#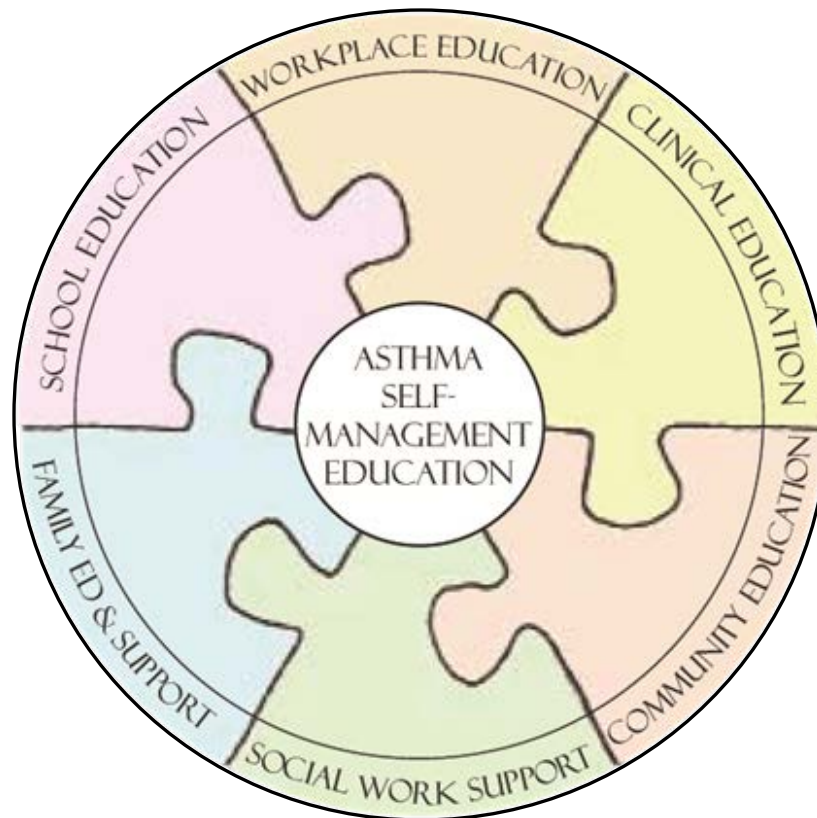 Michigan's Managing Asthma Through Case Management in Homes (MATCH) Program: Evaluation Outcomes and Sustainability Success

May 2018

MDHHS
Michigan Department of Health & Human Services

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Executive Summary

With the prevalence of current asthma at over 10% in both adults and children, asthma remains a burden in Michigan despite advances in treatment. For 2010, the age-adjusted asthma hospitalization rate in Michigan was 15.2 per 10,000 (U.S. rate was 14.1 per 10,000). Among low-income children with asthma, 28% had at least one emergency department visit for asthma and 20% missed six or more school days yearly due to asthma. Asthma is clearly a public health problem in Michigan, and some people with asthma need intensive education to address barriers to good asthma self-management.

In this paper, we provide comprehensive information about the Managing Asthma Through Case Management in Homes (MATCH) model of in-home asthma case management, including outcomes from a recent evaluation of the model's efficacy at three sites, and details about how it has been replicated in new communities and sustained since 1996.

The MATCH asthma case-management model typically includes at least six visits.

- Three home visits with a Certified Asthma Educator (AE-C®) case manager, usually a registered nurse (RN) or respiratory therapist (RT), to provide Guidelines for the Diagnosis and Management of Asthma (EPR-3)-based asthma education, assessment and reduction of participant's exposure to asthma triggers, and asthma exacerbation evaluation.
- School, daycare or worksite visit (as needed) to educate teachers, staff and employers about asthma management.
- A visit with the physician managing the client's asthma, known as a physician care conference, where the client's asthma action plan is created or updated, and barriers to self-management are voiced and addressed.
- The model also includes a visit, or minimally telephone contact, with a Licensed Master Social Worker (LMSW) to identify and assist with psychosocial issues.
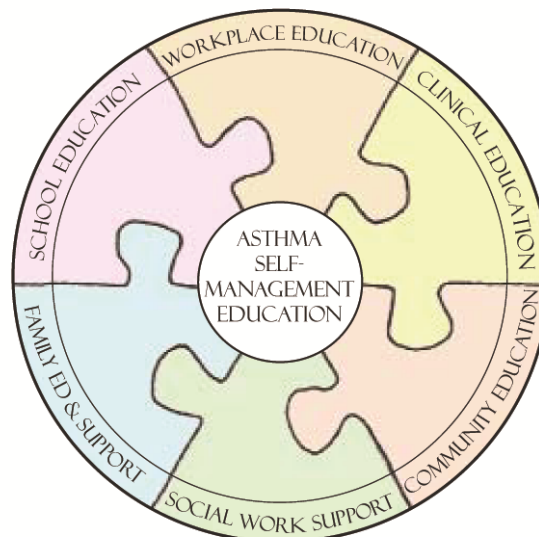
This model has been used by six community-based programs since 1994. To evaluate their efficacy, data from three mature programs were collected at the intake and final visits, regarding health care utilization, medication, symptom management, and impact on daily activities. The MATCH model benefited participants through improved asthma control, avoidance of costly healthcare visits, and fewer interruptions to daily activities. Self-reported, statistically significant ($p<0.001$) outcomes from the 173 participants who had at least one visit after intake measured the impact of the program at real-world completion levels:

- 70% decrease in asthma related inpatient hospitalization
- 51% decrease in asthma related Emergency Department visits
- 40% decrease in missed school days
- 57% decrease in missed work days

Eighty-seven participants were tracked to six months after the final visit and showed similar reductions in school- and work-days missed, and even further decreases in inpatient hospitalizations and Emergency Department visits.

Another benefit to using and promoting the MATCH model is the history of reimbursement from health plans. All of the programs currently utilizing the model have negotiated for at least one contract with a health plan, others have as many as four, and all are negotiating for additional contracts. These contracts pay the programs on a per visit basis. The model has proven to be sustainable long-term in Michigan.

Introduction

Asthma is a chronic disease characterized by wheezing, coughing, and difficulty breathing. While uncontrolled asthma may result in hospitalization or even death, proper disease management can prevent asthma symptoms (1). People with asthma should be able to lead active lives with appropriate use of medications, avoid triggers of asthma exacerbations, and recognize the onset of asthma symptoms (2).

Despite advances in care, asthma morbidity remains a burden in Michigan (2). For 2010, the age-adjusted asthma hospitalization rate in Michigan was 15.2 per 10,000 (3), greater than the U.S. rate of 14.1 per 10,000 (4). Nationally, this burden is disproportionately borne by minorities (5, 6) and lower socioeconomic groups (5-7). In Michigan, the prevalence of asthma in African Americans in 2011-2013 was almost 1.5 times that of whites (14% versus 10%, respectively) (2), and the rate of asthma hospitalizations in African Americans in 2012-2014 was more than four times the rate in whites (36.7 versus 8.7 per 10,000 population, respectively) (8). The mortality rate in African Americans in 2013 was four times the white mortality rate for asthma (29.3 versus 6.8 per 1,000,000 population) (9). Among low-income children with asthma in 2011-2013, 12% had at least two emergency department (ED) visit for asthma and 17% missed six or more school days yearly due to asthma (10).

The Asthma Network of West Michigan developed the MATCH model to address child and family-level issues that may impact asthma management: access to care, financial barriers, psychosocial stressors, family dysfunction, behavioral health issues, and health literacy.

In-home case management programs effectively reduce asthma disparities by addressing a host of child and family-level issues that may impact asthma management: access to care, financial barriers, psychosocial stressors, family dysfunction, behavioral health issues, and health literacy (11-13). The Asthma Network of West Michigan (ANWM) developed the Managing Asthma Through Case Management in Homes (MATCH) model to address these issues. ANWM was a multi-organizational coalition that is now under the umbrella of the Mercy Health St. Mary's health system, and contracts with and receives reimbursement from four health plans for case management services (11). In 1996, ANWM's pilot study documented a $55,265 average decrease in hospitalization costs among participants and a $1,625 average charge reduction per patient (11). Later studies of the ANWM model found a 68% reduction in asthma hospitalizations and a 78% reduction in the number of inpatient days. These changes in outcomes were significant when compared to a historical control group who did not receive case management services (11).

Building on ANWM's success, the Michigan Department of Health and Human Services (MDHHS) successfully promoted the model to organizations in other communities, known as MATCH programs. In order to better understand the program's replicability, in 2009 MDHHS initiated an evaluation of the MATCH model as implemented by three mature programs throughout Michigan. The efficacy of each program was measured using indicators related to asthma healthcare utilization, symptom management, and daily activity at intake, final visit, and six months post-final visit.

The MATCH Model

The MATCH model, as developed by the ANWM (11), works to improve asthma knowledge, asthma control, and quality of life; resolve psychosocial barriers to asthma management; and enhance communication with school, workplace, and medical personnel. The materials used and education are based on the Guidelines for the Diagnosis and Management of Asthma (EPR-3) and typically accomplished over the course of at least six visits with each client. The model requires that visits be conducted by a Certified Asthma Educator (AE-C®) case manager, usually a registered nurse or respiratory therapist. The case manager evaluates the participant's asthma symptoms and severity, provides tailored asthma education that

encourages good self-management. Additionally, case managers assess asthma triggers in the home and recommend methods to reduce them.

Case managers are required to be an AE-C® to ensure standard, high-level competency in asthma education and care coordination, and new hires are expected to take the National Asthma Educator Certification Board exam within one year of beginning employment.

For each participant, an intake visit was conducted in the home. If the participant was under the age of 18, a parent or guardian was the case manager's point of contact. Case managers collected information about participants' asthma symptoms and management over the past six months with standardized questionnaires and assessed participants' homes for environmental asthma triggers using the EPA Home Environment Checklist (14). From these assessments, case managers tailored educational messages and resources to each participant. Following the intake visit, completers received at least five additional visits over a period of at least five months, as described in the MATCH model below.

Though visits at the client's home are the foundation of the MATCH model, case managers' visits may occur in a variety of settings, depending on client needs. The case manager and client meet with staff at their school, daycare or worksite (as needed) to ensure access to medications, familiarize school staff with the asthma action plan (AAP), reinforce avoidance of asthma triggers, and educate on asthma-friendly policies. The AAP is the document that guides patients to appropriately use asthma medications and respond to worsening asthma, and is a crucial component of the MATCH model. The case manager also accompanies the client to a visit with the physician managing the client's asthma, known as a physician care conference, where barriers to self-management are voiced and addressed, the participants' AAP is initiated or updated with current medications and instructions, and prescriptions are updated. The case manager helps clients find a primary care physician (PCP) if they do not have one. If the clinician or office staff is unfamiliar with national

asthma guidelines-based care, the case manager will share knowledge and resources then, or offer to provide a staff in-service at a later date. The model also includes a visit, or minimally telephone contact, with a Licensed Master Social Worker (LMSW) to address asthma control barriers, including medical insurance coverage, psychosocial issues, and financial limitations.

Referrals for all of the MATCH programs can come from any source, including Medicaid-qualified health plans, hospitals, emergency departments, primary care providers, specialty care providers, school-based health centers and self-referral. In general, participants have moderate or severe asthma as defined by EPR-3, or uncontrolled asthma, with one or more hospital admissions, ED visits, unscheduled PCP visits and/or three or more missed school or work days in the past year. The programs are also open to seeing clients that do not strictly fit into those parameters, for example, some health plans are willing to pay for one home visit for a newly diagnosed client.

Measuring Efficacy

MDHHS and the MATCH programs wanted to evaluate their efficacy, and find out if the programs had similar outcomes to ANWM's pilot study. Data from three mature programs were collected at the intake and final visits, regarding health care utilization, medication, symptom management, and impact on daily activities. Referrals could come from any source for the evaluation project, as described above, but had to meet the moderate to severe criteria in EPR-3. Participants receiving any other in-home asthma intervention services were excluded, and were enrolled throughout the year to reduce the effects of seasonality.

Some participants did not complete the full model, so the evaluation design was modified to include participants who had at least a second visit to measure the impact of the program at real-world completion levels.

Data were collected using questionnaires administered at intake, at each visit, and during six-month post-final visit phone calls. Standardized questionnaires, developed by MDHHS staff and case managers using several validated surveys (13-15), consisted of multiple choice and fill-in-the-blank questions measuring demographics, healthcare utilization, medication use, and symptoms during the past six months. Participants or, if under 18 years, appropriate caregiver, were also given the Asthma Control Test© (ACT) (16, 17), the Mini-Asthma Quality of Life Questionnaire (MiniAQLQ), the Mini-Paediatric Asthma Quality of Life Questionnaire (MiniPAQLQ)(18, 19) and/or Paediatric Asthma Caregiver's Quality of Life Questionnaire (PACQLQ) (20).

Our evaluation tracked urgent asthma events, including number of hospitalizations and ED visits for asthma that occurred in the last six months, and were analyzed for differences between intake, final visit, and six months post-final visit. Impact on daily life, asthma symptoms, and quality of life were also assessed, using measures of missed work or school days and waking at night due to asthma. Poor asthma

control was defined as having a score of 19 or below indicating "not well controlled" on the ACT or the Pediatric ACT surveys (21, 22).
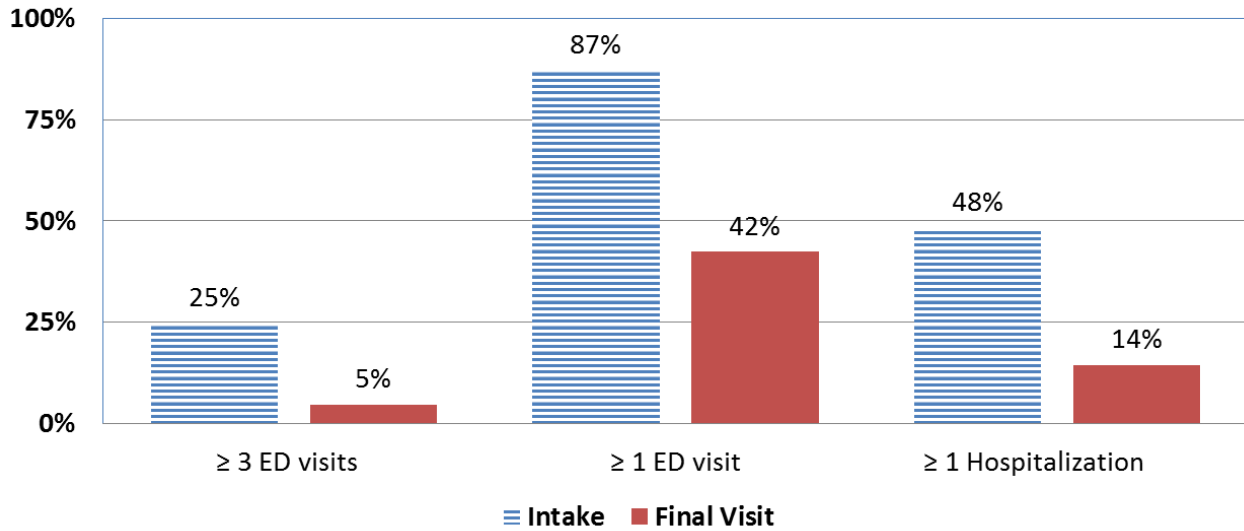
Paired t-tests were used to assess differences among intake, final visit, and six months post-final visits for mean numbers of urgent asthma events and impacts on daily life, asthma symptoms, and quality of life. The final visit was the last visit accomplished for those who were not completers. For comparisons among prevalence of health outcomes (percentages of participants with urgent asthma visits and impacts on daily life, asthma symptoms, and quality of life) at intake, final, and six months post-final visits, McNemar's tests were applied. For both tests, significance was determined at an alpha of 0.05.

Outcomes

At the beginning of the study, participants were expected to participate in the full model, at least six visits over a minimum five-month period. However, some participants did not complete the full model, and the evaluation design was modified to include participants who had at least one visit after intake. The study population included 184 participants who received an intake visit. Of these, 173 (94.0%) had at minimum one additional visit, while 132 (71.7%) were considered completers with at least six home visits or five months in the program. The post-final visit telephone survey was completed by 87 (47.3 %) participants six months after the final visit. These results focus on the 173 individuals who had at least a second visit in order to measure the impact of the program at real-world completion levels.

The majority of participants were black adults and black children (57%); however, in the post-final visit survey only 48% identified as black (Appendix 1), indicating differential loss to follow up. A majority of participants had a household income of less than $25,000 (74%) at intake. At intake, more than one third (36%) of participants had an up-to-date AAP, 23% were exposed to smoke at home, and 35% were exposed to indoor pets (Appendix 1). The percent of participants with an up-to-date AAP increased to 88% at final visit, but decreased at

Figure 1. Healthcare utilization outcomes as reported by participants at intake and final visit
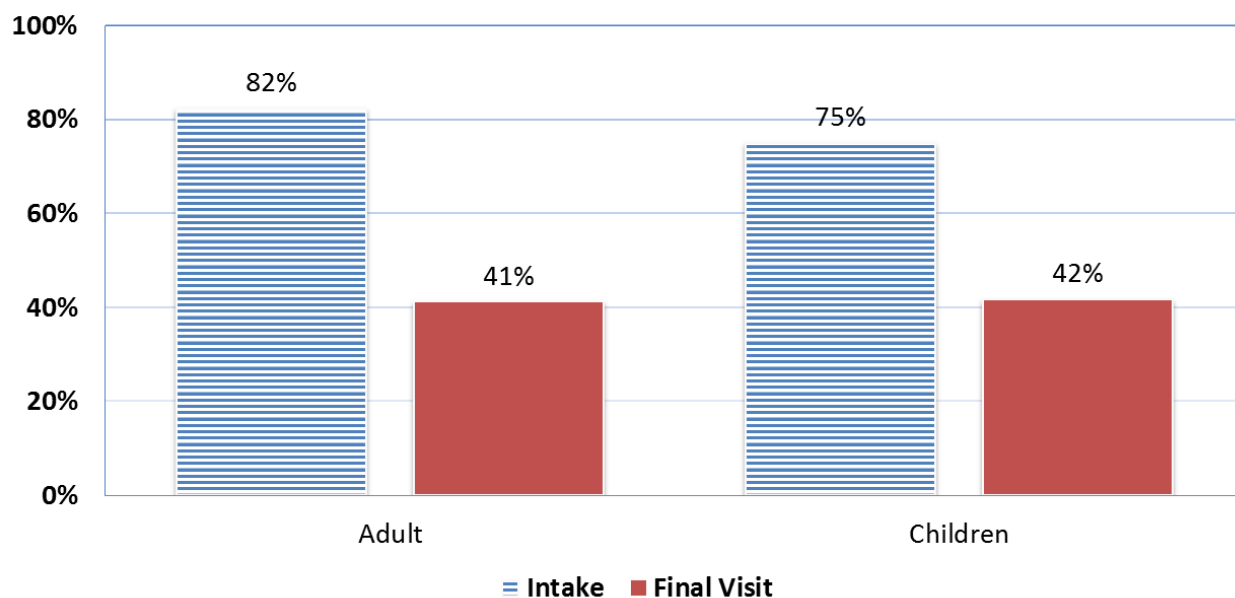

post-final visit to 61%. The prevalence of smoking in homes and indoor pets did not change (Appendix 1).

All measures of health care utilization, daily activity limitation, and symptom management showed significant improvement from intake to final visit (Appendix 2). The percent of participants with three or more ED visits, more than one ED visit and more than one inpatient hospitalization decreased significantly, from 25% to 5% (an 81% reduction), 87% to 42% (a 51% reduction) and 48% to 14% (a 70% reduction), respectively (Figure 1). The percent of participants who missed more than one school day (80% to 47%), missed more than one

workday (51% to 22%), and had more than one nighttime awakening (55% to 25%) decreased significantly from intake to final visit.

At intake, 82% of adults were classified as having "not well controlled" asthma, which decreased to 41% at final visit (a 50% reduction). Similarly, the percent of children classified as having "not well controlled" asthma decreased from 75% to 42% (a 44% reduction; Figure 2). Mean ACT and Pediatric ACT scores increased significantly, 15.65 to 19.65 and 16.54 to 19.58, respectively (Appendix 2). Quality of life means from MiniAQLQ, MiniPAQLQ, and PACQLQ also increased significantly from 62.18 to 83.63, 53.11 to 75.89, and 55.83 to 76.48, respectively.

Figure 2. ACT scores ≤ 19 for participants at intake and final visit by age

The improvements in the majority of outcomes were sustained at the six-month post-final visit survey (Appendix 3). Healthcare utilization showed sustained improvement from intake to six-month post-final visit, as did the percent of participants missing work or school days. However, statistically significant reductions were not sustained at six-month post-final visit survey for mean number of missed school days or either measure of nighttime awakenings (Appendix 3). To explore possible participation bias, sensitivity analyses were run excluding people who had less than six visits and five months in the program. These analyses showed remarkably similar results.

Discussion

The results demonstrate significant improvement in asthma outcomes for participants of the MATCH program. Specifically, measures for healthcare utilization, daily activity, and symptom management improved significantly by the final visit. Even six months after the final visit, most outcomes remained significantly improved. Only measures for nighttime-awakenings were found to have insignificant changes at this point. This may be due the reliance on caregivers being aware of nocturnal symptoms, which may be less

apparent than daytime symptoms, or a decline in asthma care adherence following the final visit. Though improved from intake, impact on AAP usage was reduced from final visit to post-final visit, suggesting lapse in adherence following the final visit.

In addition to providing education emphasizing prevention and daily management, case managers addressed both clinical and social barriers to asthma control. Case managers facilitated discussions with third parties, including PCPs and personnel from schools and workplaces. The MATCH model ensured that the patient's asthma needs were addressed in all relevant environments.

The MATCH model allows case managers to focus on asthma management, while LMSWs resolve psychosocial barriers to asthma control. As many of the program's participants lived in low-income households, it was essential to address issues overriding asthma management, i.e., personal safety, mental illness, unreliable transportation, deficient housing, and financial instability. LMSWs also helped participants navigate challenges encountered with the health care system. These results demonstrate an enduring impact on participants. Former

participants maintained improved outcomes for six months after the end of the intervention. This suggests the program enabled participants to better self-manage their asthma. The sustained improvement of outcomes after the final visit has promising implications for long-term health. This intervention replicated the previous success of ANWM's home-based case management program, providing further validation of the model.

A limitation of this evaluation was that a control group was not used, however, the consistent improvement in outcomes suggests a positive impact. Because sample sizes were small for some measures, we could not assess a dose response, but since the results were largely statistically significant, this was not a substantial limitation. These small sample sizes are attributed mostly to missing answers and represent a weakness in the administration of questionnaires. Certain participants had difficulty interpreting a few survey questions during the intervention, but review revealed no systematic pattern suggesting bias. Measures related to medication and AAP use were deemed invalid due to missing questionnaire data and are not presented. AAP updates presented are also underreported due to this difficulty. In addition, differences were expected between adults and children; however, sample sizes were large enough to look at all ages combined but not large enough to detect differences among age groups. Future studies can determine whether individual aspects of MATCH services (i.e., home visits and school visits) versus the complete package of services are most important, and can determine the differences between the effects on adults and children.

The inclusion of all participants, not just program completers, potentially introduced bias that may have increased the likelihood of finding an impact. Participants who were in the program for less than six months may not have received its full benefit, but had less time to experience (and report) ED visits or hospitalizations, perhaps underestimating the number of adverse asthma events. Conversely, it is likely that participants who did not complete the program nevertheless benefited and experienced fewer adverse asthma events. Unfortunately, the health care use

of participants after they ended their participation is unknown. Appendix 1 shows the breakdown of the different subpopulations between intake, final visit and post-final visit. No compelling differences were found among the three groups.

A crucial element to building a successful and sustainable asthma case management service is the acquisition of reimbursement contracts with health plans.

MATCH Program Sustainability

Since 2011, three new MATCH programs have started in high asthma burden counties. A crucial element to building a successful and sustainable asthma case management service is the acquisition of reimbursement contracts with health plans. All of the mature programs who use the model have negotiated for at least one contract, others have as many as four, and all are negotiating for additional contracts. Almost all of the health plans involved are Medicaid. Also since 2011, one of the original programs from the evaluation project ended due to a lack of support by program administration and a dearth of referrals from a larger, competing health system. Additional MATCH programs are in the early stages of development.

The MDHHS asthma program provides technical assistance and fosters connections between the programs and other partners as needed. Using surveillance data, they Identify counties or communities with a high asthma burden. The coverage area for MATCH services needs to be big enough to generate an adequate number of referrals to the program, but small enough to keep mileage costs from being prohibitive. MDHHS staff determine potential lead organizations to initiate MATCH; the ideal organization is relatively neutral in the community, such as a coalition or local public health department, and is able to bill health plans. A health system can sustain a MATCH program if they can generate enough referrals from within their own system. It will be more difficult for a small health system to have enough referrals to support a program if there is a

larger, competing system nearby that will not refer. The organization should also be able to track standard measures for program evaluation, such as number of visits performed, ACT results and asthma action plan development. Once an organization is identified, MDHHS staff meets with administrators to describe MATCH and answer questions about its implementation and results. They link this interested organization to mature MATCH programs, who often offer home visit ride-along opportunities and other mentoring. Staff from mature and nascent programs participate on monthly calls facilitated by MDHHS staff to discuss evaluation and contracting, and to help solve problems and celebrate successes.

Experienced programs have learned to bill for their actual costs, not what the health plan has agreed to pay; this can help illustrate the need for a higher reimbursement rate at future negotiations.

When ANWM first developed and piloted the MATCH model, they approached Priority Health, a large local health plan, with pilot results in hand and an offer to case manage their 10 most challenging asthma members. After their success with these first clients, Priority offered an ongoing contract for asthma members which is still in place 21 years later. Contracting between the health plans and MATCH programs/lead organizations is always done privately. If the program is having difficulty connecting with a health plan to start this process, MDHHS staff or one of the mature MATCH programs may be able to offer contact information or additional insight. In 2008 MDHHS, with Michigan Medicaid and other partners, hosted a health plan MATCH meeting in Flint to acquaint local plans with MATCH. This payor summit successfully launched contracting with several health plans but has not been repeated; Medicaid health plans appear to be aware of MATCH now, and MDHHS staff use partnerships and health plan champions to help promote contracting and reimbursement. The current range for reimbursement is $80 to

$120 per visit. Experienced programs have learned to bill for their actual costs, not what the health plan has agreed to pay; this can help illustrate the need for a higher reimbursement rate at future negotiations. One MATCH program has contracts with health plans but uses invoices to request reimbursement. Billing codes are determined by the health plan, commonly used codes include: G0299 direct skilled nursing services of a registered nurse (but can also be used by a respiratory therapist) with ICD-10-CM Diagnosis Code J45.909 unspecified asthma, uncomplicated; and S0315 (first visit), S0316 (remaining visits) and using an ICD-10-CM diagnosis severity code to identify asthma.

The MATCH model was developed in the 1990s and the healthcare landscape is ever evolving. Some of the new programs are using a Community Health Worker (CHW) to perform home visits, and they are preparing to take the AE-C exam. Programs using CHWs may encounter challenges with health plan contracts since the plans currently contract for a licensed health professional, and visit rates may be adjusted.

The contracting health plans have not shared their outcome data with either the programs or the Michigan Department of Health and Human Services. But the fact that they eagerly contract and renew contracts, share their lists of asthma clients with the MATCH programs, and in some cases have contracted for more than 20 years, strongly suggests that they are seeing significant cost savings and value when their members participate in MATCH. By demonstrating the successful reproduction of the MATCH model, it is our hope that additional MATCH programs will start in other high-burden communities, and more health plans will accept and contract for this type of asthma management service.

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Appendix 1: Description of study population at Intake, Final Visit and Post-Final Visit

Demographic Characteristics	Intake (n = 184)	Final Visit (n =173)	Post-Final Visit (n = 87)
Sex			
Male	77 (51%)	74 (51%)	35 (51%)
Female	74 (49%)	71 (48%)	33 (49%)
Race			
White	64 (35%)	58 (34%)	39 (45%)
Black	104 (57%)	99 (57%)	42 (48%)
American Indian/Native American	10 (5%)	10 (6%)	4 (5%)
Hispanic	25 (14%)	24 (14%)	11 (13%)
Household Income (U.S. Dollars)			
< 10K	83 (50%)	78 (50%)	35 (44%)
10K-24,999	40 (24%)	38 (24%)	19 (24%)
25K-39,999	23 (14%)	23 (15%)	13 (16%)
40K-54,999	4 (2%)	4 (3%)	2 (3%)
55K-69,999	6 (4%)	6 (4%)	3 (4%)
70K-84,999	3 (2%)	3 (2%)	2 (3%)
≥ 85K	7 (4%)	5 (3%)	5 (6%)
Age (years)			
< 18	158 (86%)	150 (87%)	73 (84%)
18 – 64	26 (14%)	23 (13%)	14 (16%)
≥ 65	0 (0%)	0 (0%)	0 (0%)
Asthma Action Plan			
Yes	36%	88%	61%
Smoking in Home			
Yes	43 (23%)	49 (23%)	16 (18%)
Indoor Pets			
Yes	64 (35%)	60 (35%)	41 (47%)
Program Visits mean (Interquartile range; IQR)	6.10 (4.00-8.00)	6.42 (4.00-8.00)	6.43 (5.00-8.00.)
Months in Program mean (IQR)	7.29 (3.27-10.12)	7.76 (3.93-10.67)	7.92 (2.77-12.0)

Appendix 2: Outcome Measures at Intake and Final Visit

Indicator	Full Sample	Intake	Final Visit	Percent Change	p[c]
Health Care Utilization[a]					
# Participants with ≥ 1 visit ED visits (%)*	85	74 (87%)	36 (42%)	-51%	<.001
White	30	27	14	-48%	<.001
Black	47	40	15	-63%	<.001
Other[e]	8	7	7	~	~
# Participants with ≥ 1 Inpatient Hospitalizations (%)*	83	40 (48%)	12 (14%)	-70%	<.001
White	29	12	5	-58%	0.008
Black	46	24	6	-75%	<.001
Other[e]	8	4	1	-75%	0.08
Impact on Daily Activity[b]					
# Participants with ≥ 1 Missed School days due to Asthma (%)*	59	47 (80%)	28 (47%)	-40%	<.001
White	14	9	7	-22%	0.16
Black	24	18	13	-28%	0.06
Other[e]	21	20	8	-60%	<.001
# Participants with ≥ 1 Missed Work days due to Asthma (%)*	45	23 (51%)	10 (22%)	-57%	<.001
White	14	9	3	-67%	0.014
Black	14	8	3	-63%	0.03
Other[e]	17	6	4	-63%	0.32
# Participants with ≥ 1 Nighttime Awakenings due to Asthma (%)	106	58 (55%)	27 (25%)	-53%	<.001
White	23	11	5	-55%	0.06
Black	47	26	6	-77%	<.001
Other[e]	36	21	16	-24%	0.20
Symptom Management					
ACT (mean score)	17	15.65	19.65	26%	0.006
White	5	15.00	19.80	32%	0.09
Black	10	16.20	21.10	30%	0.005
Other[e]	2	14.50	12.00	-17%	0.77
# Participants with Not Well-Controlled[d] Asthma by ACT (%)	17	14 (82%)	7 (41%)	-50%	0.008
White	5	4	3	-25%	0.32
Black	10	8	3	-63%	0.03
Other[e]	2	2	1	1	~
Pediatric ACT (mean score)	24	16.54	19.58	18%	0.011
White	5	18.00	21.00	17%	0.003
Black	14	15.90	18.50	16%	0.13
Other[e]	5	17.00	21.20	25%	0.23

# Participants with Not Well-Controlled Asthma by Pediatric ACT (%)	24	18 (75%)	10 (42%)	-44%	0.011
White	5	4	1	-75%	0.08
Black	14	11	8	-27%	0.18
Other[e]	5	3	1	-67%	0.16
Adult AQLQ (mean score)	11	62.18	83.63	34%	<.001
White	3	76.67	88.33	15%	0.24
Black	7	60.29	89.00	48%	<.001
Other[e]	1	32.00	32.00	0	~
Pediatric PAQLQ (mean score)	9	53.11	75.89	43%	0.005
White	2	56.50	77.50	37%	0.31
Black	7	52.14	75.42	45%	0.02
Caregiver PACQLQ (mean score)	29	55.83	76.48	37%	<.001
White	8	66.13	85.38	29%	0.004
Black	21	51.90	73.10	41%	<.001

a. Defined by utilization in last six months
b. Defined by days or nights affected in last six months or since last visit
c. For comparison of means Paired T-Tests were applied. For comparison of proportions McNemar's tests were applied. $p < 0.05$ is considered significant at $\alpha = 0.05$.
d. A score of 19 or below is consistent with not well-controlled asthma (17, 18).
e. Includes races other than black and white, as well as participants with an unreported race.
* Indicates a significant difference exists between white and black participants for that indicator. For these comparisons the Cochran-Mantel-Haenszel test was applied. $p < 0.05$ is considered significant at $\alpha = 0.05$
~ Data could not be computed due to too small of sample

Appendix 3: Comparison of Outcome Measures at Intake and Post-Final Visit (PFV) (6 Months after Last Case Management Visit)

Indicator	N	Intake	Post-Final Visit	Percent Change Intake to PFV	p^c
Health Care Utilization[a]					
# Participants with ≥ 1 visit ED visits (%)	84	68 (81%)	29 (35%)	-57%	<.001
White	33	28	12	-57%	<.001
Black	41	31	16	-48%	<.001
Other[e]	10	9	1	-89%	.005
# Participants with ≥ 1 Inpatient Hospitalizations (%)*	84	40 (48%)	9 (11%)	-78%	<.001
White	33	16	2	-88%	<.001
Black	41	23	7	-70%	<.001
Other[e]	10	1	0	100%	~
Impact on Daily Activity[b]					
# Participants with ≥ 1 Missed School days due to Asthma (%)	37	28 (76%)	17 (46%)	-39%	<.001
White	16	12	8	-33%	0.10
Black	14	10	6	-40%	0.10
Other[e]	7	6	3	-50%	0.08
Missed School days due to Asthma (mean days)	37	7.41	3.97	-46%	0.08
White	16	7.69	2.50	-67%	0.02
Black	14	5.93	3.00	-49%	0.12
Other[e]	7	9.71	9.29	-4%	0.96
# Participants with ≥ 1 Missed Work days due to Asthma (%)	38	27 (71%)	13 (34%)	-52%	0.001
White	18	14	7	-50%	0.02
Black	16	11	6	-45%	0.06
Other[e]	4	2	0	-100%	~
Missed Work days due to Asthma (mean days)	38	6.53	1.71	-74%	0.03
White	18	5.56	.94	-83%	0.01
Black	16	4.31	3.00	-30%	0.42
Other[e]	4	19.75	0.00	-100%	0.36
# Participants with ≥ 1 Nighttime Awakenings Due to Asthma (%)	65	30 (46%)	32 (49%)	7%	0.71
White	25	13	11	-15%	0.56
Black	31	15	19	27%	0.29
Other[e]	9	2	2	0%	~
Nighttime awakenings due to Asthma (mean nights)	65	4.67	4.31	-8%	0.84
White	25	4.64	1.96	-58%	0.33
Black	31	5.87	5.26	-10%	0.78
Other[e]	9	0.67	7.56	1028%	0.36

a. Utilization in last six months
b. Days or nights affected in last six months or since last visit
c. For comparison of means Paired T-Tests were applied. For comparison of proportions McNemar's tests were applied. $p < 0.05$ is considered significant at α = 0.05.

* Indicates a significant difference exists between white and black participants for that indicator. For these comparisons the Cochran-Mantel-Haenszel test was applied. $p < 0.05$ is considered significant at α = 0.05

~ Data could not be computed due to too small of sample