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Review

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Mobile Medical Clinics in the United States Post-Affordable Care Act: An Integrative Review

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Abstract

Despite changes brought about by the 2010 Affordable Care Act (ACA), millions of individuals are still unable to access health care in the United States. 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. Guided by the Anderson Behavioral Model, the purpose of this article was to review and critique the state of the current literature about mobile medical clinics in the United States since 2010. Following Whittemore and Knafl's integrative review methodology, the search was conducted in 6 databases and delivered 1934 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 12 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 (eg, 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, utilization patterns in migrant farmers). Mobile medical clinics provide care for the prevention, treatment, and management of chronic illness and their wide geographic spread confirms their broad use across the United States. They provide a return on investment through emergency room avoidance, decreasing hospital length of stay, and improving chronic disease management.

Keywords: mobile van, mobile unit, integrative review, mobile medical clinic, mobile clinic

Introduction

DESPITE CHANGES BROUGHT about by the Affordable Care Act (ACA) in 2010, millions of vulnerable individuals are still unable to access health care in the United States.[1] Access to health care includes insurance coverage, health care 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% had low income and 28% lived in rural areas.[2] Lack of access to timely and appropriate health care places these individuals at high risk for poor health outcomes.[3]

Evidence suggests that mobile medical clinics are one effective strategy for increasing health care 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

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across the nation for decades.[5,6] They have driven to the doorsteps of communities to provide access to free or low-cost health care services designated specifically for migrant workers, women in need of prenatal care, children with asthma, and minorities with HIV.[7–11]

With >2000 mobile clinics currently operating in the United States, 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 health care services to diagnose and treat chronic diseases that disproportionately impact these populations.[12,13] Staffed by physicians, nurses, and other health professionals, these mobile clinics operate with the financial support of hospital systems, universities, government agencies, and/or philanthropy.[13]

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 of individuals served, utilization patterns, and health outcomes of individuals who seek care aboard mobile medical clinics.

The purpose of this integrative review was to review the state of the current literature about primary care 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 (1) descriptive characteristics of populations served by mobile medical clinics in the United States, (2) utilization patterns of individuals who seek care aboard mobile medical clinics, and (3) health outcomes of individuals with chronic disease. Heretofore, the terms ''vulnerable,'' ''marginalized,'' and ''underserved'' will be used interchangeably and are defined as minoritized individuals excluded from adequate services and who encounter barriers accessing health care services.

Conceptual Framework

The Anderson Behavioral Model (ABM) is one of the most frequently used frameworks for explaining and predicting patient utilization of health care services and related outcomes.[14–16] 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 that enable or impede use*, and their *need for care.*[14–16]

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 toward health care 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 health care 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 that 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 the Whittemore integrative review methodology, allowing for a broad exploration of mobile medical clinics, the phenomenon of interest, and incorporating both quantitative and qualitative studies.[17] A primary care mobile medical clinic was defined as a vehicle (eg, vans, trucks, recreational vehicles) converted to a clinic to provide 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.[18] 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 of 1934 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) (Supplementary Table S1). 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 nonscientific evaluative literature.
- Studies involving specialty (eg, mobile dental, HIV, mammography, ophthalmic) clinic services.
- Studies outside the United States.
- Articles dated before 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.[19] Once imported, Covidence software was used to identify and remove the duplicates and 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 (Fig. 1).

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 were 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.[20] 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, nonrandomized studies, quantitative descriptive studies, and mixed-methods studies. Each of the categories were evaluated according to the MMAT quality criteria.

Data analysis

Evaluation data were entered into the data quality assessment form (Table 1). Primary sources were divided into subgroups: qualitative, quantitative randomized control trial (RCT), quantitative non-RCT, and quantitative descriptive studies. This initial subgroup classification was based on study type, chronology, settings, and sample characteristics.

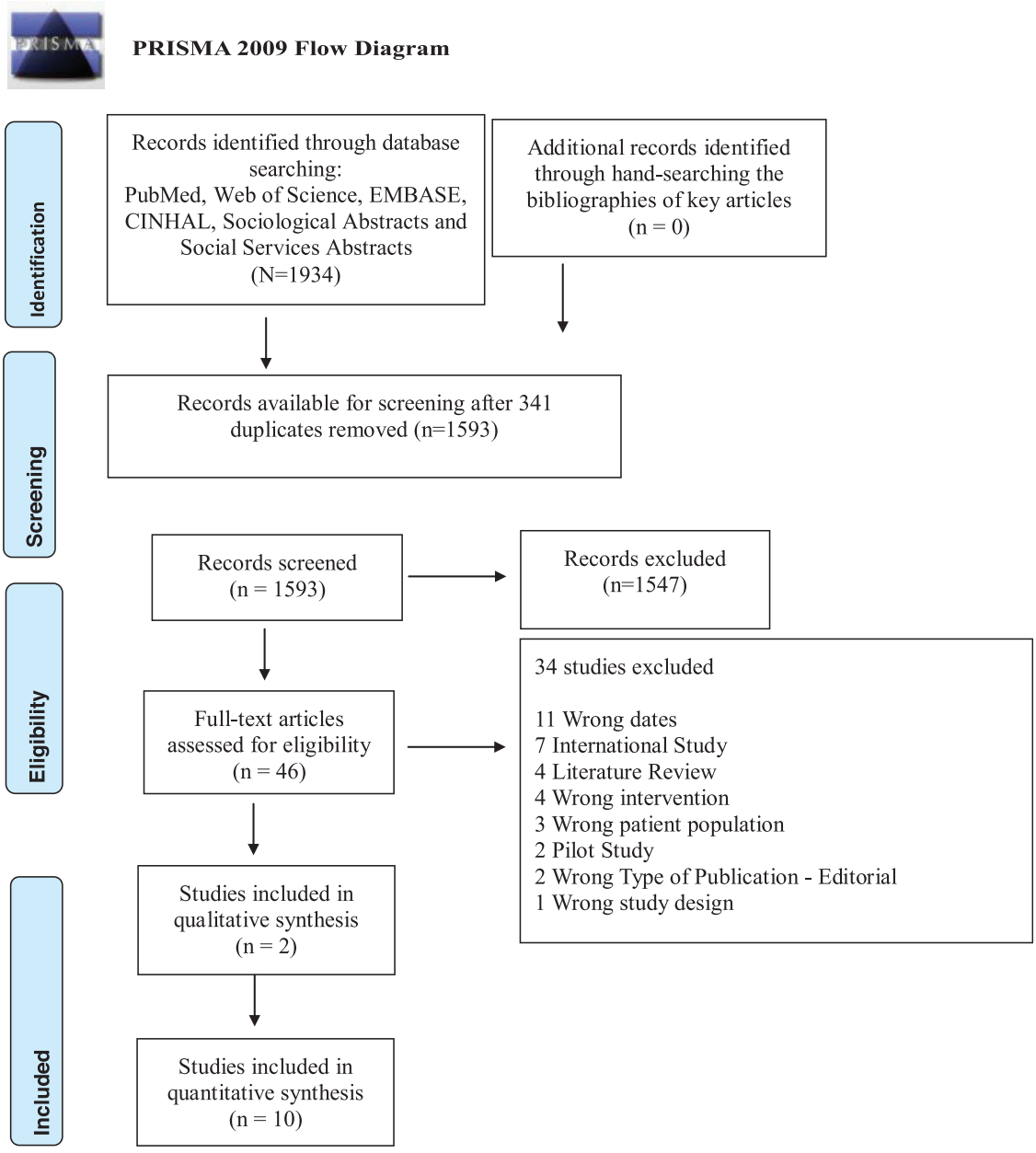

FIG. 1. PRISMA 2009 flow diagram. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analysis. Color images available online.

Table 1. 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 randomization 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 representative 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 confounders accounted for in the design and analysis?
4 Misra et al (2017)	✓	✓	✓	✓	✓	X
5 Morphew et al (2017)	✓	✓	✓	✓	✓	X
6 Toulouse and Kodadek(2016)	✓	✓	✓	✓	✓	✓
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

Furthermore, 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 (Tables 2 and 3). 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 1934 results. In total, 1593 records were available for screening after 341 duplicate articles were removed. After screening titles, abstracts, and full-texts based on the above eligibility criteria and relevance for the research aim, 12 articles were included in the present integrative literature review (Fig. 1). Most of the full-text articles were excluded because of study dates outside the 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, that were editorials, or that 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 owing to no aim or research question, measurements were unclear, and only demographic data were reported.[21] Because 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 health care access.

Confounding variables are variables that ''compete with the exposure of interest in explaining the outcome of a study.''[22, 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.[22] 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 (Table 1).

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 and 3. Twelve articles represented 12 studies but only data from 7 unique mobile clinic entities. For example, three articles used the same setting data from The Family Van[8,11,23] and two articles utilized data from the Community Health Care Van.[24,25]

Articles were published from 2010 to 2019, with most of the articles being recent (2017–2019). Various study designs were among the included articles: two qualitative studies,[9,23] one randomized controlled trial,[26] five quantitative nonrandomized studies,[27–29] and four quantitative descriptive studies.[11,21,24,25,3031] Studies varied broadly, with sample sizes ranging from 25 participants to >8000. Data sources ranged from primary data collected on small convenience samples, archived medical records, return on investment (ROI) analysis using Centers for Medicare and Medicaid Services Market Basket rates, and health care 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 ROI 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. (Supplementary Fig. S1): Georgia,[31] California,[28] Massachusetts,[8,11,23,24] Maryland,[24,25] and Texas.[27,30] All studies, but one, were conducted in an urban setting, and the remaining study was located in a rural setting.[30]

A few types of mobile clinics were represented: three were Breathmobiles,[26,28,30] one studied a mobile farm clinic,[31] and the others were studies of mobile health clinics or vans. All clinics provided free health care services for the uninsured except one whose participants were Medicaid insured.[28] All the articles that involved Breathmobiles reported children with asthma as their population of focus.[26,28,30] One mobile clinic focused on the pediatric population.[27] However, all the other mobile clinics reported care for adult underserved populations.[8,11,23–25,29,31]

The selected articles also showed diversity of chronic diseases and populations that were addressed: three articles reported on patients with asthma,[26,28,30] one on complementary alternative medicine use with children,[27] one on diabetes,[29] one on hypertension,[11] and four articles reported on patients with chronic disease in general with an emphasis on the patient experience,[8,23] one on varied diseases in migrant farmers,[31] and determinants of utilization patterns.[24,25]

Predisposing factors

Each of the studies except one reported descriptive characteristics including, age, gender, and race/ethnicity.[30] The age for the pediatric population served by Breathmobiles ranged between ages 4 and 7 years.[26,28] The other pediatric study population mean age was 8.4 years.[27] 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.[30] 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 (Table 3). The remaining four studies reported a majority of Hispanic,[27,28] Mexican,[31] or Central American[29] 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.[27,29] Other studies showed that 52% of the participants on The Family Van were publicly insured, whereas 55% of participants using the Community Health Care Van had no insurance.[24,25] Two articles that studied patient mobile clinic

Table 2. 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. Twenty-five patients were interviewed from June to 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? Twenty-five patients were interviewed after a mobile health clinic visit during summer of 2014.	Semistructured 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, FACI, Breathmobile+FACI, verses standard care from 66 Head Starts in Baltimore, MD. $N=321$.	The primary study outcomes were measured by SFD. Secondary outcomes included acute health care utilization (ED 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 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 among low-income preschool children.	Generalizability of the results to the larger population is not possible because data was not collected on nonparticipants.

(*continued*)

TABLE 2. (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 CAM 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 health care utilization and prescription claims records from January 2011 to June 2014 in Orange County, California, $N=164$. Breathmobile group $N=72$ and UC Group $N=92$).	An AMR of at least 0.05 reflects ED 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 socioeconomic 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 and Kodadek (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 operating in Mid-Atlantic Region. Archived medical records were accessed from January 2006 to December 2010. $N=65$ met the inclusion criteria.	Diabetes, hypertension, and dsylipidemia. One documented measure of HbA1c in the 12-month period before the start of PPP and one documented measure in the 12-month period after the start of PPP. Other measures include 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 were all significantly reduced from the pre- to the postintervention period. HbA1c from 8.9 to 8.26, LDL from 108.8 to 94.8 mg/dL, and systolic blood pressure from 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.

(*continued*)

TABLE 2. (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 CHCV from January 2004 to December 2012, $N=8404$.	Client characteristics with group comparison. Client stratification based on CHCV utilization. Spatial pattern using 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 are from a clinical database that comprises 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 CHCV from January 2004 to December 2012, $N=9716$. Multiple Site 4 Mobile clinics. Electronic Health Records were accessed and 1300 clients were excluded due to incomplete information, $N=8415$ 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, and 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 a series of cross-sectional encounters, so information collection is contingent upon the completeness of provider-patient visit information. Furthermore, there was no way to track successful linkage to further care.
9	Orsak et al (2018)	A study examining the ROI of the 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 BOLMPAC cost for 2015 and 2016 together was $538031.69. It provided an average ROI of $1.32 and community ROI of $1.45. Estimated benefits were $445125.00 and cost avoidance were $263853.01.	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.

(*continued*)

Table 2. (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 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 MOC provided free medical services to uninsured and underserved citizens of Gainesville, Florida. Data collected from the electronic medical record indicate 3231 clinic visits, provided to 1971 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 and 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.	CAWHS—Access to health care, Eye injuries, Skin problems, Use of PPE, pesticide exposure, musculoskeletal injuries, depression, diabetes, and hypertension. Marin-Gamba Bidimensional 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 toward 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, $N=5900$, patients who made a total of 10,509 visits from January 2010 to June 2012.	Demographic, socioeconomic, and blood pressure (systolic and diastolic) between two groups, returners ($n=1134$) and nonreturners ($n=$ROI), was estimated using financial expenditure reports for the period of January 2010–2012.	Patient population and ED avoidance—2851 patients reported they would have gone to an ED 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 6.2 mmHg. ROI—Estimated total savings of about $1.4 Million from the 2851 avoided ED 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.

AMR, Asthma Medication Ratio; BM, Breath Mobile; CAM, Complementary and Alternative Medicine; BOLMPAC, Breath of Life Mobile Pediatric Asthma Clinic; CAWHS, California Agricultural Workers Health Survey; CHCV, Community Health Care Van; ED, emergency department; FACI, Facilitated Asthma Communication Intervention; GIS, Geographic Information Science; HER, health electronic record; IUD, InterUterine Device; LARC, long-acting reversible contraception program; LDL, low-density lipoprotein; MHC, Mobile Health Clinic; MMC, Mobile Medical Clinic; MOC, Mobile Outreach Clinic; PACQLQ, Pediatric Asthma Caregiver's Quality-of-Life Questionnaire; PHQ-2, Patient Health Questionnaire-2; PPP, prescription procurement program; ROI, return on investment; SFD, symptom-free days; UC, usual care.

Table 3. Study Findings Comparing Mobile Medical Clinic Use by Population Within the Andersen Behavioral Model of Health Care Use

	Name/year published	[a]*Predisposing: Age, gender, race/ethnicity, education*	[b]*Enabling: Income, insurance, regular source of care, transportation, nearby health facilities*	[c]*Need: Chronic disease presence, severity, comorbidities*
1	Bouchelle et al (2017)	44% Younger than 50 years 16% Between 50 and 60 years 40% Greater than 65 years 40% Female **60% Male** **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 owing 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 years 68% Spoke English **30% Black** 20% Hispanic 12% White Education not reported	15 participants visited The Family Van for the first 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% to <$10,000 30% $10, 000 to $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 years Mean age of mother 33 years Mean age of father 36 years 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 source of primary care 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 and Yerba Buena
5	Morphew et al (2017)	Mean age in both groups = 7 years **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

(*continued*)

TABLE 3. (CONTINUED)

	Name/year published	[a]*Predisposing: Age, gender, race/ethnicity, education*	[b]*Enabling: Income, insurance, regular source of care, transportation, nearby health facilities*	[c]*Need: Chronic disease presence, severity, comorbidities*
6	Toulouse and Kodadek (2016)	**35% Male** **65% Female** 54% English speaking 45% Spanish speaking **Mean age: 50 years** 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% HTN 22% DLD 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 69.6% High school education or higher 27.7% Less than high school education	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** 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–12	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
10	Nall et al (2019)	$N = 18$ for total patients of MOC LARC 28% Age 18–24 years 33% Age 25–34 years 33% Age 35–44 years 38% Black 28% Hispanic 28% White	89% Uninsured 11% Medicaid 28% Income <$10,000 22% Income between $10,000 and $14,000 22% Income between $20,000 and $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	Phase 1: None reported Phase 2: None reported	Phase 1: 10% Diabetes 25% Hypertension 11% Musculoskeletal problems 12% Eye problems 5% Skin problems 7% Depression

(*continued*)

TABLE 3. (CONTINUED)

	Name/year published	[a]Predisposing: Age, gender, race/ethnicity, education	[b]Enabling: Income, insurance, regular source of care, transportation, nearby health facilities	[c]Need: Chronic disease presence, severity, comorbidities
		Mean age 33 years 99% Spanish speaking **97% Migrant farmworker** 88% Country of Birth Mexico **Education Mean 5.5 ± 1.7**		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: ($n = 1134$) **Mean age = 56.8 years** **49% Male** **68% Black** **14% Hispanic** 11% White 16% less than 12th grade **64% 12th grade** 20% more than 12th grade Nonreturners ($n = 4689$) **Mean age = 49 years** **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 Nonreturners 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%)

Bolded words = Authors' variables of interest.
[a]Predisposing (age, gender, marital status, ethnicity, and family size), [b]enabling (education level, travel time to the nearest health facility, medical expense per capita, and health insurance coverage), and [c]need factors (chronic disease).
DEP, depression; DLD, dyslipidemia; HEDIS, Healthcare Effectiveness Data and Information Set; HTN, hypertension; OC, outpatient clinic; OCS, Oral corticosteroids; SUD, Substance Use Disorder.

utilization patterns reported frequent health care 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; $P < 0.001$) and those with hypertension had 1.09 additional visits on average ($P < 0.009$; Gibson et al).

Fewer visits were reported among those who did not complete high school (0.26 fewer visits; $P < 0.001$).[25] 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[31] 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 with 13% for those in the usual care cohort ($P \leq 0.05$; Morphew et al[28]). For example, Mophew et al[28] used health care 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 >0.50, 49% ED visits, $P < 0.05$). Specifically, investigators found an AMR of >0.50 was associated with 49% fewer ED visits.[25] The study by Morphew et al was the only study that used AMR as an indicator for improved asthma outcomes. Furthermore, there was only one Breathmobile that examined the ROI of the clinic services on asthma.[30] 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 $445123.00 and cost avoidance of $263853.01.''[30]

Eakin et al conducted an 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 ED utilization for the Breathmobile and FACI group at 6 months (incident rate ratio = 0.23, $P = 0.08$). 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.''[26]

Only one study focused on hypertension, examining the association of a mobile clinic with cost savings for lowering blood pressure and ED use.[11] This study used a data set of 5900 patients who made >10,000 visits to a mobile clinic over a 2-year period. There was an average reduction in blood pressure of 10.7 and 6.2 mm/kg in systolic and diastolic blood pressure (DBP), respectively. ROI, based upon the estimated saving from reduced relative risk of stroke and myocardial infarction through blood pressure reduction and savings from ED 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 through a mobile clinic and biomarkers such as, hemoglobin A1c (HgbA1c), low-density lipoprotein (LDL), systolic blood pressure (SBP), and DBP.[29] In addition to diabetes, 95.4% of the participants had comorbid conditions and received medications for hypertension and/or dyslipidemia.

Significant pre- to postintervention positive effects were noted on HgbA1c (–0.69 ± 1.8%, 95% CI [−1.14 to −0.25], $t(64) = -3.11$, $P = 0.003$), LDL (−13.9 ± 37.4 mg/day 95% CI [−23.1 to −4.6], $t(64) = -2.99$, $P = 0.004$), and SBP (–4.5 ± 15.8 mmHg, 95% CI [−8.4 to –0.59], $t(64) = -2.30$, $P = 0.025$). 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 through the mobile clinic, this underserved population also benefited from a consistent source of care.[29]

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.[8,23] 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 was 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.[23]

Another retrospective cohort study reported the use of complementary and alternative medicine (CAM) on uninsured children receiving care aboard a mobile clinic.[27] 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.

Of interest, 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.[31]

Discussion, Strengths, and Limitations

Guided by ABM, this integrative review was organized by predisposing characteristics, enabling factors, and 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 an ROI through emergency room avoidance, decreasing hospital length of stay, and improving chronic disease managment.[12] Considerable attention has been given to calculating the ROI 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 type of care, cost savings, and health outcome benefits of mobile medical clinics.[12,32]

Children and middle-aged adults with lower income and at least a high school education is the most likely to use mobile medical clinics. In addition, 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. Although a systematic approach was used 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 et al 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.[12]

According to this study, 1500 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.[12]

Implications for Future Research and 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 health care and to meet the health care access needs of underserved individuals and populations across the nation.[32,33] Mobile clinics present a potential significant cost savings by decreasing emergency room use and hospital lengths of stay, as well as improving chronic disease management.[11,28]

This review revealed, however, that there are still significant knowledge gaps about current utilization patterns and health outcomes for adults who access this form of health care delivery in communities around the nation. An emerging topic that needs greater exploration is the use of mobile clinics in rural settings, particularly in those areas with limited broadband access. A recent study of a mobile clinic providing health care services to migrant farmers in California highlighted how these models should provide care within farming communities, offer services after business hours, and encourage immersive provider experiences in patient communities to better understand their health care needs.[34]

Future studies should also include RCTs that provide interventions for specific chronic conditions guided by conceptual frameworks such as ABM or Social Determinants of Health. Such an approach would help improve the understanding of the predisposing, enabling, and need factors associated with health outcomes of underserved populations seeking access to health care aboard mobile medical clinics. This knowledge would continue to aid in identifying populations who would 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 nontraditional delivery models, and to leverage policy development and change for health care access for vulnerable populations. Unfortunately, the lack of mobile clinic integration with hospital systems, physician practices, and/or with electronic medical records or claims records limits the ability to better identify and address population health needs and more effectively evaluate the outcomes of these mobile clinics. Policies that focus on value-based reimbursement that include mobile medical clinics would be ideal.

Creation of integrated 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.

Conclusion

Research demonstrates that mobile medical clinics are mostly used by vulnerable populations. There is indication that mobile clinics provide an ROI through emergency room avoidance, decreasing hospital length of stay, and improving chronic disease management.[12] 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 health care.

Furthermore, foundational studies have been conducted to support evaluating the ROI[7,10,35,36] and determining utilization patterns.[24] 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 health care 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.[13] 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.[13]

Authors' Contributions

A.C. (primary/first author): conceptualization (lead); writing—original draft (lead); formal analysis (lead); writing—review and editing (lead). S.J.L. (reviewer): writing—review and editing (supporting). J.J. (reviewer): writing—review (supporting). S.W. (reviewer): writing—review and editing (supporting). M.H.-P. (second reviewer for literature review): software (supporting). C.S. (senior advisor/author): supervision—reviewing and editing (supporting); writing—review and editing (equal).

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Supplementary Material

Supplementary Figure S1
Supplementary Table S1

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