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Bring It Down: A Formative Evaluation of Reach and Effectiveness of a Blood Pressure Reduction Program in Detroit, Michigan USA

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Keywords: community health workers | elevated blood pressure | emergency department | hypertension | mobile health units

ABSTRACT

Hypertension is the most important contributor to the development of cardiovascular disease. The objective of the Bring it Down program was to examine the reach and effectiveness of linkage to primary care via community health workers (CHWs) to improve blood pressure control among people with undiagnosed or uncontrolled hypertension. Adults with systolic blood pressures ≥130 mmHg were initially recruited from four urban emergency departments that serve high-risk, socially vulnerable populations. Due to the COVID-19 pandemic, we also enrolled participants in the community who presented to mobile health units. CHWs facilitated follow-up blood pressure assessment within 1 year. Of 153 630 ED patient encounters during the evaluation period, 61% were eligible to participate in the BID program; of these, 3% were approached, and 16% (395/2476) agreed to participate. Compared to ED encounters, fewer patients presenting to MHUs were eligible to participate (42%, 1780/4211), all of whom were approached, and 7% (124/1780) agreed to participate in the BID program. Among participants with at least one follow-up encounter ($n = 158$), there was a statistically significant reduction in mean systolic BP (mean difference: −16 mmHg, 99% confidence intervals (CI): −21, −12 mmHg) with a median time between SBP measurements of 20 days (interquartile range [IQR]: 8, 53 days). Clinical and community recruitment paired with CHW connections to primary care may be a viable quality improvement strategy for improving blood pressure control in high-risk, socially vulnerable populations. However, additional research is needed to understand and improve participation and follow-up rates to establish program effectiveness.

Bethany Foster and Michael J. Twiner are co-first authors.

1 | Introduction

Cardiovascular disease (CVD) is the leading cause of death worldwide [1, 2]. Non-Hispanic Black Americans suffer disproportionately higher CVD risks and sequelae than non-Hispanic White Americans [3], and uncontrolled hypertension explains ~50% of the excess burden [4–6].

In Detroit, Michigan, the nation's largest majority Black or African American city [7], the age-adjusted CVD mortality rate is 70% higher than the national average [8]. An excess burden of negative social determinants of health (SDoH) contributes to the over-representation of CVD mortality [9]. For example, while early clinical interventions can prevent or control hypertension [10], many Detroiters have limited access to primary care and instead rely on emergency departments (EDs) to fill the void. Thus, EDs offer unique opportunities for healthcare quality improvement activities focusing on people with untreated or uncontrolled hypertension.

Our team leverages community health workers (CHWs) to improve healthcare quality by facilitating clinical care coordination and linkage to social services [11, 12]. We recently implemented the "Bring it Down" (BID) pilot program with the goal of helping our hypertensive patients to achieve blood pressure (BP) control. Guided by the RE-AIM (Reach, Efficacy [or effectiveness], Adoption, Implementation, and Maintenance) framework for public health program evaluation [13], we conducted a formative evaluation of the BID pilot program focusing on "Reach" and "Effectiveness". Namely, we examined whether we were able to identify and enroll adults with elevated BPs (i.e., *Reach*), to *explore* whether systolic BPs were reduced at 1-year follow-up (i.e., effectiveness). Because we adapted the pilot program during the COVID-19 pandemic to also recruit participants in the community from mobile health units (MHUs) [14, 15], we further probed for differences compared to the ED-focused recruitment strategy.

2 | Methods

2.1 | Recruitment Strategy

Wayne State University (WSU) worked collaboratively with healthcare partners and community organizations across Detroit to implement the "BID" program. Initially, participants were recruited from four urban EDs (Detroit Receiving Hospital, Sinai Grace Hospital, Harper Hospital, Henry Ford Hospital) across two major healthcare systems serving metropolitan Detroit, MI. Electronic medical records were screened in real-time by program staff to assess eligibility. Participants were recruited in EDs from August 2019 through February 2020, when operations were paused due to the COVID-19 pandemic, before commencing again from June 2020 to March 2023. While operations were paused due to the pandemic in the EDs, we pivoted to prepare for recruitment from MHUs that were deployed in various community settings (i.e., community centers, health fairs, worksites, churches). The MHU recruitment pilot ran from June 2020 until March 2023.

People ≥18 years of age scheduled to be discharged home or to the observational unit (if enrolled from the ED) who presented with at least one of the following medical indications were eligible for inclusion: systolic BP ≥130 mmHg, hemoglobin A1c level ≥6.5%, or 10-year atherosclerotic cardiovascular disease (ASCVD) risk score ≥7.5%. Systolic BP ≥130 mmHg was chosen as it is aligned with the BP goal for our previous BP reduction programs [16, 17]. As a quality improvement project, BID was deemed exempt from requiring Institutional Review Board approval at WSU. However, participants signed release of information documents to enable WSU to share baseline information and obtain follow-up BP data from local clinics.

TABLE 1 | Bring it Down program recruitment and participation.

Characteristics	Total	ED	MHU
Encounters	157 841	153 630	4211
Eligibility rate	95 740 (60%)	93 960 (61%)	1780 (42%)
Approached for participation	4256 (4%)	2476 (3%)	1780 (100%)
Participation rate	519 (12%)	395 (16%)	124 (7%)

Abbreviations: ED, emergency department; MHU, mobile health unit.

2.2 | Blood Pressure Measurement

Triage BP obtained using the WelchAllyn 64NTXX-B Connex Vital Signs Monitor served as the basis for ED enrollments. BP measurements at the MHUs were obtained using standard screening protocols initially with an Omron 3 series device and later (as of March 2021) with the Omron HEM-907XL device using triplicate measurement with a 5-min rest period followed by three repeat readings obtained at 1-min intervals, consistent with American Medical Association (AMA) MAP guidance. All devices used for BP measurement have passed the AMA's Device Accuracy Test and are included on the US Blood Pressure Validated Device Listing (VDL) [18]. Follow-up BP levels were determined per routine medical practices employed across the various clinical settings (specifically Wayne Health; a non-profit, multi-specialty academic group practice in Detroit, MI USA).

2.3 | Follow-up

Participants were followed for up to 12 months post-enrollment by program staff. Staff completed an electronic health record (EHR) review of medical encounters with either the referred primary care physician (PCP) or a specifically trained CHW to determine follow-up rates and outcomes. Although the participants may have had multiple follow-up appointments (and, as such, multiple follow-up BP readings), only the blood pressures from the last clinic visit were used for analyses.

2.4 | Data

Part of this analysis includes publicly available data from the WSU PHOENIX (Population Health Outcomes Information Exchange) Virtual Data Warehouse [19, 20], and a limited-use dataset that included EHR data stored in REDCap 13.8.2 (2023 Vanderbilt Uni-

TABLE 2 | Participant demographics, clinical characteristics, and follow-up.

Characteristic	Overall $n = 519$	ED $n = 395$	MHU $n = 124$
Age group			
18–49	294 (57%)	250 (63%)	44 (35%)
50–69	184 (35%)	115 (29%)	69 (56%)
70+	41 (8%)	30 (8%)	11 (9%)
Sex at birth			
Female	252 (49%)	195 (49%)	57 (46%)
Male	267 (51%)	200 (51%)	67 (54%)
Gender			
Female	251 (48%)	193 (49%)	58 (46%)
Male	262 (50%)	196 (50%)	66 (53%)
Other	3 (<1%)	3 (<1%)	—
Unknown	3 (<1%)	3 (<1%)	—
Race			
Black	470 (91%)	356 (90%)	114 (92%)
Other	25 (5%)	18 (5%)	7 (6%)
Unknown	9 (2%)	8 (2%)	1 (<1%)
White	15 (3%)	13 (3%)	2 (2%)
Ethnicity			
Arab/Chaldean	2 (<1%)	1 (<1%)	1 (<1%)
Hispanic	17 (3%)	13 (3%)	4 (3%)
Not Hispanic/Arab/Chaldean	472 (91%)	369 (93%)	103 (83%)
Unknown	28 (5%)	12 (3%)	16 (13%)
Insurance			
Medicaid	233 (45%)	202 (51%)	31 (25%)
Other	92 (18%)	73 (18%)	19 (15%)
Private	86 (17%)	50 (13%)	36 (29%)
Uninsured	48 (9%)	33 (8%)	15 (12%)
Unknown	60 (12%)	37 (9%)	24 (19%)
Has PCP	172 (33%)	117 (30%)	55 (44%)
Past medical history			
Hypertension	233 (45%)	180 (46%)	53 (43%)
Diabetes	65 (13%)	55 (14%)	10 (8%)
Hyperlipidemia	88 (17%)	63 (16%)	25 (20%)
Barriers to care			
No transportation	134 (26%)	117 (30%)	17 (14%)
No appointment times for my schedule	55 (11%)	51 (13%)	4 (3%)
No personal identification	47 (9%)	43 (11%)	4 (3%)
Interested in assistance with…			
New primary care physician appointment	499 (96%)	379 (96%)	120 (97%)
Transportation	174 (34%)	163 (41%)	11 (9%)
Community resources	159 (31%)	151 (38%)	8 (7%)
Insurance	43 (8%)	40 (10%)	3 (2%)

(Continues)

TABLE 2 | (Continued)

Characteristic	Overall $n = 519$	ED $n = 395$	MHU $n = 124$
Mean PCP visits within 1 year (SD)	1.1 (2.0)	0.8 (1.6)	2.0 (2.6)
Mean CHW encounters within 6 months (SD)	0.4 (0.6)	0.3 (0.6)	0.6 (0.7)
Followed-up*	158 (30%)	88 (22%)	70 (56%)

Abbreviations: ED, emergency department; MHU, mobile health unit; PCP, primary care physician; SD, standard deviation.
*Calculated among participants with follow-up.

versity) under a community-level hospital surveillance research protocol (WSU IRB#103616MP2E).

2.5 | Reach and Effectiveness Measures

For purposes of public health program evaluation "reach" is defined, "…as an individual-level measure (e.g., patient or employee) of participation.… [that is]… measured by comparing records of program participants and complete sample or 'census' information for a defined population…[and]…calculation of participation rates is straightforward" [13]. That is, we calculated the proportions of eligible participants who were approached, consented, and attended a follow-up visit using EHRs within 12 months. Effectiveness was explored based on changes in SBP measurements between enrollment and follow-up. Although changes in blood pressure were the main focus, this project was observational and not a priori powered with a primary outcome.

2.6 | Statistical Evaluation

Means and standard deviations were used to describe interval data, whereas frequencies and percentages were tabulated to describe categorical variables. We also mapped participation rates by residential ZIP code. After testing for normality by visual plot inspection and the Kolmogorov–Smirnov test, we calculated median (interquartile range [IQR]) values and used either a paired Wilcoxon signed-rank test or a paired *T*-test to identify differences in SBP distributions between enrollment and follow-up. An alpha of 5% was used as the a priori threshold for statistical significance; post hoc we calculated a more conservative 99% confidence interval (α 1%). Analyses were conducted using RStudio 2023.09.1 Build 494 (2009–2023 Posit Software, PBC) and SAS v9.4 (Cary, NC). Maps were produced using ArcGIS Pro 3.1.3 (2023 Esri, Inc.).

3 | Results

3.1 | BID Program Reach

Of 153 630 ED patient encounters during the evaluation period, 61% were eligible to participate in the BID program; of these, 3% were approached, and 16% (395/2476) agreed to participate.

Compared to ED encounters, fewer patients presenting to MHUs were eligible to participate (42%, 1780/4211), all of whom were approached, and 7% (124/1780) agreed to participate in the BID program (Table 1).

Table 2 describes the participant characteristics both overall and by recruitment location. Most participants identified as Black (n = 470, 91%), resided in or near Detroit (Figure S1), and were interested in assistance with a new PCP appointment (n = 499, 96%); none had hemoglobin A1c levels ≥6.5% or ASCVD risk scores ≥7.5%.

Compared to participants recruited from MHUs, those recruited from EDs more frequently had Medicaid insurance (51% vs. 25%) and experienced barriers to care including a lack of transportation (30% vs. 14%), appointment time inflexibility (13% vs. 3%) and lacking personal identification (11% vs. 3%). By contrast, participants recruited from MHUs were older and had greater frequencies of PCP and CHW follow-up visits than ED-recruited participants. There was no difference in past medical histories between participants recruited from EDs and MHUs (Figure 1).

3.2 | Exploration of BID Program Effectiveness

Among participants with at least one follow-up BP measurement (n = 158; 30.4% of BID cohort), Figure 2 shows there was a statistically significant reduction in mean systolic BP (mean difference: −16 mmHg, 99% confidence intervals (CI): −21, −12 mmHg) with a median time between SBP measurements of 20 days (IQR: 8, 53 days). Additional information is provided in Table 3. Compared to those with at least one follow-up BP, the 361 participants without a recorded follow-up BP were found to have some demographic differences including age, race, ethnicity, insurance, recruitment location, established access to a primary care provider, transportation, and in need of help with transportation and insurance (Table S1).

4 | Discussion

Our formative evaluation of the BID pilot program identified large numbers of ED and MHU clinical encounters with eligible patients whose systolic blood pressure was >130 mmHg, but participation and follow-up rates were low among those approached to participate. Nevertheless, among the subset of participants who followed-up, systolic and diastolic blood pressures were significantly decreased. These results prompt us to infer that additional efforts focusing on increasing participation and follow-up rates are necessary during implementation to facilitate a formal outcome evaluation of BID program effectiveness.

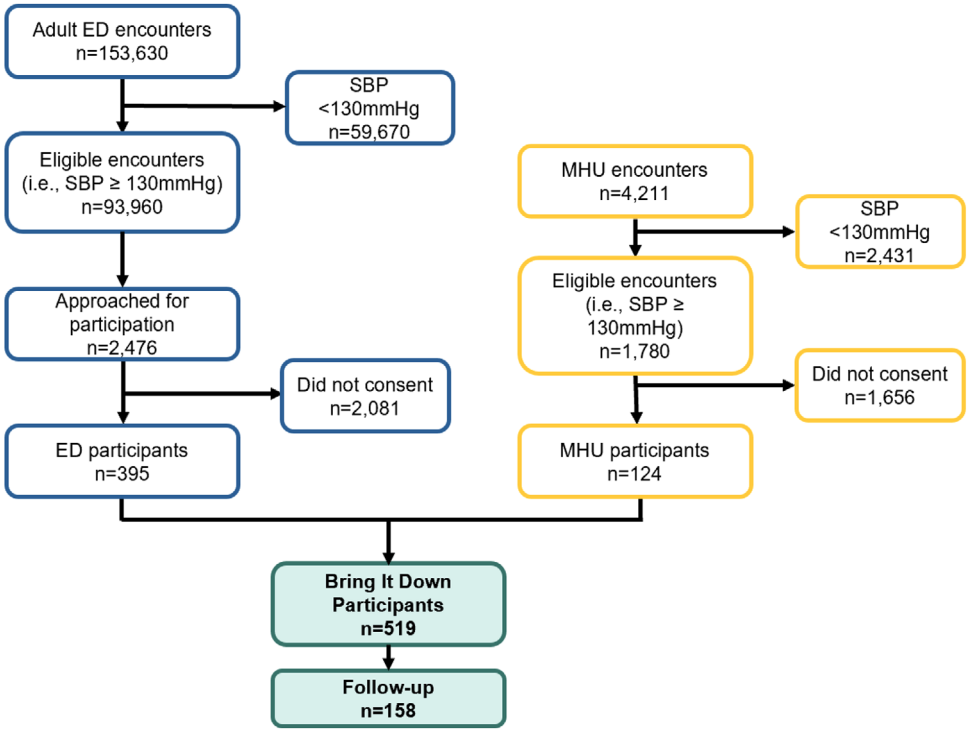

FIGURE 1 | Bring it Down participant consort diagram. ED, emergency department; MHU, mobile health unit; SBP, systolic blood pressure. ED recruitment occurred between August 2019 through February 2020 and June 2020 through June 2023. MHU recruitment occurred between June 2020 through March 2023.

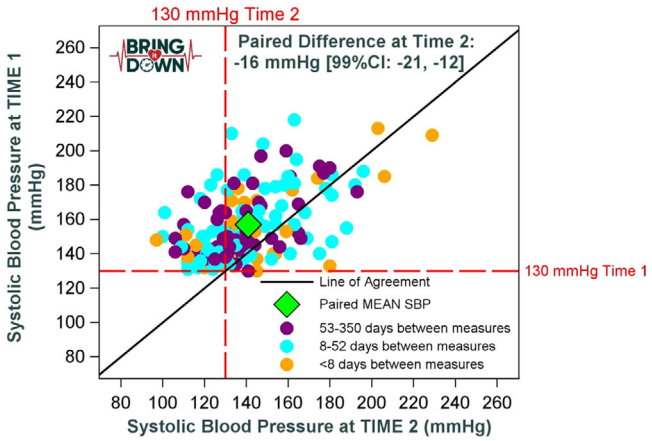

FIGURE 2 | Paired measures of systolic blood pressure (SBP) at enrollment (Time 1) and follow-up (Time 2) among Bring it Down Program Participants. Filled circles represent individual patients' paired SBP at Time 1 and Time 2 color-coded by follow-up time tercile (<8 days, 8–52 days, and 53–350 days between measures); the green diamond represents the paired mean SBP, and values located above the solid diagonal line of agreement indicate a lower SBP at follow-up Time 2 (paired difference: −16 mmHg, paired T-test $p < 0.0001$).

The systolic and diastolic blood pressure reductions observed during the BID pilot program are encouraging based on prior evidence consistent with CVD risk reduction [21]. While enthusiasm may be tempered by a low participation rate, the use of MHUs to reach socially vulnerable high-risk communities [22] coupled with CHWs remain viable candidates for mitigating negative SDoH [12, 23] that impede early identification and control of elevated blood pressure. Indeed, about half of the elevated blood pressures appeared to be newly identified. Moreover, just one of three participants had a PCP, few had private insurance, and many participants experienced multiple barriers to effective clinical care (e.g., 96% had difficulty scheduling PCP appointments). Our findings are thus consistent with evidence from previous studies that indicate CHWs are a viable option for enhancing BP control in high-risk populations in underserved areas [15, 24] (e.g., the Million Hearts initiative (https://millionhearts.hhs.gov).

4.1 | Strengths and Limitations

The major strength of this formative evaluation of the BID pilot program is that it helped inform the design of a larger randomized-controlled study sponsored by the American Heart Association targeting 334 participants, "Linkage, Empowerment, and Access to Prevent Hypertension" (LEAP-HTN) [14, 15]. Future program evaluations and research should similarly include control groups to better establish the effectiveness of CHWs to overcome negative SDoH and connect with primary care. Limitations of our work are those of all quality improvement program evaluations, that is, we do not know if our findings are generalizable to broader populations, nor are we able to distinguish between association and causation, like all observational investigations. Instead, our work is intended to enhance the quality of our program and inform future efforts that will be designed to establish program effectiveness. Indeed, our findings may be optimistically biased if patients with increased blood pressure were disproportionately lost

TABLE 3 | Initial and follow-up systolic and diastolic blood pressures.

	Initial ($n = 158$)	Follow-up ($n = 158$)	Median shift in distribution	Test for differences
SBP Median (IQR)	151 (141, 170)	136 (126, 153)	−16.0 (−19.5, −13.0)	$p < 0.001$**
DBP Median (IQR)	92 (84, 103)	83 (76, 92)	−9.5 (−11.5, −7.5)	$p < 0.001$**

Note: Measurements represent blood pressures in mmHg.

Abbreviations: DBP, diastolic blood pressure; IQR, interquartile range; SBP, systolic blood pressure.

**Paired Wilcoxon Signed Rank test for skewed distributions (SBP: V = 10766, $p < 0.001$; DBP: V = 10223, $p < 0.001$; reject null hypothesis that shift in distribution is equal to zero).

to follow-up. During the course of this project, there was a transition in BP measurement devices that may have contributed to a measurement bias, and there were significant differences between participants who followed up versus those who did not follow-up suggesting the potential for selection and/or attrition bias, which is an area to directly address in larger, follow-up studies. Moreover, our participant group was largely Black, thus limiting the generalizability of our findings. To better understand the potential utility of this approach in other populations, future studies should include broader racial and ethnic representation.

5 | Conclusions

Participant recruitment from both EDs and MHUs offers a potentially viable strategy for quality improvement programs aiming to optimize BP control in high-risk, socially vulnerable populations, but enhanced efforts focused on raising participation and follow-up rates are likely needed during program implementation.

Author Contributions

Conceptualization: Phillip Levy and Bethany Foster. Data curation: Samantha J. Bauer, Mallory A. Lund, Phillip Levy, Bethany Foster, and Jordan Gould. Statistical analysis: Samantha J. Bauer, Mallory A. Lund, and Steven J. Korzeniewski. Funding acquisition and administration: Phillip Levy and Bethany Foster. Visualization: Bethany Foster, Michael J. Twiner, Samantha J. Bauer, Phillip Levy, Steven J. Korzeniewski, and Mallory A. Lund. Writing–original draft: Bethany Foster, Michael J. Twiner, and Phillip Levy. Writing–review, editing, and approval of final draft: Bethany Foster, Michael Twiner, Samantha Bauer, Steven Korzeniewski, Mallory Lund, Jordan Gould, Katee Dawood, Sahil Bhatia, Kristina Dawkins, Michelle Byrd, Robert Brook, and Phillip Levy.

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Ethics Statement

The Wayne State University Institutional Review Board deemed this study was exempt from requiring approval (WSU IRB # 2019–111); however, follow-up information was collected from electronic health records that were included as a part of a surveillance research protocol (WSU IRB#103616MP2E) and through signed releases from individual patients in follow-up clinics.

Consent

All participants signed a release of information document for WSU program staff to share their baseline information with the follow-up providers.

Data Availability Statement

Data cannot be shared publicly because it includes personally identifiable information of human participants. Data are available via REDCap from the WSU Research Data Management Services core (https://research.wayne.edu/cores-facilities/research-data) for researchers who meet the criteria for access to confidential data. S.B., K.D., and M.B. are employed by the Michigan Department of Health which funded this study; however, they were not involved in data collection or data interpretation. The rest of the authors declare no conflicts of interest.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section.

Supporting Table 1: Patient demographics for those with 12 month follow up blood pressures versus those with no follow up. **Supporting Fig. 1:** Geographical representation of recruited Bring It Down participants in the Detroit, Michigan USA region. Pins represent the emergency department recruitment sites (Detroit Receiving Hospital, Sinai Grace Hospital, Harper Hospital, Henry Ford Hospital) employed before the implementation of the mobile health units.