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Effectiveness of Community Health Workers in Healthcare Delivery: Evidence from the Field

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ABSTRACT

Evidence suggests that health care in the United States could benefit from including the services of Community Health Workers (CHW), provided through Community Health Houses, in the delivery of care. This research project evaluated the impact of three newly-established Health Houses and the services provided to patients by Community Health Workers at three locations in the Mississippi Delta. The patients were current enrollees in the Medicare administered by United Healthcare. The program began in February 2014 and continued through September 2015. After analyzing data for payments made for each enrollee, emergency room visits and hospital admissions for the years of 2013, 2014, and 2015, we found significant decreases in the cost of health care for enrollees, the frequency of emergency room visits, and hospital admissions during the period 2013-2015. These reductions were especially marked during the years 2014 and 2015, and suggest that health care costs, patient visits to the emergency and hospital admissions could be reduced by introducing CHWs' services through an integrated Community Health House model of healthcare delivery.

Keywords: Community Health Worker; Outcome Assessment; Health Care; Health Expenditure; Medicare; Medicaid; Health House

INTRODUCTION

Health statistics in the Delta region of Mississippi and adjoining states are some of the worse in the U.S., rivaling those of many developing countries. High rates of cardiovascular diseases, diabetes and its complications in these rural regions are matched by high rates of deprivation and by utilization of hospital emergency departments for routine care. The State of Mississippi has consistently ranked toward the bottom in America's Health Rankings (2016), with the highest rates in cardiovascular disease, cancer and premature deaths, and one with the lowest availability of clinical care in the United States. The state of healthcare in Mississippi could therefore stand to benefit significantly from an alternative model of primary health care delivery.

Focusing on prevention, an alternative is urgently needed to reduce costs and improve overall health through better-informed health behaviors and help-seeking as well as reduced chronic illnesses and related complications. Community Health Workers (CHW) could offer partial yet significant solution for health-related problems in low-income communities in Mississippi. CHWs can make a valuable contribution to reducing healthcare cost and improving patient's health status by improving access to and coverage of communities with basic health services.

Several studies and synthesizing reports have suggested that CHWs could effectively contribute to the current health care system by expanding services, reducing healthcare costs and improving the delivery of care (Mirambeau, Wang, Ruggles, & Dunet, 2013). Their effectiveness is considered especially valuable for underserved populations in underserved areas (Viswanathan, et al., 2009; Nemcek, & Sabatier, 2033). One review of outcomes of CHW interventions found evidence to support the claim of improved outcomes for underserved populations for some health conditions, but found little evidence to support its cost-effectiveness. Another study found CHW intervention to be effective in improving primary care access and quality of discharge in cases where socioeconomic and behavioral factors negatively influenced post-hospital outcomes (Kangovi, et al., 2014; Wise, 2008; Fedder, Chang, Curry, & Nichols, 2003). The effectiveness of CHWs interventions has also been documented for specific health outcomes (Spencer, et al., 2011). Within the US healthcare system large opportunities exist to utilize CHWs as part of the overall healthcare delivery system (Shah, Heisler, & Davis, 2014).

Motivation

Health care in the Mississippi Delta is largely offered through small regional hospitals with little to no emphasis on related support systems designed to promote preventive behaviors. The researchers postulated that a system of Community Health Houses (CHH) managed by a Community Health Worker (CHW) would yield positive health outcomes in the community. Jackson State University and the Jackson Medical Mall Foundation developed a proposal to establish CHHs in three locations in Mississippi. Through this federally-funded pilot project, qualified community members were recruited, trained, certified and sent to their communities to serve as CHWs. The main objective of this pilot project was to assess the impact of the CHWs on health outcomes and costs.

The underlying model is motivated by the current lack of standardized integration of CHWs into the healthcare delivery system. Even though several studies have shown their effectiveness in chronic disease management, "enhancing disease prevention and screening, promoting lifestyle behavior changes, facilitating insurance enrollment, and unnecessary health service utilization" (Malcarney, Pittman, Quigley, Horton, & Seiler, 2017) progress toward a standardized integration of CHWs continues to lag behind the current needs among the rural poor. CHWs are still viewed (at best) as health promoters, and not as an essential part of the overall healthcare delivery system. In this pilot project, we tested the effectiveness of CHWs at the lowest level (Level 1 of 3 vertically integrated levels) as outlined in the visual representation below. This proposed structure is adapted from Community Health House models of health care delivery (Puderbaugh, 2009) from Iran (see the acknowledgements for details). In this model, CHHs are the basic unit of the rural health care structure, with responsibility for family health and wellness, census taking, public health education, disease monitoring and control, environmental health, and the collection and reporting of health data. The health house staff - usually local residents who have been specially trained - refer patients to the area's health center or district hospital if they need more sophisticated services.

Figure 1: All patients end up at the hospital regardless of the nature of health concern.

Figure 2: An integrated PHC-centered model creates a three tiered system

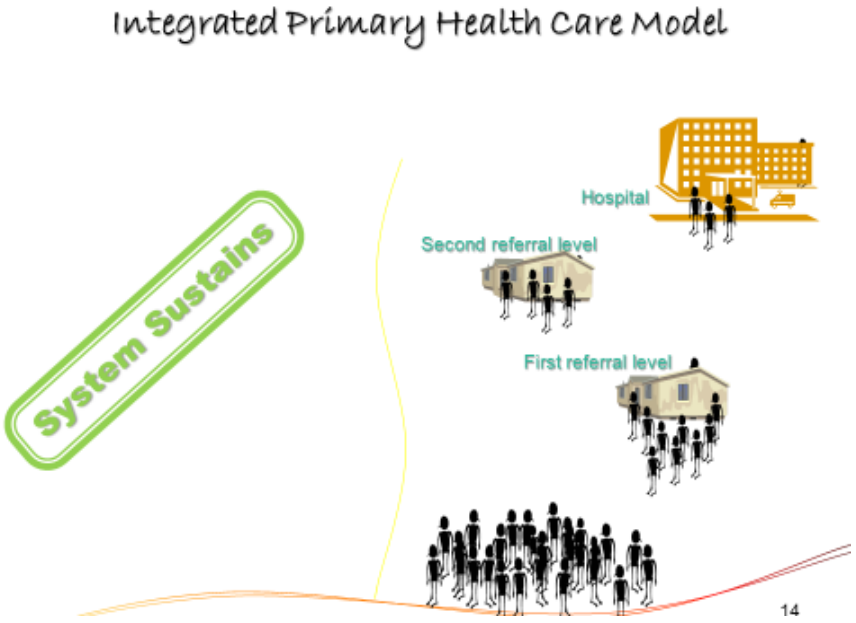
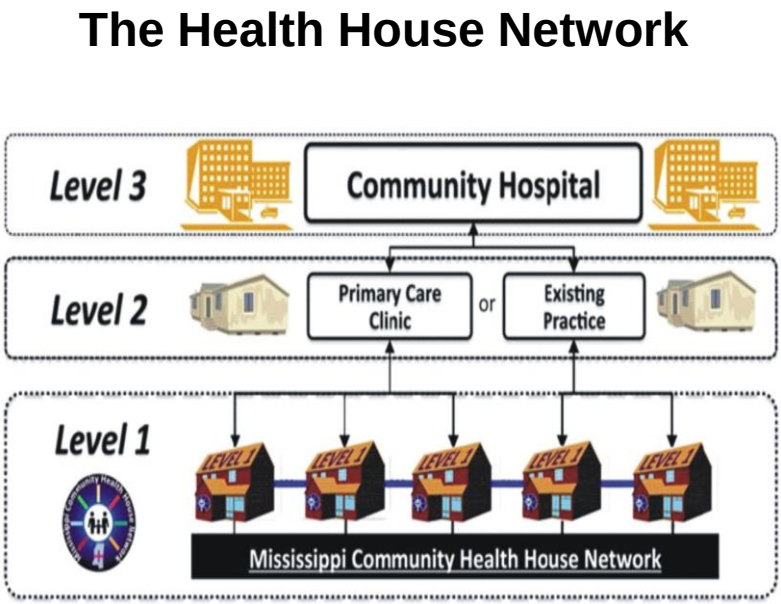


Figure 3: The three tiered system creates CHHs at the lowest level while utilizing the current institutions in levels 2 and 3.



The "Community Health House" is at the bottom of the graphic, forming the basic foundation of a vertically integrated health care delivery network. It is located in the neediest communities and is staffed by CHWs whose communities participate in their selection. They are trained and certified (as our pilot projected has documented).

In a new and larger scale model, the CHH will have a formal relationship with an existing primary care clinic, or one which will be established. This clinic will be staffed by physicians and/or certified nurse practitioners and provide back-up to the CHH, providing a level of health care beyond the competence of the CHWs. This clinic in turn will have a formal relationship with a community hospital in which community residents in need of hospital-based services will be admitted and treated. This is a key feature of the model, in that when a resident from the targeted community becomes engaged with the CHH as the entry point, the person is considered a patient of all three levels of the network -- CHH, clinic and hospital. And when a hospitalized patient is discharged, the CHW is there in the community to assist the patient in following discharge instructions, assisting with medications and needed support services. Most importantly, the primary roles of the CHWs are to prevent disease and promote health in an integrated Primary Health Care system.

The project proposed by the Jackson State University (a Historically Black College and University) team in collaboration with the Jackson Medical Mall Foundation was designed to guide residents of the Mississippi urban and rural to appropriate levels of health care services and to improve health literacy and prevention activities with the ultimate goal of eliminating unnecessary health care services, reducing overall healthcare costs, and eliminating or reducing health disparities affecting underserved and minority populations. This is fundamentally different from how CHWs have been utilized for specific targeted health problems, such as CVDs and

HIV/AIDS. This project aimed to apply a Primary Health Care-focused model of CHHs in the urban and rural parts of Mississippi to determine its effectiveness in reducing cost and improving services. The project was implemented in phases, with success or failure in each phase determining the nature of the implementation during the next.

The underlying rationale for this pilot project was that trained and certified local residents to become CHWs in the Mississippi (both in urban and rural areas), would serve to reduce expenses related to unnecessary and/or preventable Emergency Room visits among patients enrolled in Medicare. Since the length of time between visits with a physician or other health professional can greatly affect prevention efforts and increase the health care costs, CHWs in this project were trained to act as a liaison between their communities and health care providers. They helped participants with their medical appointments and educated them on how to improve self-management skills regarding particular health conditions. The study assessed whether significant changes occurred in health costs for these patients.

Current State of Knowledge

Community Health Workers are frontline public health workers who are also members of the community they serve. The relationship of trust that develops between these CHWs and community members is considered a key factor in their success. CHWs also help to increase health literacy and self-management skills in the communities they serve. They also facilitate access to health care services and improve cultural competence of service delivery. Access to primary health care services is the main purpose of training CHWs in understanding and communicating primary and secondary prevention strategies, which are related to significant global reductions in health care costs.

CHWs, being members of their communities, share the same culture and language. They experience the same living conditions. They receive formal training in order to promote and maintain the health of their communities. This trusting relationship enables them to serve as a liaison between health and social service providers and their community, thereby facilitating access to services and improving the quality and cultural competence of service delivery. Some programs have not met their goals and objectives in part because CHWs were not selected from their own communities. The cooperation of participants will decrease when they do not trust the CHWs.

What seems to make CHWs so effective is that they provide services in the communities in which they live while also being peers of program participants. They also provide more personalized interaction than traditional health care professionals, resulting in improved access to health care and better self-efficacy. CHWs are not only effective in improving health and health care quality outcomes, but also they are effective from a societal perspective, in a cost-effective way (Brown et al., 2012).

The study, Avoidable Emergency Department Usage Analysis (Truven Health Analytics Study, 2013) examined insurance claims data for over 6.5 million emergency room visits made by commercially insured individuals under age 65 in calendar year 2010. It found that only 29 percent of patients required immediate attention in the emergency room. Of the remainder, 24 percent who did not require emergency room visits, 41 percent received care that could have been safely provided in a primary care setting, and 6 percent received care that would have been preventable or avoidable with proper primary care. The authors concluded that diverting just 10 percent of these unnecessary visits to an office setting would result in saving a significant amount in total

allowed costs per health plan member, per year. Based on the 24 million enrollees represented in the Truven Health MarketScan databases, this represents a total potential savings of $461 million each year (Truven Health Analytics, 2013).

A streamlined CHW home visit program for children with uncontrolled asthma enrolled in Medicaid increased symptom-free days and reduced urgent health care utilization and costs. This program improved health outcomes and yielded a return on investment (Campbell et al., 2015). Another study conducted by the Department of Health and Human Services' Centers for Medicare and Medicaid suggested that higher utilization of emergency department might be due to unmet health needs and lack of access to appropriate settings. Cindy Mann (2015) believes that efforts to reduce ER use should focus not merely on reducing the number of ER visits but also on promoting continuous coverage for eligible individuals and improving access to appropriate care settings to better address the health needs of the population.

CHWs could function as members of a clinical team in a primary care setting. They link primary health physicians to the community by interventions such as medication adherence, diabetes education, self-management support, group sessions and assistance with overcoming barriers, navigation and follow-up telephone support. CHWs could potentially reduce the costs of health care by not only delivering health education to patients but by following-up on treatments and providing them with health services at the first level (Sabogal et al., 2010).

Deployment of CHWs is increasing across the county. Their effectiveness has been shown by improvements in the health of their clients and by reductions in health care expenditures in a number of locations (American Public Health Association [APHA], 2016). This project examined the services that were rendered by CHWs in two areas of Mississippi and the services community members indicated should be rendered; it also examines the knowledge, skills and traits needed for CHWs to be effective in Mississippi; and it evaluated the effectiveness of the CHWs based on information provided by service users.

The Role of Community Health Workers

CHWs are known by various names including, but not limited to, outreach workers, health promoters, patient navigators, peer counselors, peer health advisors, peer leaders, and community health representatives. Their basic functions are to conduct community-level activities and interventions that promote health and prevent disease and disability (Center for Chronic Disease and Prevention, 2015).

The American Public Health Association, CHW section, has acknowledged that CHWs are trusted members of their community, have an unusual understanding of the community, and are frontline public health workers. They serve as links, liaisons, or intermediaries between the community and health and social services. CHWs render a variety of services including: outreach, health education, counseling, advocacy, social support, and capacity-building (APHA, Community Health Workers Section, 2016).

Community Health Workers in Mississippi

The use of CHWs has increased during the last few years and is expected to increase because of their proven effectiveness in health care delivery, the quality of care provided, and in health outcomes (New York State Health Foundation, 2010). Organizations in Mississippi, as in many other states, have begun to use CHWs to address a number of health related issues. Unlike many other states, as of December 2012, Mississippi had no laws or statues governing the use, training, or licensure/certification of CHWs.

The Mississippi State Department of Health (MSDH) has conducted several initiatives that utilized CHWs. The Mississippi Delta Health Collaborative was one such initiative. Started in 2011, it was designed to improve the cardiovascular health of individuals living in the 18-county Delta region (CDC, 2015; Mississippi State Department of Health [MSDH], 2012). Preliminary data presented at the 2015 Southern Obesity Summit (Walls, Dove, Cole, & Mendy, 2015) suggested that the work of the CHWs contributed to statistically significant improvements in clinical outcomes in diastolic blood pressure, total cholesterol, and low-density lipoprotein. Statistically non-significant improvements also occurred in hemoglobin Alc, systolic blood pressure, high-density lipoprotein, and triglycerides.

Another CHW project in Mississippi focused on HIV prevention and was funded by the Mississippi State Department of Health. Patient Navigators for HIV prevention services, another name for CHWs, were trained and deployed to work in various community organizations to render HIV-related services ranging from linking HIV-positive clients to care and treatment, to locating individuals who may have been responsible for transmitting the virus. According to an interview with program staff (Davis, 2015) of the organization contracted to train the Patient Navigators, the program has been very effective. Individuals who were not in HIV care and treatment for various reasons are now receiving care and treatment. Individuals who may have been transmitting the virus but had not been tested because they could not be located have now been located and tested.

Research Problem

This project aimed to assess the effects of a training program for CHWs and their utilization in assisting patients with their medical needs through tasks such as home visits, health education, follow-up, and making physical appointments. Specifically, the research team hypothesized that a) there is no association between CHW intervention and hospital costs, b) there is no association between CHW intervention and emergency visits, and c) there is no improvement in patient satisfaction with their healthcare provision during the CHW intervention.

METHODS

The design of this community intervention can be considered a quasi-experimental ecological study in which progressive utilization of the CHH services is hypothesized to correlate over time with reduced local hospital emergency department visits and hence reduced costs. The study design is ecological because utilization rates will be computed taken together rather than in terms of individual help-seeking behavior. On the other hand, since utilization rates at both sites will be based on denominators for the local population, it can reasonably inferred that if the expected inverse correlation is observed, the activities of the CHWs are indeed influencing the health utilization behavior of the community.

Community Health Workers Selection

The need for qualified candidates to become Community Health Workers (in the towns of Belzoni, Jackson and Lexington, in Holmes, Hinds and Humphrey counties, respectively) were disseminated via flyers and through community leaders. Several individuals, having at least a high school diploma and/or GED, were identified and interviewed in each area. One non-negotiable criterion for selection of a candidate was that he/she must reside within the local community. Such careful selection, with simple and comprehensive training (see below) of CHWs, and with supportive and continuous supervision, distinguished this program from other health worker training programs in the state and nation. The duties of these CHWs included, but were not limited

to, home visits, health education, follow-up, making physical appointments, and collecting data. Monthly meetings with the project supervisor and the United Healthcare (UHC) representative were among the effective tools used to meet the goals and objectives of the project. It must be mentioned that, initially, it was planned to use the health houses as the centers to sign-up interested and qualified community members for the study. However, knowing the benefits of such work to the communities they were serving, UHC volunteered (with agreement and proper training of all individuals to follow HIPPA policies/regulations, etc.) to provide listings of Medicaid and Medicare service users in the said counties.

Training and Certification

After recruiting qualified candidates, the project team trained and certified the candidates based on satisfactory completion of the courses listed in Table1. The content of these courses was easy to understand yet comprehensive. Training sessions took place at JSU's School of Health Sciences (now School of Public Health), a church in Belzoni, and Lexington Community College.

As noted, the CHW Training Program and Certification Eligibility for employment for this project required a high school diploma (or GED). It also required a commitment to serve his/her community and a passing score on each of nine courses (Table 1). These courses were offered through JSU's Global Community Health Worker Training Center. The certification program was completed over a three-week period. JSU and the JMMF jointly identified, recruited, and selected qualified community residents to train as CHWs, based on community recommendations as well as their training and certification through JSU's Public Health Program. A unique feature of the certification program is that it is a component of an accredited public health certification program, i.e., has been approved through JSU's accredited Public Health Programs. Hence, CHW graduates were certified by JSU's accredited public health program; furthermore, the Global Community Health Worker Training Center has been recognized and incorporated into the International Network of Health Technicians Education (RET) – a network used by Pan-American World Health Organization for promoting health in our region.

Table 1: Required Courses for Certification

Course	Duration/hours
Health system	8
Cultural competency	8
Health education	16
Instruments	8
First aid	8
Infectious and Chronic diseases	16
Administration	8
Computer application	16
Total training hours	88

Patient Assignment

After the CHWs were trained and certified they were assigned to patients from listings provided by UHC Three listings were provided by UHC, one for each county, comprising a total of about 600 prospective patients for the project. The intent was to include 300 patients in the pilot

study. Given the likelihood of changes in address, contact information, and change in insurance status, the research team planned to have the CHWs contact over 300 patients in order to assure the targeted study population. CHWs started by trying to reach these patients by phone, followed by a home visit. Making referral appointments and follow-up contacts were the main tools to keep participants engaged in appropriate utilization of the health services that kept them away from emergency rooms for non-emergency use, as well as to assure them that someone (CHW) cared about their health concerns. The project continued for 19 months (February 2014 through September 2015). During the early months (prior to these 19 months), the research team worked to establish infrastructures for the project. Throughout this time, regular site visits and meetings took place between and among the staff (project supervisor, coordinators, CHWs). The CHWs sent weekly reports to the project coordinator. The coordinator compiled such reports and forwarded them to the project supervisor as well as to the UHC representative.

RESULTS

Data

We were provided with a list of 200 high-cost Medicare patients from United Healthcare for each of the three counties in Mississippi for the year 2013 (i.e., Hinds, Holmes and Humphreys counties). For these patients, data on Emergency Room Visits and Hospital Admissions were included. Of 200 patients in Hinds County, the CHWs succeeded in contacting 106 of them. Similarly, 56 patients in Holmes County and 42 in Humphreys County were successfully contacted. A few contacts were made toward the end of 2014. Most of the contacts were made during the first half of 2015. Data on cost, emergency room visits and hospital admissions were not available for all contacted patients across all three years. For the year 2013, data on 60 patients were available. Similarly cost data were available for 184 and 97 patients for the years 2014 and 2015 respectively. There were 49 cases for which data were available across all three years. In order to reduce the effect of extreme values, we used the Box Plot analysis to remove all extreme outlier values that exceeded three times the interquartile range for each variable. This procedure removed an additional 4 cases of extreme outliers. The resulting dataset is described below in Table 2.

Table 2: Emergency room visits, hospital admissions and Medicare payment by year

	Medicare Payments			Emergency Room Visits			Hospital Admissions		
Year	2013	2014	2015	2013	2014	2015	2013	2014	2015
Minimum	210	110	175	.00	.00	.00	14.00	6.00	1.00
Maximum	44640	45267	37628	10.00	11.00	3.00	71.00	67.00	22.00
Mean	8579	10948	4072	2.00	1.86	.51	30.51	28.77	8.84
Std. Dev	9736	10472	6194	2.42	2.54	.94	12.00	13.16	4.98
N	45	45	45	45	45	45	45	45	45

Cost Analysis

Table 3: Paired Sample t-test

				95% Conf. Interval of the Difference			
Pair	Mean Difference	Std. Dev	Std. Error of Mean	Lower	Upper	t	Sig. (2-tailed)
2013-2014	-2369.88	8150.21	1214.96	-4818.48	78.71	-1.95	.06
2013-2015	4506.68	10373.44	1546.38	1390.16	7623.21	2.91	.01
2014-2015	6876.57	9816.67	1463.38	3927.31	9825.82	4.70	.00

The paired-sample t-test in Table 3 showed no significant difference between mean payments for 2013 and 2014. But the differences in mean payments were statistically significant for both pairs of 2014-2015 and 2013-2015. There was a small increase in mean payments from 2013 to 2014. However, the post intervention mean payments decreased substantially for both 2013-2015 and 2014-2015. Hence, the results suggest that the CHW intervention led to a significant decrease in average payments. This analysis prompted our second set of analyses on 45 patients for whom we had data for all three years.

We tested the significance of differences among mean payments at three points: 2013 (pre-treatment), 2014 (during treatment), and 2015 (post-treatment) using repeated measures ANOVA. Mauchly's test of Sphericity in Table 4 indicates that the assumption of Sphericity had not been violated, $\chi 2(2) = 3.323$, $p = 0.190$. Epsilon (ε) was 0.931, as calculated according to Greenhouse & Geisser (1959), and was used to correct the one-way repeated measures ANOVA.

Table 4: Mauchly's Test of Sphericity

Mauchly's *"W"*	Approx. Chi-Square	df	sig.	Greenhouse-Geisser *"e"*
0.926	3.323	2	0.190	0.931

Under both the assumed sphericity and with Greenhouse-Geisser correction of the tests of within-subject effects, mean payments across years differed significantly: ($F(2, 88)) = 12.18$, and ($F(1.86, 81.91) = 12.18$, $p < 0.001$). The results are summarized in Table 5 below.

Table 5: Tests of Within-Subjects Effects

Source		Type III Sum of Squares	f	Mean Square		ig.	PartialEta Squared
Time	Sphericity Assumed	1.10E+09	.00	5.49E+08	2.18	000	.217
	Greenhouse-Geisser	1.10E+09	.86	5.90E+08	2.18	000	.217
	Huynh-Feldt	1.10E+09	.94	5.66E+08	2.18	000	.217
	Lower-bound	1.10E+09	.00	1.10E+09	2.18	001	.217
Error (Time)	Sphericity Assumed	3.97E+09	8.00	4.51E+07	00	000	.000
	Greenhouse-Geisser	3.97E+09	1.91	4.84E+07	00	000	.000
	Huynh-Feldt	3.97E+09	5.38	4.64E+07	00	000	.000
	Lower-bound	3.97E+09	4.00	9.01E+07	00	000	.000

Post hoc tests using Bonferroni correction revealed that mean costs increased from 2013 to 2014 by 2370. That change was statistically insignificant (p = 0.172). The mean cost decreased from 2013 to 2015 by 457.68, which is insignificant at the 99% level but significant at the 95% level (p = 0.017). Most of the initial contacts made by CHWs occurred toward the end of 2014 in Hinds and Humphreys Counties; consistent and repeated contacts were also made in all three counties, beginning February of 2015. The mean cost decreased from 2014 to 2015 by 6876, which is highly significant (p <0.0001). This evidence suggests that, on average, the intervention of the CHWs led to a substantial reduction in annual Medicare payments.

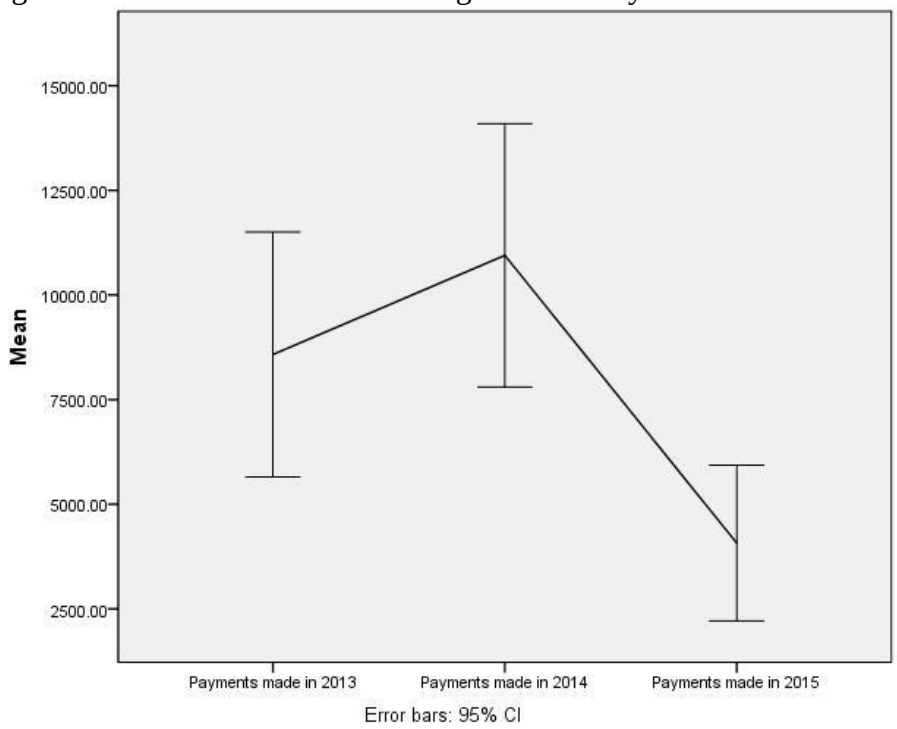
Table 6: Pairwise Comparisons

					95% Confidence Interval for Difference[a]	
(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig.[a]	Lower Bound	Upper Bound
2013	2014	2369.88	1214.962	.172	-5393.885	654.118
	2015	4506.68	1546.381	.017	657.789	8355.575
2014	2013	2369.88	1214.962	.172	-654.118	5393.885
	2015	6876.57	1463.382	.000	3234.254	10518.876
2015	2013	-4506.68	1546.381	.017	-8355.575	-657.789
	2014	-6876.57	1463.382	.000	-10518.876	-3234.254

a. Adjustment for multiple comparisons: Bonferroni.

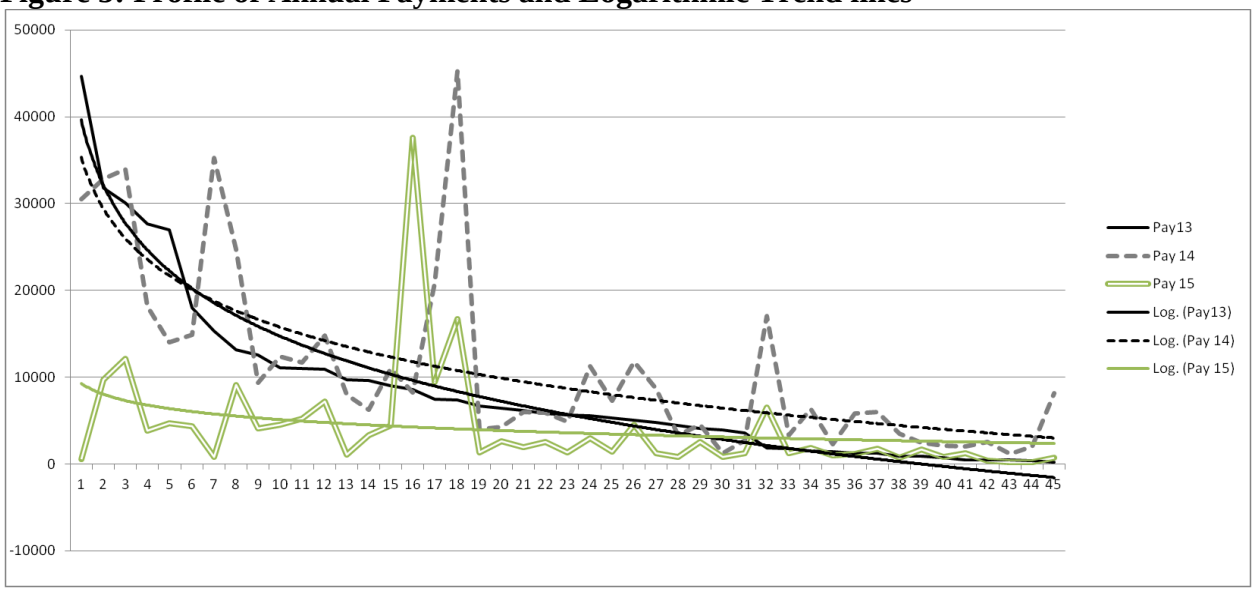
*. The mean difference is significant at the .05 level.

Figure 4: Mean Error Bars for Average Annual Payments



We found statistically significant evidence of reduced healthcare costs for the project period. The average cost increased slightly (statistically insignificant at 0.95) for the period 2013-2014. CHWs became active in early 2014 and continued through the most of 2015. For the period of 2014-2015, average cost decreased substantially by over $6,000 (statistically significant at 0.95). Figure 4 demonstrates the changes in average payments. Figure 5 uses logarithmic trend lines and actual payments to demonstrate the reductions.

Figure 5: Profile of Annual Payments and Logarithmic Trend lines



Emergency Visit analysis

The patients in this study were heavy users of emergency rooms. The average number of visits was 2.02 in 2013. The visits declined to 1.86 in 2014 and much more to 0.51. The paired sample t-test in Table 7 showed insignificant decline for the period 2013 to 2014 (p = 0.72). However the reductions in emergency room visits were highly significant for both periods of 2014-2015 and 2013-2015.

Table 7: Paired Sample t-test

				95% Conf. Interval of the Difference			
Pair	Mean Difference	Std. Dev	Std. Error of Mean	Lower	Upper	t	Sig. (2-tailed)
2013-2014	.16	2.96	.45	-.74	1.06	.36	.72
2013-2015	1.49	2.21	.33	.82	2.15	4.52	.00
2014-2015	1.39	2.38	.36	.66	2.11	3.86	.00

Similar to the cost analysis, we tested for the significance of differences among mean number of ER visits at three points: 2013 (pre-treatment), 2014 (during treatment), and 2015 (post-treatment) using repeated measures ANOVA. Mauchly's test of Sphericity in Table 8 indicates that the assumption of Sphericity had not been violated at the 95% confidence level but was violated at the 99% level, $\chi 2(2) = 6.092$, $p = 0.048$. Epsilon (ε) was 0.881, as calculated according to Greenhouse & Geisser[1], and was used to correct the one-way repeated measures ANOVA.

Table 8: Mauchly's Test of Sphericity

Mauchly's *"W"*	Approx. Chi-Square	df	sig.	Greenhouse-Geisser *"e"*
0.865	6.092	2	0.048	0.881

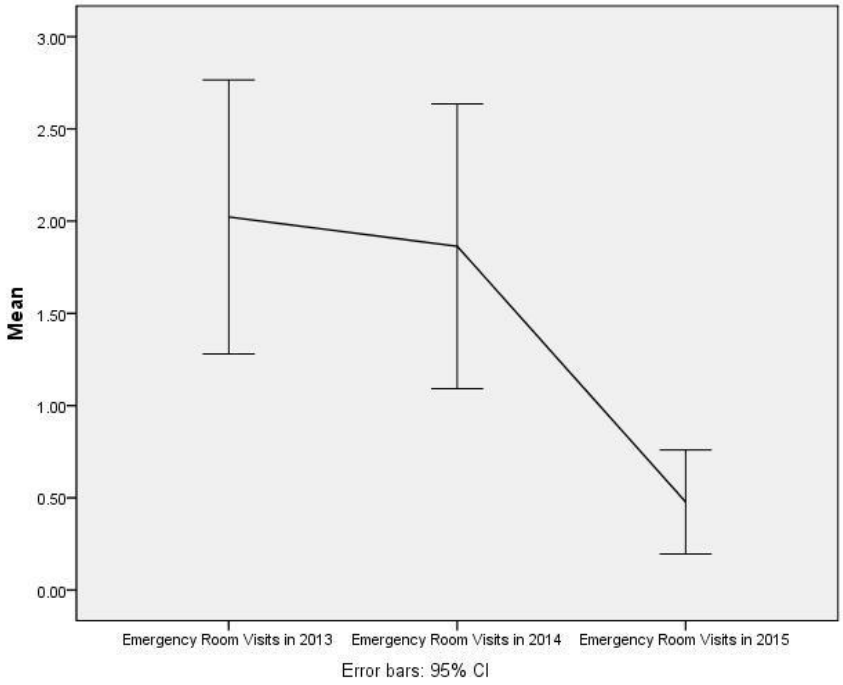
Under both the assumed Sphericity and with Greenhouse-Geisser correction of the tests of within-subject effects, mean payments across years differed significantly: ($F(2, 88)$) = 12.18, and ($F(1.86, 81.91)$ = 12.18, $p < 0.001$). The results are summarized in Table 9 below.

Table 9: Tests of Within-Subjects Effects

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	PartialEta Squared
Time	Sphericity Assumed	6.36E+01	2.00	3.18E+01	9.89	.000	.187
	Greenhouse-Geisser	6.36E+01	1.76	3.61E+01	9.89	.000	.187
	Huynh-Feldt	6.36E+01	1.83	3.47E+01	9.89	.000	.187
	Lower-bound	6.36E+01	1.00	6.36E+01	9.89	.003	.187
Error(Time)	Sphericity Assumed	2.76E+02	86.00	3.21E+00			
	Greenhouse-Geisser	2.76E+02	75.77	3.65E+00			
	Huynh-Feldt	2.76E+02	78.76	3.51E+00			
	Lower-bound	2.76E+02	43.00	6.43E+00			

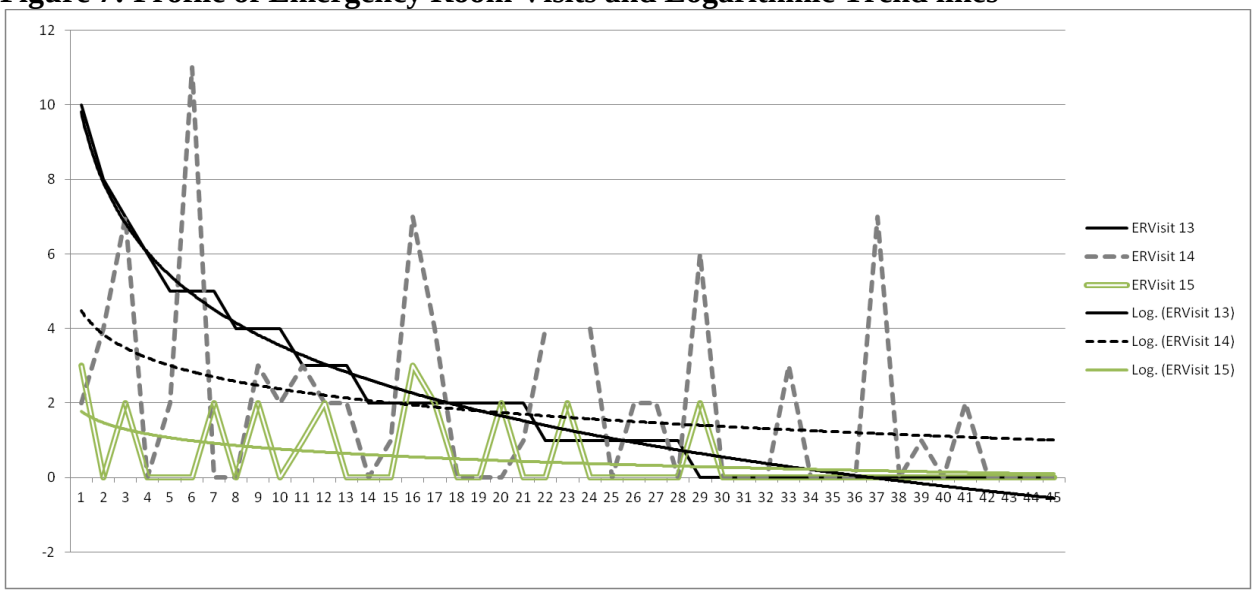
Post hoc tests using the Bonferroni correction revealed that mean ER visits decreased from 2013 to 2014 by 0.16 (NS, p = 1). Mean visits decreased from 2013 to 2015 by 1.55, which is highly significant (p <0.001). The mean number of ER visits decreased from 2014 to 2015 by 1.39, which is also highly significant (p <0.001). Therefore, the findings from data suggest that the intervention of CHWs led to a substantial reduction in ER visits.

Figure 6: Mean Error Bars for Average Emergency Room Visits



We found statistically significant evidence that ER visits declined for the project period and the decline was especially pronounced for the period of 2014-15. This period is more reflective of the potential impact made by the CHWs. Figure 6 shows the changes in average emergency room visits. Figure 7 uses logarithmic trend lines and visits data to demonstrate the decreases.

Figure 7: Profile of Emergency Room Visits and Logarithmic Trend lines



Hospital Admissions

The patients in this study were admitted to hospitals at a very high rate. The average number of visits was 30.51 in 2013. These admissions declined to 28.77 in 2014 and much more to 8.84. The paired sample t-test in Table 10 shows a non-significant decline for the period 2013 to 2014 ($p = 0.45$). However, the reductions in hospital admissions were highly significant for both periods of 2014-2015 and 2013-2015.

Table 11: Paired Sample t-test

				95% Conf. Interval of the Difference			
Pair	Mean Difference	Std. Dev	Std. Error of Mean	Lower	Upper	t	Sig. (2-tailed)
2013-2014	1.45	12.60	1.90	-2.38	5.29	.77	.45
2013-2015	21.67	10.79	1.61	18.42	24.91	13.47	.00
2014-2015	20.20	10.90	1.64	16.89	23.52	12.29	.00

Similar to the earlier analyses, we tested for the significance of differences in the mean number of hospital admissions at three points: 2013 (pre=treatment), 2014 (during treatment), and 2015 (post- treatment) using repeated measures ANOVA. Mauchly's test of Sphericity in Table 11 indicates that the assumption of Sphericity had not been violated, $\chi 2(2) = 1.719$, $p = 0.423$. Epsilon (ε) was 0.961, as calculated according to Greenhouse & Geisser (1959), and was used to correct the one-way repeated measures ANOVA.

Table 12: Mauchly's Test of Sphericity

Mauchly's *"W"*	Approx. Chi-Square	df	sig.	Greenhouse-Geisser *"e"*
0.960	1.719	2	0.423	0.961

Under both the assumed Sphericity and with Greenhouse-Geisser correction of the tests of within-subject effects, mean payments across years differed significantly: (F(2, 86)) = 97.51, and (F(1.92, 82.68) = 97.51, p <0.001). The results are summarized in Table 13 below.

Table 13: Tests of Within-Subjects Effects

Source		Type III Sum of Squares	f	Mean Square		ig.	Partial Eta Squared
Time	Sphericity Assumed	1.29E+04	.00	6.45E+03	7.51	000	.694
	Greenhouse-Geisser	1.29E+04	.92	6.71E+03	7.51	000	.694
	Huynh-Feldt	1.29E+04	.00	6.45E+03	7.51	000	.694
	Lower-bound	1.29E+04	.00	1.29E+04	7.51	000	.694
Error(Time)	Sphericity Assumed	5.69E+03	6.00	6.61E+01			
	Greenhouse-Geisser	5.69E+03	2.68	6.88E+01			
	Huynh-Feldt	5.69E+03	6.00	6.61E+01			
	Lower-bound	5.69E+03	3.00	1.32E+02			

Post hoc tests using the Bonferroni correction revealed that mean hospital admissions decreased from 2013 to 2014 by 1.46. That change was not statistically significant (p = 1). Mean admissions decreased from 2013 to 2015 by 21.66, which is highly significant (p <0.001). Mean hospital admissions decreased from 2014 to 2015 by 20.21, which is highly significant (p <0.001). Therefore, since there was no other obvious factor that may have caused the changes, we conclude that, on average, the intervention of CHWs led to substantial reduction in hospital admissions.

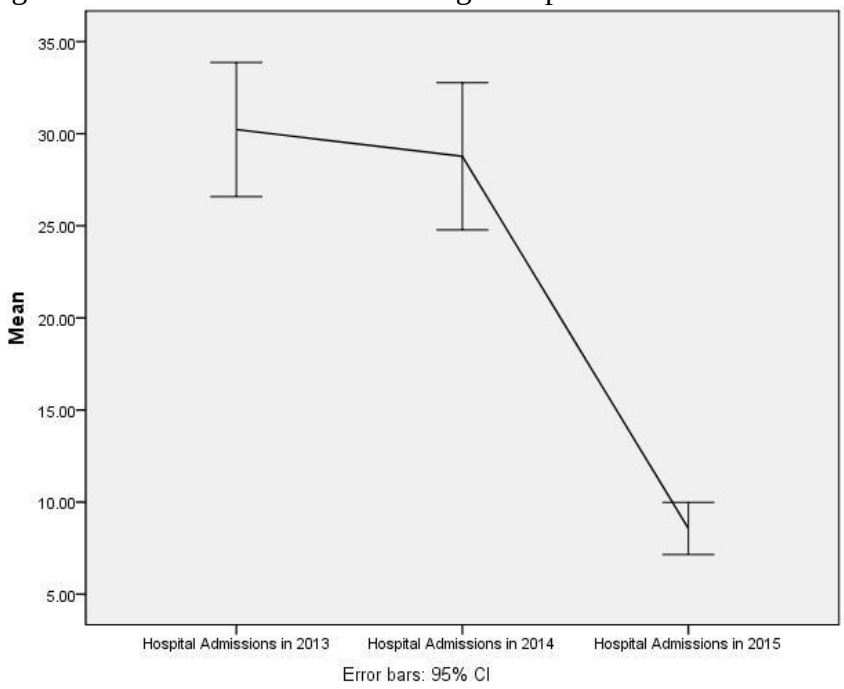
Table 14: Pairwise Comparisons

					95% Confidence Interval for Difference[a]	
(I) Time	(J) Time	Mean Difference (I-J)	Std. Error	Sig.[a]	Lower Bound	Upper Bound
2013	2014	1.455	1.900	1.000	-3.278	6.187
	2015	21.659	1.646	.000	17.559	25.760
2014	2013	-1.455	1.900	1.000	-6.187	3.278
	2015	20.205	1.644	.000	16.110	24.299
2015	2013	-21.659	1.646	.000	-25.760	-17.559
	2014	-20.205	1.644	.000	-24.299	-16.110

a. Adjustment for multiple comparisons: Bonferroni.

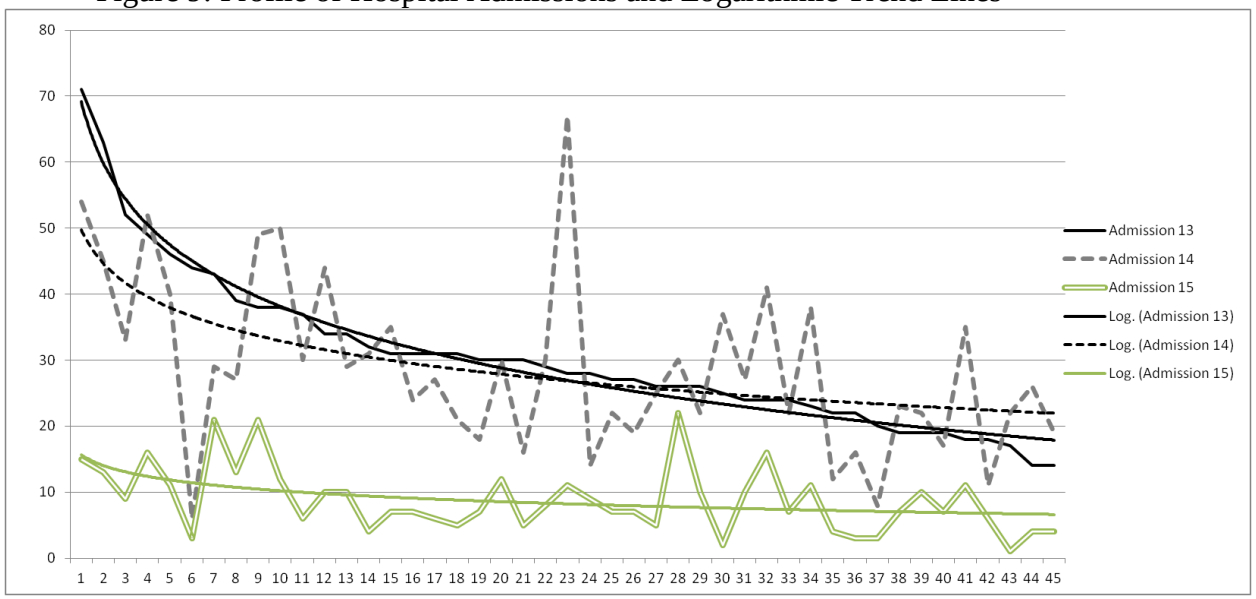
*. The mean difference is significant at the .05 level.

Figure 8: Mean Error Bars for Average Hospital Admissions



We found that hospital admissions declined significantly for the project period and the decline was especially pronounced for the period of 2014-15, which is more reflective of the potential impact of the CHWs. Figure 8 shows the changes in average hospital admissions. Figure 9 uses logarithmic trend lines and data on hospital admissions to chart the downward changes.

Figure 9: Profile of Hospital Admissions and Logarithmic Trend Lines



DISCUSSION

In this project we determined the changes in Medicare costs, Emergency Room visits, and hospital admissions and found that CHWs made a significant positive impact on community members who received services. Most of the reductions in costs, visits, and admissions were achieved through assisting patients through reductions for medicine needed for health issues, increased medication adherence, reductions in service requirements by reducing home health nursing visits due to improved health, and improved blood glucose levels. These results are not surprising and we think that the positive impact can be further improved by integrating CHWs into a larger-scale model of healthcare delivery, as outlined earlier

We found quantitative evidence of the effectiveness of CHWs in reducing healthcare utilization and costs in Mississippi. Additional information presented by community members indicated that CHWs were successful in improving the health of the individuals they served and in lowering health care costs. Broader improvements in the health of community members may require addressing a wide range of issues including; access to culturally competent medical services, medication procurement and adherence, housing, stress, early life, unemployment, social support, food scarcity or deprivation, and transportation. Many of the issues where CHWs can be utilized effectively are classified as "social determinants of health" (Phalen & Paradis, 2015). Utilizing well trained CHWs to address the social determinants of health and the other issues identified by community members could result in improvements in the quality of health care, reduced health care costs because of reduced hospital admissions, reduced emergency room visits, and fewer doctors' visits. A community member's statement summed up the role of a CHW in this project.

> *A Community Health Worker is not like a crutch, she is our enabler. She is going to enable us to get the tools and resources we need to stand. And, so that you don't become so dependent on her, but you know that is your nest. It's like our nesting syndrome; you begin in the nest and you get out the nest. But, you know that you can always come back to the nest. She is going to have that packet [food, medicine, or other resources] for us, to help us; to see us through. She's going to follow up* – a participating community member.

Limitations

This research has several limitations that should be considered in interpreting our results and its implications. First, the research did not use a randomized controlled trial methodology. It did not have a control group and hence, it is possible that the experimental group exhibited tendencies that existed prior to this research. Even though we presented data for the period of 2013 - 2014 (pre-intervention), it was not a perfect alternative to a controlled group. For future research we strongly suggest using a control group to generate more robust findings. Second, the initial patient list provided by our partner included mostly high-cost patients. It would have been better to generate a random selection of patients for this research. Although we think it unlikely, it is plausible that these high-cost patients merely exhibited the tendency to regress to the middle. Of the total of 600 patients list that we began with, only 45 were analyzed after carefully selecting the observations that were consistently recorded across all three years, and removing all extreme cases identified as outliers from the analysis. Third, we started the research with the expectation that we would be able to establish community health houses integrated with current health care providers. That proved infeasible. Hence the CHWs ended up working without the support of other health

care providers. In future, this line of research should be extended with comprehensive Community Health Houses integrated with related healthcare providers.

In spite of these limitations, we found statistically significant results to support the further progress in utilizing CHWs toward improving our health care system. In this research we found evidence related to Medicare patients. Even though efforts are currently under way to repeal or limit the Affordable Care Act, which explicitly recognized the importance of CHWs, there are reasons to suggest that CHWs could play a significant role in privately-run healthcare systems.

CONCLUSION

For the period 2013-2015, average payments declined by over $4,500, emergency room visits declined by 1.49 per patient, and average hospital admissions decreased by over 21. These results are statistically significant and were achieved by CHWs without any assistance from current health care providers. In order to further improve upon the effectiveness of CHWs, we find enough support to pursue an integrated model of health care delivery system with community health houses forming the first line of service (see figure 3) toward preventive care and reducing the ill effects of the social determinants of health.

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The idea of this project germinated when Late Dr. Aaron Shirley, Mr. James Miller and the first author visited Shiraz University of Medical Sciences (SUMS), Shiraz, Iran in early 2009 to explore and learn about Iran's successful Primary Health Care (PHC) system. Dr. Hassan Joulaei did kindly introduce us to Dr. Malekafzali and Late Dr. Shadpour (two individuals who had played significant roles in establishing the Health House concept in Iran in early 1980s). This visit led to singing of a memorandum of understanding (MOU) between Jackson State University (JSU), Jackson Medical Mall (JMM) and SUMS. In fact this was the first MOU of kind since Iran's 1979 Revolution. By late 2009, a delegate from Iran including the said gentlemen, NIH staff and representative from Pan American World Health Organization (PAWHO) met in Jackson, Mississippi to assess if some elements of Iran's PHC system could be replicated in Mississippi. On our next visit to Iran, we met another individual, Dr. Lankarani (former Minister of Health and Medical Education), who played significant role by supporting our project's community health worker training endeavor through a newly established Health Policy Research at SUMS that he directed. Our sincere thanks to all (Drs. Joulaei and Lankarani in particular without these gentlemen financial and logistic support we would not have been able to import their PHC and CHW knowledge and expertise to conduct this pilot project). We would also like to thank CHWs, Ms. Priscilla Williams, Tanisha Mims and Vida Faraji, who worked diligently to implement this pilot project successfully. Finally many thanks to Dr. Shirley's family members, Mr. Kevin Shirley in particular, for his unconditional support of this project's initial phases when he provided logistic support including spaces for training and a health house from where one of the CHW operated. Last but not least, many thanks to Dr. Masoumeh Karmi for her editorial, etc contribution to this paper.

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