# AN EVALUATION OF PRIMARY CARE BASED SOCIAL NEEDS SCREENING IMPLEMENTATION AMONG COMMUNITY HEALTH CENTERS IN NORTH CAROLINA

Connor Drake

A dissertation submitted to the faculty at the University of North Carolina at Chapel Hill in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Health Policy and Management in the Gillings School of Global Public Health.

Chapel Hill
2020

Approved by:

Christopher Shea

Kristin Reiter

David Edelman

Morris Weinberger

Justin Trogdon

# ABSTRACT

Connor Drake: An evaluation of primary care based social needs screening implementation among community health centers in North Carolina
(Under the direction of Christopher Shea)

Structural social determinants of health (SDOH) and individual-level social needs drive health outcomes and widen health disparities. Successful efforts to reform health care delivery towards value and effective population health management requires health systems to assess and address social needs in routine outpatient clinical encounters. The Protocol for Responding to and Assessing Patients' Assets, Risks, and Experiences (PRAPARE) was developed as a screening tool and corresponding clinical workflow to assess and respond to identified social needs that impact health. However, evidence on the cost of PRAPARE, the screening tool's association with clinical risk, and patients' perspectives on implementation is limited. In this dissertation, I examine these aspects of PRAPARE in federally-qualified health centers (FQHCs) across North Carolina. The first aim of this dissertation evaluates the relationship between PRAPARE responses and individuals' cardiometabolic clinical risk. The second aim examines the direct clinic-level cost of implementing and sustaining a practice pattern change required for the PRAPARE screening and response protocol. The third aim assesses implementation barriers and facilitators of the PRAPARE social needs response protocol from the patient's perspective. The findings are of interest to policy makers and payers interested in scaling this approach and provides practical implementation insights for health systems and practitioners interested in assessing and addressing individual-level social needs to improve care quality and promote health equity.

This dissertation is dedicated to my parents, brother, and spouse for their love, support, and encouragement.

# ACKNOWLEDGEMENTS

I start by acknowledging my advisor, Dr. Chris Shea, for his mentorship and guidance throughout my doctoral training and dissertation. I would also like to thank the other members of my dissertation committee, Drs David Edelman, Justin Trogdon, Kristin Reiter, and Morris Weinberger for both their substantive contributions to this work and their valuable feedback on formulating the overarching research questions. This work would not have been possible without the engagement of community, clinical partners, and collaborators. I'd like to start by thanking Dr. Howard Eisenson and colleagues at the Lincoln Community Health Center for their innovative work developing care models that engage patients around both medical and non-medical needs. Their commitment to embracing new approaches to care to better serve their patients was a source of inspiration for this work. My deepest gratitude goes to the Lincoln Community Health Center patients that agreed to participate in the qualitative study. Their willingness to provide input on how to improve how social needs screening is a valuable public service and their input was critical. Additionally, this work would not have been possible without grant support from the Blue Cross and Blue Shield Foundation of North Carolina. Second, I would like to thank my colleagues at the Duke University Health System's Analytics Center for Excellence, Michael Chrestensen and Caitlin Fisher, and the Duke Center for Personalized Health Care, Heather Batchelder, Meagan Cannady, Cindy Mitchell, Alberto Vargas, and Tyler Lian. I am especially grateful to Dr. Ralph Snyderman for his mentorship and personal investment in my growth as a researcher and professional. I am also grateful to the North

Carolina Community Health Center Association and the National Association of Community Health Centers for their support and encouragement to evaluate the implementation of social needs screening protocols among member organizations. I was extremely fortunate to work with talented collaborators throughout this dissertation.

My family and friends have been ongoing sources of inspiration, support, and encouragement. I would like to specifically acknowledge my parents, Craig and Amelia, brother, Cliff, and my cohort in the Health Policy and Management Department. I am especially grateful to my wife, Marie, for her support, perspective, and patience throughout this process.

# PREFACE

While working on this dissertation research there were two global events that profoundly influenced my views on this work. First, the global pandemic, COVID-19 has laid bare the structural inadequacies of the social and economic policies and institutions to protect Americans from the virus itself and the corresponding economic fallout. It reinforces the need for structural changes to address SDOH and the downstream social needs that result from these social and economic structures that guide the distribution of resources. Second, I would like to acknowledge and express my gratitude to the Black Lives Matter movement. The aftermath of the public execution of George Floyd by Minneapolis police officers has been marked by a sense of outrage and solidarity. It has allowed for deep discussion and rapid political activism focused on the structural components of racism that are deeply intertwined with health and health equity. By listening and learning during this time of change and uncertainty, I've come to a new appreciation of how research must never lose sight of the 'big picture'. I understood at the onset of this work in 2017 that my research is related to health disparities and the promotion of health equity, but the brutal murder of George Floyd and the political activism of Black Lives Matter has been an important reminder that this research is fundamentally related to efforts to reform and dismantle institutions that perpetuate structures of racism. We cannot be satisfied with just finding strategies to better adapt to institutional failures but, instead, we must focus on remaking these institutions to better reflect shared values and ideals related to equity. To do so, I'm convinced that efforts to promote health equity must occur on multiple levels of intervention.

While my dissertation focuses on the practical need to better respond to patients’ unmet social needs, social needs screening cannot only be a band-aid on structural failures that exacerbate disparities. Instead, I hope this work also calls attention to the need for political activism to reform the overarching social and economic policies driving inequities that have been highlighted by these recent events.

## TABLE OF CONTENTS

# LIST OF TABLES

# LIST OF FIGURES

# LIST OF ABBREVIATIONS

| | |
|---|---|
| ASCVD | Atherosclerotic cardiovascular disease |
| AIC | Akaike information criterion |
| BIC | Bayesian information criterion |
| BMI | Body mass index (kg/m2) |
| CBO | Community based organizations |
| CI | Confidence interval |
| EHR | Electronic health record |
| FQHC | Federally qualified health center |
| FTE | Full-time equivalent employee |
| HEIF | Health Equity Implementation Framework |
| i-PARIHS | Integrated-Promoting Action on Research Implementation in Health Services |
| NACHC | National Association of Community Health Centers |
| OR | Odds ratio |
| PRAPARE | Protocol for Responding to and Assessing Patients' Assets, Risks and Experiences |
| ROC | Receiver operating characteristic |
| SDOH | Social determinants of health |
| SRQR | Standards for reporting qualitative research |
| US | United States |

# CHAPTER 1: INTRODUCTION

## 1.1 Background

Social determinants of health (SDOH) are the conditions in which a person lives, works, and grows that influence their health. The evidence on SDOH indicates that population and individual health outcomes are not only impacted by medical services, but also their ability to access nutritious food, live in a safe community, and have access to opportunities associated with economic stability and education.[1] Estimates vary, but these non-medical social and economic forces shape population level health outcomes to a greater extent than health care services.[2,3] Income and education levels, for example, have a profound impact on health status and life expectancy. In the United States, inequities in resource distribution results in the wealthiest 1% living 10 to 15 years longer than the poorest 1%.[4] SDOH operate at multiple levels including federal, state, and local policy surrounding education, housing, and entitlement programs, and cultural or social forces that inform the distribution of resources. When individuals experience material insecurity like housing instability or inability to afford nutritious food, it results in worse health outcomes.[2,5-8] These basic, health-related material needs are referred to in many different ways including, social risk factors, health-related social needs, non-medical needs, and social needs. I refer to these downstream individual-level consequences of SDOH as social needs that, if resolved, can improve health.[9]

This distinction in terminology to describe SDOH as opposed to social needs is relevant to this research and designing appropriate policy recommendations and interventions.[10] Addressing SDOH involves structural changes to underlying social and economic conditions through policies that impact resource distribution. Whereas addressing social needs involves providing resources or services at an individual, patient level to ameliorate their negative impact on their health.[10] Health systems and payers are increasingly recognizing that investing in targeted interventions to address social needs including food assistance programs, temporary housing programs, and subsidized transportation for low-income patients can be less costly than providing repeated, resource intensive medical interventions. However, it is important to recognize that while these interventions may significantly benefit patients that receive them, they do not address the SDOH or the economic or social structures that produce the root-cause conditions of resource deprivation.[11] The relevance and urgency of reforms to address both structural SDOH and individual-level social needs is even greater during the current global pandemic. COVID-19 has revealed structural deficiencies that has led to widespread unemployment, food insecurity, and housing instability.[12,13]

Given the existing climate and the potential to improve outcomes and control costs, health systems and payers are increasingly investing in novel approaches to respond to patients' social needs that influence their health.[14] Strategies to do so are often embedded within primary care as a prevention and population health management.[15] These efforts are consistent with the ethos of organizing and delivering primary care according to the Chronic Care Model and the patient-centered medical home. A core component of the Chronic Care Model emphasizes linkages between the community organizations and health systems to meet patient needs outside of the narrow scope of medical services. This is done through cross-sector partnerships and establishing referrals to resources outside of the health system.[16] Similarly, a key attribute of patient centered care is sensitivity to social needs[17] and the psychosocial context of the patient's experience of illness.[18] Recent health care delivery reforms[19], emerging models for health care reimbursement,[20-25] and recommendations from medical specialty organizations[7,26] have accelerated efforts to better respond to patients' social needs as components of high quality primary care. This has been complemented by a growing evidence base of interventions to address social needs that improve outcomes and reduced health care expenditures, including legal aid, housing assistance, financial assistance, and removing environmental toxins.[27] For example, addressing food insecurity is particularly promising. Recent research suggests that receiving low-income food assistance or medically tailored meals is associated with reductions in health care expenditures,[8] cardiovascular health improvements for pregnant women,[28] and better health outcomes and behaviors for patients with diabetes.[29]

Traditionally, health care systems and social service organizations largely have operated within siloes, but this is changing as health systems recognize the potential for improving outcomes by better supporting patients across the social and health care continuum.[30] The existing literature highlights innovative strategies for successfully identifying patients with unmet social needs and providing additional social services or resources. Several studies use a case study design to describe the design and clinical implementation of social needs screening and reponse.[31-34] Other studies include social needs screening as part of a multifaceted intervention to address social needs for a special population of interest with an emphasis on families and children.[35-37] There is also literature describing strategies for integrating social needs assessment data within the electronic health record (EHR).[38-42]

Among the most prominent examples of social needs screening and response protocols is the Protocol for Responding to and Assessing Patients' Assets, Risks, and Experiences (PRAPARE). PRAPARE was developed by the National Association of Community Health Centers (NACHC), the Association of Asian Pacific Community Health Organizations, the

Oregon Primary Care Association, and the institute for Alternative Futures as part of a national effort to help community health centers collect the data needed to better understand the upstream SDOH drivers of poor health outcomes and higher health-related costs.[43] The PRAPARE assessment tool has a set of national core measures and additional optional measures that can customize the assessment to match community priorities. The assessment tool (Appendix A) has been translated into 26 languages and measures were developed and construct validity was established.[44,45] The core measures evaluate patient social drivers along the following domains: race, ethnicity, education, employment, migrant/seasonal farm work, education, employment, insurance, veteran status, income, language, material security, housing status and stability, social integration and support, neighborhood, and stress. The optional measures include incarceration history, safety, refugee status, and domestic or interpersonal violence. PRAPARE aligns with existing national initiatives,[46] ICD-10 clinical coding, and the Uniform Data System used by the Health Resources and Services Administration. PRAPARE has been implemented primarily within federally qualified health centers (FQHCs). FQHCs are a critical part the health care safety net in the United States and serve underserved communities regardless of insurance status and ability to pay. FQHCs have long attended to social needs given the vulnerable patient population they serve.

While there is growing adoption of social needs screening in health systems,[47] evidence is needed to support widespread adoption of standardized social needs screening protocols, like PRAPARE, into routine clinical encounters. Implementation science has an important role to play in identifying implementation determinants and corresponding strategies to facilitate uptake.[48] My goal with this research is to lend the theoretical lens and tools of implementation science to address three existing gaps in the literature. First, there is little evidence on the relationship between social needs assessment data and clinical risk. Second, there is little understanding of the cost to health systems to adopt and deliver social needs screening and response protocols as standard of care, which is critical prior to for implementation in clinics.[49] Finally, while there is research describing clinician and provider perspectives on social needs screening,[50,51] the only study on patients' perspectives on social needs screening is from multi-site study that used mixed-methods to evaluate patient acceptability.[52] To my knowledge, there is no existing research that examines barriers and facilitators of social needs screening implementation using a theoretically sound implementation science framework. To contribute to this rapidly emerging evidence base, my dissertation addresses these gaps by evaluating the implementation of social needs screening and response protocols in FQHCs across the state of North Carolina.

### 1.2 Research Aims

This research seeks to inform implementation efforts to incorporate social needs screening and response protocol into routine outpatient care. To do so and address the aforementioned gaps in the literature, my research focuses on the following specific aims:

> **Aim 1:** Evaluate the relationship between PRAPARE assessment tool data with cardiometabolic clinical risk in FQHC patients. I explore the association of PRAPARE responses with cardiovascular risk using predictive analytics approaches. Clinical risk dependent variables include atherosclerotic cardiovascular disease (ASCVD) risk, an algorithm to calculate the 10-year risk of heart disease or stroke,[53,54] blood pressure (systolic and diastolic), and Body Mass Index (BMI).

**Aim 2:** Determine the cost of implementing and sustaining a practice pattern change for integrating the PRAPARE social needs screening and response from the clinic level perspective. Using activity-based costing (a micro-costing method), I estimate the direct, clinic-level costs associated with the implementation of PRAPARE.

**Aim 3:** Identify and analyze barriers and facilitators for the implementation of PRAPARE from the patient perspective. Using interview guides based on the Health Equity Implementation Framework (HEIF), we conducted 10 60-minute semi-structured interviews to better understand barriers and facilitators to implementation and patient centric delivery of PRAPARE.

### 1.3 Significance

The long-term goal of this work is to improve health equity and health by promoting the uptake of clinical approaches to screen and respond to unmet patient social needs in a patient centric and coordinated fashion. This research seeks to address important gaps in the literature relevant to implementation. The first aim is particularly relevant to state-level initiatives to screen all Medicaid patients for social needs.[55,56] By understanding how the presence of social needs is associated with clinical risk, payers and health systems can better identify patients that are likely to benefit and realize cost savings from addressing modifiable social needs. Aims two and three both examine factors associated with clinic level implementation of PRAPARE with significant implications for policy level implementation determinants. My intention with both of these aims is to identify best practices for implementing PRAPARE in a cost-efficient and patient-centered manner while simultaneously informing potential policy levers that could facilitate uptake of social needs screening protocols in diverse clinical settings. Understanding variation in direct clinic-level costs associated with PRAPARE (aim 2) could inform how these clinical approaches are designed and incentivized. Additionally, by understanding barriers and facilitators to implementation (aim three)  from the patients’ perspective, interventions to screen and respond can be designed to be patient centric and sensitive to patient preferences for engagement. Furthermore, to ensure that this dissertation is relevant to clinical practice and overarching translational efforts, the aims were developed in collaboration with stakeholders at the Lincoln Community Health Center, a Durham-based FQHC, the National Association of Community Health Centers, the North Carolina Community Health Center Association, and the Blue Cross and Blue Shield Foundation of North Carolina.

# CHAPTER 2: USING SOCIAL NEEDS DATA TO PREDICT CARDIOMETABOLIC RISK IN A FEDERALLY QUALIFIED COMMUNITY HEALTH CENTER PATIENT POPULATION

## 2.1 Introduction

The evidence demonstrating that SDOH, such as food access, transportation, employment, discrimination, and housing are significant drivers of health outcomes and disparities is well established.[1,3] To successfully reform health care delivery towards value, prevention, and effective population health management, there is a need to assess and respond to health-related social needs associated with the downstream consequences of the SDOH.[2,19,57,58] To this end, systems are increasingly collecting population level SDOH data and individual level information on social needs that impact health outcomes, including food insecurity, unemployment, housing status, and transportation barrers.[14,15,33,59]

To address these social needs, PRAPARE was developed by NACHC and partnering organizations as a screening tool and corresponding clinical workflow to assess as well as to respond to patients' social needs.[43,60] However, the relationship between data from an established social needs' screening tool and clinical risk factors is not well established. A recent systematic review of PRAPARE and similar social needs screening assessments found minimal quality evidence to evaluate predictive validity.[61] This gap in the literature is relevant to the current emphasis on delivery reform emphasizing population health management and coordination of care across health and social care continuum.[19,62] With a better understanding of how social needs screening assessment data predicts clinical risk, health systems and payers can identify complex patients, measure the impact of interventions, and manage patient panels to inform care team composition and linkages to appropriate wrap around services.[63] As health systems and payers increasingly invest in collecting this information,[19,21,23] there is a need to evaluate the relationship between patients' social needs and their medical complexity to design tailored interventions.

This study examines the relationship between measures of cardiometabolic clinical risk and responses to the PRAPARE social needs screening tool among patients in a federally-qualified community health center (FQHC). We utilized predictive analytics to determine the association between social needs assessment data and the likelihood of clinical risk. The goals of this study are to 1) better understand the medical complexity of a defined population and 2) evaluate the utility of PRAPARE and social needs assessments for risk prediction, stratification, and population health management by exploring the association of assessment responses with clinical risk. We hypothesized that predictive models using social needs data from PRAPARE would have moderate performance for predicting the presence of the indicators of cardiometabolic clinical risk: obesity, stage 2 hypertension, and borderline ASCVD risk.

## 2.2 Methods

### 2.2.1 Study Setting & Data Collection

The study was conducted at a FQHC in a medium-sized city in the southeastern United States. In 2018, the partnering FQHC saw 33,961unique patients, 75% of whom had incomes at or below 200% of the federal poverty level; 55% of patients were uninsured and over 92% were members of racial or ethnic minorities. This study protocol was reviewed and approved by the Duke University Health System Institutional Review Board.

The FQHC began implementing PRAPARE in mid-2017 in its Pediatric, Adult Medicine, and Family Medicine clinics. The PRAPARE assessment tool was fully integrated within the FQHC's EHR system. The PRAPARE social needs assessment is administered via patient interview, and referrals to community resources or social services are made based on identified needs. Additional detail on the FQHC's clinical workflow, patient population, EHR integration, and implementation logistics are published elsewhere.[64] We obtained the data used in this analysis through a retrospective query to abstract charts of patients that had received PRAPARE as part of their clinical encounter.

### 2.2.2 Measures

PRAPARE includes a set of national, well-validated core measures and additional optional measures to match community priorities.[44,45] The core measures evaluate patient social drivers along the following domains: race, ethnicity, education, employment, migrant/seasonal farm work, education, employment, insurance, veteran status, income, language, material security, housing status and stability, social integration and support, neighborhood, and stress. The optional measures include incarceration history, safety, refugee status, and domestic or interpersonal violence (Appendix A). PRAPARE aligns with existing national initiatives,[46] ICD-10 clinical coding, and the Uniform Data System used by the Health Resources and Services Administration. All core and optional measures were included in this analysis as independent variables of interest except for neighborhood, refugee status (not consistently collected during the chart abstraction period), language (high missing data reasons and correlation with ethnicity), and income (for reasons related to data quality/missingness). Gender and age were included as covariates in the analysis.

We used three measures of cardiometabolic clinical risk: body mass index (BMI), systolic and diastolic blood pressure, and atherosclerotic cardiovascular disease (ASCVD) 10-year risk. These outcomes were selected because of their relevance to commonly-used indicators of quality in primary care,[65,66] data availability and integrity, and causal links to how social needs can effect clinical risk.[67] All three clinical risk measures were dichotomized. Derived from weight and height, we defined clinical risk as being obese (BMI ≥ 30); patients without a height or weight recorded in the EHR were dropped in the analytic sample (n = 2,153). Stage 2 hypertension was defined as systolic value greater than 140 mm/Hg or a diastolic value greater than 90, consistent with diagnosis guidelines.[68] All patients with recorded systolic and diastolic blood pressure values were included in the analysis (n = 2,174). Finally, ASCVD risk was defined as being above a threshold of 7.5%. The ASCVD risk score is an estimate of the likelihood of an ASCVD event over the following 10 years and was developed to identify patients that might benefit from primary prevention.[69] The 7.5% threshold is a clinically relevant score that prompts additional clinical intervention using statin therapy.[54,70] Because ASCVD is not a valid cardiovascular estimate for patients younger than 40 years, they were excluded, leading to an analytic sample of 1,468 patients for this outcome. For patients that did not have a cholesterol period recorded in their medical record, a healthy value was imputed.[71]

### 2.2.3 Statistical Analysis

We used two approaches to evaluate PRAPARE response's relationship to clinical risk: a backward stepwise logistic regression and a logistic least absolute selection and shrinkage operation (lasso logit regression). The backwards stepwise logistic regression is a parametric modeling approach wherein predictor variables are included in the model and removed individually if they were not statistically significant at a .05 level.[72]

The lasso is a type of supervised machine learning that performs model selection by “shrinking” or penalizing variables, setting certain coefficients to zero, if they are not contributing explanatory power to the model.[73] In doing so, the lasso is better at avoiding overfitting when compared to a regression without a penalization function. The lasso logit is best for maximizing prediction accuracy and interpretability on an outcome outside of the sample used in the analysis. The goal of this modeling technique is to assist with variable selection that minimizes prediction error, maximizes out of sample performance, and addresses issues with multicollinearity.[74] We used three different types of lasso logistic regression models with different penalization or parameter shrinking functions. One was based on an adaptive lasso, one was minimized based on Bayesian information criteria (BIC) and one was based on minimizing the Akaike information criteria (AIC) which estimates the amount of information lost by using the model.[75,76] Model fit was similar across all three lasso approaches but the penalization function that was informed by AIC consistently performed well and was selected based on performance and theory. Additional results comparing the different lasso approaches can be found in Appendix B.

To evaluate model predictive performance, we compared the logistic regression and lasso logit using a concordance statistic (c) which can range from 0 to 1. A c-statistic of .5 indicates that the model performs as well as random chance at classifying outcomes and 1 indicates perfect prediction. The c-statistic is identical to the area under the receiver operating characteristic (ROC) curve. To test predictive performance, we used the full dataset for the logistic regression and randomly assigned 80% of observations into a training dataset for the lasso model and 20% of observations to a validation dataset. Our hypothesis was that PRAPARE model prediction performance would be satisfactory across the three clinical risk areas evaluated when tested upon the validation dataset. We defined satisfactory performance as having a c-statistic > .65 which is used as the lower bound for moderate discrimination.[77] All statistical analysis was conducted in Stata version 16.[78]

## 2.3 Results

At the time of the analysis, PRAPARE had been delivered to 2,192 patients, primarily those with complex medical needs and patients referred to behavioral health either as part of a primary care appointment or as a stand-alone appointment with behavioral health. The analytic samples used in the analyses ranged from 1,468 to 2,153 patients who had received PRAPARE as part of standard of care between May 2017 and February 2019 (Table 2.1). Across analytic samples, the median patient age was 50 or greater and the majority were female (59.%-61.8%). Almost half of patients were African American, and 24-35% were Hispanic. The lower proportion of Hispanic patients in the ASCVD model was due to a higher proportion being excluded because they were younger than 40 years. Approximately one third of patients lacked a high school education, and the majority were uninsured across all three analytic samples. Patients reported a range of social needs on the PRAPARE assessment, the most common of which were: unemployment, social isolation, financial barriers to health care and medicine, lack of stable housing, transportation barriers, food insecurity, and stress. Over half of patients were obese by BMI, and approximately a quarter had stage 2 hypertension and were in the high-risk category for 10 year ASCVD cardiovascular risk.

The presence of social needs was generally greater among patients with, compared to without, each clinical risk indicator (Table 2.2). For example, food insecurity, lack of access to care and medicine, inability to afford a phone plan, and unemployment were more prevalent in patients with high blood pressure and borderline ASCVD risk than patients without these clinical risk indicators. However, this trend was not consistent across all three clinical risk indicators of interest. Obese patients were more likely to have housing, had fewer transportation barriers, and lower stress when compared to non-obese patients.

### 2.3.1 Lasso and logistic regression results

Both models across all three clinical risk indicators used a combination of demographic and social need independent variables to maximize prediction accuracy. The number of variables included varied but the most commonly utilized (defined as inclusion in a minimum of three models) were age, gender, race, lack of housing, unemployment among job seekers, high stress, access to medicine or health care, and inability to afford phone service. The number of variables retained in each model ranged between 3 and 9 for the logistic regression models and between 5 and 17 for the lasso logistic regression models (Table 2.3). The magnitude and direction of the odds ratios (OR) were consistent across models, with a few notable exceptions. Housing instability was associated with lower odds of being obese (OR= 0.73-0.88) but higher odds of being borderline ASCVD risk and having stage 2 hypertension in the lasso models (ASCVD OR = 1.19 ; stage 2 hypertension OR = 1.11). Being unemployed and lacking access to medicine or health care were associated with greater odds of having both borderline ASCVD risk in the lasso model (unemployed lasso OR = 1.25; access to medicine lasso OR = 1.25; access to medicine logistic OR = 1.83) and stage 2 hypertension in both lasso and logistic models (unemployed lasso OR = 1.37; unemployed logistic OR = 1.40; access to medicine lasso OR = 1.26; access to medicine logistic OR = 1.43) but not in the obesity predictive models. Food insecurity was associated with higher odds of being borderline ASCVD risk in both models (logistic OR = 2.05

; lasso OR = 1.51). Inability to afford phone service was associated with greater odds of borderline ASCVD in the lasso model (OR = 2.62) and with greater odds of stage 2 hypertension in both models (logistic OR = 2.00 ; lasso OR = 2.37).

Across all three clinical risk indicators, the logistic regression and lasso logistic models performed similarly (see Appendix C for receiver operating characteristic (ROC) curves and additional information on performance). Prediction performance, as measured by the c-statistic, was poor for predicting obesity (logistic = 0.586; lasso = 0.587), moderate for stage 2 hypertension (logistic = 0.703; lasso = 0.688), and high for borderline ASCVD (logistic = 0.954; lasso = 0.950). The high prediction performance for borderline ASCVD risk was expected as age and gender are used to calculate the score and were included as covariates alongside the PRAPARE variables. However, it is notable that performance was high even without the clinical parameters or health behaviors used to calculate ASCVD, including blood pressure, total and high density lipoprotein cholesterol, diabetes diagnosis, smoking status, and hypertension treatment. When a model was tested without PRAPARE variables using only age and gender, predictive performance was still high but statistically significantly worse than the models that included PRAPARE predictor variables (logit and lasso c-statistic = 0.89).

## 2.4 Discussion

Assessing and responding to social needs is a major priority for health care delivery systems seeking to deliver high-value care. There are a variety of efforts to better integrate these activities into routine clinical encounters and standard of care[14,79] including EHR integration,[38,40,41] innovative care models,[57,80,81] and cross-sector collaboration.[56,82] To our knowledge, this is the first study to evaluate the relationship between social needs assessment responses with multiple measures of clinical risk. By doing so, the findings can inform the refinement of tools for measuring social needs and provide insights into how predictive analytics can be applied to information on patient social needs. Our intention with this work is to highlight practical analytical tools for leveraging social risk information from PRAPARE, and screening tools like it,[19,83,84] to inform activities associated with value based care including population health management, panel management,[63] and integrated intervention design and implementation.[27,37,58,85]

We evaluated the relationship between data from PRAPARE screening assessment to three measures of cardiometabolic risk using predictive analytic approaches including supervised machine learning. We found that social needs were more prevalent in patients with stage 2 hypertension and borderline ASCVD risk. Interestingly, obese patients had fewer social needs than those who were not obese. The stepwise logistic regression decreased the dimensionality of the data by using fewer (3-9) variables in the final predictive model than the lasso (5 to 17 variables). This was unexpected since the penalization parameter used by lasso typically results in models with fewer predictors. We also found that across all three clinical risk indicators, both analytic approaches utilized social needs data to improve prediction accuracy. However, homelessness, inability to afford phone service, unemployment, and access to medicine and health care were the only social needs that were selected for prediction in more than one clinical risk category. These social needs may be proxies for additional, interrelated non-medical drivers of health. We hypothesized that the predictive analytic approaches would perform well (c-statistic > .65) at predicting the presence of cardiometabolic risk indicators. We found support for this hypothesis in predicting borderline ASCVD risk and stage 2 hypertension, but not for predicting obesity.

The stepwise logistic and machine learning lasso regression models has similar utility for predicting clinical risk. This finding is consistent with prior studies assessing the performance of predictive models.[86,87] A potential explanation is that logistic regression models tend to perform better in smaller datasets, like ours, while more advanced machine learning techniques like the lasso regression or random forest models perform better in larger datasets.[77,88] The number and functional form of predictor variables also can influence results with similar research demonstrating better prediction performance for machine learning approaches when more variables and continuous variables are used.[89,90] This underscores the importance of considerations regarding sample size, data transformation, variable functional form, and data missingness when using and selecting a predictive analytical approach.

This study is not without limitations. The predictive analytical approaches used in this analysis reduced the dimensionality of the data by selecting only the strongest predictors for model inclusion. Thus, any interpretation surrounding causation and effect size is discouraged without additional investigation. Furthermore, since the PRAPARE was administered only to a subset of complex patients, there was less variation in social need levels to base predictive analytics. The smaller sample size of primarily medically complex patients from one FQHC used in this analysis may have limited prediction performance and generalizability to other populations.

Despite these limitations, this study provides important insights into how social needs data can be used in outpatient settings. First, it has the potential to proactively identify patients that could benefit from an intervention to address their social needs. As payors, including state Medicaid programs,[55,91] collect social needs data for new enrollees, it is important that they be able to identify patients at risk for worsening medical complexity based on social need assessment data. Our findings suggest that this may depend on how medical complexity is defined. The differences in social needs prevalence and prediction performance across the cardiometabolic risk indicators examined in this study suggests that social needs may vary by disease pathway. Future research should evaluate social needs prevalence and association with additional clinical risk indicators to better understand the variation in the relationship between social needs and different measures of clinical risk. Ideally, this would include linking multiple data sources to comprehensively describe patient behaviors and environment in addition to information on social needs. Second, understanding the relationship between clinical risk and social needs may have important ramifications for reimbursement. It could inform how payers adjust risk and may inform the business case for health systems implement interventions to address social needs.[19-21,23] Understanding the relationship between social needs and clinical risk is a first step to efficiently focusing resources to narrow disparities in health outcomes resulting from social and economic inequities. Future research should build off of this work by evaluating the relationship between social needs assessment data with the likelihood of requiring costly types of heath care utilization including inpatient and emergency department visits. Finally, as social need screening becomes wider spread, there is a need to understand how this data can be used to improve health equity. A critical step will be to design quality measures that complement care guidelines to focus support on medically complex patients with unmet social needs.[24]

Table 2.1. Description of analytic samples

| | Obese (N = 2,153) | High BP, Stage 2 (N = 2,174) | ASCVD, Borderline (N = 1,468) |
|---|---|---|---|
| **Demographics** | | | |
| Age, yr, median (Q1 – Q3) | 50 (40 – 60) | 50 (40 – 60) | 56 (48 – 62) |
| Female, % (n) | 61.8 (1,330) | 61.7 (1,342) | 59.5 (874) |
| Race, % (n) | | | |
| Black/African American | 49.4 (1,063) | 49.3 (1,071) | 59.4 (872) |
| White/Caucasian | 13.9 (300) | 14.0 (305) | 15.1 (222) |
| Other | 26.9 (578) | 26.8 (583) | 25.5 (374) |
| Not reported/declined | 9.9 (212) | 9.9 (215) | 0.0 (0) |
| Hispanic/Latino, % (n) | 35.3 (759) | 35.2 (765) | 24.4 (358) |
| Preferred language, % (n) | | | |
| English | 67.9 (1,262) | 67.9 (1,275) | 76.7 (998) |
| Spanish | 29.5 (548) | 29.4 (552) | 20.4 (265) |
| Members per household, % (n) | | | |
| Lives alone | 28.0 (545) | 27.9 (548) | 34.1 (455) |
| Two | 22.8 (444) | 22.8 (448) | 24.3 (325) |
| Three to four | 30.9 (601) | 30.9 (606) | 27.5 (368) |
| More than five | 18.3 (356) | 18.4 (362) | 14.1 (188) |
| Migrant or seasonal work, % (n) | 0.8 (16) | 0.8 (16) | 0.6 (8) |
| Military discharge, % (n) | 1.6 (32) | 1.6 (32) | 2.2 (30) |
| Refugee status, % (n) | 0.6 (12) | 0.6 (12) | 0.3 (4) |
| Recent incarceration, % (n) | 1.6 (33) | 1.6 (33) | 1.5 (21) |
| | | | |
| **Social Needs** | | | |
| No housing, % (n) | 19.2 (385) | 19.4 (392) | 19.9 (273) |
| Worried about losing housing, % (n) | 14.4 (288) | 14.4 (290) | 14.2 (195) |
| Lacks high school education, % (n) | 34.5 (690) | 34.8 (702) | 32.8 (450) |
| Work situation, % (n) | | | |
| Full-time | 25.0 (499) | 24.9 (502) | 20.5 (280) |
| Part-time | 19.6 (391) | 19.5 (393) | 17.0 (233) |
| Unemployed, seeking work | 26.7 (533) | 26.7 (538) | 29.4 (403) |
| Unemployed, not seeking work | 28.7 (573) | 28.9 (582) | 33.1 (453) |
| Main insurance, % (n) | | | |
| Uninsured | 58.5 (1,168) | 58.6 (1,182) | 50.2 (687) |
| Medicare | 14.5 (289) | 14.4 (290) | 19.1 (262) |
| Medicaid | 13.8 (276) | 13.8 (278) | 15.4 (211) |
| Other public | 11.3 (225) | 11.3 (227) | 13.0 (178) |
| Private | 2.0 (40) | 2.0 (40) | 2.3 (31) |
| Lacks transportation, % (n) | 17.5 (346) | 17.5 (349) | 17.4 (236) |
| Low social interaction, % (n) | 36.8 (731) | 36.9 (740) | 37.0 (504) |
| High stress, % (n) | 14.1 (280) | 14.2 (286) | 14.3 (195) |
| Feels unsafe at residence, % (n) | 7.7 (153) | 7.7 (156) | 8.6 (117) |
| Afraid of partner, % (n) | 3.6 (71) | 3.7 (74) | 2.6 (35) |
| Other self-reported need, % (n) | | | |
| Food | 16.2 (329) | 16.2 (334) | 17.8 (248) |
| Access to medicine or health care | 19.0 (386) | 19.3 (396) | 20.2 (282) |
| Utilities | 7.3 (148) | 7.3 (150) | 7.6 (106) |
| Clothing | 4.4 (89) | 4.4 (91) | 4.5 (63) |
| Child care | 1.5 (30) | 1.5 (30) | 0.6 (8) |

| | | | |
|---|---|---|---|
| Phone | 2.6 (53) | 2.6 (53) | 2.8 (39) |
| Other | 6.9 (141) | 7.0 (143) | 6.9 (96) |
| | | | |
| **Clinical Measures** | | | |
| Systolic BP, mmHg, median (Q1 – Q3) | 127.7 (118.0 – 139.6) | 127.7 (117.9 – 139.6) | 130.9 (121.5 – 142.7) |
| Diastolic BP, mmHg, median (Q1 – Q3) | 77.2 (71.8 – 83.5) | 77.2 (71.8 – 83.5) | 78.4 (73.1 – 84.7) |
| Elevated BP, % (n) | 17.2 (370) | 17.2 (373) | 17.6 (258) |
| High BP, stage-1, % (n) | 37.1 (799) | 37.3 (810) | 42.2 (620) |
| High BP, stage-2, % (n) | 26.2 (564) | 26.2 (570) | 32.1 (471) |
| BMI, median (Q1 – Q3) | 30.7 (26.7 – 36.1) | 30.7 (26.7 – 36.1) | 31.1 (27.2 – 36.7) |
| Overweight, % (n) | 28.5 (613) | 28.5 (613) | 28.0 (411) |
| Obese, % (n) | 54.5 (1,173) | 54.5 (1,173) | 56.7 (829) |
| Total cholesterol, mg/dl, median (Q1 – Q3) | 180.8 (152 – 208) | 180.5 (152 – 208) | 179 (150 – 207) |
| With imputation | 200 (176 – 200) | 200 (176 – 200) | 200 (170 – 200) |
| HDL, mg/dl, median (Q1 – Q3) | 44 (37 – 53) | 44 (37 -53) | 44 (37 – 54) |
| LDL, mg/dl, median (Q1 – Q3) | 102 (79 – 127) | 102 (79 – 127) | 102 (78 – 126) |
| ASCVD, %, median (Q1 – Q3) | 10.8 (4.7 – 19.9) | 10.8 (4.7 – 19.9) | 10.8 (4.7 – 19.9) |
| Low risk, % (n) | 26.4 (386) | 26.4 (387) | 26.4 (387) |
| Borderline, % (n) | 10.9 (159) | 11.0 (161) | 11.0 (161) |
| Intermediate risk, % (n) | 38.1 (556) | 37.9 (557) | 37.9 (557) |
| High risk, % (n) | 24.6 (360) | 24.7 (363) | 24.7 (363) |
| | | | |
| **Medical History** | | | |
| Diabetes, % (n) | 32.2 (694) | 32.2 (699) | 37.9 (557) |
| Hypertension, % (n) | 53.0 (1,141) | 52.8 (1,147) | 67.2 (987) |
| Tobacco Use, % (n) | 23.3 (502) | 23.3 (506) | 27.7 (407) |
| Tobacco Abuse, % (n) | 17.1 (369) | 17.1 (372) | 20.5 (301) |

Table 2.2. Description of differences between patients across clinical risk indicators

| | Obese | | | High BP, Stage 2 | | | ASCVD, Borderline | | |
|---|---|---|---|---|---|---|---|---|---|
| | - | + | P-value | - | + | P-value | - | + | P-value |
| **Demographics** | | | | | | | | | |
| Age, yr, mean | 49.2 | 50.2 | 0.102 | 47.9 | 54.8 | 0.000*** | 47.4 | 58.7 | 0.000*** |
| Female, % (n) | 53.3 (523) | 68.8 (807) | 0.000*** | 63.9 (1025) | 55.6 (317) | 0.000*** | 79.1 (306) | 52.5 (568) | 0.000*** |
| Race, % (n) | | | | | | | | | |
| Black/African American | 45.5 (446) | 52.6 (617) | 0.001*** | 43.1 (692) | 66.5 (379) | 0.000*** | 26.1 (101) | 71.3 (771) | 0.000*** |
| White/Caucasian | 15.8 (155) | 12.4 (145) | 0.021* | 14.9 (239) | 11.6 (66) | 0.0499* | 18.1 (70) | 14.1 (152) | 0.058 |
| Other | 28.5 (279) | 25.5 (299) | 0.120 | 30.5 (489) | 16.5 (94) | 0.000*** | 55.8 (216) | 14.6 (158) | 0.000*** |
| Not reported /declined | 10.2 (100) | 9.6 (112) | 0.611 | 11.5 (184) | 5.4 (31) | 0.000*** | - | - | - |
| Hispanic/Latino, % (n) | 36.4 (356) | 34.4 (403) | 0.330 | 40.7 (652) | 19.9 (113) | 0.000*** | 56.8 (220) | 12.8 (138) | 0.000*** |
| Members per household, % (n) | | | | | | | | | |
| Lives alone | 30.1 (269) | 26.2 (276) | 0.059 | 25.8 (373) | 33.7 (175) | 0.001*** | 16.3 (58) | 40.5 (397) | 0.000*** |
| Two | 22.0 (197) | 23.5 (247) | 0.450 | 21.3 (308) | 27.0 (140) | 0.008** | 18.3 (65) | 26.5 (260) | 0.002*** |
| Three to four | 30.8 (275) | 31.0 (326) | 0.914 | 32.6 (471) | 26.0 (135) | 0.005** | 40.3 (143) | 22.9 (225) | 0.000*** |
| More than five | 17.1 (153) | 19.3 (203) | 0.215 | 20.3 (293) | 13.3 (69) | 0.000*** | 25.1 (89) | 10.1 (99) | 0.000*** |
| Migrant or seasonal work, % (n) | 0.9 (8) | 0.7 (8) | 0.753 | 0.7 (11) | 0.9 (5) | 0.647 | 0.8 (3) | 0.5 (5) | 0.479 |
| Military discharge, % (n) | 1.8 (17) | 1.4 (15) | 0.405 | 1.7 (25) | 1.3 (7) | 0.576 | 0.3 (1) | 2.9 (29) | 0.004*** |
| **Social Needs** | | | | | | | | | |
| No housing, % (n) | 22.3 (206) | 16.6 (179) | 0.001*** | 18.7 (279) | 21.4 (113) | 0.167 | 15.3 (56) | 21.6 (217) | 0.009** |
| Worried about losing housing, % (n) | 14.7 (135) | 14.1 (153) | 0.721 | 14.4 (216) | 14.1 (74) | 0.859 | 20.2 (74) | 12.1 (121) | 0.000*** |
| Lacks high school education, % (n) | 35.3 (324) | 33.8 (366) | 0.502 | 35.8 (533) | 31.8 (169) | 0.099 | 41.8 (154) | 29.5 (296) | 0.000*** |
| Work situation, % (n) | | | | | | | | | |
| Full-time | 25.0 (229) | 25.1 (270) | 0.959 | 27.4 (407) | 18.0 (95) | 0.000*** | 34.3 (124) | 15.5 (156) | 0.000*** |
| Part-time | 20.9 (192) | 18.5 (199) | 0.168 | 21.3 (316) | 14.6 (77) | 0.001*** | 26.8 (97) | 13.5 (136) | 0.000*** |
| Unemployed, seeking work | 25.8 (237) | 27.5 (296) | 0.409 | 24.3 (361) | 33.5 (177) | 0.000*** | 23.2 (84) | 31.7 (319) | 0.002*** |
| Unemployed, not seeking work | 28.3 (260) | 29.0 (313) | 0.726 | 27.1 (403) | 33.9 (179) | 0.003*** | 15.8 (57) | 39.3 (396) | 0.000*** |
| Uninsured, % (n) | 60.5 (557) | 56.7 (611) | 0.081 | 59.7 (889) | 55.4 (293) | 0.081 | 68.3 (248) | 43.6 (439) | 0.000*** |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Lacks transportation, % (n) | 19.7 (179) | 15.7 (167) | 0.022* | 17.3 (254) | 18.2 (95) | 0.656 | 17.7 (64) | 17.4 (172) | 0.890 |
| Low social interaction, % (n) | 37.3 (341) | 36.4 (390) | 0.658 | 36.3 (535) | 38.6 (205) | 0.339 | 34.4 (125) | 37.9 (379) | 0.237 |
| High stress, % (n) | 16.3 (149) | 12.2 (131) | 0.009** | 13.8 (204) | 15.4 (82) | 0.354 | 17.8 (65) | 13.0 (130) | 0.024* |
| Feels unsafe at residence, % (n) | 8.1 (74) | 7.3 (79) | 0.548 | 7.8 (116) | 7.6 (40) | 0.862 | 10.1 (37) | 8.0 (80) | 0.210 |
| Afraid of partner, % (n) | 3.4 (31) | 3.7 (40) | 0.675 | 4.1 (60) | 2.6 (14) | 0.138 | 3.6 (13) | 2.2 (22) | 0.149 |
| Other self-reported need, % (n) | | | | | | | | | |
| Food | 15.9 (148) | 16.4 (181) | 0.738 | 14.9 (226) | 20.0 (108) | 0.006** | 10.6 (39) | 20.4 (209) | 0.000*** |
| Access to medicine or health care | 20.2 (188) | 18.0 (198) | 0.207 | 17.1 (259) | 25.4 (137) | 0.000*** | 16.3 (60) | 21.6 (22) | 0.027* |
| Utilities | 7.4 (69) | 0.7.2 (79) | 0.840 | 6.7 (102) | 8.9 (48) | 0.097 | 6.5 (25) | 8.0 (82) | 0.355 |
| Clothing | 5.3 (49) | 3.6 (40) | 0.074 | 4.0 (61) | 5.6 (30) | 0.136 | 3.0 (11) | 5.1 (52) | 0.098 |
| Child care | 1.4 (13) | 1.5 (17) | 0.783 | 1.5 (23) | 1.3 (7) | 0.714 | 0.3 (1) | 0.7 (7) | 0.370 |
| Phone | 2.7 (25) | 2.5 (28) | 0.842 | 1.8 (27) | 4.8 (26) | 0.000*** | 1.1 (4) | 3.4 (35) | 0.020* |
| Other | 7.5 (70) | 6.4 (71) | 0.345 | 7.3 (111) | 5.9 (32) | 0.275 | 6.8 (25) | 6.9 (71) | 0.925 |

* = significant at 0.95, ** = significant at 0.99, *** = significant at 0.995

Table 2.3. Model comparison of selected variables for inclusion

| | **Obese** | | **High BP, Stage 2** | | **ASCVD, Borderline** | |
|---|---|---|---|---|---|---|
| | **Logistic** | **LASSO** | **Logistic** | **LASSO** | **Logistic** | **LASSO** |
| Age | | X | X | X | X | X |
| Female | X | X | X | X | X | X |
| Race (base = Black/African American) | | | | | | |
| White/Caucasian | | | X | X | X | X |
| Other | | | X | X | X | X |
| Not reported/declined | | | X | X | | |
| Hispanic/Latino | | | | X | | X |
| Members per household (base = lives alone) | | | | | | |
| Two | | | | X | | |
| Three to four | | | | | | |
| More than five | | | | | | |
| Migrant or seasonal work | | | | X | | |
| Military discharge | | | | X | | X |
| No housing | X | X | | X | | X |
| Worried about losing housing | | | | | | |
| Lacks high school education | | | | | | |
| Work situation (base = Full-time) | | | | | | |
| Part-time | | | | | | |
| Unemployed, seeking work | | | X | X | | X |
| Unemployed, not seeking work | | | | | | X |
| Uninsured | | | X | X | | |
| Lacks transportation | | X | | | | |
| Low social interaction | | | | X | | X |
| High stress | X | X | | | | X |
| Feels unsafe at residence | | | | | | X |
| Afraid of partner | | | | | | |
| Other self-reported need | | | | | | |
| Food | | | | | X | X |
| Access to medicine or health care | | | X | X | X | X |
| Utilities | | | | | | |
| Clothing | | | | | | |
| Child care | | | | | | X |
| Phone | | | X | X | | X |
| Other | | | | | | X |
| Number of Variables | 3 | 5 | 9 | 15 | 6 | 17 |

Table 2.4. Model comparisons across clinical risk indicators

| | **Obese** | | **High BP, Stage 2** | | **ASCVD, Borderline** | |
|---|---|---|---|---|---|---|
| | **Logistic** | **LASSO** | **Logistic** | **LASSO** | **Logistic** | **LASSO** |
| Age | | 1.00 | 1.04<br>(1.03 – 1.05) | 1.03 | 1.28<br>(1.23 – 1.32) | 1.24 |
| Female | 2.00<br>(1.65 – 2.43) | 1.85 | 0.79<br>(0.63 – 0.98) | 0.78 | 0.11<br>(0.07 – 0.17) | 0.13 |
| Race (base = Black/African American) | | | | | | |
| White/ Caucasian | | | 0.57<br>(0.40 – 0.82) | 0.70 | 0.13<br>(0.08 – 0.23) | 0.23 |
| Other | | | 0.40<br>(0.30 – 0.55) | 0.60 | 0.08<br>(0.05 – 0.13) | 0.21 |
| Not reported/declined | | | 0.35<br>(0.22 – 0.55) | 0.63 | | |
| Hispanic/Latino | | | | 0.83 | | 0.61 |
| Members per household (base = lives alone) | | | | | | |
| Two | | | | 1.02 | | |
| Migrant or seasonal work | | | | 0.44 | | |
| Military discharge | | | | 1.31 | | 1.54 |
| No housing | 0.73<br>(0.57 – 0.92) | 0.88 | | 1.11 | | 1.19 |
| Work situation (base = Full-time) | | | | | | |
| Unemployed, seeking work | | | 1.40<br>(1.10 – 1.79) | 1.37 | | 1.25 |
| Unemployed, not seeking work | | | | | | 1.59 |
| Uninsured | | | 1.49<br>(1.14 – 1.95) | 1.27 | | |
| Lacks transportation | | 0.88 | | | | |
| Low social interaction | | | | 1.09 | | 1.22 |
| High stress | 0.63<br>(0.47 – 0.84) | 0.79 | | | | 0.63 |
| Feels unsafe at residence | | | | | | 0.85 |
| Other self-reported need | | | | | | |
| Food | | | | | 2.05<br>(1.12 – 3.73) | 1.51 |
| Access to medicine or health care | | | 1.43<br>(1.09 – 1.89) | 1.26 | 1.83<br>(1.10 – 3.04) | 1.25 |
| Child care | | | | | | 3.89 |
| Phone | | | 2.00<br>(1.08 – 3.70) | 2.37 | | 2.62 |
| Other | | | | | | 1.06 |
| Constant | 0.86<br>(0.74 – 1.02) | 0.77 | 0.06<br>(0.03 – 0.11) | 0.06 | 0.00<br>(0.00 – 0.00) | 0.00 |
| ***C-statistic*** | 0.586<br>(0.531 – 0.641) | 0.587<br>(0.530 – 0.645) | 0.703<br>(0.647 – 0.759) | 0.688<br>(0.632 – 0.744) | 0.954<br>(0.932 – 0.976) | 0.950<br>(0.927 – 0.973) |

# CHAPTER 3: THE DIRECT CLINIC LEVEL COST TO ASSESS AND ADDRESS SOCIAL NEEDS IN DIVERSE COMMUNITY HEALTH CENTER PRIMARY CARE CLINICAL SETTINGS

## 3.1 Introduction

SDOH, defined as the conditions in which people are born, live, learn, work, play, worship, and age, include educational attainment, discrimination, housing, transportation, food security, employment status, and social support. They affect a wide range of health indicators, as well as quality of life and clinical risk for disease.[1-3] Significant and increasing evidence suggests that addressing the downstream consequences of SDOH, including individual-level social needs, such as housing instability, social isolation, or food insecurity can improve health[27,92,93] and reduce health care expenditures.[8,94,95] Successful efforts to reform health care delivery to increase value and promote prevention will require health systems to assess and address social needs in routine outpatient clinical encounters. Recent federal and state efforts have focused on collecting social needs data useful in addressing upstream drivers of health status and health care utilization as well as mitigating health disparities.[21,55,91,96] To improve patient outcomes, providers and health care systems must be able to use these data. For example, clinics may acquire information on patients' social needs through screening and EHR documentation and use that information to form cross-sector relationships with community based organizations (CBOs) to better respond to patient social and economic needs.

Community health centers, particularly FQHCs, serve a predominantly low-income patient population and have long worked to be responsive to their patients' social context and non-medical needs; only recently have they implemented systematic approaches for collecting

SDOH data and addressing social needs.[14] PRAPARE was developed by the NACHC, the Association of Asian Pacific Community Health Organizations, the Oregon Primary Care Association, and the Institute for Alternative Futures as part of a national effort to help community health centers collect the data needed to better understand the upstream SDOH drivers of poor health outcomes and higher health-related costs.[43] PRAPARE is a standardized patient SDOH risk assessment tool, as well as a process for addressing identified risks at the individual and population levels.[97]

Despite growing interest in using PRAPARE and other standardized approaches, the cost of screening and responding to patients' social needs for a clinic remains poorly understood. Information on cost is a critical consideration for implementation into routine clinical encounters. Our objective was to estimate the direct costs of implementing and maintaining PRAPARE in primary care clinics across four community health centers.

## 3.2 Methods

### 3.2.1 Practice Selection

We used purposive sampling to recruit FQHCs which had engaged in screening and responding to identified social needs for at least two years prior to June 2019. We invited four FQHCs recommended by the North Carolina Community Health Center Association based on their size and geographic location to participate. For each FQHC, we obtained information on patient volume, total number of full-time equivalent employees (FTEs), geographic location, staffing, and payer mix from publicly available resources, including the FQHC website and the 2018 Health Resources & Services Administration's Uniform Data System (most recent reporting period). The study protocol was reviewed and approved by the Institutional Review Board of the University of North Carolina at Chapel Hill.

### 3.2.2 Data Collection

Using a multi-case design, we conducted semi-structured telephone interviews between July 2019 and January 2020 to: (1) identify novel clinical activities and implementation processes to build organizational capacity (e.g. designing workflows, EHR documentation protocol and workforce development) and (2) estimate costs using activity-based costing. Specifically, we spoke with clinical champions, administrators, and front-line staff involved in developing and delivering PRAPARE at each FQHC to determine how their clinics had implemented PRAPARE, including a comprehensive description of relevant activities, organizational capacity and context, roles, and responsibilities. We also asked about PRAPARE implementation and delivery, barriers and facilitators, and practice patterns across multiple members of the care team. We used an iterative process to clarify and validate responses; each interview took between two and four hours.

To estimate costs, we identified specific activities, inputs, and workflows associated with PRAPARE's implementation and maintenance (Table 3.1). The implementation phase was comprised primarily of one-time, organizational capacity-building activities, (e.g., planning and decision-making time, workforce development, EHR integration, CBO resource directory development). Maintenance-related activities included ongoing (primarily clinical) activities associated with delivering PRAPARE to patients (e.g., SDOH screening and CBO referrals, EHR documentation, reporting, and case management activities associated with addressing social needs as a part of care planning).

### 3.2.3 Activity Based Cost Estimation

Using data from our interviews, we developed a practice-level costing tool in Microsoft EXCEL® based on instruments used in similar primary care-based studies.[98,99] We used activity-based costing, a micro-costing technique, to evaluate direct clinic-level costs. Activity-based costing is ideal for retrospectively assessing clinic-level costs of primary care transformation for a single practice or a small group of practices.[98] We organized activities into two categories. Personnel costs included the time required for activities, including but not limited to, screening for social needs, referring patients to appropriate community resources or social services, and providing ongoing case management. Additional details on the clinical workflows, EHR integration, and implementation logistics are published elsewhere.[64] Wages were estimated using the median national labor pay rates in the 2018 US Bureau of Labor Statistics, with a fringe benefit rate of 28%. Non-personnel costs included office supplies, technology, and software required for PRAPARE planning, measurement, or analysis functions. For non-personnel costs, we collected information on direct expenditures for activities (e.g., consulting and EHR flowsheet templates) and any allocation of existing resources devoted to PRAPARE (e.g., training and workforce development). In addition, we used FQHC staff and clinician responses to determine whether activities were fixed or variable). The estimates of the volume of patients screened and the proportion of patients who screened positive for social needs were based on administrative records, EHR-generated reports (when available), and/ or stakeholder estimates. Key informants provided estimates of the proportion of patients offered ongoing case management.

## 3.3 Results

The four participating FQHC ranged in size, geographic location, and payer mix (Table 3.2). Each had an EHR system and either designed a flowsheet for the PRAPARE assessment tool or used an existing template offered by the EHR vendor. The number of total clinical FTEs ranged from 10.1 to 83, but only half of the FQHCs had dedicated clinical informatics personnel. All except FQHC D selectively screened patients who were suspected to be at higher social risk or who had greater medical complexity.

### 3.3.1 Implementation Costs

We found significant variation among estimates of the direct costs from the four FQHCs, with the largest cost driver being personnel (Table 3.3). Implementation costs, which were largely associated with capacity building, ranged from \$6,635 to \$41,486. One contributor to cost variation was the level of EHR flowsheet design and customization. PRAPARE developers encourage health systems to customize the screening assessment tool with a combination of core and optional measures based on their patient population. Individual FQHCs either created custom EHR flowsheets or, when available from the EHR vendor, imported an existing template. Training and workforce development cost estimation was limited to skill-building directly associated with PRAPARE activities, which included training to screen for social needs in clinical settings and local context specific strategies and resources for responding to social needs.

### 3.3.2 Maintenance Costs

We found large variation in estimated maintenance costs attributable to variation in patient volume (Table 3.3). PRAPARE screening and referral inputs varied based on the proportion of patients with identified social needs and the intensity (time) of the response. Overall, sites were limited in the amount of ongoing case management that they could provide to patients to resolve CBO referrals. Cost estimates were higher for clinics with a greater proportion of patients screening positive for social needs and/or offered ongoing case management. Process and workflow design contributed to the proportion of patients identified with a social need as well as the intensity of the screening and response. For example, FQHC B included additional items in their social needs screening instrument which may account for the high rate (81%) of patients identified as having a social need. FQHC D utilized a patient self-screening process which resulted in lower costs associated with screening and response activities. On a per patient basis, annual direct costs for PRAPARE ranged widely from $9.27 to $45.63.

### 3.4 Discussion

Many primary care practices are adopting protocols to screen for and to address patients' social needs. However, the cost of doing so within a practice is not known. We sought to estimate the clinic-level costs associated with implementing and maintaining such a protocol, PRAPARE, in four FQHCs. The drivers of variation on which we focused were the volume of patients screened, proportion of screened patients with an identified social need, and intensity of the intervention required to respond to identified social needs. The heterogeneity we found in the proportions of patients who screened positive for a social need (10% to 81%) is consistent with findings from other studies[27] and is likely due to varying levels of social risk and contextual factors. For example, a customized social needs screening tool that includes optional domains based on risks or social adversity commonly experienced by the patients served may result in identifying more social needs.

Our findings suggest that there may be cost-effective EHR integration practices that could lower clinic implementation expenditures. Interviews with key stakeholders revealed a spectrum of EHR integration planning activities. On the less resource-intensive end, the smallest FQHCs (B & D) leveraged an existing social needs flowsheet template from their EHR vendors with little customization. The largest FQHC (C) involved multiple levels of leadership and clinical personnel input to customize the EHR flowsheet to match priorities for data reporting and an iterative testing process before widespread use across all providers. These findings complement existing literature that describes a number of considerations and tradeoffs related to designing and implementing processes for EHR documentation of social needs assessments.[38]

Our cost estimates may inform the design of SDOH screening and response protocols such as approaches that may be implemented in a more targeted way, for example, offering this service to patients with the highest utilization or especially vulnerable communities. PRAPARE could include an abbreviated social needs assessment that triggers a comprehensive assessment when a need is identified. This may have the potential for triaging patients and focusing resources on high-risk patients and families. Emerging technologies to facilitate medical care and social care integration could reduce both implementation and maintenance costs.[35,80,100] Workforce considerations could also impact the value proposition for offering robust social need responses. This has motivated expanding the role of community health workers, community resource navigators, or trained volunteers to include screening and case management activities across the social and medical care continuum.[101,102] This is especially important for small and/or free clinics that have an average annual operating budgets less than $300,000;[103] upfront costs associated with clinic capacity may be a large barrier to implementation.

Our study has several limitations. The small number of FHQCs in one state limits generalizability to other FQHCs and clinical settings (e.g., inpatient, emergency department). Also, we relied on self-reported time estimates which is vulnerable to bias. Finally, we did not consider indirect costs (space, utilities, administrative overhead), so the actual total cost associated with implementation and maintenance is higher.

Despite these limitations, we are first to quantify direct clinic-level costs of a program to screen and respond to SDOH. Our findings offer actionable insights into strategies for a tailored response and cost efficiencies, especially for primary care clinicians and administrators who seek to respond to their patients' social needs and other non-medical drivers of health.[29,58,104] The use of SDOH data to address patients social needs, especially for medically and socioeconomically vulnerable populations, could have important implications for value-based payment models that reward population level health improvements.[22] To this end, health care systems should understand the emerging business case for offering social interventions to vulnerable communities.[20] Furthermore, policymakers and payers could consider introducing reimbursement mechanisms tied to social needs screening and response encounters to accelerate translational efforts[105] with the potential to improve health outcomes and reduce disparities.

There are several priority areas for future research to build off our work. First, we need to better understand the drivers of social needs identification rates. Our findings suggest this could be due to the characteristics of the communities served, design of the assessment itself, and method by which the social needs are assessed (in-person, online, or self-screening by paper). Second, research is required to identify potential cost efficiencies associated with integrating technology into social needs screening and response interventions. We found high levels of variable personnel costs that limit the potential for economies of scale; however, emerging approaches have embraced web- or text-based.[80,100] These technologies come with potential to efficiently scale social needs screening and response protocols in an accessible and patient centric manner. Third, further research is required to develop an optimized approach to EHR integration that balances cost and implementation considerations[40,48] with effective population health management.[39] Finally, our work has implications for the composition of care teams to efficiently respond to patients' social needs. While we found that most PRAPARE activities were being conducted by nurses and physicians, further research on the composition of a multidisciplinary team that includes community health workers is important to understand how to best deliver ongoing case management.

Table 3.1. Maintenance and implementation phase activities

| **Phase** | **Activity** | **Description** |
|---|---|---|
| Implementation | Planning | Meetings with leadership, clinical informatics, and behavioral health integration to design workflows and embed screening and response protocols within existing quality improvement and population health improvement initiatives. |
| | Workforce development | Training and workforce development activities ranging from EHR documentation for quality assurance to best practices for engaging patients around social needs. |
| | EHR integration | Creation and customization of an EHR flowsheet template. This also includes quality assurance activities and troubleshooting. |
| | CBO directory development | The result of these activities is the compilation of an up-to-date and curated directory of community resources and social services that patients may qualify for. This includes coordination and communication with local agencies and CBOs. |
| Maintenance | Social needs screening | Activities and clinical effort to administer the social needs screening tool on a per patient basis. |
| | CBO referrals | Activities and clinical effort to refer patients to CBOs or social services based on needs identified through screening. These activities are only completed for patients with identified needs. |
| | EHR documentation and reporting | Social need documentation in patient health records and any related ongoing training or |

| Phase | Activity | Description |
|---|---|---|
| | | quality assurance activities. This also includes effort associated with generating reports with SDOH data for planning and population health management. |
| | Case management activities | These activities apply for a subset of complex patients that require ongoing case management to resolve CBO referral(s). |

CBO = Community based organization; EHR = Electronic health record

Table 3.2. Description of participating FQHC characteristics

| Characteristics | FQHC A | FQHC B | FQHC C | FQHC D |
|---|---|---|---|---|
| Community type[a] | Urban | Rural | Suburban | Rural |
| Year founded | 1971 | 2001 | 1970 | 1981 |
| Medical specialties | FM, IM, P | FM, IM, P | FM, IM, P | FM |
| Total Clinician FTEs | 69 | 41 | 83 | 10.1 |
| Informatics specialist (Y/N) | Y | N | Y | N |
| EHR (Y/N) | Y | Y | Y | Y |
| Patient volume[b] | 33,961 | 15,704 | 47,226 | 2,324 |
| % children (<18 yrs)[b] | 25.91% | 12.10% | 29.75% | 18.24% |
| % racial or ethnic minority[b] | 92.30% | 59.18% | 76.35% | 30.32% |
| Uninsured (as % of payer mix)[b] | 55.02% | 13.12% | 49.89% | 34.25% |
| PRAPARE/month[c] | 68 | 66 | ~125 | ~100 |

IM= internal medicine; FM= family medicine; P= pediatrics

[a] Community type: rural = <25,000 population; suburban = 25,000-150,000; urban = >150,000
[b] Total patient according to Uniform Data Systems 2018 reporting period
[c] PRAPARE monthly patient volume

Table 3.3. Direct Clinical Cost Estimates for Implementation and Maintenance Phases, by Activity Category

| | **Direct Clinic Costs by Activity Categories** | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Implementation Costs** | | | | **Annualized Maintenance Costs** | | | | |
| | **EHR integration** | **Workforce development & planning** | **Total** | **Per Clinical FTE** | **Social needs identified (%)** | **Screening & response** | **Ongoing case management** | **Total*** | **Per patient** |
| CHC A | $3,725 | $5,072 | $9,297 | $134.74 | 43 | $8,420 | $4,233 | $30,367 | $37.21 |
| CHC B | $745 | $7,590 | $8,834 | $215.41 | 81 | $15,961 | $3,082 | $36,137 | $45.63 |
| CHC C | $20,597 | $20,389 | $41,486 | $499.83 | 50 | $22,831 | $3,321 | $39,086 | $21.71 |
| CHC D | $883 | $4,952 | $6,335 | $782.04 | 10 | $3,894 | $1,324 | $11,129 | $9.27 |
| Average | $6,488 | $9,501 | $16,488 | $408 | 46 | $12,777 | $2,990 | $29,180 | $28.46 |

IM= internal medicine; FM= family medicine; P= pediatrics

*Based on site-specific estimates of PRAPARE patient volume

# CHAPTER 4: PATIENT PERSPECTIVES ON IMPLEMENTATION BARRIERS AND FACILITATORS OF A PROTOCOL TO SCREEN AND RESPOND TO SOCIAL NEEDS IN PRIMARY CARE

## 4.1 Introduction

The SDOH, or the conditions in which people and communities live, work, and play are major drivers of health outcomes,[6,106] disparities,[2,5] and health care utilization.[8,94,107,108] As a result, health systems are increasingly called upon to identify and implement strategies to address individual patient level social needs that result from SDOH such as food instability, discrimination, unemployment, and housing instability. Health systems' embrace of financial incentives to deliver value based care[19,21] and manage population health[59], coupled with recommendations from medical specialty associations, has led to increased uptake of approaches to screen and respond to patients' social needs.[57,58] This has resulted in a need for evidence on the best practices for doing so in routine clinical encounters.[48]

The current literature describing experiences with screening and responding to identified social needs has focused on electronic health record integration,[38,40,42] provider perspectives,[51,84,109] and patient acceptability,[52] sometimes using implementation case studies.[33,34,36] Despite the impact of social needs on health outcomes, implementation factors that influence the uptake of protocols to assess and address social needs remain poorly understood. Specifically, the literature lacks the application of an established implementation science framework to describe patient perspectives on barriers and facilitators of integrating a social needs and response protocol into outpatient clinical encounters.[48] This is despite implementation science theories and frameworks consistently emphasizing the importance of patient, client or recipient perspectives or acceptability as a key determinant of successful implementation.[110]

To address this gap in the literature, the goal this study is to examine patients' perspectives on barriers and facilitators to implementing PRAPARE, a widely adopted protocol for screening and responding to social needs in diverse clinical settings. PRAPARE was developed by the NACHC, the Association of Asian Pacific Community Health Organizations, the Oregon Primary Care Association, and the Institute for Alternative Futures as part of a national effort to help community health centers collect the data needed to better understand the upstream SDOH drivers of poor health outcomes and higher health-related costs.[43] Practice patterns associated with the delivery of PRAPARE are heterogeneous based on the composition of the care team, patient complexity, and the patient population being served.[34] Understanding factors that influence implementation would contribute to the growing literature to promote the adoption of PRAPARE and similar approaches in diverse clinical settings to promote health equity and improve outcomes.[19,27,35,83,97] Moreover, responding to social and non-medical needs are consistent with frameworks for delivering high-quality, patient-centered care that improves outcomes and promotes health equity.[111-115] Furthermore, as care models developed to better respond to social or non-medical needs are designed to promote health equity by mitigating disparities that arise from unmet social needs, understanding perspectives from patients that belong to these vulnerable or marginalized groups is critical. Incorporating patient perspectives on implementation ensures that translation of social needs screening into routine practice is complementary to the ethos of the patient centered medical home and efforts to promote health equity.

## 4.2 Methods Section

### 4.2.1 Study Setting & Patient Eligibility

The study site was a federally-qualified health center (FQHC) in a medium-sized city in southeastern U.S. city that served 33,961 unique patients across 9 outpatient and community-based clinics in 2018. It is accredited as a primary care medical home by The Joint Commission. A trained social worker identified patients' social needs as part of the behavioral health integration team using the PRAPARE assessment tool. Alternatively, a primary care provider could refer a patient to the behavioral health integration team if there is evidence of unmet social needs either through chart review or during the clinical encounter. If unmet social needs are identified, a referral is made by the behavioral health team member to a community based organization or social service. Additional details of the clinical delivery of PRAPARE used at the participating clinical site have been published elsewhere.[64]

Patients were recruited to participate in the study between November 2019 and February 2020 using a purposeful and criterion sampling strategy to both identify information rich cases and ensure diversity across age, gender, and race.[116] Only English-speaking patients who received the PRAPARE as part of standard of care in the Adult Medicine, Family Medicine, and Pediatrics clinics were eligible to participate in the study. After providing informed consent, patients participated in a semi-structured interview about their experience with PRAPARE.

### 4.2.2 Procedures

The Health Equity Implementation Framework was used to identify and evaluate barriers and facilitators to implementation.[117] HEIF integrates the Integrated-Promoting Action on Research Implementation in Health Services (i-PARIHS),[118] with the Health Care Disparities

Framework.[119] The former is a well-known implementation science theoretical framework that accounts for multiple levels of implementation determinants (context or systems level, recipients, and characteristic of the innovation or intervention) and posits that the most effective implementation strategies must be multi-faceted to account for these distinct levels (Figure 4.1). The latter is used in health services research to identify drivers of health disparities at the patient, provider, clinic, and health system level. We chose the HEIF to qualitatively evaluate social needs screening and response implementation because it accounts for factors at multiple levels including those that may be unique to vulnerable populations because of social context and historical marginalization.

We designed the interview guide (Appendix D) to identify and evaluate barriers and facilitators across HEIF domains that included patient factors, provider factors, the clinical encounter, characteristics of PRAPARE, both inner and outer context, and societal level factors which included structural social, political, and economic factors. We used a semi-structured interview approach to allow for the discovery or elaboration of meaningful information that they may be unwilling to share in other formats.[120] The flexibility of this approach allows the interview to pursue an idea or response in more detail. Interviews were conducted by a trained study team member and ranged in length from 40 minutes to 75 minutes. All interviews were recorded on an encrypted recording device and professionally transcribed. Study participants were provided a financial incentive to participate in the interview. This study protocol was reviewed and approved by the Duke University Health System Institutional Review Board.

### 4.2.3 Analysis

We used the standards for reporting qualitative research (SRQR).[121] Interview transcripts were analyzed using a directed content analysis approach.[122] This method uses codes based on a theoretical framework or theory, in our case HEIF. As a result, our analysis is guided by a more structured process wherein key concepts are used as initial codes nested within categories. Two trained coders (HB & MC) independently coded the transcripts and then reconciled differences to create a codebook. Coders periodically met to ensure consistent application of codes and identify new categories and codes that either offer a distinct view of the phenomenon or further contextualize, expand, and enrich understanding of barriers and facilitators to implementation. A third coder (CD) applied the final codebook (Appendix E) to all transcripts. Finally, the coded qualitative data were reviewed for patterns and major sources of saturation to organize the findings into major themes and facilitate interpretation. The thematic analysis used an inductive approach wherein themes were identified based on patterns that emerged from the data, instead of an apriori narrative based on existing theory. An indicator of theme saturation was defined as when individual or patterns of codes or categories described a similar phenomenon on repeated occasions across multiple respondents.[123] The study team came to consensus on what patterns of codes constituted a theme and the prevalence of the pattern required for saturation.[124] All coding and analysis was conducted using NVivo version 12.6.0.

## 4.3 Results

The sample included 10 patients, 5 females and 5 males ranging in age from 26 to 64 years. Seven respondents were uninsured and 8 indicated that English was their preferred language. The majority lived in a household consisting of 1-4 people and felt safe in their home. They reported a variety of social needs during screening, including food insecurity, health care access, unemployment, stress or emotional needs, transportation challenges, and other material needs (e.g. financial assistance for utilities; Table 3.1).

Overall, patients viewed social needs screening as important and valuable and were comfortable with their health care team being aware of their social needs to improve the quality of care. Their insights into implementation barriers and facilitators based on HEIF domains (Appendix F) were organized around three key themes to inform implementation efforts associated with evidence based screening and response protocols, including PRAPARE.

### Theme 1: Patients find social needs screening and response protocols to be acceptable and described it as a mechanism for providing high quality, comprehensive care.

Patients viewed social needs screening as not only acceptable, but an important component of high quality primary care. Patients appreciated that providers cared about their social and economic situation even though, in their experience, they were not traditionally discussed during a medical visit. One respondent indicated that it made her feel that the provider cared for “as a whole”, that her health care team was interested in their “personal life” and could provide better care because they understood what she was going through. Another respondent felt that, when their provider understood that economic pressures posed by expensive medication made adherence to treatment plans difficult, the entire visit became more productive because tailored referrals to resources and social services could be made. This experience was in contrast to many respondents’ previous experiences with medical visits wherein “you just went for treatment. They treated you and that was it;” they didn’t realize that a range of additional support could be provided. Respondents indicated that the relationship with their health care team improved as a result of being able to openly discuss social and economic needs. This enhanced relationship appeared to spill over to treatment and care planning.

Patients consistently reported being comfortable and willing to talk about their social needs but did not know they could or were uncomfortable initiating the conversation to ask for assistance. One respondent said, “I’ve never dreamed of asking anybody until she (the social worker) approached me that day.” Another described the value of their newly-acquired awareness of these resources, “There’s so many things like that around this area that you don’t know they exist until you’re in need or someone cares about the need.” Another patient described appreciation for having a member of the health care team initiate the discussion and the stigma associated with asking for assistance surrounding social and financial needs, “she (social worker) stressed that, ‘You just need to ask,’ and that was what I really remember, so it took the shame off my face from asking… it is so embarrassing to beg… Because you’re used to doing those things for yourself. So, because you’re not used to it, so it’s hard to just get up and start asking people and things like that. So, it was little difficult to ask about it.” Respondents were asked to comment on utilizing screening protocols that included proactive outreach and universal screening. Respondents were all comfortable using alternative modalities including self-screening, patient portal messages, e-mail, or even text messaging. However, there were also advantages to the in-person, interview approach to screening with one patient commenting, “…but as for me, I like the one-on-one being it’s more personable.”

An implementation facilitator that emerged was the combination of not feeling rushed and having it be a brief encounter attached to their existing medical visit as part of warm hand-off to a behavioral health case manager. One respondent described being in the examination room as the PRAPARE screening instrument was administered, “I was still waiting to see my doctor when she came in, so it was perfect timing.” This additional benefit and team-based approach was widely reported as a perceived benefit by the respondents which increased the value and convenience of the medical visit. Respondents described the PRAPARE component of the clinical encounter as ranging from 5-20 minutes but did not feel rushed, allowing for a collaborative process. Additionally, no respondent indicated concerns over privacy or their health care team having access to this information.

### Theme 2: Patients' social and medical needs are interrelated and require a tailored response.

The social needs identified rarely appeared in a vacuum and often were interconnected with medical needs that, together, impacted treatment. For example, one patient identified financial barriers related to health care access, which were exacerbated by lack of transportation. Conversely, there were situations where health and treatment impacted social need. One respondent described an experience where an unmet medical need led to unemployment, "my mangers would see me, like, fall, and they would say, well, you have to—we're going to have to lay you off till you get take—your knees taken care of.". Respondents also described structural economic and social forces that made addressing social needs impossible. For example, multiple respondents screened positive for housing insecurity and were confronted with immutable barriers associated with a lack of supply of affordable housing and lack of funding for programs designed to provide housing assistance. One respondent described the difficultly of accessing housing through the local housing authority, "Yes. Because the list I had from the Housing Authority when I was calling was like, "We're no longer taking Section 8." "We're no longer"—well, like, "What in the world?". Another added, "The Housing Authority is failing the tenants," adding that exploitative landlords not making basic repairs has undermined their trust in the institution. Similarly, administrative burden presented a significant challenge to accessing needed social services. One respondent described the challenges to accessing resources due to means testing and many layers of eligibility criteria, “Because they (Social Service Department) be like, “Well, okay, what did you do with—okay, you got $60 left. What did you do with that?” Well, I buy food. I mean, I have to buy food. And then, if I try to shop on the diabetic aisles, diabetic food is higher… If you’re really trying to eat healthy, it’s more expensive. So, they don’t look at it like that. They won’t accept the fact that you may have to pay out your pocket.”

Respondents reported discrimination and racism both when accessing resources to which they had been referred and during previous encounters with the larger health care system, social service agencies, and/or community based organizations. This presented a significant barrier to the utilization of these resources and services as it discouraged participation and undermined trust in institutions tasked with serving vulnerable and historically underserved patient populations. Additionally, respondents’ description of social and economic policies and procedures through experiences with administrative burden and under-resourced social services were representative of structural inequities.

### Theme 3: Workforce development and training focused on empathic communication, knowledge of community context, and shared decision making may improve implementation effectiveness.

Respondents consistently appreciated the communication with the social worker as a facilitator to the PRAPARE process, especially respectful listening, empathic communication, motivational interviewing and shared decision making (part of the HEIF Clinical Encounter domain). One respondent described this empathic method of communication by contrasting it with a negative experience having social needs addressed at a local social service agency, “Yes. Yeah, I was comfortable because of their approach. You know, some people have a hard approach, you know, to you, to your situation—you know, why this happen, why that happen? But they didn’t go into that. They didn’t go into, “What did you do with every penny?” You know, because I told her, I said, “Look, I only get so much a month, I only get SSI, and I have a high gas, high electric.” So, she was like, “Don’t worry about that. This is what you need.” You know?”

We also found that provider knowledge of community context was a facilitator to implementation because it allowed for a more convenient, responsive encounter that provided patients with accurate information. A potential implementation barrier to the referral can be inaccurate or dated information. Respondents described how having detailed and accurate information on community resources made it easier to resolve their referral, “No, I really think that it was put together perfect for me, because I didn’t have to scramble around. I didn’t have to call 10 or 15 different places and they’re not offering anything that’s on the paper, you know.”

## 4.4 Discussion

Patients’ perspectives are critical to implementing a social needs screening and response protocol. Guided by HEIF, we sought to identify patient-perceived barriers and facilitators to implementing PRAPARE and similar approaches. During patient interviews, three themes emerged. First, patients found the approach acceptable and their health care team having information on patients’ social needs offered more comprehensive, high-quality care. The ethos for organizing and improving the quality of care in primary care is largely based around patient centered care and the medical home.[112] This and other models for delivering high quality chronic disease management are rooted in a collaborative approach to care based on shared decision making that is responsive to patients’ values, preferences, and needs to provide ‘whole-person’ care.[111] Patients reported views on social needs screening that are consistent with the ethos of patient centered care. For example, patients described a shared decision making process and indicated that it strengthened the patient-provider relationship. Patients also reported that

PRAPARE had spillover benefits for care planning and treatment of medical needs. Interestingly, privacy concerns were not a barrier. Patients believed there were benefits to broader screening and were amenable to this being done through alternative modalities (electronic message, text message, or self-screening during intake). Some respondents did express that talking in person may be more effective to elicit sensitive information and overcome initial unwillingness to initiate a discussion on non-medical needs. Taken together, our findings suggest that designing the clinical delivery to incorporate a shared decision making process initiated by the health care team could facilitate implementation efforts.

Second, we found that social needs are clustered and interrelated, suggesting that response protocols must be tailored to address commonly co-occurring social need clusters. For example, unemployment and the inability to access health services due to financial burden are commonly co-occurring and require a comprehensive response.[125-127] This may require an adaptable and multi-component intervention consisting of complementary referrals and case management across a spectrum of interrelated social needs. These findings suggest that implementation efforts should take into account the importance of coordinated social needs response protocols with ongoing care planning. Social need response interventions must be complementary to treatment goals and treatment must include considerations for newly introduced social needs. However, there are limitations to the extent to which implementation strategies can overcome health system capacity constraints and barriers related to structural social and economic forces embedded within administrative policies for social service delivery. This presents unique, context-specific implementation considerations that are impacted by structural social and economic policies. The HEIF Societal Influence domain shed light on PRAPARE implementation determinants that are related to structural social and economic factors. We find that upstream determinants of health are especially challenging to address through individual level intervention and likely require intervention at the system or policy level. Patients reported mistrust of medical and social service institutions as a barrier to responding to social needs. This is consistent with literature on negative experiences with other public institutions.[128,129] This barrier makes it more difficult to effectively respond to the clustered and interrelated nature of social needs and medical needs. Taken together, these accounts suggest that implementation efforts must recognize institutional mistrust as a barrier and design context-specific implementation strategies.

Finally, respondents commented on several important implementation facilitators including the use of shared decision making, empathic communication, and accurate information on community resources or social services. Patient respondents typically described a screening process that led to a shared decision making process wherein patients were presented with a range of community based resources or social services and were able to choose the resources they wanted to access based on location, hours, eligibility criteria, and patient preference or priority. Our findings suggest that workforce development and training is an important implementation strategy. Specifically, leveraging empathic communication and shared decision making techniques coupled with knowledge of the community context and available resources may improve the effectiveness of the approach. These patient perspectives suggest that implementation efforts should include two distinct components. First, implementation efforts should employ workforce development strategies to develop a skill set associated with empathic communication and shared decision making surrounding sensitive social needs. Second, such efforts should involve conducting a recurring environmental scan of available resources and the creation of multi-sector partnerships to ensure seamless transitions from health care to social care entities. Our findings suggest that this is critical so that patients receive up-to-date information on eligibility, hours, and service locations for commonly used agencies or community based organizations.

Our findings underscore the importance of addressing social needs implementation determinants at the policy level. Strategies to accomplish this may include engaging in multi-sector coalition building around health and social care integration to both better serve vulnerable communities through coordination and to advocate for policy-level changes to promote health equity.[19,82,91,100] When combined with previous literature, our results incate that translation efforts must include 1) an overarching strategy that identifies opportunities and threats for improving health equity that are specific to the community context;[56,130] 2) making explicit linkages to social needs screening and response protocols to an overarching population health management strategy for underserved patient populations;[59] 3) ensuring that implementation strategies are evaluated with performance measures that are associated with health equity.[24]

This study has several limitations. First, the small number of patients from a single community health center who volunteered to be in our study limits generalizability. Second, there may have also been a threat of social desirability bias given the sensitive subject matter. Third, the small sample size limited our ability to analyze implementation factors that are distinct for subgroups of interest. For example, we heard testimony of unique barriers and facilitator for immigrant populations. Finally, since there is great heterogeneity in practice patterns associated with PRAPARE and approaches like it, the implementation considerations reported in this manuscript may vary in relevance depending on screening and referral delivery method.

Despite these limitations, this study makes an important contribution to the existing literature. To our knowledge, it is the first to elicit patients' perspective on barriers and facilitators of implementing patient centered protocols to identify and respond to social needs. This is an area of great interest to both interventionists and implementation scientists.[48] By describing patient perspectives on implementation, we contribute to a growing body of literature that informs strategies for increasing the uptake of PRAPARE and approaches like it. There are several areas that we believe should be prioritized for future research. First, further research is needed to identify potential areas of symmetry between providers' perspectives on barriers and facilitators with the perspective of the patients they serve. Second, since we found that patients are amenable to alternative modalities including electronic message, text-message, or self-administration, additional research is needed to compare modalities for social needs screening in a patient centric manner. Third, additional research is required to understand distinct implementation considerations that are relevant to special populations of interest, like immigrants or refugees. Finally, this research contributes to the development of generalizable implementation strategies to promote the uptake of social needs screening as part of routine care delivery in diverse settings. Implementation strategies must be designed to be adaptable and leverage the facilitators and overcome the barriers identified in this and other studies. Based on our findings and other relevant literature, we believe these strategies will include an emphasis on training and workforce development,[27] EHR integrated decision support tools,[38,64] and the formation of multi-section partnerships and coordination.[35,56] By doing so, implementation scientists and health services research can identify best practices for integrating models that strengthen the medical home, inform population health management and advocacy efforts, and improve outcomes associated with high quality care and health equity.

Figure 4.1. Health Equity Implementation Framework

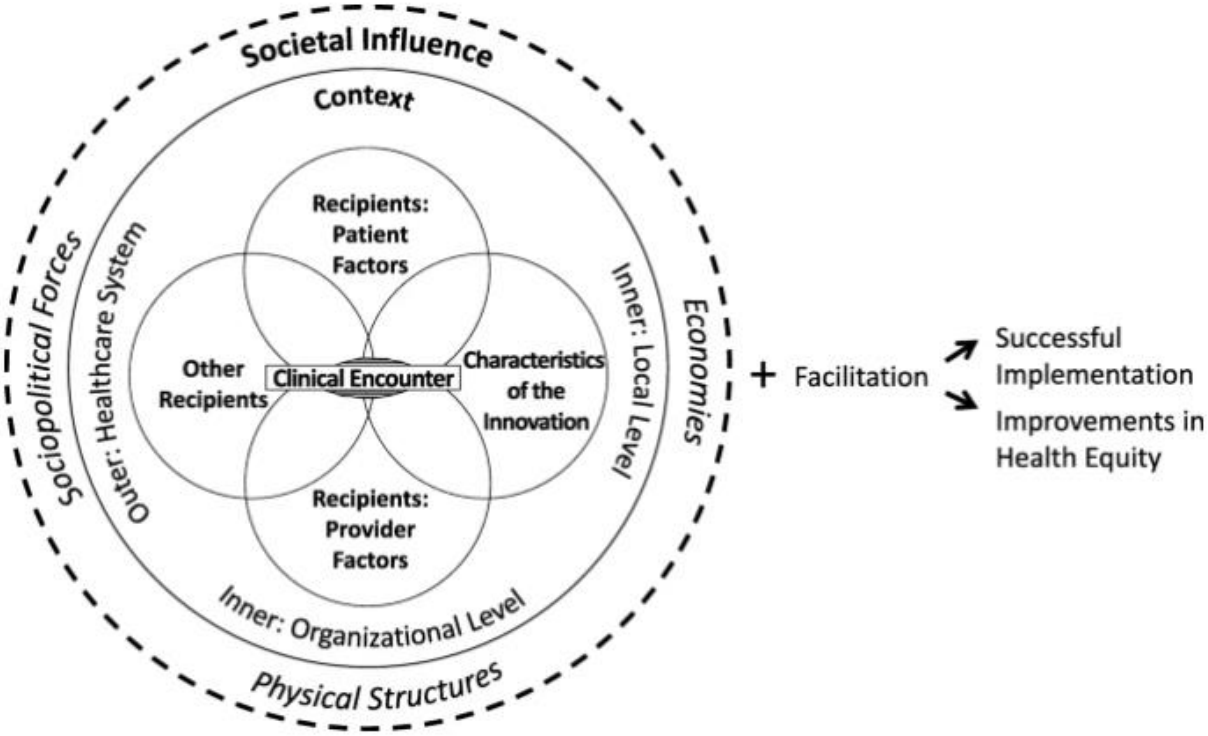


Table 4.1. Respondent Demographics

| **Variable** | **Survey and Interview Participants (n=10)** |
|---|---|
| **Ages, year** | |
| 18-44 | 3 |
| 45-60 | 4 |
| ≥ 61 | 3 |
| **Sex** | |
| Female | 5 |
| **Race** | |
| Black, non-Hispanic/Latino | 8 |
| Hispanic/Latino | 2 |
| **Housing Situation** | |
| Does not have housing | 2 |
| **Fears Losing Housing** | |
| Yes | 1 |
| **Preferred Language** | |
| English | 8 |
| Spanish | 2 |
| **Number of Individuals in Household** | |
| 1-4 | 9 |
| 5-8 | 1 |
| **Education Level** | |
| Less than high school degree | 1 |
| High school diploma or GED | 1 |
| More than high school degree | 8 |
| **Current Work Situation** | |
| Unemployed | 1 |
| Part-time or temp work | 2 |
| Full-time work | 2 |
| Unemployed, but not seeking work | 4 |
| Non-response | 1 |
| **Primary Insurance** | |
| None/uninsured | 7 |
| Medicaid | 2 |
| Medicare | 1 |
| **Transportation Barrier Prevented Attending Appointments or Work** | |
| Yes | 1 |
| **Social Support Frequency** | |
| 1-2x per week | 1 |
| 3-5x per week | 1 |
| 5+ times per week | 8 |

| **Variable** | **Survey and Interview Participants (n=10)** |
|---|---|
| **Levels of Stress** | |
| Not at all / A little bit | 6 |
| Somewhat | 1 |
| Quite a bit/ Very much | 3 |
| **Feel Safe at Home** | |
| No | 1 |
| **Material Needs** | |
| Yes, food security concern | 1 |
| Yes, barriers to transportation | 2 |
| Yes, housing concerns | 3 |
| Yes, financial concerns | 5 |
| Yes, access to medical care concerns | 4 |
| Yes, social and emotional health concerns | 2 |

# CHAPTER 5: CONCLUSION

Although social needs screening is increasingly common, the implementation of novel approaches to care such as PRAPARE is challenging and requires careful analysis of barriers and facilitators to design strategies for adoption. This research addressed three gaps in the literature that are critical to inform the implementation of social needs screening and response protocols in diverse primary care settings. While the findings of each aim have key takeaways that are of interest to practitioners and policymakers alike, the cumulative contribution of this work can be better described using an overarching theoretical framework, HEIF, to understand the barriers and facilitators to its implementation, how our findings advance current research, and future research directions.

## 5.1 Multi-level Implementation Determinants

The primary goal of the field of implementation science is to develop implementation strategies to promote the uptake of novel, evidence based approaches to care.[131] These efforts include, but are not limited to, adapting evidence based approaches, creating methods for training and decision support, guidelines, altering incentive structures, and attending to contextual drivers of implementation.[132] HEIF and other implementation science theoretical frameworks posit that implementation strategies are most effective when they attend to different levels of implementation determinants.[110,117,118,133] This is especially important when the intervention is intended to promote health equity by addressing social needs, or the downstream consequences of structural inequities. This requires not only recognition of health disparities as an implementation failure but also extends to designing implementations strategies to address multi-level determinants of health equity. In doing so, successful implementation is defined not only in terms of uptake and successful adoption but also improvements in health equity. The findings from each aim have implications for the design of implementation strategies that are explicitly responsive to health equity-related implementation determinants consistent with the organization of HEIF: clinical encounter determinants, health system determinants, and societal influence determinants.

### 5.1.1 Clinical Encounter Determinants

Attention to the clinical encounter is especially important to respond to health disparities experienced by historically marginalized and vulnerable populations.[119] This research illustrates several noteworthy implementation determinants on the clinical encounter level that should be recognized when designing implementation strategies for promoting the adoption of PRAPARE and protocols like it. In chapter 3, we describe the resources dedicated to planning clinical encounter workflows and practice patterns for engaging patients around their social needs. We found that significant resources were dedicated to workforce development and ongoing training opportunities that are critical to social needs screening and patient-centered response protocols. In chapter 4, patients reported that an important implementation facilitator was having a member of health care team initiate conversations in a collaborative and non-judgmental manner. Patients also described a shared decision-making process that allowed them to identify needs and provide input on which referrals were provided. The techniques are consistent with patient-centered communication including respectful listening, shared decision-making, empathic communication, and motivational interviewing.[134-136] Our findings suggest that this may promote trust and improve the patient-provider relationship. These facilitators underscore the ways in which social needs screening and response implementation must be consistent with the organizing ethos of the patient-centered medical home. This has implications for designing practice patterns and training and workforce development as implementation strategies to ensure patients are being engaged. For example, social needs implementation strategies could include staff training on shared decision making, empathic communication, and awareness of community based organizations to refer patients to.

Across chapters we also found implementation considerations related to the design of the screening assessment itself. Findings from Chapter 3 suggest that positive social need identification rate may be related to how the social needs screener is designed. Additional social needs domains, including behavioral dimensions of health may lead to higher social need identification rates and trigger additional clinical activities to respond. Fortunately, patients indicated in the semi-structured interviews (Chapter 4) that the amount of time spent on answering social needs questions is not a barrier and that they see value in it being part of the clinical encounter. This finding is consistent with existing literature on patient attitudes towards social needs screening.[52] Patients even expressed willingness to have social needs information collected using different modalities including patient portal, e-mail, paper, or via text message. These findings highlight the flexibility in adapting and designing social needs screening assessments to existing capacity constraints, community priorities, and existing technologies. However, benefits associated with context specific adaptation to a social needs assessment tool must be compared against the benefits of assessment standardization. The latter allows for meaningful comparisons of social needs data across populations and data quality and harmonization that could inform risk adjustment and reimbursement.[21,23]

### 5.1.2 Health System Determinants

All three chapters identify and describe implementation determinants at the organizational or health system level. Chapters 2 and 3 describe implementation considerations around investments in social needs data collection through the EHR. Specifically, Chapter 3 describes the resource intensity of capacity-building activities for a clinic or health system to collect and store relevant information in the patients' EHR is significant and varied. This finding expands the existing literature describing heterogeneous approaches to integrating social needs data into a patient's medical record.[40] Our findings reveal that the driver in cost variation was related to local customization in flowsheet design and reporting and could represent a profound implementation barrier for small clinics without dedicated informatics personnel. Social needs assessment data quality, integrity, functional form, and missingness can all impact how this data can be used for population health management. To inform this application, Chapter 2 demonstrates that the prevalence of social needs and their relationship to clinical risk depends on how risk is defined. Different levels of prediction performance for cardiometabolic measures of risk suggests that the relationship between social needs assessment data and medical complexity is nuanced. Rather than a one-size-fits all approach to responding to identified social needs, health systems should tailor social care integration within disease pathways based on the relationship between social needs and clinical risk for the patients they serve. To advance this work, we offer practical insights into how predictive analytics can be used to better identify patients at higher risk due to unmet social needs using EHR data. Most notably, specialized supervised machine learning techniques, like lasso regression, may not be necessary for optimizing prediction performance since a simpler, conventional modeling approach performed similarly. However, there is reason to believe that supervised machine learning, like the lasso regression, may be superior for prediction in certain situations such as when analyzing larger datasets.[86] Regardless of analytical application, EHR data quality, form, and missingness are critical to evaluate when working with social needs assessment data.

### 5.1.3 Societal Influence Determinants

Structural SDOH are profoundly important to work related to assessing and addressing individual-level social needs. Given the inextricable link between SDOH and social needs, implementation efforts must recognize barriers and facilitators related to social and economic policy and overarching cultural factors that inform the distribution of resources and opportunities. We used the HEIF to provide a lens to analyze patient perspectives on implementation factors and make linkages back to structural inequities and policies that must be recognized as implementation determinants. Effectively responding to identified social needs is profoundly influenced by federal and state level social and economic policies. Chapter 4 sheds light on barriers to implementing social needs and response that are a result of the availability of benefits and the administrative complexity for acquiring social services or financial assistance programs patients are eligible for. For example, if a referral to Section 8 for housing assistance or the Supplemental Nutrition Assistance Program for food insecurity does not result in a resolved referral either because of cumbersome application or reporting requirements, then these policy decisions constitute an implementation barrier. Therefore, implementation determinants must be evaluated beyond the clinic and clinical encounter levels and recognize the importance of institutions and policy on adoption. To advance health equity, the field of implementation science should not only identify and describe policy and structural factors as implementation barriers or facilitators but take the extra step of proposing policy reforms as a type of implementation strategy that complement clinic and patient-level implementation strategies. Our findings suggest that to be most effective at responding to patient social needs, health systems must complement robust responses to social needs presented on the individual patient level with advocacy for policies that can expand the capacity of the public institutions associated with health equity and that address upstream drivers of health.

## 5.2 Future Research Directions

This research complements a growing evidence base on the best practices of social needs screening and response implementation. There are several areas worthy of additional research to advance this burgeoning field. First, implementation scientists must go beyond describing implementation determinants of social needs screening and response interventions and take the next step of designing and testing the effectiveness of multi-level implementation strategies in routine clinical encounters.[137] This could include leveraging a randomized hybrid trial on the effectiveness of the social needs screening intervention and the effectiveness of a bundle of implementation strategies designed to facilitate uptake of PRAPARE.[138]

Second, this research, particularly chapter 3, has significant implications for the care team composition and staffing best practices. Our findings highlight how decisions on staffing and care team composition can influence the cost to offer PRAPARE to patients. Additional research is needed to identify members of the health care team with the training and skills to cost-effectively screen and respond to patients' social needs. Community health workers, for example, may be uniquely equipped to efficiently engage with patients to resolve unmet social needs.[101,102]

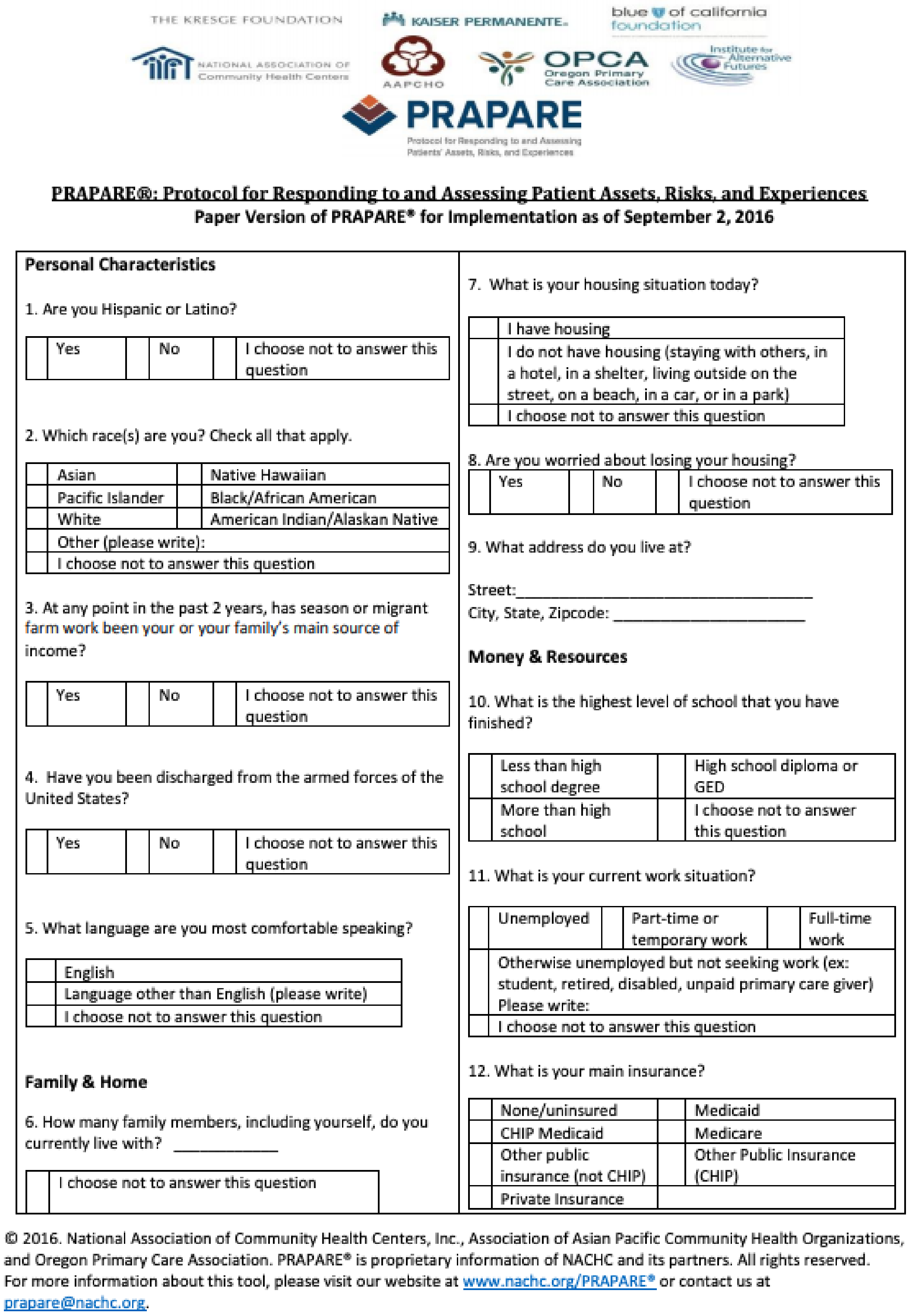
Third, findings from Chapter 2 can help inform how health systems use EHR data to identify how medical complexity is associated with the presence of social needs. However, additional research is required to understand the clusters of commonly co-occurring morbidities that may benefit disproportionately from social care integration. Much of the current literature focuses on addressing unmet social needs for children and families.[35-37,58,109] Future work should identify other medically-complex patients who are most adversely affected by unmet social needs and to design tailored interventions to improve outcomes and control costs.

Finally, technology will play a pivotal role in coordinating services across the health care and social care continuum. Chapter 4 highlighted that patients are amenable to social needs screening using modalities such as electronic message, patient portal, and text message. Coupled with our findings related to the cost of personnel to screen and respond to social needs, there is an important role and opportunity for technology to make screening and responding to social needs efficient and patient centric. Our work and related research and policy initiatives[80,100] suggest that this is a fruitful direction for future research.

## 5.3 Conclusion

We leveraged multiple methods to address gaps in the literature related to the implementation of social needs screening and response protocols in primary care. Examining implementation factors related to cost, patient perspectives, and the association of social needs data with cardiometabolic clinical risk underscores the importance of planning implementation at multiple levels including at the clinical encounter, the organization, and at the societal and policy level. To do so effectively, implementation strategies should be designed to overcome barriers and leverage facilitators. Attention to these multi-level implementation determinants is critical to accelerating the translation of social needs screening best practices into routine care delivery to promote health equity and improve health.

# APPENDIX A: PRAPARE SOCIAL NEEDS ASSESSMENT



**PRAPARE®: Protocol for Responding to and Assessing Patient Assets, Risks, and Experiences**

**Paper Version of PRAPARE® for Implementation as of September 2, 2016**

**Personal Characteristics**

1. Are you Hispanic or Latino?

| | | |
|---|---|---|
| ☐ Yes | ☐ No | ☐ I choose not to answer this question |

2. Which race(s) are you? Check all that apply.

| | |
|---|---|
| ☐ Asian | ☐ Native Hawaiian |
| ☐ Pacific Islander | ☐ Black/African American |
| ☐ White | ☐ American Indian/Alaskan Native |
| ☐ Other (please write): | |
| ☐ I choose not to answer this question | |

3. At any point in the past 2 years, has season or migrant farm work been your or your family's main source of income?

| | | |
|---|---|---|
| ☐ Yes | ☐ No | ☐ I choose not to answer this question |

4. Have you been discharged from the armed forces of the United States?

| | | |
|---|---|---|
| ☐ Yes | ☐ No | ☐ I choose not to answer this question |

5. What language are you most comfortable speaking?

| |
|---|
| ☐ English |
| ☐ Language other than English (please write) |
| ☐ I choose not to answer this question |

**Family & Home**

6. How many family members, including yourself, do you currently live with? ____________

☐ I choose not to answer this question

7. What is your housing situation today?

| |
|---|
| ☐ I have housing |
| ☐ I do not have housing (staying with others, in a hotel, in a shelter, living outside on the street, on a beach, in a car, or in a park) |
| ☐ I choose not to answer this question |

8. Are you worried about losing your housing?

| | | |
|---|---|---|
| ☐ Yes | ☐ No | ☐ I choose not to answer this question |

9. What address do you live at?

Street:____________________________________

City, State, Zipcode: ______________________

**Money & Resources**

10. What is the highest level of school that you have finished?

| | |
|---|---|
| ☐ Less than high school degree | ☐ High school diploma or GED |
| ☐ More than high school | ☐ I choose not to answer this question |

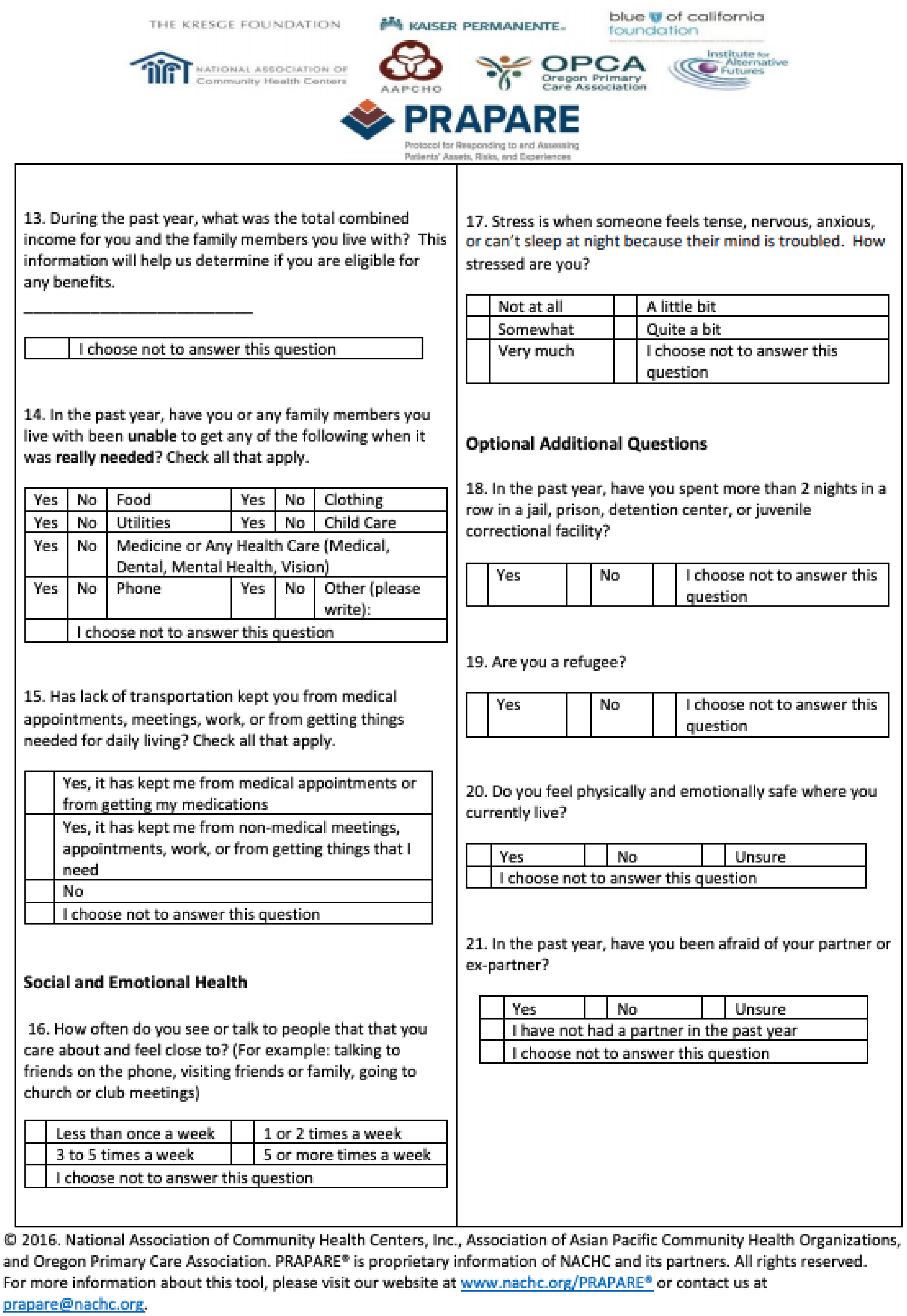
11. What is your current work situation?

| | | |
|---|---|---|
| ☐ Unemployed | ☐ Part-time or temporary work | ☐ Full-time work |
| ☐ Otherwise unemployed but not seeking work (ex: student, retired, disabled, unpaid primary care giver) Please write: | | |
| ☐ I choose not to answer this question | | |

12. What is your main insurance?

| | |
|---|---|
| ☐ None/uninsured | ☐ Medicaid |
| ☐ CHIP Medicaid | ☐ Medicare |
| ☐ Other public insurance (not CHIP) | ☐ Other Public Insurance (CHIP) |
| ☐ Private Insurance | |

For more information about this tool, please visit our website at www.nachc.org/PRAPARE® or contact us at prapare@nachc.org.



THE KRESGE FOUNDATION

KAISER PERMANENTE

blue of california foundation

NATIONAL ASSOCIATION OF Community Health Centers

AAPCHO

OPCA Oregon Primary Care Association

Institute for Alternative Futures

PRAPARE

Protocol for Responding to and Assessing Patients' Assets, Risks, and Experiences

13. During the past year, what was the total combined income for you and the family members you live with? This information will help us determine if you are eligible for any benefits.

_______________________________

| | |
|---|---|
| | I choose not to answer this question |

14. In the past year, have you or any family members you live with been **unable** to get any of the following when it was **really needed**? Check all that apply.

| | | | | | |
|---|---|---|---|---|---|
| Yes | No | Food | Yes | No | Clothing |
| Yes | No | Utilities | Yes | No | Child Care |
| Yes | No | Medicine or Any Health Care (Medical, Dental, Mental Health, Vision) | | | |
| Yes | No | Phone | Yes | No | Other (please write): |
| | I choose not to answer this question | | | | |

15. Has lack of transportation kept you from medical appointments, meetings, work, or from getting things needed for daily living? Check all that apply.

| | |
|---|---|
| | Yes, it has kept me from medical appointments or from getting my medications |
| | Yes, it has kept me from non-medical meetings, appointments, work, or from getting things that I need |
| | No |
| | I choose not to answer this question |

**Social and Emotional Health**

16. How often do you see or talk to people that that you care about and feel close to? (For example: talking to friends on the phone, visiting friends or family, going to church or club meetings)

| | | | |
|---|---|---|---|
| | Less than once a week | | 1 or 2 times a week |
| | 3 to 5 times a week | | 5 or more times a week |
| | I choose not to answer this question | | |

17. Stress is when someone feels tense, nervous, anxious, or can't sleep at night because their mind is troubled. How stressed are you?

| | | | |
|---|---|---|---|
| | Not at all | | A little bit |
| | Somewhat | | Quite a bit |
| | Very much | | I choose not to answer this question |

**Optional Additional Questions**

18. In the past year, have you spent more than 2 nights in a row in a jail, prison, detention center, or juvenile correctional facility?

| | | | | | |
|---|---|---|---|---|---|
| | Yes | | No | | I choose not to answer this question |

19. Are you a refugee?

| | | | | | |
|---|---|---|---|---|---|
| | Yes | | No | | I choose not to answer this question |

20. Do you feel physically and emotionally safe where you currently live?

| | | | | | |
|---|---|---|---|---|---|
| | Yes | | No | | Unsure |
| | I choose not to answer this question | | | | |

21. In the past year, have you been afraid of your partner or ex-partner?

| | | | | | |
|---|---|---|---|---|---|
| | Yes | | No | | Unsure |
| | I have not had a partner in the past year | | | | |
| | I choose not to answer this question | | | | |

For more information about this tool, please visit our website at www.nachc.org/PRAPARE® or contact us at prapare@nachc.org.

# APPENDIX B: LASSO LOGISTIC REGRESSION MODEL COMPARISONS

Table B.1. Comparison across lasso logistic regressions for obesity clinical risk

| | **Obese** | | | |
|---|---|---|---|---|
| | **Cross Valid.** | **minAIC** | **minBIC** | **Adaptive** |
| Age | 1.00 | 1.00 | | 1.01 |
| Female | 1.85 | 1.85 | 1.51 | 2.13 |
| Race (base = White/Caucasian) | | | | |
| Black/African American | 1.01 | 1.01 | | |
| Asian | 0.46 | 0.46 | | 0.25 |
| No housing | 0.88 | 0.88 | | 0.81 |
| Lacks transportation | 0.89 | 0.89 | | 0.80 |
| High stress | 0.79 | 0.79 | | 0.67 |
| Constant | 0.76 | 0.76 | 0.87 | 0.63 |
| ***C-statistic*** | 0.5849 (0.5274 – 0.6424) | 0.5849 (0.5274 – 0.6424) | 0.5487 (0.5000 – 0.5975) | 0.5861 (0.5287 – 0.6434) |
| ***$X_2$ test for C-statistic equality*** | p-value = 0.1623 | | | |

Table B.2. Comparison across lasso logistic regressions for Stage 2 hypertension clinical risk

| | **High BP, Stage 2** | | | |
|---|---|---|---|---|
| | **Cross Valid.** | **minAIC** | **minBIC** | **Adaptive** |
| Age | 1.03 | 1.03 | 1.02 | 1.04 |
| Female | 0.80 | 0.80 | 0.92 | |
| Race (base = White/Caucasian) | | | | |
| Black/African American | 1.74 | 1.74 | 1.59 | 2.03 |
| Multiracial | 0.91 | 0.91 | | |
| Native Hawaiian/other Pacific Island | 1.91 | 1.91 | | |
| Hispanic/Latino | 0.93 | 0.93 | 0.97 | |
| Military discharge | 0.56 | 0.56 | | 0.49 |
| No housing | 1.09 | 1.09 | | |
| Work situation (base = Full-time) | | | | |
| Unemployed, seeking work | 1.33 | 1.33 | 1.19 | 1.40 |
| Unemployed, not seeking work | | | | |
| Uninsured | 1.19 | 1.19 | | 1.30 |
| Low social interaction | 1.06 | 1.06 | | |
| Other self-reported need | | | | |
| Access to medicine or health care | 1.26 | 1.26 | 1.16 | 1.30 |
| Phone | 2.19 | 2.19 | 1.73 | 2.54 |
| Constant | 0.04 | 0.04 | 0.07 | 0.03 |
| ***C-statistic*** | 0.6842 (0.6280 – 0.7404) | 0.6842 (0.6280 – 0.7404) | 0.6878 (0.6315 – 0.7441) | 0.6893 (0.6330 – 0.7457) |
| ***$X_2$ test for C-statistic equality*** | p-value = 0.0200 | | | |

Table B.3. Comparison across lasso logistic regressions for borderline ASCVD clinical risk

| | **ASCVD, Borderline** | | | |
|---|---|---|---|---|
| | **Cross Valid.** | **minAIC** | **minBIC** | **Adaptive** |
| Age | 1.23 | 1.25 | 1.19 | 1.27 |
| Female | 0.15 | 0.13 | 0.25 | 0.10 |
| Race (base = White/Caucasian) | | | | |
| Black/African American | 4.33 | 4.64 | 3.33 | 5.20 |
| Asian | 0.72 | 0.60 | | 0.49 |
| American Indian/Alaskan Native | 46.99 | 100.3 | 2.18 | 2371.01 |
| Other | 0.63 | 0.60 | 0.75 | 0.55 |
| Hispanic/Latino | 0.71 | 0.71 | 0.72 | 0.68 |
| Military discharge | | 1.44 | | |
| No housing | 1.14 | 1.19 | | 1.27 |
| Work situation (base = Full-time) | | | | |
| Unemployed, seeking work | 1.14 | 1.24 | | 1.40 |
| Unemployed, not seeking work | 1.42 | 1.56 | 1.07 | 1.80 |
| Low social interaction | 1.13 | 1.21 | | 1.32 |
| High stress | 0.71 | 0.63 | | 0.54 |
| Feels unsafe at residence | 0.92 | 0.86 | | 0.80 |
| Other self-reported need | | | | |
| Food | 1.47 | 1.54 | 1.24 | 1.63 |
| Access to medicine or health care | 1.19 | 1.27 | | 1.37 |
| Child care | 2.52 | 3.70 | | 17.39 |
| Phone | 2.37 | 2.70 | 1.40 | 3.54 |
| Other | | 1.12 | | |
| Constant | 0.00 | 0.00 | 0.00 | 0.00 |
| ***C-statistic*** | 0.9495 (0.9262 – 0.9729) | 0.9489 (0.9254 – 0.9725) | 0.9490 (0.9251 – 0.9730) | 0.9475 (0.9236 – 0.9715) |
| ***$X_2$ test for C-statistic equality*** | p-value = 0.4135 | | | |

# APPENDIX C: RECEIVER OPERATING CHARACTERISTIC (ROC) CURVES FOR PREDICTION OF CARDIOMETABOLIC RISK INDICATORS

Figure C.1. Receiver operating characteristic (ROC) curve for obesity

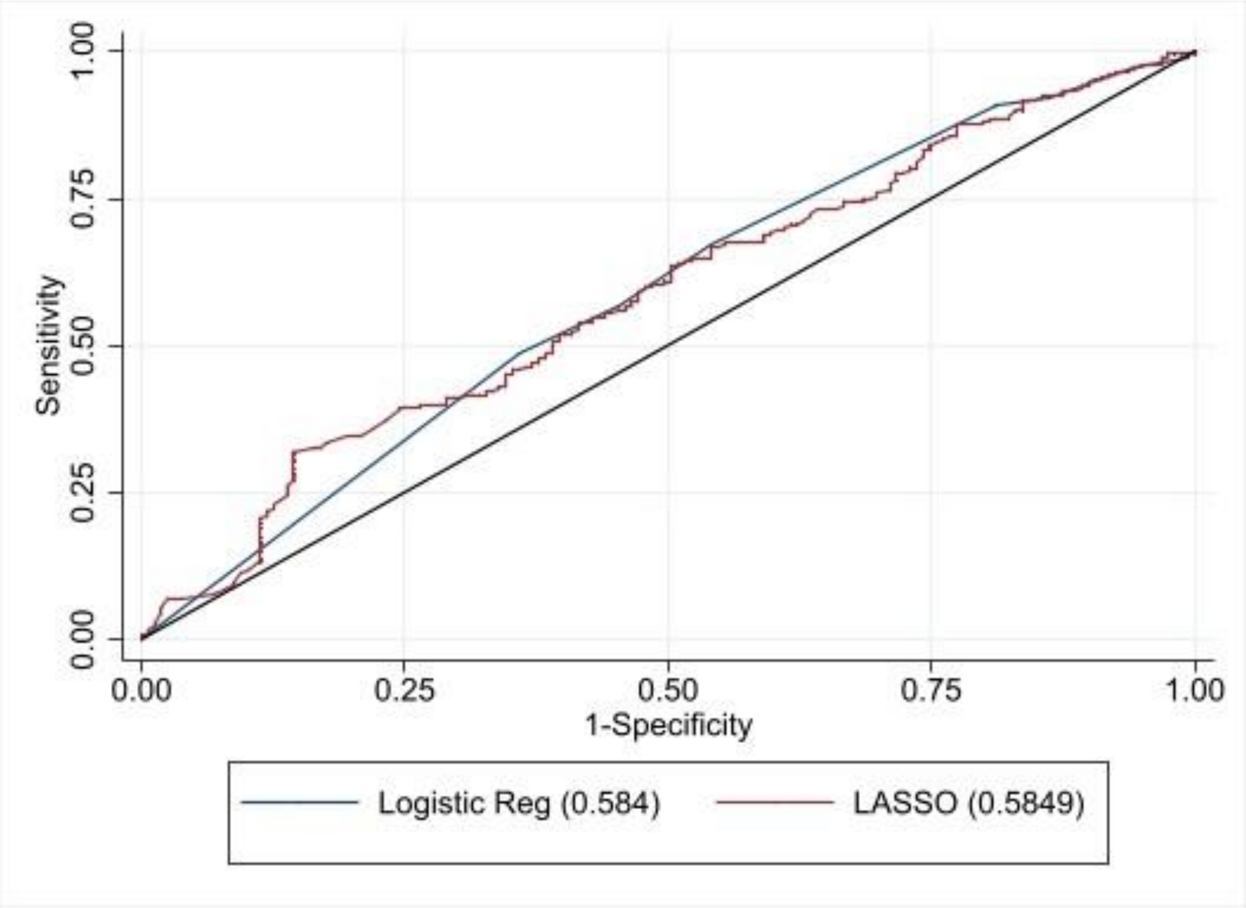


Figure C.2. Receiver operating characteristic (ROC) curve for Stage 2 hypertension

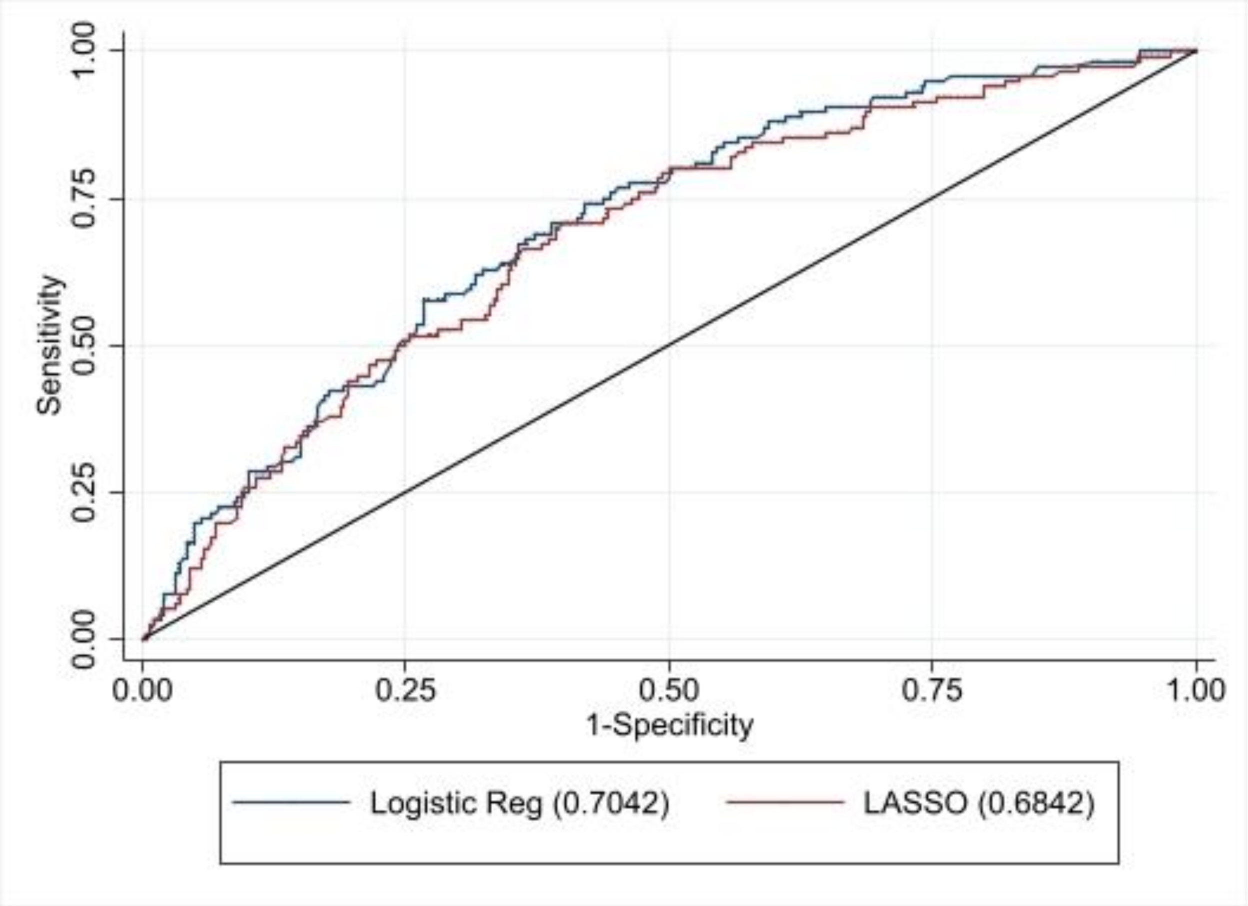
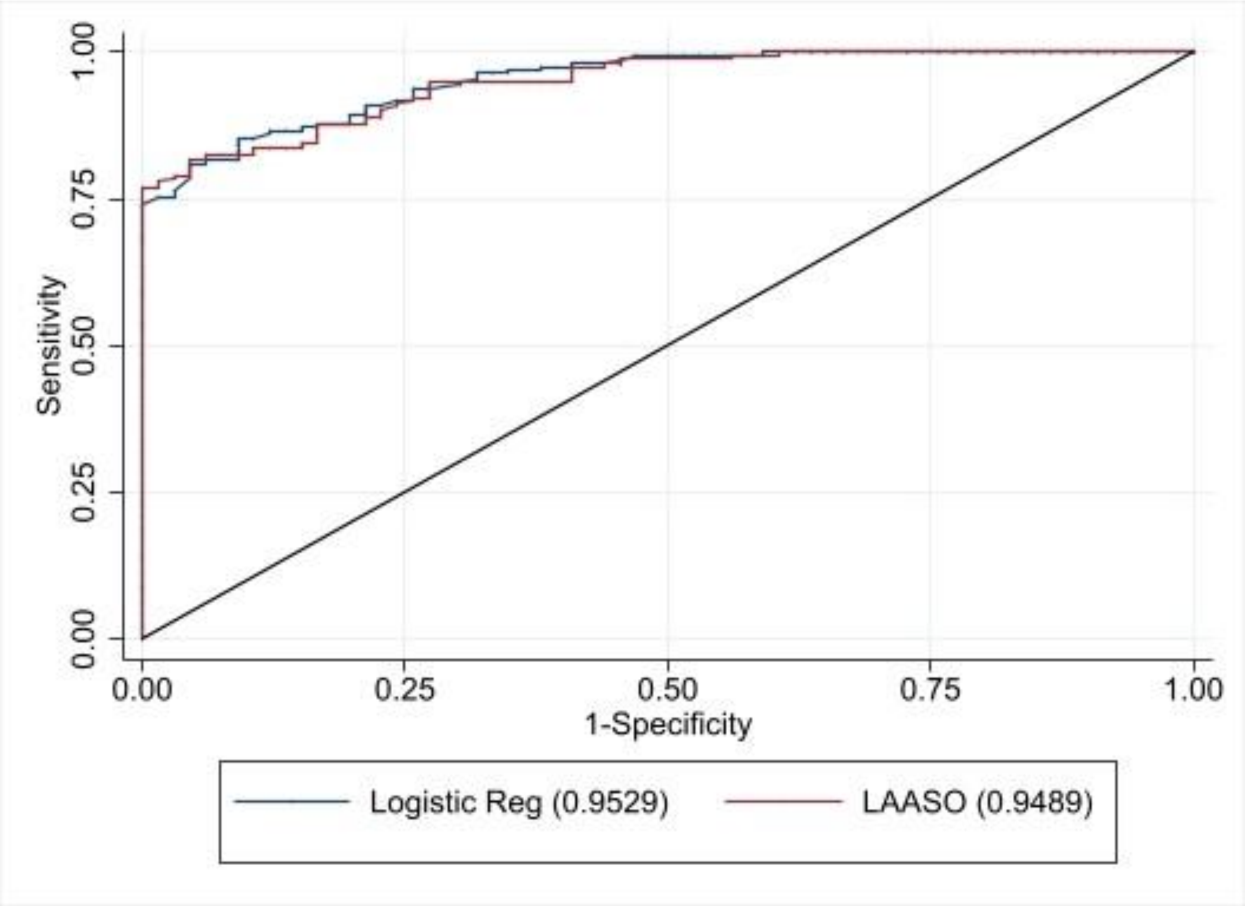


Figure C.3. Receiver operating characteristic (ROC) curve for borderline ASCVD



## APPENDIX D: HEALTH EQUITY IMPLEMENTATION FRAMEWORK SEMI-STRUCTURED INTERVIEW GUIDE

# Patient Experience related to the Protocol for Responding to and Assessing Patients' Assets, Risks, and Experiences (PRAPARE)

## Patient Semi-Structured Interview Guide

**Purpose:** To understand the patient experience and perspectives on implementation barriers and facilitators of PRAPARE

**Respondents:** FQHC patients that have participated in PRAPARE

**Anticipated Time:** 60 minutes per interview

Subject ID: ______

Age:

Gender:

Race:

Education level:

Living situation:

PRAPARE Social Needs Identified:

Community Resource Referrals:

Start Time: ________________________AM / PM

End Time: ________________________AM / PM

Interviewer: ____________________________________________________

Thank you very much for your time and participation today. Let's talk about your experience at *<community health center name>*. During your visit with *<behavioral health case manager*

*name*> back in <*month of PRAPARE administration*> you were asked questions about non-medical needs like food, housing, stress, and transportation. *[Hand patient PRAPARE Sample and leave out during the interview to reference as needed].* Here is a sample of the questions that you were asked, such as…[*read out a few of the questions*]. Then, once you gave your answers, you were provided resources in the community *[list community resource referrals that were made].* I want to learn more about your experience answering these questions and receiving referrals to these community resources so that we can improve the way health care can support patients and provide better quality care.

If it's okay with you, I'd like to digitally record this interview. The recording will be kept on this password protected recorder until I can download the recording into a secure, limited access folder that only myself and the study team has access to. After the recording is downloaded, it will be immediately deleted from the recorder. We will then send it to an approved transcription service that will transcribe the interview for us so that we can learn more about your experience. Do you have any questions about that process? *[Wait for response, if no questions, continue on with the interview].*

If you'd like me to stop recording at any time, please let me know and I'll turn off the recorder. Also, please remember that you can always decline to answer any of my questions. Your responses will be kept completely confidential and will not affect your care or from any community organization. Do you have any questions before I turn on the recorder? *[Wait for response, if no further questions, begin the recorder and the interview questions].*

## I. Characteristics of PRAPARE Assessment and Referral (*HEIF Framework Element: Characteristics of the Innovation)*

1. PRAPARE stands for the Protocol for Responding to Patients Assets Risks and Experiences and includes questions on social and economic aspects of your life. For example, whether you have stable housing, enough food for you and your family, and about your employment situation. Why do you think you were asked these questions?

    - *Probe:* Are there other aspects of your life that you think it’s important for your health care team to know about that are not covered in the questions you were asked?
    - *If yes:* Please describe to me what some of those aspects are.

2. Do you think it is important that <*community health center name*> has this information? Why or why not?
    - *If yes:* In what ways do you think these topics are important to your health?
    - *If no:* Why do you think these topics are not important to your health? What topics would be important for us know about your health?

3. What do you remember about the conversation you had with [NAME] about your social and financial needs?
    - *Optional Probe:* What was the most memorable part of your experience in answering these questions with [NAME]?
4. Approximately how long did it take to answer these questions with [NAME]?
    - *Optional probe:* Could you tell me more about the amount of time it took?
5. What do you remember about the community resources you were provided?
6. Was it hard to access the community resource you were referred to?
    - *Optional follow up probing question:* Could you tell me more about why it was hard/easy?
    - *If no*, how did you decide on which resources that you would look into?
    - *If yes,* what could have made it easier for you to look into the resources you were provided?

7. Did you feel that the community resources you were referred to were helpful?
    - *Optional follow up probing question:* Could you tell me more about why these resources were helpful/unhelpful?

## II. Patient Experience (*HEIF Framework Elements: Clinical Encounter, Patient Factors, Provider Factors)*

*Thank you for sharing all of that information with me. Now I'd like to learn more about what made the PRAPARE process easier or harder. Are you ready?*

8. Were you comfortable sharing answers with the staff member at <*community health center name*>? Why or why not? What could have made the experience even better?
9. Were any of the questions difficult to understand?
    - *Optional follow up probing question:* Could you tell me more about why it was hard/easy?
10. Did you have any concerns about your privacy?
    - *Optional Probe:* How do feel about your responses to [NAME] questions being shared with other members of your health care team?
    - *Optional probing question if response is in the affirmative:* Could you tell me more about your privacy concerns?
11. We are considering administering the questions [NAME] asked you in different ways.
    - What are your thoughts on answering these questions using a paper form in clinic while you wait?
    - What are your thoughts on answering these questions online using a computer, phone, or tablet?
    - What are your thoughts on answering these questions over the phone?

- How could we improve your experience of answering the questions in person with a <*community health center name*> staff member?

12. We are considering different ways to follow up with patients after they've answered the questions and received community referrals. The goal of a follow-up would be to make sure patients were able to access the community resources, and if not, provide a reminder, information (i.e., hours of operation, contact information, forms), or help troubleshoot challenges to accessing the resource.
    - What are your thoughts on receiving a follow-up call from a volunteer or member of the health care team at <*community health center name*>?
    - What are your thoughts on receiving a follow-up text message?
    - What are your thoughts on receiving a follow-up email or message through your patient portal [ex: MyChart]?

13. If you had any, did you feel that your questions were answered by [NAME]?

14. Did you feel like you were treated differently or unfairly while answering these questions with [NAME]?

    - *Optional follow up probing question:* If so, could you tell me more about this experience?

15. Did you feel that you needed more time with [NAME] while answering the questions?

16. Did you feel that you were respected by <*community health center name*> staff or clinicians during your visit where you answered these questions [can reference the physical PRAPARE form]?

    - *If no*: Please describe why you felt this way.

17. Did you feel that [NAME] gave you choices or accepted your input on the type of community resource to use?

    - *Probe*: How was your input utilized in choosing community resources?

## III. Context and Health System Factors (*HEIF Framework Elements: Inner Context, Outer Context)*

*Thank you for sharing all of that information with me. Now I'd like to learn more about your experiences with health care and in the community in general. Are you ready?*

18. Had you previously ever had a bad health care experience?
    - *Optional follow up probing question:* If so, could you tell me more about that experience? Do you think it impacted your experience with PRAPARE?
19. Had you ever had a bad experience at a community resource before?
    - *Optional follow up probing question: If so, could you tell me more about that experience?* Do you think it affected your experience with PRAPARE?
20. Did you feel that there is an expectation from society that you not accept help?
    - *Optional follow up phrasing:* Do you feel like there's an expectation you shouldn't accept help? Did you feel uncomfortable accepting help?
    - *Optional follow up probing question:* If so, could you describe how this may have affected your experience with answering PRAPARE questions about your social and financial situation?
    - *Optional follow up probing question:* If so, how did this effect your willingness to accept the referral to this community resource?
21. Did you feel that there is an expectation from society that you not discuss social or financial aspects of your life?
    - *Optional follow up phrasing:* Do you find it hard to discuss social or financial aspects of your life in a doctor's visit?

    - *Optional follow up probing question:* If so, could you describe how this may have affect your experience with answering PRAPARE questions about your social and financial situation?
    - *If affirmative, follow up question:* Would you mind sharing what made it difficult?

*22.* Do you feel your identity (ex: race, gender, religion, etc.) has led you to be treated differently in a health care or community settings? For example, did you feel that your race, gender, or identity impacted how you were treated?

    - *If yes,* Tell me more about this. How were you treated differently?
    - *If yes,* What could we do to further improve how you are treated here?

Thank you for your time!

*[Stop audio recorder and as soon as possible load recorder to secure drive. Once successfully saved to drive, delete recording from recording device.]*

## APPENDIX E: PRAPARE HEIF CODEBOOK

Codebook guide:

**DOMAIN-** Domains are based on the Health Equity Implementation Framework (HEIF) and are capitalized and in bold

***Category*** – Categories are larger groupings of codes relevant to a specific HEIF domain. Each category is nested within a HEIF Domain. It is possible for a category to be nested within multiple HEIF Domains. Categories are in bold and italicized.

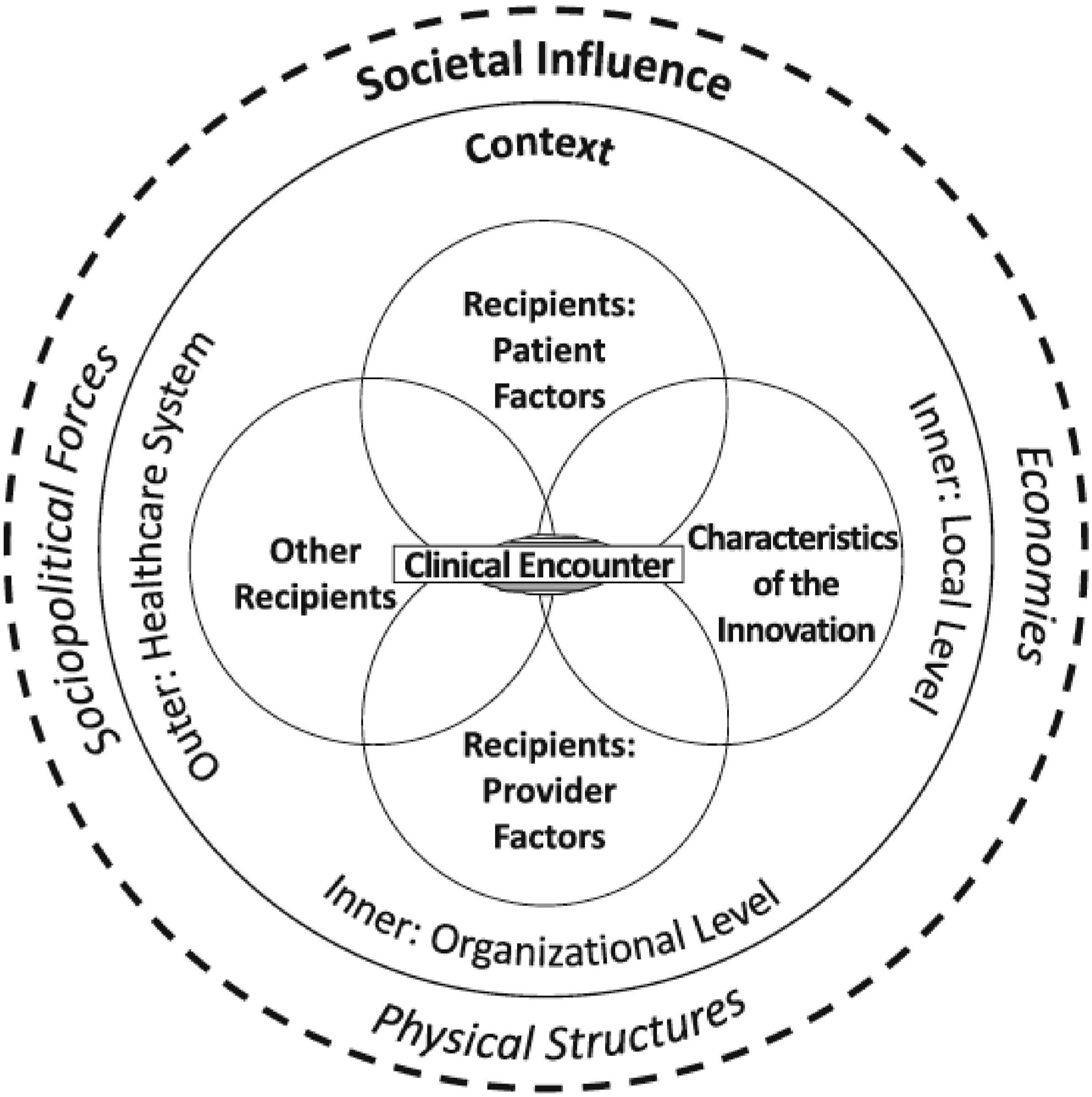
**Code** – Codes are words or short phrases that are essence capturing. They are used to symbolize or translate data. Each code is nested within an overarching category. Codes are in bold.

Overarching codes:

**Codable Quotes –** The ‘Codable Quotes’ code is applied to quotes or short excerpts that illustrate the concept of the code in a way that is illustrative and help explain the phenomenon. This code should be applied to qualitative data that may be included verbatim in the final manuscript to present the larger findings of the qualitative analysis.

**Barrier –** The ‘Barrier’ code is applied in conjunction with other codes to indicate a challenge, obstruction, or difficulty that has an implication for PRAPARE implementation and administration. For example, not enough time for a discussion on community resource options could be a barrier that makes it more challenging for patients to successfully accessed resources they have been referred to.

**Facilitator –** The ‘Facilitator’ code is applied in conjunction with other codes to indicate a factor that aided the implementation of PRAPARE and administration. For example, a non-judgmental and respectful approach to PRAPARE administration may have made it easier for patients to honestly report their social needs and makes it more likely that they receive relevant and needed resources.



HEIF Domains, Categories, and Codes:

**CLINICAL ENCOUNTER –** The clinical encounter, or patient-provider interaction between recipients, which is important to patient satisfaction, trust in providers, and health outcomes. The clinical encounter might be even more important for patients from vulnerable populations due to preferences unique to these populations. This category includes aspects of PRAPARE that are specific to the clinical encounter such as communication with staff/clinicians.

***Process*** **–** This category refers to the clinical workflow or process by which patients were selected and administered PRAPARE (i.e. warm hand-off, in waiting room, or post-visit referral). It describes how PRAPARE was incorporated into the larger clinical visit.

**Screening –** Any description of the process or clinical workflow that led to screening.

**Referral –** Any description of the process or clinical workflow that led to or describes the referral to community resources or social services.

***Responsiveness*** **–** Any comment on the timeliness or amount of time associated with the screening or referral connection that was made.

***Communication*** **–** Any comment on the communication or relationship between the patient and the clinical staff during the PRAPARE clinical encounter.

**PATIENT FACTORS –** These are factors that are specific to the patient and can include beliefs about PRAPARE, an individual's situation, preferences for communication/engagement, and attitudes towards specific stakeholders or institutions.

***Patient Beliefs*** **–** Patient beliefs about PRAPARE, it's role or purpose, characteristics, or delivery style.

**Purpose of PRAPARE –** Why patients believe PRAPARE is being conducted.

**Patient acceptability –** Patient's level of comfort to engage with PRAPARE and their beliefs about whether they are willing to share private information or not. This can also include attitudes related to 'accepting help' and the individual's willingness or unwillingness to do so.

**Perceived benefit –** When a patient comments on the screening or referrals of PRAPARE being helpful or perceiving the service to be beneficial to them or others.

***Patient Knowledge*** **–** Apply when patients are describing information they know or don't know. What information the patient has access to and can be either a barrier (lack of knowledge) or facilitator (greater awareness and knowledge that makes responding to a social need more effective).

***Patient Situation* –** Whenever a patient is describing an element of their life or experience that is specific to them. This could also relate to larger social and economic structures, but it is how it affects them day-to-day. This includes information on the social need that was identified and responded to.

**Transportation –** When a patient describes their transportation situation as a factor that effects treatment, medical visits, accessing community resources, or day-to-day experience.

**Job stability/unemployment** – When a patient describes their employment situation as a factor that effects treatment, medical visits, accessing community resources, or day-to-day experience.

**Housing instability –** When a patient describes their housing situation (including utilities) as a factor that effects treatment, medical visits, accessing community resources, or day-to-day experience.

**Food security –** When a patient describes their ability to access healthful food as a factor that effects treatment, medical visits, accessing community resources, or day-to-day experience.

**Conflict with the criminal justice system –** When a patient describes their legal situation or a situation with the criminal justice system as a factor that effects treatment, medical visits, accessing community resources, or day-to-day experience.

**Financial barriers** - When a patient describes their financial situation (not otherwise easily coded by one of the above categories) as a factor that effects treatment, medical visits, accessing community resources, or day-to-day experience.

**PROVIDER FACTORS –** These are factors specific to the provider or clinician (this includes behavioral health case managers). This can include method of communication, time constraints, or techniques/skills used to screen and respond to social needs.

***Method of Communication* –** Any description of provider (behavioral case manager) approach to communicating PRAPARE questions or referral information to the patient.

**Polite/Respectful/Compassionate –** Any description of provider communication that is polite, respectful, compassionate, and collaborative.

**Inquiry** – A description of provider communication that involves inquiring on the patient's specific situation and questions related to understanding needs or accessing resources. Efforts to understand the patient's situation.

***Treatment* –** Any description of providers or members of health care team creating a treatment plan, prescribing medication, or referring to a specialist for surgery. This could be associated with PRAPARE or a separate part of their treatment plan from a different member of the health care team.

**Medication –** When the PRAPARE process involves medication adherence or accessing medication. This can also include when social needs are affecting medication adherence or another element of the provider treatment plan's medication regimen.

**Surgical Intervention –** When the PRAPARE process involves surgery (outpatient or inpatient) or accessing tertiary surgical services. This can also include when social needs are affecting access to surgery as part of the provider's treatment plan.

**Mental and Behavioral Health -** When the PRAPARE process involves behavioral health or mental health or counseling services. This can also include when social needs are affecting mental health or behavioral health treatment as an element of the provider's treatment plan.

**CHARACTERISTICS OF THE INNOVATION –** This is typically defined as characteristics related to the treatment itself, such as its usability (e.g., side effects, modes of delivery), its relative advantage over existing treatments, or its trialability for patients. This could include information about the PRAPARE screening itself or the process of referring patients to a resource based on an identified need. The "innovation" is the full PRAPARE protocol which includes both screening, documentation, the referral process, and any ongoing case management.

***Ease of Use*** **–** Any description about PRAPARE (either screening or resource referral) that commented on how easy, simple, or intuitive it was to complete screening questions or the resource referral. For example, if PRAPARE screening items were unclear to the patient then this would be coded as a Barrier and Ease of Use – Screening.

**Screening –** Any activities or communication that made it easier for the client to understand the screening questions or answer them fully and honestly.

**Referral –** Any activities or communication that made it easier for the client to connect with the community resource that they were being referred to.

***Effectiveness*** **–** Any description about PRAPARE (either screening or resource referral) that commented on the perception of how effective, beneficial, or helpful it was to complete screening questions or the resource referral. For example, if community resource referral information revealed to patients that they could receive more support and benefits for a need they didn't know <*community health center name*> could respond to then this would be coded as a Facilitator and Effectiveness – Referral.

**Screening –** Any activities or communication that made it easier for the client to understand the screening questions or answer them fully and honestly.

**Referral –** Any activities or communication that made it easier for the client to connect with the community resource that they were being referred to.

***Patient preferences*** **–** Any description about preferences for how patients would like to be engaged or approached with PRAPARE (either screening or resource referral) this includes method (text message, e-mail, patient portal) and approach (communication style or personnel).

**Screening –** Any patient preferences related to PRAPARE method and approach to screening.

**Referral –** Any patient preferences related to PRAPARE method and approach to referral.

***Time*** **–** This is a description of PRAPARE screening or referral in terms of the amount of time it took during the clinical encounter that PRAPARE was administered during.

**Screening –** Any description of the amount of time spent related to PRAPARE method and approach to screening.

**Referral** – Any description of the amount of time spent related to PRAPARE method and approach to referral.

**CONTEXT –** Inner context factors at the local or organizational level can include leadership support for an innovation, feedback processes, the structure of a system, or any formal policies to embed change within a practice.

Outer context factors might include incentives or mandates of the larger health care delivery system that patients work within. This includes environmental (in)stability of a political, economic, or cultural nature within the healthcare system and may relate to health care access or quality outside of LCHC.

***Inner: Organizational Level –*** *<community health center name>* specific testimonies about positive or negative previous experiences.

**Positive experience –** When an interaction or service provided by a community resource or social service is perceived as helpful, convenient, or beneficial to the patient/client.

**Negative experience -** When an interaction or service provided by a community resource or social service is perceived as unhelpful, inconvenient, or difficult to the patient/client.

***Inner: Local Level –*** In reference to local community resources, social services, or challenges and opportunities associated with the Durham community whether it be economic forces or social forces. This could include positive or negative experiences.

**Positive experience –** When an interaction or service provided by a community resource or social service is perceived as helpful, convenient, or beneficial to the patient/client.

**Negative experience -** When an interaction or service provided by a community resource or social service is perceived as unhelpful, inconvenient, or difficult to the patient/client.

***Outer: Health Care System -*** The larger health care system. This could include a hospital’s commitment to reducing disparities or its culture regarding quality improvement and health equity. This could also include negative or positive previous experiences.

**Positive experience –** When an interaction or service provided by a community resource or social service is perceived as helpful, convenient, or beneficial to the patient/client.

**Negative experience -** When an interaction or service provided by a community resource or social service is perceived as unhelpful, inconvenient, or difficult to the patient/client.

**SOCIETIAL INFLUENCE –** Societal influence includes structural social and economic forces that shape decision making within a health care system, design of policies or procedures, or individual-level perception.

***Sociopolitical Forces –*** Larger, structural factors that include stigma, societal expectations, or political climate.

**Discrimination & Bias –** Any description of events or experiences, implicit or explicit, wherein patients are subjected to racism or discrimination based on their identity.

**Accepting Help** – Any comment on stigma or societal influence surrounding answering questions related to social and economic factors or accepting help in the form of referrals to social services or community resources. This could also pertain to how this societal influence is expressed on an individual, patient-level belief.

***Economies –*** The economic forces within which patients, providers, and other recipients are living and attempting to be healthy or provide healthcare or access health care.

# APPENDIX F: PATIENT QUOTES ON BARRIERS AND FACILITATORS OF PRAPARE IMPLEMENTATION

Table F.1. Respondents' Illustrative Quotes Describing Implementation Barriers or Facilitators Organized by the HEIF

| Qualitative Code Categories | HEIF Domain | Description | Illustrative Quotes of Implementation Barriers and Facilitators |
|---|---|---|---|
| Ease of Use, Effectiveness, Patient Preferences, and Time | Characteristics of the Innovation | Characteristics related to the evidence based approach itself. In this case this includes both the PRAPARE screening and response protocols and any ongoing case management. This includes being simple or intuitive (Ease of Use) or beneficial or useful (Effectiveness). This also includes how the integration of patient preferences and the amount of time (Time) affected usability (Patient Preferences). | "I was just so grateful. I didn't know I could get that kind of service the same day." (Facilitator)<br>"Another thing that <care manager name> told me was if I took the bus, that they could help with bus pass. <care manager name> was saying things like that. You know, she just threw out everything that could to help me." (Facilitator)<br>"I was like, very, very happy about that because sometimes—you know, I've been an independent person all my life. I never asked for help. I don't like to ask when I can because somebody else is worse than me. And for her to go into what I was going through, for her to bring it out of me, to just say it—I was very grateful." (Facilitator)<br>"It was good because the food they gave me, it was something I could use. Like some pantries give you things and you really can't use them, but they gave me |

| Qualitative Code Categories | HEIF Domain | Description | Illustrative Quotes of Implementation Barriers and Facilitators |
|---|---|---|---|
| | | | things that I wouldn't buy for myself like squash, zucchini. Sometimes I can't really afford it, but they gave it to me." (Facilitator) |
| Process and Responsiveness | Clinical Encounter | The clinical encounter or clinical workflows that led to the patient-provider interaction or between recipients. These delivery mechanisms are of particular importance to vulnerable populations due to characteristics or preferences for engagement that are unique. | "I was still waiting to see my doctor when she came in, so it was perfect timing." (Facilitator)<br>"…she took her time. I would say it was closer to eight. Maybe around eight to 10 minutes, something like that. She stood there. She took her time." (Facilitator)<br>it was in between my appointment. I was there for my appointment, so she just like sneaked her way in. The nurse told her that she could, you know, come and see me if I agreed to it, so I agreed. So, she didn't take long at all. (Facilitator)<br>"I was really impressed because she says, "Well, I left a message." She says, "If they don't get back to you, call me and let me know." So, it just really impressed me. A lot of people say, "Oh, I'll make a phone call. Somebody will get back to you." They never get—you know." (Facilitator) |

| Qualitative Code Categories | HEIF Domain | Description | Illustrative Quotes of Implementation Barriers and Facilitators |
|---|---|---|---|
| | | | “No. It was just like boom, boom, boom [ph]. She just connected me to these things. And they were just on it [ph].” (Facilitator)<br>*“<Provider name>* was very, very helpful to me. Because I was surprised that she would even supply that kind of help, or just even tell me that I could get a little bit of help. She kept asking me, “After you got sick and went back to work, do you have food? Do you have money?” She kept asking me those kind of questions now and I’m like, how did she even think about those kinds of things, because usually you go to your doctor and they would just treat you and you leave, but she was just awesome.” (Facilitator)<br>“Yeah, I was waiting for an appointment. She came in asking me these questions, and she asked me did I agree to do it, and I said “yes.” So, she really got me stuff Section 8. She really got me a lot of information, you know.” (Facilitator)<br>“That’s what really just, you know, really just got to me. You know, I was telling you know the other clients, the other people that was sitting there, you know, about how well they helped, how |

| Qualitative Code Categories | HEIF Domain | Description | Illustrative Quotes of Implementation Barriers and Facilitators |
|---|---|---|---|
| | | | quick—I mean they just—it really shocked me how quickly— They jumped in to help you.” (Facilitator)<br>“No, I really think that it was put together perfect for me, because I didn’t have to scramble around. I didn’t have to call 10 or 15 different places and they’re not offering anything that’s on the paper, you know.” (Facilitator) |
| Inner Context (Local and Organizational Level) and Outer Context (Health Care System) | Context | Inner context factors include formal policies, previous experiences, or descriptions of political, social, or economic implementation drivers that is associated with the clinic, community based organizations, or locally administered social services. Outer context includes engaging with health care systems at large. This could include factors associated with access or quality or institutional policies. | “The Housing Authority is failing the tenants. They are. They really are. And I’m like, I just don’t get it. I don’t get it.” (Barrier)<br>“Yeah. I’m pretty sure everybody knows that you go to the doctor and emergency or something like that, a big bill [ph] is going to follow… And I believe that’s something that needs to be in everybody’s mind when going to the doctor if [ph] they don’t have insurance.” (Barrier)<br>“I set an appointment, I cancelled an appointment, and I feel that they don’t want to treat me. I don’t know why. I cancelled the last appointment because I have fever. It’s very difficult to go to the dentist with fever. I don’t know why they |

| Qualitative Code Categories | HEIF Domain | Description | Illustrative Quotes of Implementation Barriers and Facilitators |
|---|---|---|---|
| | | | are not flexible. And as I told you before, they are dealing with patients, they are not dealing with machines or robots." (Barrier)<br>"I had to go to the social service department and provide proof. It was just such a long process and they didn't need an appointment, but I was there for like hours and it was so draining. I'm like, if I had known this, I would have just made an appointment, maybe it would have been faster. I sat in the lobby for a long time, probably like a good hour waiting to see someone… Do you know what I'm saying? I didn't want to spend half of my day sitting there waiting to get assistance with a bill." (Barrier) |
| Patient Beliefs, Knowledge, and Situation | Patient Factors | Factors that affect implementation that are specific to the patient and can include beliefs, acceptability, privacy concerns, and individual's situation, preferences for communication or engagement, and attitudes towards relevant stakeholders or institutions. | "Because a lot of people don't realize how much help is out there. You know, unless you ask, you never know. And I've never dreamed of asking anybody at (FQHC name) that until she approached me that day. So, it really helped me, you know?" (Barrier)<br>"For one, it shows that it's not just about seeing a patient, getting them in and out, that they actually care about the patients. I've been |

| Qualitative Code Categories | HEIF Domain | Description | Illustrative Quotes of Implementation Barriers and Facilitators |
|---|---|---|---|
| | | | going to (FQHC name) off and on for many years and I know that the majority of the patients, including myself, are low-income. So, knowing that there are other resources out that can help with different things, that's real helpful." (Facilitator)<br>"No, I didn't have any concerns about my privacy, because I felt like they was there to help, and you know, the only way for them to help me is to give them the information that they need to help me. If I beat around the bush, then it'll take longer, because I'm not really giving them the straight information. So no, I really wasn't concerned about, you know, my privacy." (Facilitator) |
| Method of Communication and Treatment | Provider Factors | A description of factors specific to the provider or care team. This can include method of communication or techniques used to screen and respond for social needs. This also includes implementation considerations related to the integration of PRAPARE with treatment, care | "Yeah, I have a very good relationship and when you have people that actually listen—that was another thing about the social worker, she actually listened to me." (Facilitator)<br>"I know some people need help, but they're a little more prideful and they're not—you know? So maybe the wording. I don't remember exactly how she asked about—I think she said something about—do you |

| Qualitative Code Categories | HEIF Domain | Description | Illustrative Quotes of Implementation Barriers and Facilitators |
|---|---|---|---|
| | | planning, and addressing medical needs. | feel, you know, with your current living situation, are you feeling safe? Maybe wording things a little different so the person doesn't feel intimidated or feel like—am I being asked this question because of my income status, or because I'm a—feeling like they've been placed in like a category because they're a patient at (FQHC name)." (Facilitator)<br>"Yeah, I was comfortable because of their approach. You know, some people have a hard approach, you know, to you, to your situation—you know, why this happen, why that happen? But they didn't go into that. They didn't go into, "What did you do with every penny?" You know, because I told her, I said, "Look, I only get so much a month, I only get SSI, and I have a high gas, high electric." So she was like, "Don't worry about that. This is what you need." You know?" (Facilitator) |
| Economies and Sociopolitical Forces | Societal Influence | A description of factors that effect implementation but are subject to larger, structural forces that include stigma, discrimination, | "Q: Did you find it hard to ask those questions before? A: In a way yes. Yeah. As I said, because I've always been independent. I've always done everything for myself. So, when you're done everything for yourself |

| Qualitative Code Categories | HEIF Domain | Description | Illustrative Quotes of Implementation Barriers and Facilitators |
|---|---|---|---|
| | | societal expectation, economic policy, and/or political climate. | it is so embarrassing to beg. Not beg, but it's—… Because you're used to doing those things for yourself. So, because you're not used to it, so it's hard to just get up and start asking people and things like that. So, it was a little difficult to ask about it." (Barrier)"<br>"To go all the way out there (affordable housing property) and then find out, "Oh, this was—this isn't offered anymore." "Why they still have us on the list? Because we're not taking Section 8 (housing assistance) anymore. We stopped taking Section 8 two or three years ago." (Barrier)<br>"Q: Did you find that anything else, just like in your background, your culture, that made it difficult to ask those questions or reach out for help? A: Yes. Because, like my culture—when we come, and you travel, you travel to be strong You don't travel to be weak, because we are stronger like 10 times more because that's why we came here. We didn't come to be a liability, you see? So, these are some of the things that you think about, too. You didn't come to be a liability, and so we work like 10 times harder." (Barrier) |

| Qualitative Code Categories | HEIF Domain | Description | Illustrative Quotes of Implementation Barriers and Facilitators |
|---|---|---|---|
| | | | "Prior to getting my Medicare… I had a lot of problems getting the proper care I needed because I wasn't working. So, I was really dependent on my sister to pay my copays, and she has a family on her—of her own, and she stays in D.C. But she did the best she could." (Barrier)<br>"The problem—let me be honest with you. We are in the process with the United States Citizenship and Immigration Service, and I told the person, I remember the—probably she was a social worker or something like that. I told the person that we can't receive any, any help from the government right now because we are in the process with the United States Citizenship and Immigration Service. I talked with my lawyer. He told me that it's not the time—it's not good for us to receive any government help right now." (Barrier)<br>"Sometimes, when you're applying for a job, or when you are filling out a form, sometimes I feel that it's like discriminatory. Discriminatory because if, for example, if I say ________, "He's Hispanic, |

| Qualitative Code Categories | HEIF Domain | Description | Illustrative Quotes of Implementation Barriers and Facilitators |
|---|---|---|---|
| | | | he's American Indian," probably you don't get that job, or you don't get—or probably, sometimes—I think sometimes that you don't—you're going to be treated fairly or something like that because it's a barrier." (Barrier)<br>"Well, I'm on social media and I notice when people post or make comments about being in need or whatever. Of course, their close friends or family might comment and sound sympathetic or whatever. But it seems like there's always backlash from that like, "People need to stop putting up"—not me personally. I would never do a GoFundMe to raise money for a family member's funeral. That's just a personal thing. But some people, that may be the only choice they have. And depending on their situation, so you just see like a lot of backlash when people do ask for help like they're not supposed to. But then it's like, "Well, how do you expect some people to be able to do better if they don't make it known that they need help?" (Barrier)<br>"People judge. You know, "Why do you need help? What did you do with—aren't you working?" Things |

| Qualitative Code Categories | HEIF Domain | Description | Illustrative Quotes of Implementation Barriers and Facilitators |
|---|---|---|---|
| | | | like that. Because people tend to judge. If you're in need and they figure it's something you didn't do right or it's something you did wrong, whereas that may not necessarily be the situation." (Barrier)<br>"Yeah, so I know social services is like that with—I think they're like that with rent. They only help once a year. Well, once you reach a certain amount. So, like, I think, like, if—they'll help you up to $600 per year. Anything more than at, you have to find somewhere else to get the assistance. And it's like, if your rent is already like eight, when you come, you've got to have the other amount." (Barrier)<br>"Yeah, it's crazy. In the last year, I've needed help. In all honesty, I probably would have gotten approved but that's all of the hoops and hoops you have to jump through and jump over to get it. I just wasn't in for it, so I didn't bother." (Barrier)<br>"So, Section 8, this has been a really frustrating experience, getting the repairs you need and the feeling that the landlord's not doing their job, not doing their part. Yeah, he's not. |

| Qualitative Code Categories | HEIF Domain | Description | Illustrative Quotes of Implementation Barriers and Facilitators |
|---|---|---|---|
| | | | And then you're letting him get by with it." (Barrier)<br>"Well, social needs, financial needs, I don't discuss with anybody because ain't nobody going to listen to you. The people that I normally talk to, they don't have no more than I have, so there's no one else to talk to because don't nobody else want to listen. That's how I look at it. Like the mayor. We talk and talk and talk and talk, and he just does what he wants to do." (Barrier) |

# REFERENCES

1. Marmot M. Economic and social determinants of disease. *Bulletin of the World Health Organization.* 2001;79:988-989.

2. Marmot MG, Bell R. Action on health disparities in the United States: commission on social determinants of health. *Jama.* 2009;301(11):1169-1171.

3. Booske BC, Athens JK, Kindig DA, Park H, Remington PL. Different perspectives for assigning weights to determinants of health. *University of Wisconsin: Population Health Institute.* 2010.

4. Chetty R, Stepner M, Abraham S, et al. The association between income and life expectancy in the United States, 2001-2014. *Jama.* 2016;315(16):1750-1766.

5. Marmot M. Social determinants of health inequalities. *The lancet.* 2005;365(9464):1099-1104.

6. Health CoSDo. *Closing the gap in a generation: health equity through action on the social determinants of health: final report of the commission on social determinants of health.* World Health Organization; 2008.

7. Havranek EP, Mujahid MS, Barr DA, et al. Social determinants of risk and outcomes for cardiovascular disease: a scientific statement from the American Heart Association. *Circulation.* 2015;132(9):873-898.

8. Berkowitz SA, Seligman HK, Rigdon J, Meigs JB, Basu S. Supplemental Nutrition Assistance Program (SNAP) participation and health care expenditures among low-income adults. *JAMA internal medicine.* 2017;177(11):1642-1649.

9. Alderwick H, Gottlieb LM. Meanings and misunderstandings: a social determinants of health lexicon for health care systems. *The Milbank Quarterly.* 2019;97(2):407.

10. Green K, Zook M. When talking about social determinants, precision matters. *Health Affairs Blog.* 2019.

11. Castrucci B, Auerbach J. Meeting individual social needs falls short of addressing social determinants of health. *Health Affairs Blog.* 2019;10.

12. Jani A. Preparing for COVID-19’s aftermath: simple steps to address social determinants of health. *Journal of the Royal Society of Medicine.* 2020:0141076820921655.

13. Shah GH, Shankar P, Schwind JS, Sittaramane V. The Detrimental Impact of the COVID-19 Crisis on Health Equity and Social Determinants of Health. *Journal of Public Health Management and Practice.* 2020;26(4):317-319.

14. Fraze TK, Brewster AL, Lewis VA, Beidler LB, Murray GF, Colla CH. Prevalence of screening for food insecurity, housing instability, utility needs, transportation needs, and interpersonal violence by US physician practices and hospitals. *JAMA network open.* 2019;2(9):e1911514-e1911514.

15. DeVoe JE, Bazemore AW, Cottrell EK, et al. Perspectives in primary care: a conceptual framework and path for integrating social determinants of health into primary care practice. In: Annals Family Med; 2016.

16. Barr V, Robinson S, Marin-Link B, et al. The expanded chronic care model. *Hosp Q.* 2003;7(1):73-82.

17. Shaller D. *Patient-centered care: What does it take?* : Commonwealth Fund New York; 2007.

18. Epstein RM. The science of patient-centered care. *Journal of Family Practice.* 2000;49(9):805-810.

19. Alley DE, Asomugha CN, Conway PH, Sanghavi DM. Accountable health communities—addressing social needs through Medicare and Medicaid. *N Engl J Med.* 2016;374(1):8-11.

20. Bachrach D. *Addressing patients' social needs: an emerging business case for provider investment.* Commonwealth Fund; 2014.

21. Joynt KE, De Lew N, Sheingold SH, Conway PH, Goodrich K, Epstein AM. Should Medicare value-based purchasing take social risk into account? *New England Journal of Medicine.* 2017;376(6):510-513.

22. Framework APM. Work Group (2016). Alternative payment model (APM) framework. *Health Care Payment Learning & Action Networks, via https://hcp-lan org/workproducts/apm-whitepaper pdf.*

23. National Academies of Sciences E, Medicine. *Accounting for social risk factors in Medicare payment: criteria, factors, and methods.* National Academies Press; 2016.

24. Anderson AC, O’Rourke E, Chin MH, Ponce NA, Bernheim SM, Burstin H. Promoting health equity and eliminating disparities through performance measurement and payment. *Health Affairs.* 2018;37(3):371-377.

25. Huffstetler AN, Phillips Jr RL. Payment structures that support social care integration with clinical care: social deprivation indices and novel payment models. *American Journal of Preventive Medicine.* 2019;57(6):S82-S88.

26. Pediatrics CoC. Poverty and child health in the United States. *Pediatrics.* 2016;137(4):e20160339.

27. Gottlieb LM, Wing H, Adler NE. A systematic review of interventions on patients' social and economic needs. *American Journal of Preventive Medicine.* 2017;53(5):719-729.

28. Morales ME, Epstein MH, Marable DE, Oo SA, Berkowitz SA. Peer reviewed: Food insecurity and cardiovascular health in pregnant women: Results from the Food for Families Program, Chelsea, Massachusetts, 2013–2015. *Preventing Chronic Disease.* 2016;13.

29. Berkowitz SA, Delahanty LM, Terranova J, et al. Medically tailored meal delivery for diabetes patients with food insecurity: a randomized cross-over trial. *Journal of general internal medicine.* 2019;34(3):396-404.

30. Fichtenberg C, Delva J, Minyard K, Gottlieb LM. Health And Human Services Integration: Generating Sustained Health And Equity Improvements: An overview of collaborations, partnerships, and other integration efforts between health care and social services organizations. *Health Affairs.* 2020;39(4):567-573.

31. Page-Reeves J, Kaufman W, Bleecker M, et al. Addressing social determinants of health in a clinic setting: the WellRx pilot in Albuquerque, New Mexico. *J Am Board Fam Med.* 2016;29(3):414-418.

32. Thomas-Henkel C, Schulman M. Screening for social determinants of health in populations with complex needs: implementation considerations. *Center for Health Care Strategies https://www chcs org/media/SDOH-Complex-Care-Screening-Brief-102617 pdf Published October.* 2017.

33. O'Gurek DT, Henke C. A Practical Approach to Screening for Social Determinants of Health. *Family Practice Management.* 2018;25(3):7-12.

34. LaForge K, Gold R, Cottrell E, et al. How 6 organizations developed tools and processes for social determinants of health screening in primary care: An overview. *The Journal of ambulatory care management.* 2018;41(1):2.

35. Garg A, Marino M, Vikani AR, Solomon BS. Addressing families' unmet social needs within pediatric primary care: the health leads model. *Clinical pediatrics.* 2012;51(12):1191-1193.

36. Bottino CJ, Rhodes ET, Kreatsoulas C, Cox JE, Fleegler EW. Food insecurity screening in pediatric primary care: can offering referrals help identify families in need? *Academic pediatrics.* 2017;17(5):497-503.

37. Gottlieb LM, Hessler D, Long D, et al. Effects of social needs screening and in-person service navigation on child health: a randomized clinical trial. *JAMA pediatrics.* 2016;170(11):e162521-e162521.

38. Gold R, Cottrell E, Bunce A, et al. Developing electronic health record (EHR) strategies related to health center patients' social determinants of health. *J Am Board Fam Med.* 2017;30(4):428-447.

39. Cottrell EK, Gold R, Likumahuwa S, et al. Using health information technology to bring social determinants of health into primary care: a conceptual framework to guide research. *Journal of health care for the poor and underserved.* 2018;29(3):949.

40. Gold R, Bunce A, Cowburn S, et al. Adoption of Social Determinants of Health EHR Tools by Community Health Centers. *The Annals of Family Medicine.* 2018;16(5):399-407.

41. de la Vega PB, Losi S, Martinez LS, et al. Implementing an EHR-based screening and referral system to address social determinants of health in primary care. *Medical Care.* 2019;57:S133-S139.

42. Cantor MN, Thorpe L. Integrating Data On Social Determinants Of Health Into Electronic Health Records. *Health Affairs.* 2018;37(4):585-590.

43. NACHC. PRAPARE. National Association of Community Health Centers. http://www.nachc.org/research-and-data/prapare/. Published 2018. Accessed November 11, 2018, 2018.

44. Walsh WB, Betz NE. *Tests and assessment.* Prentice-Hall, Inc; 1995.

45. PRAPARE Validation Using 8 “Gold Standard” Stages of Measure Development. National Association of Community Health Centers. http://www.nachc.org/wp-content/uploads/2019/10/prapare_validation-fact-sheet-2019-9-26.pdf. Published 2019. Accessed.

46. People H. Healthy people 2020 objectives. *US Department of Health and Human Services.* 2020.

47. Andermann A. Screening for social determinants of health in clinical care: moving from the margins to the mainstream. *Public Health Reviews.* 2018;39(1):19.

48. Gottlieb L, Cottrell EK, Park B, Clark KD, Gold R, Fichtenberg C. Advancing social prescribing with implementation science. *The Journal of the American Board of Family Medicine.* 2018;31(3):315-321.

49. Fixsen DL, Blase KA, Naoom SF, Wallace F. Core implementation components. *Research on social work practice.* 2009;19(5):531-540.

50. Tong ST, Liaw WR, Kashiri PL, et al. Clinician experiences with screening for social needs in primary care. *The Journal of the American Board of Family Medicine.* 2018;31(3):351-363.

51. Schickedanz A, Hamity C, Rogers A, Sharp AL, Jackson A. Clinician experiences and attitudes regarding screening for social determinants of health in a large integrated health system. *Medical care.* 2019;57(Suppl 6 2):S197.

52. Byhoff E, De Marchis EH, Hessler D, et al. Part II: a qualitative study of social risk screening acceptability in patients and caregivers. *American Journal of Preventive Medicine.* 2019;57(6):S38-S46.

53. Lambert M. ACC/AHA Release Updated Guideline on the Treatment of Blood Cholesterol to Reduce ASCVD Risk. *American family physician.* 2014;90(4):260.

54. Karmali KN, Goff DC, Ning H, Lloyd-Jones DM. A systematic examination of the 2013 ACC/AHA pooled cohort risk assessment tool for atherosclerotic cardiovascular disease. *Journal of the American College of Cardiology.* 2014;64(10):959-968.

55. Cohen MK. North Carolina's Transformation to Medicaid Managed Care. *North Carolina medical journal.* 2019;80(5):277-279.

56. Byhoff E, Taylor LA. Massachusetts community-based organization perspectives on Medicaid redesign. *American Journal of Preventive Medicine.* 2019;57(6):S74-S81.

57. Theiss J, Regenstein M. Facing the need: screening practices for the social determinants of health. *The Journal of Law, Medicine & Ethics.* 2017;45(3):431-441.

58. Beck AF, Cohen AJ, Colvin JD, et al. Perspectives from the Society for Pediatric Research: interventions targeting social needs in pediatric clinical care. *Pediatric research.* 2018;84(1):10.

59. Gottlieb L, Tobey R, Cantor J, Hessler D, Adler NE. Integrating social and medical data to improve population health: opportunities and barriers. *Health Affairs.* 2016;35(11):2116-2123.

60. Weir CR, Jester M. *Assessing the Relationship Between Social Determinants of Health and Outcomes: Findings from the PRAPARE Pilot.* nachc.org: National Association of Community Health Centers; June 25, 2018 2018.

61. Henrikson NB, Blasi PR, Dorsey CN, et al. Psychometric and pragmatic properties of social risk screening tools: a systematic review. *American journal of preventive medicine.* 2019;57(6):S13-S24.

62. Cantor J, Cohen L, Mikkelsen L, Pañares R, Srikantharajah J, Valdovinos E. Community-Centered Health Homes. *Oakland, CA: Prevention Institute.* 2011.

63. Neuwirth EEB, Schmittdiel JA, Tallman K, Bellows J. Understanding panel management: a comparative study of an emerging approach to population care. *The Permanente Journal.* 2007;11(3):12.

64. Drake C, Eisenson H. Assessing and Addressing Social Needs in Primary Care. *New England Journal of Medicine Catalyst.* 2019;5(6).

65. HEDIS N. Healthcare effectiveness data and information set. *Washington DC: NCQA.* 2009.

66. Walsh JM, McDonald KM, Shojania KG, et al. Quality improvement strategies for hypertension management: a systematic review. *Medical care.* 2006:646-657.

67. Kreatsoulas C, Anand SS. The impact of social determinants on cardiovascular disease. *Canadian Journal of Cardiology.* 2010;26:8C-13C.

68. Whelton P, Carey R, Aronow W, et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA Guideline for the Prevention, Detection, Evaluation, and Management of High Blood Pressure in Adults: Executive Summary: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines (vol 71, pg 2199, 2018). *JOURNAL OF THE AMERICAN COLLEGE OF CARDIOLOGY.* 2018;71(19):2273-2275.

69. Lloyd-Jones DM, Huffman MD, Karmali KN, et al. Estimating longitudinal risks and benefits from cardiovascular preventive therapies among medicare patients: the Million Hearts Longitudinal ASCVD Risk Assessment Tool: a special report from the American Heart Association and American College of Cardiology. *Journal of the American College of Cardiology.* 2017;69(12):1617-1636.

70. Lambert M. ACC/AHA release updated guideline on the treatment of blood cholesterol to reduce ASCVD risk. *American family physician.* 2014;90(4):260-264.

71. Wells BJ, Chagin KM, Nowacki AS, Kattan MW. Strategies for handling missing data in electronic health record derived data. *Egems.* 2013;1(3).

72. Hosmer DW. Lemeshow S. Applied logistic regression. *New York.* 2000.

73. Ahrens A, Hansen CB, Schaffer ME. lassopack: Model selection and prediction with regularized regression in Stata. *arXiv preprint arXiv:190105397.* 2019.

74. Belloni A, Chernozhukov V, Hansen C. High-dimensional methods and inference on structural and treatment effects. *Journal of Economic Perspectives.* 2014;28(2):29-50.

75. Kennedy P. *A guide to econometrics.* MIT press; 2003.

76. Hu S. Akaike information criterion. *Center for Research in Scientific Computation.* 2007;93.

77. Steyerberg EW, Harrell Jr FE, Borsboom GJ, Eijkemans M, Vergouwe Y, Habbema JDF. Internal validation of predictive models: efficiency of some procedures for logistic regression analysis. *Journal of clinical epidemiology.* 2001;54(8):774-781.

78. StataCorp L. Stata statistical software: release 16. College Station, TX. 2019.

79. Fichtenberg CM, Alley DE, Mistry KB. Improving social needs intervention research: key questions for advancing the field. *American journal of preventive medicine.* 2019;57(6):S47-S54.

80. Hassan A, Scherer EA, Pikcilingis A, et al. Improving social determinants of health: effectiveness of a web-based intervention. *American journal of preventive medicine.* 2015;49(6):822-831.

81. Doyle SK, Chang AM, Levy P, Rising KL. Achieving health equity in hypertension management through addressing the social determinants of health. *Current hypertension reports.* 2019;21(8):58.

82. Tipirneni R, Vickery KD, Ehlinger EP. Accountable communities for health: moving from providing accountable care to creating health. *The Annals of Family Medicine.* 2015;13(4):367-369.

83. Billioux A, Verlander K, Anthony S, Alley D. Standardized screening for health-related social needs in clinical settings: The accountable health communities screening tool. *NAM Perspectives.* 2017.

84. Thomas-Henkel C, Schulman M. Screening for social determinants of health in populations with complex needs: implementation considerations. *Available from:) The Robert Wood Johnson Foundation and the Center for Health Care Strategies, New York, NY.* 2017.

85. Garg A, Toy S, Tripodis Y, Silverstein M, Freeman E. Addressing social determinants of health at well child care visits: a cluster RCT. *Pediatrics.* 2015;135(2):e296-e304.

86. Frizzell JD, Liang L, Schulte PJ, et al. Prediction of 30-day all-cause readmissions in patients hospitalized for heart failure: comparison of machine learning and other statistical approaches. *JAMA cardiology.* 2017;2(2):204-209.

87. Miller PE, Pawar S, Vaccaro B, et al. Predictive abilities of machine learning techniques may be limited by dataset characteristics: insights from the UNOS database. *Journal of cardiac failure.* 2019;25(6):479-483.

88. van der Ploeg T, Austin PC, Steyerberg EW. Modern modelling techniques are data hungry: a simulation study for predicting dichotomous endpoints. *BMC medical research methodology.* 2014;14(1):137.

89. Strobl C, Boulesteix A-L, Zeileis A, Hothorn T. Bias in random forest variable importance measures: Illustrations, sources and a solution. *BMC bioinformatics.* 2007;8(1):25.

90. van der Ploeg T, Steyerberg EW. Feature selection and validated predictive performance in the domain of Legionella pneumophila: a comparative study. *BMC Research Notes.* 2016;9(1):1-7.

91. Wortman Z, Tilson EC, Cohen MK. Buying Health For North Carolinians: Addressing Nonmedical Drivers Of Health At Scale: This article describes initiatives the North Carolina Department of Health and Human Services is implementing to integrate medical and nonmedical drivers of health. *Health Affairs.* 2020;39(4):649-654.

92. Galea S, Tracy M, Hoggatt KJ, DiMaggio C, Karpati A. Estimated deaths attributable to social factors in the United States. *American journal of public health.* 2011;101(8):1456-1465.

93. Burgard SA, Seefeldt KS, Zelner S. Housing instability and health: findings from the Michigan Recession and Recovery Study. *Social science & medicine.* 2012;75(12):2215-2224.

94. Berkowitz SA, Terranova J, Hill C, et al. Meal delivery programs reduce the use of costly health care in dually eligible Medicare and Medicaid beneficiaries. *Health Affairs.* 2018;37(4):535-542.

95. McGinnis JM, Stuckhardt L, Saunders R, Smith M. *Best care at lower cost: the path to continuously learning health care in America.* National Academies Press; 2013.

96. Health UDo, Services H. National Healthcare Quality and Disparities Report and 5th Anniversary Update on the National Quality Strategy. *Rockville, MD: Department of Health and Human Services) Available online at https://www ahrq gov/sites/default/files/wysiwyg/research/findings/nhqrdr/nhqdr15/2015nhqdr pdf.* 2015.

97. Weir RC, Proser M, Jester M, Li V, Hood-Ronick CM, Gurewich D. Collecting Social Determinants of Health Data in the Clinical Setting: Findings from National PRAPARE Implementation. *Journal of Health Care for the Poor and Underserved.* 2020;31(2):1018-1035.

98. Wasserman M, Berninger J, Gerteis J. Estimating the Costs of Primary Care Transformation: A Practical Guide and Synthesis Report. *Rockville, Maryland: AHRQ.* 2015.

99. Magill MK, Ehrenberger D, Scammon DL, et al. The cost of sustaining a patient-centered medical home: experience from 2 states. *The Annals of Family Medicine.* 2015;13(5):429-435.

100. Thomas A, Ferguson E. NCCARE360 Building Healthier Communities Through Collaboration. *North Carolina medical journal.* 2019;80(5):308-308.

101. Moffett ML, Kaufman A, Bazemore A. Community health workers bring cost savings to patient-centered medical homes. *Journal of community health.* 2018;43(1):1-3.

102. Hartzler AL, Tuzzio L, Hsu C, Wagner EH. Roles and functions of community health workers in primary care. *The Annals of Family Medicine.* 2018;16(3):240-245.

103. Darnell JS. Free clinics in the United States: a nationwide survey. *Archives of internal medicine.* 2010;170(11):946-953.

104. Pruitt Z, Emechebe N, Quast T, Taylor P, Bryant K. Expenditure reductions associated with a social service referral program. *Population health management.* 2018;21(6):469-476.

105. Garg A, Homer CJ, Dworkin PH. Addressing social determinants of health: challenges and opportunities in a value-based model. *Pediatrics.* 2019;143(4).

106. Starks MA, Schmicker RH, Peterson ED, et al. Association of neighborhood demographics with out-of-hospital cardiac arrest treatment and outcomes: where you live may matter. *JAMA cardiology.* 2017;2(10):1110-1118.

107. Zhang Y, Ancker JS, Hall J, Khullar D, Wu Y, Kaushal R. Association Between Residential Neighborhood Social Conditions and Health Care Utilization and Costs. *Medical Care.* 2020;58(7):586-593.

108. Hatef E, Ma X, Rouhizadeh M, Singh G, Weiner JP, Kharrazi H. Assessing the Impact of Social Needs and Social Determinants of Health on Health Care Utilization: Using Patient-and Community-Level Data. *Population Health Management.* 2020.

109. Byhoff E, Garg A, Pellicer M, et al. Provider and staff feedback on screening for social and behavioral determinants of health for pediatric patients. *The Journal of the American Board of Family Medicine.* 2019;32(3):297-306.

110. Chaudoir SR, Dugan AG, Barr CH. Measuring factors affecting implementation of health innovations: a systematic review of structural, organizational, provider, patient, and innovation level measures. *Implementation science.* 2013;8(1):22.

111. Wagner EH, Austin BT, Davis C, Hindmarsh M, Schaefer J, Bonomi A. Improving chronic illness care: translating evidence into action. *Health affairs.* 2001;20(6):64-78.

112. Stange KC, Nutting PA, Miller WL, et al. Defining and measuring the patient-centered medical home. *Journal of general internal medicine.* 2010;25(6):601-612.

113. Rosland AM, Wong E, Maciejewski M, et al. Patient-Centered Medical Home Implementation and Improved Chronic Disease Quality: A Longitudinal Observational Study. *Health services research.* 2017.

114. Jackson GL, Powers BJ, Chatterjee R, et al. The patient-centered medical home: a systematic review. *Annals of internal medicine.* 2013;158(3):169-178.

115. Smith QW, Street Jr RL, Volk RJ, Fordis M. Differing levels of clinical evidence: exploring communication challenges in shared decision making. *Medical Care Research and Review.* 2013;70(1_suppl):3S-13S.

116. Palinkas LA, Horwitz SM, Green CA, Wisdom JP, Duan N, Hoagwood K. Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. *Administration and policy in mental health and mental health services research.* 2015;42(5):533-544.

117. Woodward EN, Matthieu MM, Uchendu US, Rogal S, Kirchner JE. The health equity implementation framework: proposal and preliminary study of hepatitis C virus treatment. *Implementation Science.* 2019;14(1):26.

118. Harvey G, Kitson A. PARIHS revisited: from heuristic to integrated framework for the successful implementation of knowledge into practice. *Implementation science.* 2015;11(1):33.

119. Kilbourne AM, Switzer G, Hyman K, Crowley-Matoka M, Fine MJ. Advancing health disparities research within the health care system: a conceptual framework. *American journal of public health.* 2006;96(12):2113-2121.

120. Gill P, Stewart K, Treasure E, Chadwick B. Methods of data collection in qualitative research: interviews and focus groups. *British dental journal.* 2008;204(6):291.

121. O’Brien BC, Harris IB, Beckman TJ, Reed DA, Cook DA. Standards for reporting qualitative research: a synthesis of recommendations. *Academic Medicine.* 2014;89(9):1245-1251.

122. Hsieh H-F, Shannon SE. Three approaches to qualitative content analysis. *Qualitative health research.* 2005;15(9):1277-1288.

123. Saunders B, Sim J, Kingstone T, et al. Saturation in qualitative research: exploring its conceptualization and operationalization. *Quality & quantity.* 2018;52(4):1893-1907.

124. Boyatzis RE. *Transforming qualitative information: Thematic analysis and code development.* sage; 1998.

125. Check DK, Hutcheson KA, Poisson LM, et al. Factors associated with employment discontinuation among older and working age survivors of oropharyngeal cancer. *Head & neck.* 2019;41(11):3948-3959.

126. De Boer AG, Taskila T, Ojajärvi A, Van Dijk FJ, Verbeek JH. Cancer survivors and unemployment: a meta-analysis and meta-regression. *Jama.* 2009;301(7):753-762.

127. Zafar SY, Abernethy AP. Financial toxicity, part I: a new name for a growing problem. *Oncology (Williston Park, NY).* 2013;27(2):80.

128. Williamson LD, Bigman CA. A systematic review of medical mistrust measures. *Patient education and counseling.* 2018;101(10):1786-1794.

129. Alang S, McAlpine DD, Hardeman R. Police Brutality and Mistrust in Medical Institutions. *Journal of Racial and Ethnic Health Disparities.* 2020:1-9.

130. Shediac-Rizkallah MC, Bone LR. Planning for the sustainability of community-based health programs: conceptual frameworks and future directions for research, practice and policy. *Health education research.* 1998;13(1):87-108.

131. Brownson RC, Colditz GA, Proctor EK. *Dissemination and implementation research in health: translating science to practice.* Oxford University Press; 2017.

132. Proctor EK, Powell BJ, McMillen JC. Implementation strategies: recommendations for specifying and reporting. *Implementation Science.* 2013;8(1):139.

133. Weiner BJ. A theory of organizational readiness for change. *Implementation science.* 2009;4(1):67.

134. Hettema J, Steele J, Miller WR. Motivational interviewing. *Annu Rev Clin Psychol.* 2005;1:91-111.

135. Suchman AL, Markakis K, Beckman HB, Frankel R. A model of empathic communication in the medical interview. *Jama.* 1997;277(8):678-682.

136. Swenson SL, Buell S, Zettler P, White M, Ruston DC, Lo B. Patient-centered communication. *Journal of general internal medicine.* 2004;19(11):1069-1079.

137. Chinman M, Woodward EN, Curran GM, Hausmann LR. Harnessing Implementation Science to Increase the Impact of Health Disparity Research. *Medical care.* 2017;55(Suppl 9 2):S16.

138. Curran GM, Bauer M, Mittman B, Pyne JM, Stetler C. Effectiveness-implementation hybrid designs: combining elements of clinical effectiveness and implementation research to enhance public health impact. *Medical care.* 2012;50(3):217.