a provider; physician, physician assistant or nurse practitioner. This examination may be followed by lab draw, medication prescription when appropriate, and health education.

Study Variables and Measures

The dependent variable was mobile clinic utilization. Mobile clinic utilization was operationally defined as the total number of visits per year during the 2-year study period and the mean number of visits per year.

The independent variables were categorized as predisposing, enabling, and need factors following Andersen's Behavioral Model. Predisposing factors refer to the propensity of individuals to use services[20] and included demographic characteristics including sex (male or female), race/ethnicity (African American, White, or Hispanic), age, and marital status (single or married). Enabling factors refer to resources specific to the individual or attributes of the community in which the person lives[20] that either enable or impede health care utilization. Such enabling factors for this study included insurance status (uninsured, insured, and other) and housing status (housed or homeless based on having a zip code). Need factors refer to the level of illness which is the most proximate cause of health service use and may be either perceived by the individual or identified by a care provider.[20] Such need factors included: the presence of obesity and/or depression; the Charlson Comorbidity Index (CCI) score; and chronic illness diagnoses of diabetes and hypertension, and their control status based on hemoglobin A1c level and systolic and diastolic blood pressure, respectively.

The presence of obesity and depression at baseline were ascertained by chart review of a diagnosis of obesity[22] or depression[21] or an existing medication prescription for depression (Abilify, Elavil, Prozac, or Zoloft based on known available mobile clinic treatment options). While it is possible that these prescriptions for depression could be used for other mental health disorders (e.g., anxiety, panic, post-traumatic stress disorders, Schizophrenia, etc), chart review did not reveal these other mental health diagnoses. The Charlson Comorbidity Index (CCI) documents the presence of 19 comorbidities (e.g., age, CHF, CVA, COPD), allocates a weight of 1-6 based upon the adjusted relative risk of 1-year mortality, and is then summed to provide a total index score which serves as an indicator of disease burden and a strong estimation of mortality. [23,24,36] Based on distribution of CCI scores in the study sample, the CCI variable was coded categorically (CCI = 0, 1, 2, 3, 4+), with CCI=0 as the referent category.

Presence of diabetes was identified in the patient chart by the record of the disease diagnosis and/or presence of diabetes medication (e.g., metformin, glipizide). Controlled diabetes was defined as hemoglobin A1c <6.5%, based on the Centers for Disease Control and Prevention (CDC) guidelines.[25] Hemoglobin A1c provides an average level of blood sugar over the past 3 months. The higher the Hemoglobin A1c level, the more poorly diabetes is controlled.[26] Hemoglobin A1c tests were extracted from all visits in which hemoglobin A1c was tested.

The presence of hypertension was identified in the patient chart by the record of the disease diagnosis and/or presence of hypertensive medication (e.g., Amlodipine, HCTZ, Losartan, Lisinopril). All systolic and diastolic blood pressure recorded values were extracted from each patient record. Controlled hypertension was defined as systolic pressure <140 mmHg and diastolic pressure <90 mmHg. According to JNC-8 hypertension guidelines, for individuals 18 to 59 years of age without major comorbidities and patients 60 years or older who have diabetes, chronic kidney disease (CKD), or both conditions, the new blood pressure goal is <140/90 mmHg.[27]

Data Analyses

Descriptive statistics were used to summarize the characteristics of the sample and the total number of visits by sample characteristics. Descriptive statistics were reported as means and standard deviations for continuous variables and frequencies and percentages for categorical variables. We examined the relationship between the number of mobile clinic visits and the presence of chronic illness (diabetes and hypertension) using both poisson and negative binomial regressions and conducted a formal test of poisson versus negative binomial on the full multivariable model to determine a better model. Since individuals were required to have at least one visit to the clinic in order to be considered part of the cohort and the counts were overdispersed, we chose a zero-truncated negative binomial regression.

Covariates of predisposing, enabling, and need factors were included based on a theoretical approach. The analysis adjusted for an exposure time offset which was calculated for members who were already in the mobile clinic health care system from 01/01/2018 (study start) to 12/31/2019 (study end) and for new patients who started to visit during the study time period, from the time of their first visit to 12/31/2019 (study end). Unadjusted and adjusted results were presented with Incident Rate Ratios (IRR) and 95% Confidence Intervals (CIs). Data analysis was conducted in R v4.1.0[28] using the R package VGAM v1.1.5.[29]

Results

Characteristics of Overall Study Sample

Table 3.1 presents the baseline characteristics, total number of clinic visits, and mean number of visits for adults who received care at a Southern California mobile medical clinic between January 1, 2018 and December 31, 2019. Over the course of the 2-year study period, 411 patients made a total of 1790 mobile medical clinic visits. The majority of the mobile clinic patients were female (*n* = 281, 68%), Hispanic (*n* = 321, 78%), and married (*n* = 192, 47%), with a mean age of 50 (range 42-57, SD = 11). Uninsured individuals accounted for 38% (*n* = 156) of the study sample. Nearly all mobile clinic patients reported a home address (*n* = 402, 98%) while only 2% (*n* = 9) indicated homeless housing status.

Of the total 411 mobile clinic patients, 181 (44%) had hypertension and 117 (29%) had diabetes. The mean number of visits for those with hypertension (n=181) and uncontrolled hypertension (n= 89) were 6.3 (SD=4.3) and 7.0 (SD=4.2), respectively. The mean number of visits for those with diabetes (n=117) and uncontrolled diabetes (n= 69)were 6.6 (SD=4.2) and 8.7 (SD=3.7), respectively. Those with depression accounted for 2.4% of the study sample (*n* = 10) and on average, these patients visited mobile clinics 6.1 (SD = 6.3) times over the study period. Roughly two-thirds of patients (*n* = 261, 63%) had some level of comorbidity (CCI = 1-4+). Mobile clinic patients with a CCI score of 3 had two times the mean number of visits than those with a CCI score of 0 [CCI 3: 6.6 (SD = 4.3); CCI 0: 2.8 (SD = 2.6)].

Characteristics of Patients with Diabetes and Uncontrolled Diabetes

Table 3.2 presents baseline characteristics of the patients with a diagnosis of diabetes and uncontrolled diabetes. Among the mobile clinic patients with diabetes (*n* = 117, 29%), 68% (*n* = 80) were female, 82% (*n* = 92) were Hispanic, 55% (*n* = 67) were married, 51% (*n* = 60) were uninsured, 100% (*n* = 117) were housed, and their mean age was 55.5 (SD = 10.0) years old. Of those with diabetes, 70% (*n* = 82) also had a diagnosis of hypertension.

Among those with diabetes, 59% had uncontrolled diabetes (*n* = 69) as measured by hemoglobin A1c >6.5%. The majority of mobile clinic patients with uncontrolled diabetes were female (*n* = 47, 68%), Hispanic (*n* = 57, 83%), and uninsured (*n* = 41, 60%) with comorbid hypertension (*n* = 50, 73%) and obesity (*n* = 21, 30%).

Characteristics of Patients with Hypertension and Uncontrolled Hypertension

Table 3.3 presents baseline characteristics of the patients at the mobile medical clinic with a diagnosis of hypertension and uncontrolled hypertension. Of the 411 patients in the study, 44% (*n*=181) had a diagnosis of hypertension, of these, 49% (*n*=89) had uncontrolled hypertension (systolic blood pressure >140 and/or diastolic blood pressure >90).

Table 3.1 Baseline Characteristics and Clinic Visits of Patients Receiving Care at Mobile Medical Clinics in Southern California between January 1, 2018 and December 31, 2019

Variables	Mobile clinic patients[a] n (%)	Total number of visits[b] n	Number of clinic visits[c] mean (SD)
TOTAL SAMPLE*	411 (100.0)	1790	4.4 (3.9)
Initial visit before 2018	158 (38.4)		1.7 (1.4)
Initial visit 2018–2019	253 (61.6)		2.7 (2.5)
Predisposing variables			
Gender/Sex			
Female	281 (68.4)	1229	4.4 (3.9)
Male	130 (31.6)	561	4.3 (4.0)
Race/Ethnicity			
Hispanic	321 (78.1)	1513	4.7 (4.0)
African American	25 (6.1)	63	2.5 (3.3)
White	24 (5.8)	67	2.8 (3.5)
Unspecified	41 (10.0)	147	3.6 (3.2)
Age			
26-35	29 (7.1)	53	1.8 (1.6)
36 -45	107 (26.0)	329	3.5 (3.4)
46–55	141 (34.3)	568	4.3 (3.9)
56–65	93 (22.6)	577	5.3 (4.2)
66 +	37 (9.0)	263	5.4 (4.3)
Mean (SD)	50.3 (11.2)		6.6 (4.2)
Marital Status			
Married	192 (46.7)	511	5.0 (4.1)
Single	151 (36.7)	957	3.4 (3.5)
Unknown	68 (16.5)	322	4.7 (3.8)
Enabling variables			
Insurance Status			
Uninsured	156 (38.0)	934	6.0 (4.3)
Unknown	230 (56.0)	75	3.4 (3.3)
Other	25 (6.1)	781	3.0 (3.2)
Housing Status			
Housed	402 (97.8)	1137	4.4 (3.9)
Homeless	9 (2.2)	776	1.1 (0.3)
Clinic Location			
Ontario, CA	160 (38.9)	533	4.6 (4.1)
Fontana, CA	119 (29.0)	61	5.2 (3.8)
Muscoy, CA	99 (24.1)	413	3.6 (3.9)
San Bernardino, CA	33 (8.0)	474	2.3 (2.7)
Need variables		472	
Chronic Illness			
Hypertension	181 (44.0)	1137	6.3 (4.3)
Uncontrolled hypertension	89 (49.2)	627	7.0 (4.2)
Diabetes	117 (28.5)	776	6.6 (4.2)
Uncontrolled diabetes	69 (59.0)	602	8.7 (3.7)
Other Medical Conditions			
Obesity	89 (21.7)	533	6.0 (4.5)
Depression	10 (2.4)	61	6.1 (6.3)
Charlson Comorbidity Index score			
0	150 (36.5)	413	2.8 (2.6)
1	105 (25.6)	474	4.5 (4.0)
2	84 (20.4)	472	5.6 (4.4)
3	50 (12.2)	328	6.6 (4.3)
4+	22 (5.4)	103	4.7 (4.2)

* Row Percent

[a]Mobile clinic patients = number of patients included in the study who visited the clinic between January 1, 2018 and December 31, 2019.

[b]Total number of visits = number of visits during the study period between January 1, 2018 - December 31, 2019

[c]Mean number of visits over the 2-year study period with standard deviation. SD=Standard Deviation

Table 3.2 Baseline Characteristics of Patients with Diabetes and Uncontrolled Diabetes Receiving Care at a Mobile Medical Clinics in Southern California between January 1, 2018, and December 31, 2019

Variables	**Diabetes Yes**[a]	**Uncontrolled**[b] Hemoglobin **A1c ≥6.5**
TOTAL SAMPLE*	117 (28.5)	69 (59.0)
Predisposing variables		
Gender/Sex		
Female	80 (68.4)	47 (68.1)
Male	37 (31.6)	22 (31.9)
Race/Ethnicity		
Hispanic	96 (82.1)	57 (82.6)
African American	3 (2.6)	1 (1.4)
White	6 (5.1)	3 (4.3)
Unspecified	12 (10.3)	8 (11.6)
Age		
25-35	1 (0.9)	0 (0.0)
36 -45	22 (18.8)	14 (20.3)
46–55	28 (23.9)	13 (18.8)
56–65	49 (41.9)	31 (44.9)
66 +	17 (14.5)	11 (15.9)
Mean (SD)	55.54 (10.0)	56.41(10.3)
Marital Status		
Married	67 (57.3)	39 (56.5)
Single	28 (23.9)	14 (20.3)
Unknown	22 (18.8)	16 (23.2)
Enabling variables		
Insurance Status		
Uninsured	60 (51.3)	41 (59.4)
Unknown	53 (45.3)	25 (36.2)
Other	4 (3.4)	3 (4.3)
Housing Status		
Housed	117 (100.0)	69 (100.0)
Homeless	0 (0.0)	0 (0.0)
Clinic Location		
Ontario	46 (39.3)	28 (40.6)
Fontana	44 (37.6)	29 (42.0)
Muscoy	20 (17.1)	9 (13.0)
San Bernardino	7 (6.0)	3 (4.3)
Need variables		
Chronic Illness		
Hypertension	82 (70.1)	50 (72.5)
Diabetes	117 (100.0)	69 (100.0)
Other Medical Conditions		
Obesity	32 (27.4)	21 (30.4)
Depression	1 (0.9)	1 (1.4)
Charlson Comorbidity Index Score		
0	9 (7.7)	2 (2.9)
1	30 (25.6)	18 (26.1)
2	37 (31.6)	23 (33.3)
3	30 (25.6)	20 (29.0)
4+	11 (9.4)	6 (8.7)

[a]Diabetes Yes = Had a written diagnosis of diabetes in the chart, recorded hemoglobin A1c >6.5, or was taking diabetes medication (i.e., metformin, glipizide)
[b]Diabetes Uncontrolled = hemoglobin A1c >6.5 at the start of the study

Table 3.3 Baseline Characteristics of Patients with Hypertension and Uncontrolled Hypertension Receiving Care at Mobile Medical Clinics in Southern California between January 1, 2018 and December 31, 2019

Variables	**Hypertension Yes**[a]	**Uncontrolled**[b] **systolic ≥140 or diastolic ≥90 mmHg**
TOTAL SAMPLE*	181(44.0)	89 (49.2)
Predisposing variables		
Gender/Sex		
Female	125 (69.1)	61 (68.5)
Male	56 (30.9)	28 (31.5)
Race/Ethnicity		
Hispanic	148 (81.8)	74 (83.1)
African American	10 (5.5)	7 (7.9)
White	7 (3.9)	1 (1.1)
Unspecified	16 (8.8)	7 (7.9)
Age		
Mean (SD)	57.36 (9.9)	56.48 (9.1)
Marital Status		
Married	102 (56.4)	53 (59.6)
Single	53 (29.3)	24 (27.0)
Unknown	26 (14.4)	12 (13.5)
Enabling variables		
Insurance Status		
Uninsured	91 (50.3)	53 (59.6)
Unknown	78 (43.1)	32 (36.0)
Insured	12 (6.6)	4 (4.5)
Housing Status		
Housed	179 (98.9)	89 (100.0)
Homeless	2 (1.1)	0 (0.0)
Clinic Location		
Ontario	63 (34.8)	30 (33.7)
Fontana	62 (34.3)	29 (32.6)
Muscoy	42 (23.2)	23 (25.8)
San Bernardino	14 (7.7)	7 (7.9)
Need variables		
Chronic Illness		
Hypertension	181 (100.0)	89 (100.0)
Diabetes	82 (45.3)	42 (47.2)
Other Medical Conditions		
Obesity	50 (27.6)	22 (24.7)
Depression	4 (2.2)	2 (2.2)
Charlson Comorbidity Index Score		
0	33 (18.2)	18 (20.2)
1	46 (25.4)	24 (27.0)
2	57 (31.5)	29 (32.6)
3	35 (19.3)	15 (16.9)
4+	10 (5.5)	3 (3.4)

[a]Hypertension Yes = Had a written diagnosis of Hypertension in the chart, Systolic >140 and/or Diastolic >90
[b]Hypertension Uncontrolled = record of blood pressure >140/90 start of study

Among mobile clinic patients with hypertension, 69% were female (*n* = 125), 82% Hispanic (*n* = 148), 56% married (*n* = 102), 50% uninsured (*n* = 91) and 99% housed (*n* = 179) with a mean age of 57.3 (SD = 9.9). Nearly half of these individuals (*n* = 89, 49%) had uncontrolled hypertension (Systolic>140/Diastolic>90). Of those with uncontrolled hypertension, the majority were female (*n* = 61, 68%), Hispanic (*n* = 74, 83%), and uninsured (*n* = 53, 60%) with 47% having comorbid diabetes (*n* = 42), 25% obesity (*n* = 22), and 2% depression (*n* = 2).

Rates of Mobile Medical Clinic Visits

Table 3.4 presents the univariate and the multivariate relationships between rates of mobile medical clinic visits and patient characteristics and chronic illness.

In the unadjusted model, race/ethnicity was significantly associated with the frequency of mobile clinic utilization, with Hispanics having almost 2 times the rate of visits as Whites (IRR = 2.09, 95% CI, 1.34-3.26). Age was also significant, showing higher rates of visits among ages 36-66+. Those who were single had significantly higher rates of visits compared to those who were married (IRR = 0.63, 95% CI, 0.51-0.78).

In the adjusted model, race/ethnicity remained significantly associated with the rate of mobile clinic utilization, with Hispanics having almost 2 times the rate of visits than Whites (IRR = 1.68, 95% CI, 1.14-2.48). Those who were single had significantly higher rates of visits compared to those who were married (IRR = 0.74, 95% CI, 0.62-0.89). Age, insurance status, and a CCI score of 4 were no longer significant after adjusting for sociodemographic and health characteristics.

Chronic illness need variables were all significant factors in mobile clinic utilization. Patients with hypertension had 1.61 times the rate of mobile clinic visits than those without hypertension (IRR = 1.61, 95% CI, 1.36-1.92). Mobile clinic patients with diabetes had 1.22 times the rate of a mobile medical clinic visits than those without diabetes (IRR = 1.22, 95% CI, 1.02-1.45). Those with obesity had 1.27 times the rate of visits than those without obesity (IRR = 1.27, 95% CI, 1.07-1.51). In addition, individuals with a CCI score of 1, 2, and 3 had 1.55, 1.74, and 1.88 times the rate of mobile clinic visits than those with a CCI score of 0 (IRR = 1.55, 95% CI, 1.22-1.98), (IRR = 1.74, 95% CI ,1.26-2.40), (IRR = 1.88, 95% CI, 1.27-2.77), respectively.

Table 3.4 Zero Truncated Negative Binomial Regression: Rates of Mobile Medical Clinic Visits Per Year by Chronic Illness in a Sample of Mobile Medical Clinic Patients between January 1, 2018 - December 31, 2019 (*N* = 411)

Variable	Unadjusted model IRR (95% CI)	Adjusted model: IRR (95% CI)
All		
Predisposing variables		
Gender/Sex		
Female	1.04 (0.84-1.28)	1.02 (.09-1.20)
Male	Referent	Referent
Race/Ethnicity		
Hispanic	2.09 (1.34-3.26) ****	1.68 (1.14-2.48) ***
African American	1.02 (0.54-1.93)	1.07 (0.62-1.87)
White	Referent	Referent
Unspecified	1.35 (0.80-2.28)	1.38 (0.87-2.21)
Age		
25-35	Referent	Referent
36 -45	2.37 (1.34-4.19) ***	1.42 (0.87-2.33)
46–55	2.99 (1.71-5.22) ****	1.32 (0.80-2.19)
56–65	3.80 (2.17-6.65) ****	1.12 (0.64-1.96)
66 +	3.36 (1.87-6.05) ****	0.98 (0.54-1.79)
Marital Status		
Single	0.63(0.51-0.78) ****	0.74(0.62-0.89) ****
Married	Referent	Referent
Unknown	0.77 (0.60- 0.99) **	0.95 (0.77-1.17)
Enabling variables		
Insurance Status		
Uninsured	2.10 (1.37-3.24) ****	1.40 (0.96-2.06)
Other	Referent	Referent
Unknown	1.09 (0.71-1.67)	0.94 (.64-1.38)
Need variables		
Chronic Illness		
Hypertension	2.31 (1.93-2.76) ****	1.61 (1.36-1.92) ****
Diabetes	1.89 (1.56-2.29) ****	1.22 (1.02-1.45) *
Other Medical Conditions		
Obesity	1.52 (1.22-1.90) ****	1.27 (1.07-1.51) ****
Depression	1.32 (2.34-2.59)	–
Charlson Comorbidity index Score		
0	Referent	Referent
1	1.91 (1.49-2.45) ****	1.55 (1.22-1.98) ****
2	2.21 (1.72-2.85) ****	1.74 (1.26-2.40) ****
3	2.46 (1.85-3.27) ****	1.88 (1.27-2.77) ***
4+	1.69 (1.13-2.54) **	1.54 (0.95-2.50)

[d]The adjusted model included all variables except for depression because the cell number was below 5
Significance levels: *p<.05, **p<.01; ***p<.001; ****p<.0001
Abbreviations: IRR = Incident Rate Ratio; CI = Confidence Interval

Discussion

To our knowledge, this is the first mobile medical clinic study of the western region of the United States and the first to use the Andersen Behavioral Model to describe mobile medical clinic patient characteristics and factors associated with mobile clinic utilization in this region. This retrospective cohort study described the predisposing, enabling, and need factors associated with mobile medical clinic use among mobile medical clinic patients in Southern California. It further examined the relationship between mobile clinic utilization and presence and control of diabetes and hypertension. We hypothesized that patients with chronic illness (diabetes and hypertension) will have a higher rates of mobile clinic visits compared to those without chronic illness, controlling for sociodemographic and health characteristics. Study findings revealed that patients with both hypertension and diabetes had higher rates of mobile clinic visits than those without those chronic conditions.

Applying a theoretical model of health services utilization, like the Anderson Behavioral Model, to vulnerable mobile clinic populations, can help elucidate some of the unique challenges faced in obtaining the services required to maintain and improve health status.[13] For example, this study demonstrated that mobile clinics intervene in particular demographics: married Hispanic females, between the ages of 46-57, living with some level of chronic illness burden (e.g., CCI score of 1-4) and insurance status as either not reported or uninsured. These findings are consistent with other national studies,[18,11, 30] with the main exception of race/ethnicity. This study had a much higher proportion of mobile clinic patients who were Hispanic (78%) compared to other studies that ranged from 19% - 35%.[11,30,32] This is reflective of the western region of the United States and the areas' overall demographic, potentially offering unique insights into possible access to care challenges for this population.[35]

In terms of mobile clinic utilization, the patients in this cohort had fairly similar mean visits per year compared to other studies[33] (4.4-7.0 vs 2.5-6.9, respectively). Consistent with the literature and the Andersen Behavioral Model, this study demonstrated that rates of mobile clinic utilization depended mainly on predisposing factors such as ethnicity and need factors such as chronic illness status.[34] Surprisingly, enabling factors (i.e. insurance status) were not associated with mobile medical clinic use.

Notably, individuals who were Hispanic visited the Southern California mobile clinics at almost 2 times the rate of Whites. Such a finding highlights the importance for geographic variability in clinical delivery and research studies.[37] Ultimately, chronic illness diagnosis and burden (CCI score 1-4) had the greatest influence on frequency of mobile clinic visits. Such need characteristics are most proximal to service use and prompt the importance for medical care.[14,20] Compared to other studies,[18,32] this mobile clinic population had much higher prevalence rates of hypertension (44%) and diabetes (29%), as well as significant uncontrolled disease. Moreover, this study further found that those with hypertension and diabetes had higher mobile clinic visit rates than those without such chronic illnesses. Mobile clinics provide a unique opportunity to deliver care to vulnerable individuals with chronic illness by addressing social determinants of health; delivering timely high-quality health care services; reducing travel distance; and eliminating transportation issues and scheduling challenges for marginalized individuals and communities.[35]

Limitations

This study has some important limitations to consider. First, this study was a secondary analysis of retrospective clinical chart data that was not originally collected for the purposes of research. As a result, some demographic and clinical visit data were not consistently recorded by clinic personnel. For example, some demographic information was either not reported or recorded as unknown. In addition, there was limited chart information on education and income – two enabling variables known to influence mobile clinic utilization.[3,11,32]

Second, the clinic was staffed by volunteer providers which introduced a potential discrepancy in standard of care and systematic data collection. For example, a hemoglobin A1c may be ordered by a physician after an exam every 3 months, while another may request a hemoglobin A1c every 6 months, thus there were varying dates and frequency of hemoglobin A1c readings and BP readings, and some patients had more readings than others. Consequently, when assessing associations between variables and the number of visits per year, some individuals received fewer follow ups than others. We adjusted for this by using the standard offset adjustment in the zero truncated negative binomial regression analysis.

Finally, this study was also limited in its access to medical records from traditional settings including the local Health Information Exchange. This data would provide insight on whether patients seek care only at the mobile medical clinic or if they were seeking care elsewhere. Literature shows mobile clinic users may use various sources in seeking medical care. (Gibson et al., 2014) Nevertheless, we believe that this study is valuable in its current presentation of characteristics, frequency of visits, and associations between mobile medical clinic visit rates despite the potential of other health care use options.

Implications for Practice, Policy, and Research

From a practice standpoint, the results of this study can guide considerations of sociodemographic characteristics in practice at mobile medical clinics (i.e., age, gender, ethnicity). Knowledge of gendered demographics in visiting mobile clinics creates opportunities for gender-focused interventions. For example, by knowing that more women than men visit this clinic, the clinic could use these findings to develop new programs for women's health screenings and education.

Given the higher visit rates among patients with chronic illness, specialty services should be considered for these patients including endocrinology, cardiology, and podiatry. With nearly half of the mobile clinic population having chronic illness, specialists could help stave off the progression of disease and improve care outcomes using their specialized approach to care. Telehealth could be used on the clinic for these specialty services, minimizing cost to the specialist, while providing a much-needed service to the vulnerable individuals.

With the high prevalence of hypertension, diabetes, and obesity, focusing on non-pharmacological interventions such as recommendations for diet, stress management, and exercise is essential to effectively improve healthcare outcomes. In addition, this data could be used for developing grants to support new programs that target a specific population in need.

From a policy standpoint, access to care is essential for disease prevention and promotion of good health. Policy makers can leverage the knowledge gained from this study to promote the utilization of mobile medical clinics as a consistent source of care for vulnerable groups. Further, policy makers can advocate for government agencies serving the disenfranchised and minority groups that lack healthcare access due to transportation, lack of funds, or lack of insurance.

From a research perspective, additional work is needed to improve our understanding of other factors such as education level and income that may influence use of mobile medical clinics. In the future, prospective studies would be useful to ensure that data is standardized and collected at specific time-points for measurement over time. Standards of care should be followed, such that each patient has a set of biomedical readings during the same time frame and with the same time interval.

Overall, this study expands our understanding of the characteristics of individuals who receive care aboard mobile medical clinics, particularly in the Western region of the U.S. In particular, our study contributes data on adults with insurance and chronic illness who visit mobile clinics. Care should be taken to locate mobile clinics close to the community most in need, as bridging gaps in health delivery offers to improve chronic illness, decrease emergency room utilization, and increase regular source of care.[35] Future studies are needed to examine how mobile clinics can be integrated with health systems to decrease readmissions of patients with chronic illnesses such as diabetes, hypertension, chronic heart failure, and chronic kidney disease. Mobile medical clinics could be an upstream solution for these patients who are often readmitted due to an unmet need for care located close to home and provided by trusted sources.[35]

Conclusions

In the present study, individuals' characteristics and use of mobile medical clinics in Southern California differed as a function of the presence and control of chronic illness. In describing the factors associated with mobile medical clinic use, the present study demonstrated associations between clinic utilization and presence and control of chronic illness. This study contributes to a growing body of evidence that mobile clinics serve as an important system of health care delivery, especially to vulnerable populations, those who are both insured and uninsured, and those with uncontrolled chronic illness. Regardless of insurance status, access to mobile medical clinics in the areas were people, work, live, pray, and play is essential to increasing their use of services.

The deployment of mobile medical clinics in communities of vulnerable individuals is a step toward improving healthcare access including high quality, cost-effective care for patients.

Understanding factors associated with mobile medical clinic utilization informs providers, policy makers, health care leaders, and government health care representatives with evidence on alternative ways to bridge the gap in health inequities, recognize the value of mobile medical clinics, and invest in mobile medical clinics thereby addressing social determinants of health and improving chronic illness health outcomes for all who utilize them. Given the present study's findings, public health, health systems, universities, and private organizations can leverage the descriptive characteristics of patients who visit clinics to guide policy in support of these clinic modalities, guide practice interventions specific to gender and chronic illness needs, guide research for improving health delivery models, and promote philanthropic and grant funding for these community-focused services.

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Chapter 4:

Examining the Association Between Frequency of Mobile Clinic Visits and Chronic Illness Control

Abstract

Objective: To examine the association between frequency of mobile clinic visits and diabetes or hypertension control among patients who received regular mobile clinic care, controlling for patient sociodemographic characteristics and comorbidities.

Design: Retrospective cohort study using patient chart review.

Sample: Patients who regularly visited mobile medical clinics in Southern California (N = 218) between January 1, 2018 and December 31, 2019.

Measurements: The dependent variables were hemoglobin A1c and blood pressure control. The independent variable was number of visits per year. Longitudinal associations were examined using a linear mixed model or generalized linear mixed model.

Results: Among regular mobile clinic patients with diabetes (n = 86), there was no significant association between number of visits and hemoglobin A1c control (hemoglobin A1c < 6.5). Among regular mobile clinic patients with hypertension (n = 129), the odds of hypertension control (blood pressure < 140/90 mmHg) over time significantly increased as the frequency of clinic visits increased (adjusted OR = 5.27, 95% CI 1.63-16.99).

Conclusions: The study findings suggest that regular mobile clinic use by adults with hypertension improves blood pressure control over time. However, the frequency of mobile clinic visits had no effect on diabetes control overtime. Patients with diabetes need additional interventions to achieve hemoglobin A1c control.

Keywords: Mobile Medical Clinic, Diabetes, Hypertension, Utilization, Predisposing, Enabling, Need Factors

Background

More than 2,000 mobile clinics operate in the United States, providing an estimated 5 to 6.5 million visits annually and serving more than 2.1 million uninsured people (Malone et al., 2020). Historically, mobile medical clinics have served the most vulnerable populations in the nation, providing quality access to migrant workers, women in need of prenatal care, children with asthma, and minorities with HIV (Yu et al., 2017). Mobile clinics are uniquely positioned to provide health care services to people with chronic illnesses (Bouchelle et al., 2017; Yu et al., 2017) and they contribute to alleviating health disparities among vulnerable and underserved populations (Kelch & Gallardo, 2017). In 2017, 28 million people did not have health insurance. Of the 62 million who were unable to access primary care services, 43% were low-income and 28% lived in rural areas (Medical Economics®., 2014).

Access to health care, an important determinant of health, includes insurance coverage, health care services, and timely care. Lack of insurance is one of the most formidable barriers to care (Institute of Medicine, 2002). Social determinants of health (i.e., conditions in the environment where people live, work, play, and pray) affect a wide range of health and quality-of-life outcomes and risks (Office of Disease Prevention and Health Promotion [ODPHP], 2019). These modifiable barriers to access can lead to unmet health needs, delays in receiving appropriate care, and preventable hospital admissions (Clarke et al., 2017).

Research suggests that mobile clinics can improve health outcomes, increase patient quality of life, and reduce health care costs by reducing unnecessary emergency department visits or hospital readmissions (Hill et al., 2016; Oriol et al., 2009). For example, a study by Song et al. (2013) found that patients who received screening and counseling from a mobile medical clinic had reductions in both systolic and diastolic blood pressures by 10.7 mmHg and

6.7 mmHg, respectively. These changes in blood pressure were associated with 32% and 45% reductions in risks of myocardial infarctions and strokes, respectively, which translated into a cost savings estimation of $235,254 over 30 months.

It is critical to better understand how innovative models of care can address these social determinants of health to improve health care access and reduce health disparities for people with health care needs. According to the 2019 Kaiser Foundation Hospital report, residents in Southern California report poorer values on several indicators of access to care compared to residents of the state overall. For example, two San Bernardino County cities, Fontana and Ontario, have lower rates of primary care visits (66.6% and 66.8%, respectively) compared to the rest of the state (72.9%). Prevalence of diabetes is higher in the Fontana and Ontario service regions (11.5% and 10.2%, respectively), compared to the rest of California (7.3%). Type 2 diabetes is a chronic illness that impacts the lives of people worldwide and is projected to be the 7th leading cause of death in the world by 2030 (Mathers & Loncar, 2006). The cost of diabetes is a substantial expense for individuals and governments; therefore, implementing population-based interventions that focus on prevention, early detection, and medication management to prevent disease progression is paramount to halting the continued surge of diabetes globally (Mathers & Loncar, 2006; World Health Organization [WHO], 2016; “Worldwide Trends," 2016).

In addition, prevalence of hypertension is higher in San Bernardino compared to the rest of the State of California (32% versus 27%, respectively; San Bernardino County, 2018). Hypertension is a major risk factor for cardiovascular illness. Lowering blood pressure has been shown to decrease the incidences of stroke, heart attack, and heart failure. Further, 1 in 5

Hispanic males have hypertension. However, hypertension is more prevalent in non-Hispanic Blacks (57%) than Hispanics (43.7%; CDC, 2020).

For optimal treatment of chronic illness, patients need to make appropriate use of available health care, including regular follow-up. Various factors can affect health care use among patients. The Andersen Behavioral Model (ABM) is one of the most frequently used frameworks for explaining and predicting patient utilization of health care services and related outcomes (Andersen, 1973, 1995, 2008; Andersen & Newman, 1995). According to the ABM, use of health services is a function of individual predisposition to use services, factors which enable or impede use, and the need for care (Andersen, 1973, 1995, 2008; Andersen & Newman, 1995). The ABM feedback loop provides a holistic perspective of the determinants of health that can influence access to health care. This loop shows that health outcomes can affect subsequent predisposing, enabling, and need characteristics of the individual and their utilization of health services. Need characteristics, which are most proximal to service use, are medical conditions that prompt the importance of medical care.

Access to quality health care is essential to achieve improved health outcomes and to increase quality of life. Limited access to care impacts each individuals' ability to reach their full potential and negatively affects their quality of life (Kaiser Foundation Hospital, 2019). However, it is unknown to what degree the utilization of mobile medical clinics influences outcomes of treatment for chronic diseases, such as diabetes and hypertension, especially among vulnerable individuals in marginalized communities in California. Therefore, the aim of this study was to examine the association between frequency of clinic visits and chronic illness status over a 2-year period among regular mobile clinic users, after adjusting for sociodemographic characteristics and comorbidities. We hypothesized that adults with well-controlled diabetes or hypertension will use mobile clinics more frequently than those without well-controlled conditions.

Methods

Study Design and Sample

This retrospective cohort study included patients who received regular care in four mobile medical clinic locations in Southern California from January 1, 2018 to December 31, 2019. The Well of Healing Mobile Medical Clinic is a no-cost, faith-based, primary care mobile clinic licensed by the State of California as a free mobile clinic in San Bernardino County. The clinic opened its doors in 2004 as a non-profit 501(c)(3) organization and provides health care access to uninsured and underinsured people who live in the Southern California communities of Fontana, Ontario, San Bernardino, and Muscoy, an unincorporated area. The no-cost health care services provided by the clinic include a physical examination and evaluation by either a physician or a nurse practitioner, point-of-care testing, medications, health education, and prayer (Well of Healing Mobile Medical Clinic, 2019). Patient medical record charts were reviewed to determine study inclusion or exclusion.

The study inclusion criteria included adults 26 years old and older who visited the clinic at least three or more times during the 2-year study period. From a clinical perspective, individuals in this age range are more likely to have chronic illnesses of interest per our study criteria. A regular clinic user was defined as a person who visited the clinic three or more times per year, based upon the recommended visits for chronic illness reevaluation and management. (American Heart Association [ADA], 2021; King et al., 2017) There were 411 patients who visited the clinic during the study period and 218 (53%) were identified as regular users. Of those regular users, 86 (39%) had a diagnosis of diabetes and 129 (59%) had a diagnosis of hypertension. The number of new patients who were regular users during the study period was 58% (*n* = 127), whereas 42% were established patients (*n* = 91). Figure 4.1 provides a diagram of the process through which patients were selected for the study and included in the analysis. Individuals who did not have at least two hemoglobin A1c measures were excluded from the diabetes control analysis. Individuals who did not have at least two blood pressure measures were excluded from the blood pressure and hypertension control analysis.

Data Collection

Approval of the study was granted by Well of Healing Mobile Medical Clinic Board of Directors. Data were retrieved by the lead author (AC) from the medical charts of all patients who visited the clinics during 2018–2019. A medical record data abstraction tool was created to capture information regarding the variables of interest from records of the patient's initial visit and all subsequent visits between 2018 and 2019. All patients were assigned a subject ID number and deidentified data were entered into RedCap. Presence of diabetes was identified in the patient chart by record of disease diagnosis and/or prescription of diabetes medication (e.g., metformin, glipizide). For patients with diabetes, we collected all hemoglobin A1c readings during the 2-year study period. The presence of hypertension was identified in the patient chart by record of disease diagnosis and/or prescription of hypertensive medication (e.g., Amlodipine, HCTZ, Losartan, Lisinopril). For patients with hypertension, we collected all systolic and diastolic blood pressure readings during the 2-year study period.

Study Measures

The dependent variables in this study were hemoglobin A1c, systolic blood pressure, and diastolic blood pressure. Hemoglobin A1c and blood pressure were used as continuous variables and also dichotomous variables of controlled diabetes or hypertension were created. Control of diabetes was defined as hemoglobin A1c < 6.5% based on the Centers for Disease Control and Prevention (CDC) guidelines (CDC, 2020). Hemoglobin A1c provides an average level of blood sugar over the prior 3 months; the higher the hemoglobin A1c level, the higher the average blood glucose levels over the past 3 months and, thus, the more poorly controlled the diabetes (U.S. Department of Health and Human Services, 2018). Control of hypertension was defined as systolic pressure < 140 mmHg and diastolic pressure < 90 mmHg. According to the Eighth Joint National Committee (JNC-8) hypertension guidelines, for individuals 18 to 59 years of age without major comorbidities, and for patients 60 years or older who have diabetes, chronic kidney disease, or both conditions, the goal blood pressure level is < 140/90 mm Hg (Hernandez-Vila, 2015).

The main independent variable of interest was the number of clinic visits per year. For patients who were new to the clinic and had less than 1 year of study data, we calculated a projected number of visits per year, adjusting for the duration of observation in the study. Covariates were selected based on the ABM, including predisposing, enabling, and need factors. Predisposing factors comprised demographic characteristics, including sex (male/female), race/ethnicity (African American, White, Hispanic), age at first visit during the study period, and marital status (single, married). Enabling factors included insurance status (uninsured, private pay, public insurance) and housing status (housed, homeless). Need factors included obesity, depression, and the Charlson Comorbidity Index (CCI) score. The presence of depression and obesity was determined by chart review of diagnosis of depression or obesity or existing medication prescription for depression (Abilify, Elavil, Prozac, Zoloft based on known available treatment options). The CCI is a method of classifying comorbidity, which assesses the presence of 19 comorbidities (e.g., congestive heart failure, cerebral vascular accident, chronic obstructive pulmonary disease) and produces an unweighted count of the number of comorbid diseases and creates a sum that considers both the number (frequency) and seriousness (severity) of comorbid conditions (Charlson, 2020). The CCI is a validated and widely used tool for predicting mortality and cost of chronic illness (Charlson et al., 2008). Each chronic condition (diabetes, hypertension) was included as a covariate when analyzing the other condition.

Data Analysis

Descriptive statistics were used to summarize the baseline characteristics of the sample at the first visit during the study period and to describe the total number of visits by sample characteristics. Descriptive statistics were reported as mean and standard deviation for continuous variables, and as frequencies and percentages for categorical variables.

To analyze the continuous hemoglobin A1c data for diabetes patients and systolic and diastolic blood pressure data for hypertension patients during the study period we utilized a linear mixed model in lme4 v1.1.27.1 (Bates et al., 2015). For dichotomous outcomes (controlled hypertension), we utilized a generalized linear mixed model with a logistic regression link. For hemoglobin A1c, modeling hemoglobin A1c as a continuous variable had the most powerful fit; therefore, we presented results using continuous hemoglobin A1c data. We first fitted a model with main effects. We then added an interaction term to the unadjusted model to examine the interaction between the frequency of clinic visits and the amount of time an individual had been in the study(referred to in the multivariate models as “study-time.”) on hemoglobin A1c or blood pressure control. Several sensitivity tests were conducted to determine the best model fit. We used two-tailed tests with an alpha level of .05. The final multivariate model adjusted for all covariates of predisposing, enabling, and need factors based on the ABM theoretical model, regardless of statistical significance.

Results

Characteristics of the Study Participants

Table 4.1 presents the baseline characteristics of the 218 patients who received regular care and the number of visits between January 1, 2018 and December 31, 2019. These patients made a total of 1430 visits to the mobile clinics during the study period, with a mean number of 6.6 (SD = 4.2) visits. The majority of the regular mobile clinic users were female (68%), Hispanic (87%), and married (56%); mean age was 53 (SD=11.0). Uninsured individuals accounted for 53% of regular users. Nearly all regular mobile clinic users reported a home address (99%), while only 1% indicated homeless housing status.

Table 4.2 presents the characteristics of patients with diabetes and hypertension. Of the regular clinic users, 39% had diabetes (n = 86), 59% had hypertension (n = 129), 26% had obesity (n = 57), and 2% had depression (n = 5). Among 86 mobile clinic patients with diabetes, 67% had uncontrolled diabetes (hemoglobin A1c > 6.5; n = 58). Of 129 regular users with hypertension, 54% had uncontrolled hypertension (n = 70). Nearly 73% of the study sample had other comorbidities (CCI $\geq$ 1).

Associations Between Number of Visits and Hemoglobin A1c Values

Table 4.3 presents the linear mixed model regression results examining the association between the number of mobile clinic visits per year and hemoglobin A1c levels over time among regular users with initial and follow-up hemoglobin A1c data (n = 64). These patients made a total of 618 visits to the mobile clinics, with a mean of 9.6 (SD = 3.0) number of visits.

In both unadjusted and adjusted models, no association were found between number of visits and hemoglobin A1c measurement ($p > .05$). Additionally, none of the predisposing or enabling variables were significantly associated with hemoglobin A1c level. Among need variables, CCI score was significantly associated with hemoglobin A1c levels over time in both the unadjusted and adjusted models. Compared to those with a CCI of 0, those with a CCI score of 2 had a 2.46 increase in hemoglobin A1c level (Coefficient = 2.46, 95% CI 0.15 to 4.77, p = .041), adjusting for patient sociodemographic characteristics and comorbidities. There was no interaction effect between study-time and number of visits on hemoglobin A1c control.

Associations Between Number of Visits and Blood Pressure and Hypertension Control

Table 4.4 presents linear mixed model results examining the association between number of mobile clinic visits and continuous measurement over time, while controlling for patient sociodemographic characteristics and comorbidities.

There was no evidence for a main effect of number of visits per year on systolic blood pressure, either in the unadjusted or adjusted models ($p > .05$). However, there was a significant interaction effect between number of clinic visits and study-time on systolic blood pressure in the unadjusted model ($\beta = -9.48$, 95% CI -16.8 to -2.12, $p = .012$). The significant interaction between number of clinic visits and study-time, on systolic blood pressure remained in the adjusted model ($\beta = -10.76$, 95% CI= -18.28 to -3.25, $p = .005$). Figure 4.2 shows the trajectory of systolic blood pressure over time by frequency of visits. The purple line, representing the most frequent clinic users (# visits/year = 7.3), shows the sharpest decline in systolic blood pressure over the 2-year study period, whereas the red line, representing the least frequent clinic users, shows almost no change in systolic blood pressure over time.

For diastolic blood pressure, both in the unadjusted and adjusted models, there was no evidence of a main effect of number of visits on diastolic blood pressure ($p = .28$) or an interaction effect with study-time. However, mobile clinic patients with obesity had an increase in diastolic blood pressure by 3.95 compared to those without obesity in the unadjusted model (β

= 3.95, 95% CI 0.72 to 7.19, p = .018). Additionally, there was a significant inverse association between CCI and diastolic blood pressure control. Compared to those with a CCI score of 0, significant decreases in diastolic blood pressure control were observed for those with a CCI score of 2 (β = -6.89, 95% CI -11.40 to -2.42, p = .003), a CCI score of 3 (Coefficient = -8.62, 95% CI -13.30 to -3.93, p = .000), and a CCI score of 4+ (Coefficient = -14.5, 95% CI -21.20 to -7.82, p = .000).

Table 4.4 presents results of a generalized linear mixed model, with a logistic regression link examining the relationship between the number of clinic visits and hypertension control (blood pressure < 140/90 mmHg). There was no evidence for a main effect of the number of clinic visits on hypertension control in the unadjusted and adjusted models (adjusted OR = 0.46, 95% CI 0.20 to 1.08, p = .075). However, there was a significant interaction between the number of clinic visits and study-time on hypertension control (OR = 4.91, 95% CI 1.54 to 15.60, p = .007) and the significant interaction remained in the adjusted model (adjusted OR = 5.27, 95% CI 1.63 to 16.99, p = .005). Figure 4.3 illustrates the probability of hypertension being controlled over time by frequency of visits. Patients with the highest frequencies of clinic visits (mean 7.3 visits/year in the purple line) showed increased hypertension control over the 2-year study period whereas patients with the lowest frequencies of clinic visits (mean 4.3 visits/year in the green line) showed decreased hypertension control over time. No predisposing, enabling, or need variables were significant in the unadjusted and adjusted models.

Discussion

In this retrospective cohort study, we examined two selected chronic illness biomarkers (hemoglobin A1c and blood pressure) over a 2-year period among regular mobile medical clinic users in Southern California. We hypothesized that adults with well-controlled diabetes or hypertension would have used mobile clinics more frequently than those without well-controlled diabetes or hypertension and that the number of clinic visits would influence the controlled status. This study's findings suggest that the trajectory of hypertension control over time among regular mobile clinic users significantly differ by the frequency of clinic visits. However, such an interaction effect between the number of visits and the length of time a participant was engaged with the clinic was not observed for diabetes control.

In this study of regular mobile medical clinic users in Southern California, patients had high prevalence of hypertension (59%) and diabetes (39%) and the majority of patients were Hispanic, age around 60, uninsured, female patients with multiple comorbidities. These patient characteristics are similar to reports from other studies of mobile clinics (Malone et.al., 2020; Misra et.al.,2017; Toulouse & Kodadek, 2016), with the exception that other studies have demonstrated that Black patients visit mobile clinics more frequently than Hispanic patients (Song et al., 2013).

This study did not find an association between frequency of clinic visits and diabetes control measured by hemoglobin A1c level among regular mobile medical clinic users. Although previous research suggests that increased access to medication improves healthcare outcomes for diabetes (Gibson et al., 2017), more frequent visits to the mobile medical clinic for regular users in this study were not linked to improvement in hemoglobin A1c. In fact, many of the patients in this study showed poor diabetes control (hemoglobin A1c >6.5), indicating challenges in adequate management of diabetes, particularly in this vulnerable population with limited resources. For adults with diabetes, only one in eight people achieve the American Diabetes Association goals for hemoglobin A1c (Toulouse & Kodadek, 2016). Therefore, futures studies need to identify modifiable factors that collectively can improve hemoglobin A1c values in individuals, particularly for vulnerable populations who depend on mobile clinics for health care services.

This study found that patients who visited the mobile clinic more frequently over time were more likely to achieve controlled hypertension. There has been little research that examined the relationship between healthcare utilization frequency and hypertension control, but previous literature provides evidence that mobile health clinics improve outcomes of treatment for hypertension over time. In a study by Song et.al. (2013) mobile clinic patients with hypertension had an average reduction of 10.7 mmHg in systolic blood pressure and 6.2 mmHg in diastolic blood pressure compared to their first visit. These patients had a mean of six visits to the clinic during a thirty-month period (Song et al., 2013). Another study found that hypertension control was significantly associated with visit intervals to a primary care provider among middle and older populations (King et al.,2017). The results of this study joins a growing body of evidence that regular and frequent care provided by mobile medical clinics can contribute to hypertension control among their patients.

Limitations

This study had several limitations to consider. First, the retrospective study design and use of existing medical record data limited control over available information and the consistency of the data collected. Education level and income may be important potential confounders, but information on those variables were not available in the patient medical charts. In addition, this study utilized medical records that were designed for clinical care, which were not systematically completed for research purposes and therefore contained gaps in data. In contrast, most prior studies reported only aggregate data and provided big picture insight regarding care (Malone et al., 2020). Using medical record review, including biological data, can provide advantages over self-report.

Second, the clinic involved in this study was faith-based (non-denominational) and, given its religious affiliation, the population served may have chosen to visit the clinic because of its faith-based mission; alternatively, this could have been a deterrent to potential patients. Thus, the findings may not be generalizable to patients seeking care from other types of mobile clinics. However, future studies should consider the faith-based environment as an enabling factor for mobile medical clinic use.

Third, there was a lack of any measures of quality of care (e.g. nature of interactions with patients) and how this covariate could influence outcomes. Future studies should document the experience of adults receiving care aboard a mobile clinic as a way to measure quality of care and understand the patient perception of this medical delivery model.

Finally, this study included all patients who visited the clinics between 2018 and 2019, and the observation period varied by patient. In the study sample, 58% of patients were new to the clinic and some patients made only a few visits during the study period. Consequently, these variations were taken into consideration during the analysis, and we calculated a projected number of clinic visits per year using available data; using projected data in some cases may have introduced error.

Implications for Public Health Nursing

Public health nursing emphasizes the importance of understanding the dynamics of where people live, work, play, and pray. Mobile medical clinics are positioned to inform policy, improve chronic disease treatment outcomes, and advance health equity among vulnerable populations, and thus an ideal way to bridge the gap between hospitals and communities (Malone et al., 2020). Future research is needed to investigate the cost of services aimed toward reducing the burden of chronic illness (e.g., diabetes type 2, hypertension) on patients, communities, and health systems.

Understanding the patient characteristics and health outcomes of individuals served by mobile medical clinics provides researchers, public health nurses, policymakers, and health systems leaders the data needed to guide clinical practice interventions in unconventional spaces, support non-traditional health care delivery models, and leverage policy change to increase health care access for vulnerable populations. Future studies should document the experience of individuals seeking regular care aboard mobile medical clinics, as a way to better understand their perspective of visit frequency in improving health outcomes in this population.

These research findings improve our understanding of the characteristics of people who regularly utilize care aboard mobile clinics and help us to ascertain the effects of non-traditional health care delivery models on health outcomes among medically underserved individuals. An exploration of financial models for sustaining these healthcare systems is essential to continuing the public health efforts focused on improving health care access and outcomes in individuals and communities.

Conclusion

Utilization of mobile medical clinics can contribute to reducing the burden of illness by providing consistent access to regular clinical care, particularly to vulnerable, marginalized populations. This study joins a growing body of evidence demonstrating that frequent utilization of mobile medical clinics can improve chronic illness control such as hypertension. For diabetes control, we did not find a significant association with frequency of mobile medical clinic visits, and this finding may indicate that diabetes control requires consideration of other aspects, particularly patients' comorbidity conditions. Given this information, providers, health system leaders, and patients with diabetes should consider additional interventions for improving diabetes control.

Knowledge of the role of mobile medical clinics in improving chronic illness control and the importance of ensuring access as often as needed among individuals who visit mobile medical clinics gives health systems, policy makers, and government agencies a leg up in directing resources to the communities in their catchment areas when needing to reach vulnerable populations. Further, the results of this research add to the scientific foundation on which to develop future studies that focus on mobile clinic patients and inform care management interventions for individuals with chronic illness, such as diabetes and hypertension.

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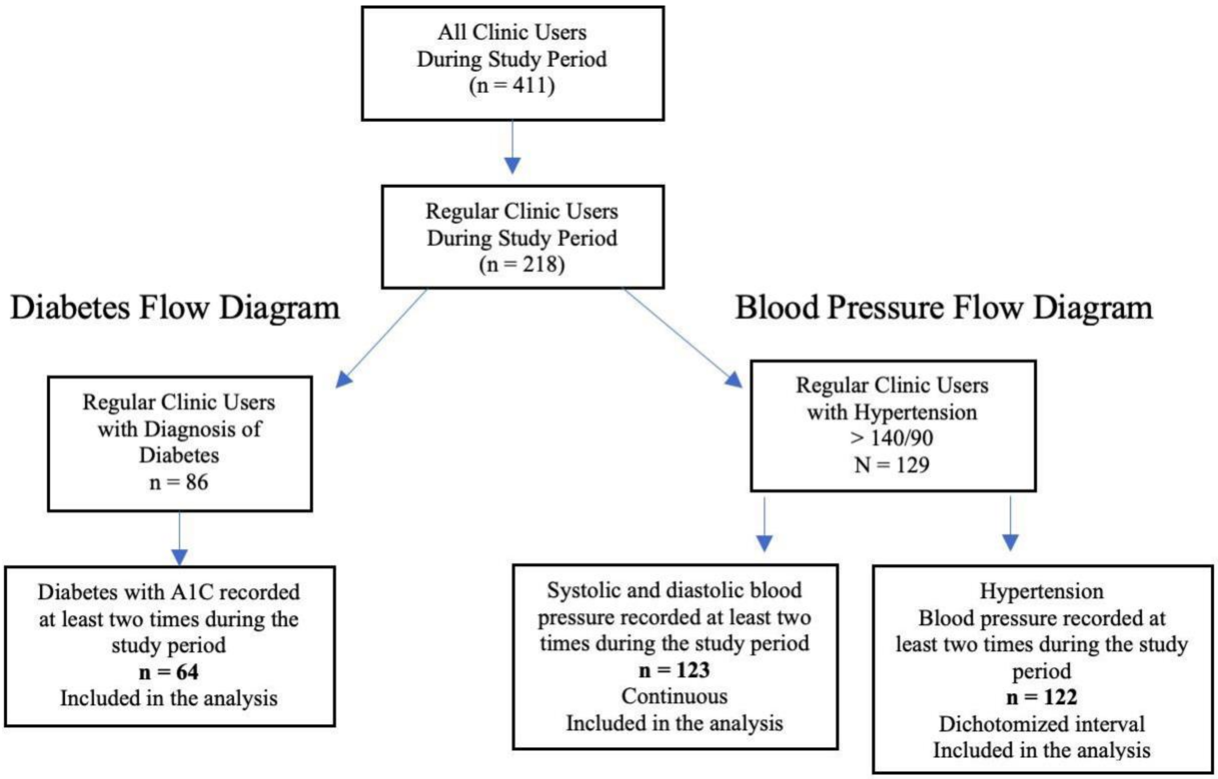

Figure 4.1 Diabetes and Blood Pressure Data Analysis Flow Diagram

Table 4.1 Baseline Characteristics of Patients Receiving Regular Care at Mobile Medical Clinics in Southern California Between January 1, 2018 and December 31, 2019 by Total Number and Mean Number of Visits

Variables	**Regular mobile clinic users[a]** ***n* (%)**	**Total number of visits[b] *n***	**Number of visits[c] mean (SD)**
TOTAL SAMPLE*	218	1430	6.6 (4.2)
NEW PATIENTS*	127 (58%)	494	3.9 (2.9)
Predisposing variables			
Gender/Sex			
Female	150 (68.8)	985	6.6 (4.1)
Male	68 (31.2)	445	6.5 (4.4)
Race/Ethnicity			
Hispanic	190 (87.2)	1254	6.6 (4.2)
African American	10 (4.6)	43	4.3 (4.8)
White	3 (1.4)	32	10.7 (4.9)
Other/Unknown	15 (6.9)	101	6.7 (3.4)
Age			
25-35	11 (5.0)	27	2.5 (2.5)
36-45	43 (19.7)	240	5.6 (4.0)
46-55	68 (31.2)	436	6.4 (4.3)
56-65	70 (32.1)	510	7.3 (4.1)
66+	26 (11.9)	217	8.3 (3.7)
Mean (SD)	53.04 (11.10)	n/a	n/a
Marital status			
Married	122 (56.0)	818	6.7 (4.2)
Single	67 (30.7)	369	5.5 (4.3)
Unknown[g]	29 (13.3)	243	8.4 (3.1)

Variables	Regular mobile clinic users[a] *n* (%)	Total number of visits[b] *n*	Number of visits[c] mean (SD)
Enabling variables			
Insurance status			
Uninsured	115 (52.8)	846	7.4 (4.2)
Unknown[d]	93 (42.7)	530	5.7 (4.0)
Other[e]	10 (4.6)	54	5.4 (3.9)
Housing status			
Housed	217 (99.5)	1429	6.6 (4.2)
Homeless	1 (0.5)	1	1.0 (NA)
Clinic location			
Ontario	102 (46.8)	622	6.1 (4.3)
Fontana	70 (32.1)	511	7.3 (3.6)
Muscoy	43 (19.7)	267	6.2 (4.6)
San Bernardino	3 (1.4)	30	10.0 (2.6)
Need variables			
Chronic illness			
Hypertension[f]	129 (59.2)	1020	7.9 (3.9)
Diabetes[g]	86 (39.4)	696	8.1 (3.9)
Obesity[h]	57 (26.1)	464	8.1 (4.2)
Depression[i]	5 (2.3)	53	10.6 (6.3)
Charlson Comorbidity index score[j]			
0	60 (27.5)	264	4.4 (3.3)
1	59 (27.1)	377	6.4 (4.4)
2	54 (24.8)	410	7.6 (4.2)
3	35 (16.1)	296	8.5 (3.6)
4+	10 (4.6)	83	8.3 (3.8)

Variables	Regular mobile clinic users[a] *n* (%)	Total number of visits[b] *n*	Number of visits[c] mean (SD)

[*]Row percent
[a]Have 3+ visits per year
[b]Total number of visits = number of visits during the study period between January 1, 2018 - December 31, 2019
[c]Mean number of visits – mean number of visits over the 2-year study period with standard deviation. SD=Standard Deviation
[d]Unknown = Missing from record/not reported
[e]Other = Medicare only, Medicare and Medicaid, private pay, or Covered California
[f]Hypertension=Had a written diagnosis of hypertension in patient chart, systolic >140 and/or diastolic > 90 and/or prescription of hypertensive medication (e.g., Amlodipine, HCTZ, Losartan, Lisinopril)
[g]Diabetes=Had a written diagnosis of diabetes in the chart, recorded hemoglobin A1c > 6.5, or was taking diabetes medication (e.g., metformin, glipizide)
[h]Obesity=Had a written diagnosis of obesity
[i]Depression=Had a written diagnosis of depression or an existing medication prescription for depression (Abilify, Elavil, Prozac, or Zoloft based on known available mobile clinic treatment options)
[j]https://www.mdcalc.com/charlson-comorbidity-index-cci

Table 4.2 Baseline Characteristics of Patients Receiving Regular Care at Mobile Medical Clinics in Southern California between January 1, 2018 and December 31, 2019 by Presence of Uncontrolled Diabetes or Hypertension

Variables	Diabetes Yes[a]	Uncontrolled[b] diabetes hemoglobin A1c ≥ 6.5	Hypertension Yes[d]	Uncontrolled[e] hypertension systolic ≥ 140 or diastolic ≥ 90
TOTAL SAMPLE*	86 (39.4)	58 (67.4)[c]	129 (59.2)	70 (54.3)[f]
Predisposing variables				
Gender/Sex				
Female	55 (64.0)	37 (63.8)	88 (68.2)	48 (68.6)
Male	31 (36.0)	21 (36.2)	41 (31.8)	22 (31.4)
Race/Ethnicity				
Hispanic	77 (89.5)	51 (87.9)	114 (88.4)	62 (88.6)
African American	0 (0.0)	0 (0.0)	4 (3.1)	4 (5.7)
White	3 (3.5)	2 (3.4)	1 (0.8)	0 (0.0)
Other/Unknown	6 (7.0)	5 (8.6)	10 (7.8)	4 (5.7)
Age				
25-35	1 (1.2)	0 (0.0)	1 (0.8)	0 (0.0)
36-45	16 (18.6)	11 (19.0)	11 (8.5)	7 (10.0)
46-55	18 (20.9)	10 (17.2)	39 (30.2)	23 (32.9)
56-65	39 (45.3)	28 (48.3)	55 (42.6)	28 (40.0)
66+	12 (14.0)	9 (15.5)	23 (17.8)	12 (17.1)
Mean (SD)	55.5 (10.0)	56.4 (10.3)	57.4 (9.9)	56.5 (9.1)
Marital status				
Married	53 (61.6)	34 (58.6)	82 (63.6)	44 (62.9)
Single	20 (23.3)	13 (22.4)	29 (22.5)	17 (24.3)
Unknown[g]	13 (15.1)	11 (19.0)	18 (14.0)	9 (12.9)

Variables	Diabetes Yes[a]	Uncontrolled[b] diabetes hemoglobin A1c ≥ 6.5	Hypertension Yes[d]	Uncontrolled[e] hypertension systolic ≥ 140 or diastolic ≥ 90
Enabling variables				
Insurance status				
Uninsured	52 (60.5)	37 (63.8)	78 (60.5)	45 (64.3)
Unknown[g]	32 (37.2)	19 (32.8)	47 (36.4)	23 (32.9)
Other[h]	2 (2.3)	2 (3.4)	4 (3.1)	2 (2.9)
Housing status				
Housed	86 (100.0)	58 (100.0)	129 (100.0)	70 (100.0)
Homeless	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Clinic location				
Ontario	38 (44.2)	24 (41.4)	55 (42.6)	26 (37.1)
Fontana	32 (37.2)	24 (41.4)	45 (34.9)	23 (32.9)
Muscoy	14 (16.3)	8 (13.8)	26 (20.2)	19 (27.1)
San Bernardino	2 (2.3)	2 (3.4)	3 (2.3)	2 (2.9)
Need variables				
Chronic illness				
Hypertension[a]	66 (76.7)	45 (77.6)	129 (100.0)	70 (100.0)
Diabetes[d]	86 (100.0)	13 (22.4)	66 (51.2)	34 (48.6)
Obesity[i]	24 (27.9)	58 (100.0)	39 (30.2)	19 (27.1)
Depression[j]	1 (1.2)	0 (0.0)	3 (2.3)	2 (2.9)
Charlson Comorbidity Index score[k]				
0	5 (5.8)	1 (1.7)	17 (13.2)	12 (17.1)
1	21 (24.4)	15 (25.9)	31 (24.0)	18 (25.7)
2	29 (33.7)	19 (32.8)	43 (33.3)	23 (32.9)
3	23 (26.7)	18 (31.0)	30 (23.3)	14 (20.0)
4+	8 (9.3)	5 (8.6)	8 (6.2)	3 (4.3)

Variables	Diabetes Yes[a]	Uncontrolled[b] diabetes hemoglobin A1c $\geq$ 6.5	Hypertension Yes[d]	Uncontrolled[e] hypertension systolic $\geq$ 140 or diastolic $\geq$ 90

[*]Row percent

[a]Diabetes Yes, Had a written diagnosis of diabetes in the chart, recorded hemoglobin A1c > 6.5, or was taking diabetes medication (e.g., metformin, glipizide)

[b]Diabetes uncontrolled, hemoglobin A1c > 6.5 at baseline

[c]Hemoglobin A1c controlled, and uncontrolled numbers do not equal the number of patients with diabetes because hemoglobin A1c data was missing hemoglobin A1c recorded measure *(n* = 22)

[d]Hypertension Yes, Had a written diagnosis of hypertension in the chart, systolic > 140 and/or diastolic > 90 and/or prescription of hypertensive medication (e.g., Amlodipine, HCTZ, Losartan, Lisinopril)

[e]Hypertension uncontrolled; record of blood pressure > 140/90

[f] Hypertension controlled, and uncontrolled numbers do not equal the number of patients with hypertension because blood pressure data was missing at baseline *(n* = 3)

[g]Unknown = Missing from record/not reported

[h]Other = Medicare only, Medicare and Medicaid, private pay and Covered California

[I]Obesity = Had a written diagnosis of obesity

[j]Depression = Had a written diagnosis of depression or an existing medication prescription for depression (Abilify, Elavil, Prozac, or Zoloft based on known available mobile clinic treatment options)

[k]https://www.mdcalc.com/charlson-comorbidity-index-cci

Table 4.3 Linear mixed model regression: Association between number of visits and diabetes among regular clinic users[a] at mobile medical clinics in Southern California between January 1, 2018 and December 31, 2019

	Patients with diabetes[b] & baseline hemoglobin A1c	Total number of visits[c]	Mean number of visits[d]	Hemoglobin A1c value	
Variable	**n (%)**	**n**	**Mean (SD)**	**Unadjusted model coefficient (95% CI)**	**Adjusted model coefficient (95% CI)**
TOTAL SAMPLE	64 (100)	618	9.66 (3.0)		
Predisposing variables*					
Gender/Sex					
Female	42 (65.6)	408	9.7 (2.6)	0.03 (-0.78, 0.84)	-0.02 (-0.93, 0.88)
Male	22 (34.4)	210	9.5 (3.8)	Referent	Referent
Race/Ethnicity					
Hispanic	56 (87.5)	545	9.7 (3.1)	0.87 (-0.26, 1.99)	0.62 (-0.59, 1.83)
White	3 (4.7)	32	10.7 (4.9)	Referent	Referent
Age [Mean (SD)]	56.5 (10.2)	618	9.7 (3.0)	0.74 (-0.03, 1.51)	-0.01 (-0.08, 0.06)
Marital status					
Single	15 (23.4)	147	9.8 (2.8)	0.49 (-0.44, 1.42)	0.63 (-0.40-1.66)
Married	36 (56.2)	355	9.9 (3.4)	Referent	Referent
Unknown[e]	13 (20.3)	116	8.9 (2.2)	-0.09 (-1.24, 1.05)	0.12 (-1.09, 1.33)
Enabling variables					
Insurance status					
Uninsured	42 (65.6)	435	10.4 (2.5)	0.37 (-0.44, 1.18)	0.35 (-0.53, 1.23)
Other[f]	2 (3.1)	19	9.5 (2.1)	Referent	Referent
Need variables					
Chronic illness					

	Patients with diabetes[b] & baseline hemoglobin A1c	Total number of visits[c]	Mean number of visits[d]	Hemoglobin A1c value	
Variable	**n (%)**	**n**	**Mean (SD)**	**Unadjusted model coefficient (95% CI)**	**Adjusted model coefficient (95% CI)**
Hypertension[g]	49 (76.6)	471	9.6 (3.0)	0.31 (-0.58, 1.21)	-0.23 (-1.21, 0.75)
Obesity[h]	18 (28.1)	182	10.1 (4.0)	0.18 (-0.66, 1.03)	0.17 (-0.72, 1.06)
Charlson Comorbidity Index score[i]					
0	3 (4.7)	19	6.3 (1.2)	Referent	Referent
1	16 (25.0)	151	9.4 (3.9)	1.49 (-0.34, 3.33)	1.03 (-1.17, 3.23)
2	20 (31.2)	203	10.2 (3.2)	2.23 (0.43, 4.04)*	2.46 (0.15, 4.77)*
3	18 (28.1)	174	9.7 (2.4)	1.83 (0.01, 3.65)	2.05 (-0.40, 4.50)
4+	7 (10.9)	71	10.1 (2.0)	0.66 (-1.33, 2.65)	0.80 (-1.99, 3.59)
Clinic visit					
Log number of visits per year	n/a	n/a	n/a	0.28 (-1.26, 1.82)	-0.10 (-1.93, 1.72)
Log number of visits per year x study time (interaction)	n/a	n/a	n/a	-0.43 (-1.84, 0.98)	-0.34 (-1.76, 1.08)

Significance levels: *p < .01; **p < .001; ***p < .0001
Abbreviations: SD, standard deviation; IRR, incident rate ratio; CI, confidence interval
*Based on the Andersen Behavioral Model we used to guide this analysis; we included all predisposing, enabling, and need factors
[a]Regular users = Have 3+ visits per year
[b]Diabetes Yes, Had a written diagnosis of diabetes in the patient chart; recorded hemoglobin A1c > 6.5, or was taking diabetes medication (e.g., metformin, glipizide)
[c]Total number of visits = number of visits during the study period between January 1, 2018 - December 31, 2019
[d]Mean number of visits – mean number of visits over the 2-year study period with standard deviation. SD=Standard Deviation
[e]Unknown = Missing from record/not reported
[f]Other = Medicare only, Medicare and Medicaid, private pay and Covered California
[g]Hypertension =Had a written diagnosis of hypertension in the patient chart; systolic > 140 and/or diastolic > 90
[h]Obesity =Had a written diagnosis of obesity
[i]CCI Score = https://www.mdcalc.com/charlson-comorbidity-index-cci

Table 4.4 Linear Mixed Model Regression and a Generalized Linear Mixed Model with a Logistic Regression Link: Association Between Number of Visits and Blood Pressure and Hypertension Control among regular clinic users[a] at Mobile Medical Clinics in Southern California between January 1, 2018, and December 31, 2019

	Patients with hypertension[b]	Total number of visits[c]	Mean number of visits[d]	Systolic blood pressure		Diastolic blood pressure		Hypertension control (< 140/90 mmHg)	
Variable	**n (%)**	**n**	**Mean (SD)**	**Unadjusted model coefficient (95% CI)**	**Adjusted model coefficient (95% CI)**	**Unadjusted model coefficient (95% CI)**	**Adjusted model coefficient (95% CI)**	**Unadjusted model OR (95%CI)**	**Adjusted Model OR (95% CI)**
TOTAL SAMPLE	124								
Predisposing variables*									
Gender/Sex									
Female	85 (68.5)	712	8.4 (3.6)	-2.85 (-7.54, 1.84)	-1.39 (-6.08, 3.30)	-2.69 (-5.99, 0.60)	-3.37 (-6.46, 0.28)*	1.18 (0.72, 1.95)	1.09 (0.65, 1.83)
Male	39 (31.5)	317	8.1 (4.0)	Referent	Referent	Referent	Referent	Referent	Referent
Race/Ethnicity									
Hispanic	109 (87.9)	908	8.3 (3.8)	-3.49 (-10.40, 3.39)	-1.865 (-8.74, 5.01)	-0.0165 (-4.87, 4.84)	-1.59 (-6.12, 2.95)	1.17 (0.56, 2.43)	1.18 (0.55, 2.50)
White	1 (0.8)	13	13.0 (NA)	Referent	Referent	Referent	Referent	Referent	Referent
Age Mean (SD)]	57.1 (9.6)	1029	8.3 (3.7)	0.302 (0.08, 0.52)	0.57 (0.20, 0.93)**	-0.4 (-0.541, -0.258)***	-0.21 (-0.45, 0.03)	0.99 (0.97, 1.02)	0.96 (0.92, 1.00)*
Marital Status									
Single	26 (21.0)	217	8.3 (4.0)	0.46 (-5.09, 6.01)	-0.15 (-5.60, 5.29)	2.58 (-1.22, 6.37)	1.16 (-2.45, 4.76)	1.15 (0.641, 2.05)	1.06 (0.58,1.95)
Married	80 (64.5)	645	8.1 (3.9)	Referent	Referent	Referent	Referent	Referent	Referent
Unknown[e]	18 (14.5)	167	9.3 (2.4)	-2.4 (-9.85, 5.05)	-2.24 (-9.47, 5.00)	-6.51 (-11.6, -1.44)**	-3.09 (-7.90, 1.72)	1.33 (0.69, 2.56)	1.13 (0.57, 2.33)
Enabling variables									
Insurance Status									
Uninsured	74 (59.7)	664	9.0 (3.5)	1.71 (-2.80, 6.23)	1.44 (-2.98, 5.85)	0.818 (0.50, 1.35)	0.37 (-2.54, 3.27)	0.77 (0.48, 1.25)	0.85 (0.52, 1.39)

	Patients with hypertension[b]	Total number of visits[c]	Mean number of visits[d]	Systolic blood pressure		Diastolic blood pressure		Hypertension control (< 140/90 mmHg)	
Variable	**n (%)**	**n**	**Mean (SD)**	**Unadjusted model coefficient (95% CI)**	**Adjusted model coefficient (95% CI)**	**Unadjusted model coefficient (95% CI)**	**Adjusted model coefficient (95% CI)**	**Unadjusted model OR (95%CI)**	**Adjusted Model OR (95% CI)**
Other[f]	4 (3.2)	28	7.0 (3.4)	Referent	Referent	Referent	Referent	Referent	Referent
Need variables									
Chronic illness									
Diabetes[g]	66 (53.2)	549	8.3 (3.8)	-0.45 (-4.84, 3.95)	1.41 (-3.40, 6.21)	-0.762 (-3.86, 2.33)	1.00 (-2.19, 4.19)	0.98 (0.61, 1.55)	0.73 (0.43, 1.25)
Obesity[h]	39 (31.5)	356	9.1 (4.0)	0.23 (-4.46, 4.91)	0.06 (-4.50, 4.62)	3.95 (0.72, 7.19)**	2.13 (-0.91, 5.16)	0.63 (0.39, 1.04)	0.69 (0.42, 1.14)
Charlson Comorbidity Index score[i]									
0	17 (13.7)	130	7.6 (3.3)	Referent	Referent	Referent	Referent	Referent	Referent
1	30 (24.2)	242	8.1 (4.0)	5.03 (-2.37, 12.40)	2.06 (-5.69, 9.81)	-2.13 (-6.83, 2.56)	-0.77 (-5.87, 4.33)	0.95 (0.43, 2.10)	1.37 (0.58, 3.25)
2	40 (32.3)	348	8.7 (3.9)	5.07 (-2.00, 12.10)	-3.84 (-13.10, 5.41)	-6.89 (-11.40, -2.42)***	-4.20 (-10.34, 1.95)	1.16 (0.55, 2.46)	2.45 (0.88, 6.87)
3	30 (24.2)	250	8.3 (3.7)	6.88 (-0.50, 14.30)	-4.11 (–14.84, 6.62)	-8.62 (-13.30, -3.93)***	-4.84 (-11.92, 2.23)	1.00 (0.46, 2.20)	2.52 (0.77, 8.29)
4+	7 (5.6)	59	8.4 (3.0)	4.11 (-6.63, 14.80)	-10.45 (-25.55, 4.65)	-14.5 (-21.20, -7.82)***	-8.05 (-18.09, 1.98)	1.42 (0.45, 4.54)	4.25 (0.77, 23.36)
Clinic visit									
Log number of visits per year	n/a	n/a	n/a	2.49 (-4.57, 9.55)	0.96 (-6.52, 8.44)	2.77 (-2.25, 7.79)	0.19 (-4.59, 4.97)	0.47 (0.21, 1.07)	0.46 (0.20, 1.08)
Log number of visits per year x study time (interaction)	n/a	n/a	n/a	-9.48 (-16.8, -2.12)**	-10.76 (-18.28, -3.25)**	-3.2 (-7.83, 1.44)	-4.21 (-8.87, 0.46)	4.91 (1.54, 15.60)**	5.27 (1.63, 17.00)**

	Patients with hypertension[b]	Total number of visits[c]	Mean number of visits[d]	Systolic blood pressure		Diastolic blood pressure		Hypertension control (< 140/90 mmHg)	
Variable	**n (%)**	**n**	**Mean (SD)**	**Unadjusted model coefficient (95% CI)**	**Adjusted model coefficient (95% CI)**	**Unadjusted model coefficient (95% CI)**	**Adjusted model coefficient (95% CI)**	**Unadjusted model OR (95%CI)**	**Adjusted Model OR (95% CI)**

Significance levels: *p < .01; **p < .001; ***p < .0001
Abbreviations: SD, standard deviation; IRR, incident rate ratio; CI, confidence interval
*Based on the Andersen Behavioral Model we used to guide this analysis; we included all predisposing, enabling, and need factors
[a]Regular users = Have 3+ visits per year
[b]Hypertension =Had a written diagnosis of hypertension in the patient chart; systolic > 140 and/or diastolic > 90
[c]Total number of visits = number of visits during the study period between January 1, 2018 - December 31, 2019
[d]Mean number of visits – mean number of visits over the 2-year study period with standard deviation. SD=Standard Deviation
[e]Unknown = Missing from record/not reported
[f]Other = Medicare only, Medicare and Medicaid, private pay and Covered California
[g]Diabetes Yes, Had a written diagnosis of diabetes in the patient chart; recorded hemoglobin A1c > 6.5, or was taking diabetes medication (e.g., metformin, glipizide)
[h]Obesity =Had a written diagnosis of obesity
[i]CCI Score = https://www.mdcalc.com/charlson-comorbidity-index-cci

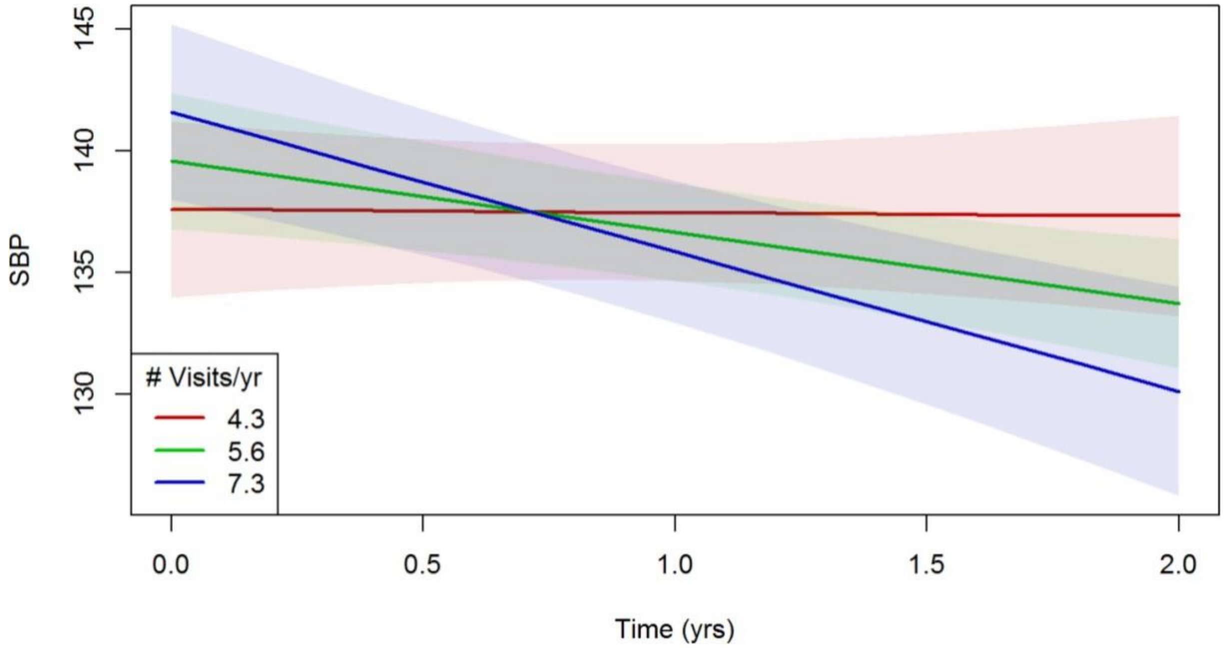

Figure 4.2 Systolic Blood Pressure (SBP) Trajectory Over the 2-Year Study Period by Number of Visits Among Regular Users of a Mobile Medical Clinic in Southern California, from January 1, 2018, to December 31, 2019, After Adjusting for Sociodemographic Characteristics and Comorbidity.

Note: Shaded areas indicate 95% confidence intervals.

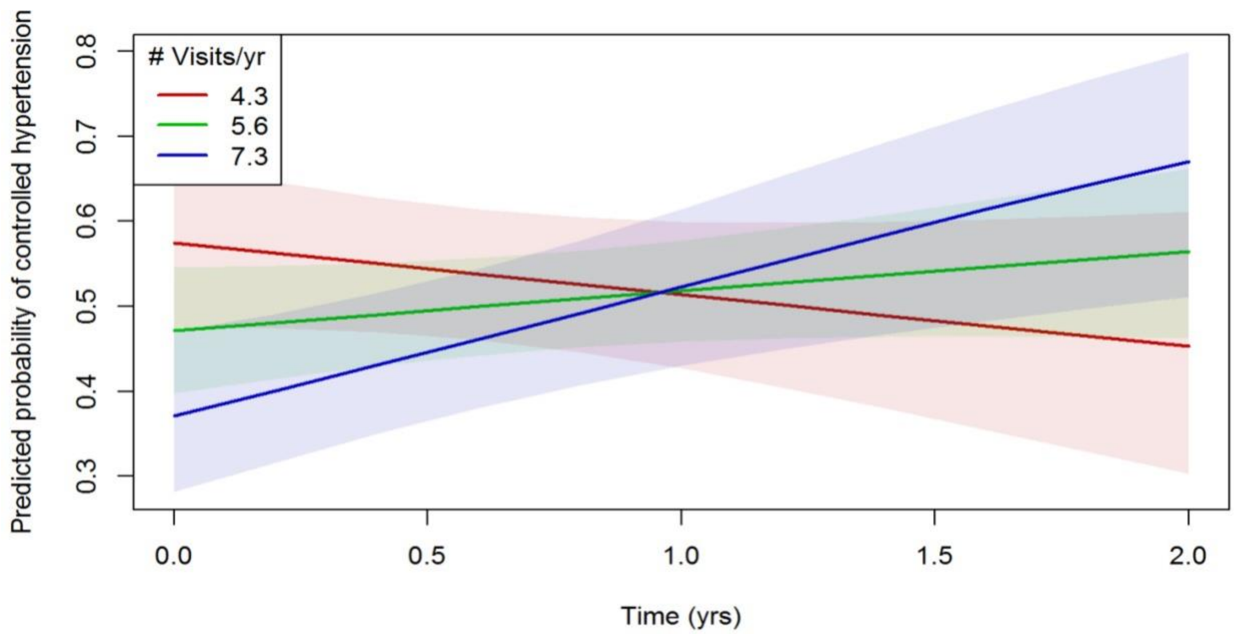

Figure 4.3 Predicting Probability of Hypertension Control by Number of Visits Over the 2-Year Study Period Among Regular Users of a Mobile Medical Clinic in Southern California, from January 1, 2018 to December 31, 2019, After Adjusting for Sociodemographic and Health Characteristics.
Note: Shaded areas indicate 95% confidence intervals.

Chapter 5: Discussion

The overall goal of this dissertation was to describe predisposing, enabling, and need factors associated with mobile medical clinic use and to examine the effect of frequency of clinic use on chronic illness control. The data indicate that factors associated with use of mobile medical clinics include age, with predominant use by adults between the ages of 46–57, Hispanic ethnicity, and the presence of chronic illness, particularly, diabetes type 2 and hypertension. Surprisingly, uninsured status was not associated with frequent mobile medical clinic use. In this chapter, I review the current knowledge in this area and summarize the findings of my dissertation, with discussion of the implications of the research findings on practice, policy, theory-guided research, and future directions.

Summary of the Dissertation

Review of Current Knowledge

The impact of mobile medical clinic use in the United States is growing, according to a recent mobile clinic mapping survey (Malone, 2020). Over the past decade, studies of mobile medical clinics have been conducted in the mid-Atlantic and eastern regions of the United States to analyze their return on investment (Aung et al., 2015; Bollinger, 2010; Morphew et al., 2013; Oriol et al., 2009) by assessing chronic disease management outcomes (Song et al., 2013; Yu et al., 2017) and identifying utilization patterns (Gibson et al., 2014). Studies have also been carried out to measure the effectiveness of mobile clinics in increasing access to health care in communities marginalized by geographic, social, and/or structural barriers (Gibson et al., 2014; Yu et al., 2017). Furthermore, mobile medical clinics have provided cost-effective health care for underserved individuals and populations across the nation (Abdel-Aleem et al., 2016; Hill et al., 2016).

Variations in populations and health care landscape throughout the United States underscore the need to understand how mobile medical clinics impact healthcare access, healthcare utilization, health outcomes, and cost in different areas. For example, there are approximately 120 mobile clinics licensed and operating in California (Malone, 2020). However, little is known about these clinics. No studies to date have described the characteristics, health care utilization, and outcomes of treatment for chronic illness among adults served by primary care mobile medical clinics operating in the Western United States. Therefore, guided by the conceptual framework of Andersen's Behavioral Model (ABM) of Healthcare Services Use (Andersen 1973, 1995), the findings from the three studies included in my dissertation help to fill the gap in knowledge regarding the characteristics of patients who visit mobile medical clinics in Southern California and the impact of number of visits on chronic illness (diabetes and hypertension).

Dissertation Findings

The first study was an integrative review of the literature on populations served by mobile medical clinics. According to the literature mobile medical clinics provide a variety of services that target high-need and vulnerable populations. At the individual level, this includes, predisposing factors (e.g., age, gender, ethnicity), enabling factors (e.g., insurance, income level, education, marital status), and need factors (e.g., chronic illness, comorbidities).

Results from the second study provide a retrospective analysis of medical charts from mobile medical clinics in Southern California. The study setting was the Well of Healing Mobile Medical Clinic which provides free primary care services to four communities. This study compiled and analyzed baseline characteristics, total number of clinic visits, and mean number of visits of patients who received care from January 1, 2018 to December 31, 2019. Out of the sample of 411 patients who made a total of 1790 visits per year to the mobile medical clinic, the majority of the mobile clinic patients were female, Hispanic, and married, and the overall cohort had a mean age of 50 years (SD = 11). Just under half of the patients had hypertension and a third had diabetes. Over half of the patients had varying degrees of comorbidities.

Among the patients with diabetes, the majority were female and Hispanic, about half were uninsured, married and their mean age was slightly above the average users of the clinic. Of this same group, more than half had uncontrolled diabetes, as measured by hemoglobin A1c > 6.5%, and nearly half had uncontrolled hypertension, as measured by systolic blood pressure > 140 mmHg and/or diastolic blood pressure > 90 mmHg.

The next analysis examined the relationship between rates of mobile medical clinic visits, patient characteristics, and chronic illness. Chronic illness need variables were all significant factors in mobile clinic utilization. Patients with hypertension had 1.61 times the mobile medical clinic visit rate compared to those without hypertension. Similarly, mobile clinic patients with diabetes had 1.22 times the mobile medical clinic visit rate compared to those without diabetes. Patients with obesity had 1.27 times the clinic visit rate comparted to those without obesity.

In addition, individuals with multiple comorbidities visited the mobile clinic more frequently than those who without comorbidities. After adjusting for sociodemographic and health characteristics, race/ethnicity was significantly associated with frequency of mobile clinic utilization, with Hispanics having twice rates of visits than Whites. Those who were single had significantly lower rates of visits compared to those who were married. Age, insurance status and CCI score of 4 were no longer significant after adjusting for sociodemographic and health characteristics.

The third study presented retrospective data from a sub cohort of regular mobile medical clinic users (n = 218), with a mean of 6.6 (SD = 4.2) visits during the study period. Results from the third study suggested that regular clinic users were primarily female, and the majority were Hispanic, married, and between the ages of 46 and 65. Additionally, more than 50% were uninsured. Individuals in this sample had high rates of diabetes (39%) and hypertension (59%), and nearly 73% of patients in the study sample had other comorbidities (CCI $\geq$ 1).

In examining the association between number of mobile medical clinic visits and continuous measurement of hemoglobin A1c and blood pressure over time, while controlling for patient sociodemographic characteristics and comorbidities, this study found that there was no interaction effect between study-time and number of visits on the hemoglobin A1c control. The subset of patients with diabetes made a total of 618 visits to mobile clinics, with a mean of 9.6 (SD = 3.0) visits. For blood pressure control, results revealed that, over time, there was a significant interaction effect between number of clinic visits and systolic blood pressure in contrast to diastolic blood pressure. With both the unadjusted and adjusted models, there was no evidence for a main effect of number of visits on diastolic blood pressure or an interaction effect with study-time.

Using a generalized linear mixed model with a logistic regression link, we examined the relationship between the number of clinic visits and hypertension control and, after adjusting for sociodemographic and chronic illness characteristics, while the main effect of the frequency of clinic visits was not significant, there was a significant interaction effect with study-time. These results indicate that the trajectory of hypertension control over time among regular mobile clinic users significantly differ by the frequency of clinic visits, and better hypertension control was achieved with more frequent clinic visits.

Overall, these findings contribute to closing the knowledge gap regarding mobile medical clinic use by adults in the Western region of the United States in general, and in Southern California in particular. While previous studies of mobile medical clinics in California focused on children with asthma, consistent themes of community-based and frequent use of mobile clinics are common in both pediatric and adult populations. Furthermore, although previous studies were conducted in communities in Mid-Western states, the results reported in this dissertation provide a link between prior findings in Mid-Western populations and Southern California communities. Rather than distinct findings about the relationship between mobile clinic use and particular ethnic groups (Black versus Hispanic), the geographic variation of these studies reflect the significance of social determinants of health, such that "access" is essential to reducing health disparities in treatment and health care outcomes in vulnerable individuals. Additionally, by highlighting the characteristics of individuals who seek care aboard mobile medical clinics, this study demonstrated the importance of mobile clinic use in addressing chronic illness need factors among those in underserved communities in Southern California.

Implications of Research Findings

Clinical Practice

There are a number of immediate clinical implications of this study findings. Clinicians should recognize that individuals who seek care aboard mobile medical clinics appear to benefit from regular clinic visits; this is especially true for patients with hypertension. Further, clinicians should consider alternate or additional clinical interventions for individuals with diabetes who visit the clinic regularly, as services such as education regarding healthy food and meal preparation and exercise prescriptions may be needed. Knowing the frequency of mobile clinic use and the effects on disease course and treatment outcomes should spur clinicians to recommend additional services (e.g., exercise, meal planning) which may aide in improving hemoglobin A1c levels and blood pressure control. In addition, clinicians should be aware of gender-specific guidelines for preventive care and take advantage of knowing that females are more prevalent than males as users of mobile medical clinics in Southern California. Intentionally providing women's health care and other care designed specifically for the ethnic communities they serve via mobile medical clinics would allow clinicians to offer culturally relevant care that greatly improves the health and well-being of members of currently underserved communities.

Policy

The Patient Protection and Affordable Care Act (ACA), signed into law by President Barack Obama in 2010, provides (a) subsidies that lower insurance costs for households with incomes between 100-400% of the federal poverty level, (b) Medicaid-expansion programs to cover those with incomes below 138% of the federal poverty level, and (c) supports delivery methods designed to lower the cost of care (U.S. Department of Health & Human Services, 2018). Mobile medical clinics have not been included in the reimbursement structure for insured visitors. However, the findings from this dissertation point to important policy implications related to payment that will support these health care delivery models. Although the majority of mobile medical clinic users are adults with health insurance, many people who visit mobile clinics are uninsured. Current payment policies should provide financial incentives to insurance plans and hospitals for high-cost patients with chronic illness who utilize mobile medical clinics.

Mobile clinics are primarily supported by philanthropic donors and grants. However, findings from this study suggest that mobile medical clinics can provide a bridge between community and health systems that will improve health outcomes for adults with hypertension, diabetes, and other comorbid conditions. Policies that focus on value-based reimbursement that include mobile medical clinics would be ideal. Creation of business models that include hospitals, insurance companies, accountable care organizations, and mobile medical clinics need to be explored. An intentional financial strategy by hospitals and insurance companies could be the shift needed to ensure the sustainability of mobile medical clinics, which will, in turn, help patients avoid emergency rooms as they seek more preventive and maintenance care. Policy makers seeking effective ways to increase health care access while regulating health care spending should consider mobile medical clinics as a clinically and financially beneficial model of health care delivery.

Theory-Guided Research

The use of the Andersen Behavioral Model helped guide this research in a systematic way. It further helped inform and explain the findings from the three studies included in this dissertation. The knowledge of the predisposing, enabling, and need factors associated with mobile clinic use is essential to administrators who establish these clinics and aim to develop interventions to increase mobile medical clinic use by adults through identification of modifiable individual and health characteristics. Churches, universities, government, and health systems can use these study results to identify target populations and implement intentional strategies to guide the services provided via mobile clinics. For example, hypertension is a need characteristic that is expected to increase health care service use. In addition, increasing numbers of middle-aged adults with multiple comorbidities will require mobile medical clinic access to meet the increased need for care. Further, guided by this theory, philanthropists and upstream thought leaders can strategically position mobile medical clinics in communities with critical need to address specific deficits in availability of health care.

Future Directions

There are 120 mobile medical clinics operating in California today (Malone, 2020). Mobile clinic services are expected to be utilized by community members who seek to improve their health and quality of life. This work provides foundational studies on which to build a body of knowledge that will support discovery of the health and financial impacts of these clinical care models throughout communities in Southern California.

In design of future studies, researchers should consider the cost savings that are concomitant with improved health outcomes for patients with chronic illness. For health systems, this information may inspire long-term financial support for mobile medical clinics. In addition, care should be taken to investigate the sustainability of mobile medical clinics. To this end, a future study may focus on review of the current literature on business models that may be considered in funding mobile clinics.

Health systems and universities should partner through research on evidence-based, community-level interventions to benefit mobile clinic users. Future studies should also include accountable care organizations and insurance plans, with the goal of supporting policy-makers in establishing government and insurance-based payment methods that can be used at mobile clinics. These future studies would add to current knowledge by fillings gaps in our understanding of the role of mobile medical clinics both in specific communities and, more broadly, in regional health care systems. More research is needed to inform clinical practice, policy, and the development of business models that will support sustainable use of mobile clinics.

Conclusion

Caring for marginalized and underserved adults with chronic illness is an immense challenge facing the healthcare system in the United States and society as a whole. It is critical to understand the predisposing, enabling, and need factors of adults with limited access to health care and who use mobile medical clinics in underserved communities—the health of members of the most vulnerable communities depends on it. The results reported in this dissertation underscore some of these important variables, including characteristics of the people seeking care, frequency of mobile clinic use, and the impact of use on biomarkers of chronic illness. Next, greater depth of investigation of predispositions and health care needs of mobile medical clinic users is needed, along with documentation of user experiences and health outcomes. Continuing to improve our understanding of the characteristics and health outcomes of mobile clinic patients, such as those served by the Well of Healing Mobile Medical Clinic, will inform development of evidence-based, population-level interventions and the policy reform necessary to address health disparities in high-risk populations.

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