ADOPTION OF MHEALTH AMONG LATINOS WITH CARDIOMETABOLIC RISK FACTORS

by
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Abstract

Purpose of the Study: The aim of this explanatory mixed methods study was to understand what factors motivate Latinos with cardiometabolic risk factors (CMRF) to use mHealth.

Design and Methods: Data from N=101 participants (63=Female, 38=Male) in the cross-sectional survey and N=17 respondents in the semi-structured interviews were used to be analyzed and evaluated in the mixed methods phase. Survey items consisted of demographic information, clinical history, smoking and alcohol use, and predictors of mHealth use (Perceived health risks, Health Consciousness, Perceived usefulness, and mHealth literacy). In-depth interviews were conducted with Latinos with CMRF and transcripts of the interviews were analyzed for thematic content. Relationship between predictors of mHealth use was tested using regression and chi-squared analysis. Transcripts were analyzed using qualitative content analysis.

Results: Health consciousness was found to be a statistically significant predictor of Perceived usefulness (β=0.24, *P*=0.050). Both Health consciousness and Perceived Usefulness were positively associated with mHealth use (β=0.15, *P*=0.151), (β=0.90, *P*=0.000) respectively. mHealth literacy moderated the relationship between Perceived usefulness and mHealth use (β=-2.05, *P*=0.046), and was related to both barriers and facilitators to mHealth use even though the interaction effect was negative. Seven major themes emerged with three facilitators of mHealth use: (1) Intrinsic motivation to learn how to improve health, (2) Availability of social resources, (3) Personalized features to meet their needs; and four barriers: (4) Lack of self-efficacy to operate devices, (5) Concern over affordability and financing mHealth, (6) Competing priorities lead to sedentary behaviors, and (7) Navigating a new country.

Conclusion: In Latinos with CMRF, there is a strong awareness of perceived disease risk and

the need to take care of oneself. mHealth was qualitatively reported as an important tool that can help with disease self-management. Yet, mHealth literacy was needed to moderate the relationship between how participants appreciate its utility and their actual uptake. Given that such barriers are unique to the Latino community, researchers should create mHealth interventions that are literacy focused, culturally tailored, and affordable since they all influence mHealth use and CMRF self-management.

Primary Reader and Advisor: Hae-Ra Han

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Dedication

This dissertation is dedicated to my precious daughter, Sophia, for being my main source of motivation and perseverance during the culmination of my program.

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CHAPTER 1

Background

Cardiometabolic risk factors (CMRF) —a cluster of risk factors, including obesity, high fasting blood sugar, high blood pressure, high triglyceride, and low HDL cholesterol, that raises one's risk for coronary heart disease (CHD) and diabetes, is a public health burden in the US.[1] Annual health care expenditures from 2010-2012 were approximately double for those with three or four CMRFs at $7,640, compared with $3,940 and $3,523 for those with one CMRF and zero CMRF, respectively.[2] Latinos in the US experience higher morbidity for CMRF than non-Hispanic whites (41% vs. 32%). [3-8] Due to a host of sociodemographic and cultural barriers such as lack of insurance, lack of transportation, or language discordance, Latinos with CMRF often have difficulty managing their health condition which results in increased CHD, stroke, and heart failure.[7] Evidence suggests that mobile health (mHealth) can be an effective and cost-saving approach to managing chronic health conditions. mHealth is defined as the use of mobile phones and other wireless technology to communicate and access health related information. [9,10] Examples of mHealth modality may include SMS facilitated (i.e., text messaging) patient-provider communication, smartphone applications (apps). Therefore, Latinos can potentially leverage this platform for self-management of CMRF. For the purposes of this study, mHealth is defined as text messaging and use of mobile apps since they are reported to be the highest used modalities in the Latino community.

Given the high cell phone penetration in the Latino community, [13,14] mHealth presents a promising avenue for educating and motivating Latino patients with CMRF to promote heart health.[15] This study is a continuation of a pilot study where we received feedback from key informants in the Latino community about the study questionnaire and interview guide. The researcher proposes to examine the factors that influence the use of mHealth among Latinos with

CMRF. The modified Technology Acceptance Model (TAM) [16,17] offers a comprehensive pathway to understand how health beliefs (Perceived Health Risks and Health Consciousness), attitudes (Perceived Usefulness) and mHealth literacy—one's ability to understand and use mHealth [18,19]—can influence Latino's use of mHealth. This study is innovative because it is the first to explore the motivating factors that influence mHealth use in Latinos, the fastest growing demographic group in the country yet one of the most understudied populations in the mHealth literature. An understanding of Latino patients with CMRF in terms of their characteristics, perceptions and sociocultural norms and how they influence the Latino patients' use of mHealth can inform the design of a patient-centered mHealth intervention and enable its implementation.

Purpose and Specific Aims

The purpose of this study is to examine and explore factors that motivate Latinos to use mHealth for self-management of their CMRF. A cross-sectional, explanatory sequential mixed-methods design is used to answer the research question guided by the modified TAM. The data is collected and analyzed in the quantitative arm followed by the qualitative arm. Quantitative data is collected cross-sectionally via in person questionnaires and is analyzed via Stata (v. 14 College Station, TX) using multiple linear regression models. Participants are purposively sampled for the qualitative arm based on their level of mHealth use. The researcher uses traditional one-on-one qualitative interview techniques involving open-ended questions in order to elicit participant experiences. The qualitative data is analyzed through coding and thematic analysis using NVivo. 12. In the mixed methods analysis phase, the researcher iteratively analyzes the data from both arms to provide better explanations about individual beliefs and behaviors in understudied populations such as Latinos. Latino health disparities are often contextually bound and culturally grounded.[26] Quantitative methods can help us generalize

findings, but qualitative methods are also needed to understand the sociocultural underpinnings in which health risks occur. Therefore, mixed methods designs are the most ideal in analyzing health beliefs in ethnically diverse populations and bridging the gap in differential health outcomes. To this end, the proposed aims of the study are:

Quantitative Aims:

1. To examine the relationship among health beliefs (Perceived Health Risks and Health Consciousness), Perceived Usefulness, and mHealth Use among Latinos with CMRF.

Hypothesis 1.1: *Perceived Health Risks* and *Health Consciousness* will be positively associated with *Perceived Usefulness* even after adjusting for age, sex, income, education, English proficiency, and cardiovascular disease (CVD) risk score.

Hypothesis 1.2: *Health Consciousness* will be positively associated with *mHealth Use* even after adjusting for age, sex, income, education, English proficiency, and CVD risk score.

Hypothesis 1.3: *Perceived Usefulness* will be positively associated with of *mHealth Use* even after adjusting for age, sex, income, education, English proficiency, and CVD risk score.

2. To examine the role of mHealth literacy in mHealth Use.

Hypothesis 2.1: *mHealth literacy* will moderate the relationship between *Perceived Usefulness* and *mHealth Use*.

Qualitative Aim:

3. To explore the individual experiences of Latinos with CMRF in the United States to elicit barriers and facilitators of mHealth use.

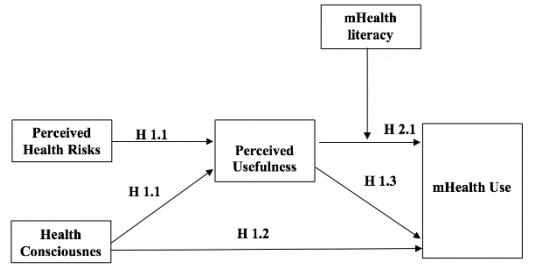
Mixed Methods Aim:

4. To generate a comprehensive understanding of understanding of how cultural and social norms of Latinos with CMRF influence their mHealth use.

Conceptual Framework

The Technology Acceptance Model (TAM) has been one of the most popular models to understand mHealth use among disadvantaged populations such as the elderly, less educated folks and ethnic minorities.[27-30] The TAM provides a comprehensive framework to explore the intricate relationship among health beliefs (e.g., Perceived Health Risks), Perceived Usefulness, mHealth Literacy and mHealth Use.[16,17] The original TAM was modified for the purpose of the study (Figure 1) to add a health belief construct, Health Consciousness. Health Consciousness, "the extent to which a person takes care of his or her health,"[24] is a particularly relevant concept to Latinos most of whom are first generation immigrants. Latinos recognize family as the locus of control in decision making and place low priority in caring for their own health resulting in poor health consciousness.[3,25] According to the study framework, both Perceived Health Risks and Health Consciousness influence the person's perception of usefulness. mHealth literacy is defined as one's ability to understand and use mobile phone-based health related applications.[18,19] Despite the positive cardiovascular health outcomes in mHealth and the potential to reach marginalized populations, successful mHealth programs require that patients have the knowledge to access and use the functions their phones have.[18,19] Limited health literacy is negatively associated with the use of preventive services, management of chronic conditions (e.g., CMRF) and self-reported health. [22,23] One proposed way to reduce health disparities is to close the gap in health literacy and increase the use of health information and communication technology to support patient self-management.[23] In the TAM, levels of mHealth literacy moderate the relationship between Perceived Usefulness and mHealth and mHealth use in Latinos with CMRF.

Figure 1. Modified Technology Acceptance Model



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CHAPTER 2

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Efficacy of mHealth for Self-Management of Cardiometabolic Risk Factors: a Theory-guided Systematic Review

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Competing Interests: All authors have no conflicts to disclose.

Abstract

Background: Although mobile health technologies (mHealth) are burgeoning in the research arena, there is a lack of mHealth interventions focused on improving self-management of individuals with cardiometabolic risk factors (CMRF).

Objective: The purpose of this paper was to critically and systematically review efficacy of mHealth interventions for self-management of CMRF while evaluating quality, limitations, and issues with disparities using the Technology Acceptance Model as a guiding framework.

Methods: PubMed, CINAHL, EMBASE, and Lilacs were searched to identify research articles published between January 2008 and November 2018. Articles were included if they were published in English, included adults, were conducted in the United States and used mHealth to promote self-care or self-management of CMRF. A total of 28 articles were included in this review.

Results: Studies incorporating mHealth have been linked to positive outcomes in self-management of diabetes, physical activity, diet and weight loss. Most mHealth interventions included modalities such as text messaging, mobile applications and wearable technologies. There was a lack of studies that are: (1) in resource-poor settings, (2) theoretically driven, (3) community-engaged research, (4) measuring digital/health literacy, (5) measuring and evaluating engagement, (6) measuring outcomes related to disease self-management, and (7) focused on vulnerable populations, especially immigrants.

Conclusion: There is a still a lack of mHealth interventions created specifically for immigrant populations, especially within the Latino community—the largest growing minority group in the United States. In an effort to meet this challenge, more culturally tailored mHealth interventions are needed.

BACKGROUND

Cardiovascular disease places a significant public health burden on the US healthcare system.[1] Cardiometabolic risk factors (CMRF) are a cluster of risk factors, including obesity, high fasting blood sugar, hypertension, and high triglycerides that increase the risk of cardiovascular disease and diabetes.[1] Adjusted annual health care expenditures are approximately double for those with three or four CMRF compared with those with zero or one CMRF.[2] Moreover, racial disparities exist within cardiovascular care where Blacks and Hispanics have lower cardiovascular disease treatment rates than non-Hispanic Whites.[3,4] Mobile health (mHealth) technologies are innovative health care delivery mechanisms that may improve self-management of CMRF.

Mobile phone ownership and Internet access have drastically increased;[4] 95% of the United States population own mobile phones.[5] When adopted, mHealth interventions are effective in improving treatment adherence and health outcomes, especially CMRF.[6,7] Common mHealth modalities include text messaging-facilitated patient-provider communication, smartphone mobile applications, wearable technologies, and medical peripheral devices to monitor and access health-related information. Interventions using cell phones, smartphone apps, and text messaging resulted in improved self-care, adherence to treatment,[8] improved self-management,[9] and health care savings.[9] Despite the promising potential of mHealth to improve self-management of CMRF, its use in clinical and real-world settings is unrealized—partly because of the lack of systematic evidence of its efficacy.

As an immediate first step, it is important to examine and synthesize research regarding self-management of CMRF using mHealth. In this review we: (1) evaluated the efficacy of existing mHealth interventions targeting self-management of CMRF, (2) identified factors

associated with adoption of successful mHealth interventions in CMRF management, and (3) reviewed disparities in mHealth research for self-management of CMRF. Specifically, we used the Technology Acceptance Model as a framework to systematically identify social, structural, and systematic barriers and facilitators to mHealth adoption.

THEORETICAL FRAMEWORK

Previously published systematic reviews and meta-analyses have demonstrated the benefit of using a framework for integration of data to assess relationships between constructs and variables.[10] We used the Technology Acceptance Model[11] to guide this review's exploration of how perceptions, attitudes, and intentions influence mHealth adoption among people with CMRF (see Figure 1). The model uses the following constructs to identify predictive factors in participants' adoption of mHealth: perceived usefulness, the "subjective probability that using a specific application system will increase job performance," perceived ease of use, "the degree to which the [. . .] user expects the target system to be free of effort,"[(11, p985)] attitude towards using the system; behavioral intention to use; and actual adoption.

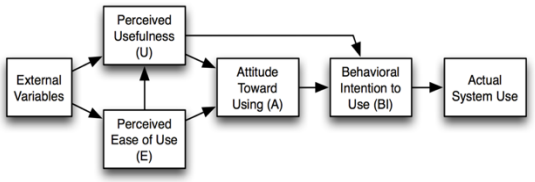


Figure 1. Technology Acceptance Model[11]

METHODS

Search methodology. This systematic review is reported according to Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines.[12] A comprehensive search was carried out in the Cumulative Index to Nursing and Allied Health Literature, PubMed, EMBASE, and Lilacs databases for articles published between January 2008 and October 2018 to identify literature on mHealth interventions to improve self-management among populations with CMRF. We restricted our scope to studies conducted in the United States to capture health care

disparities among groups such as racial and ethnic minorities or those who are immigrants living in the United States.[3,4] In consultation with a medical librarian, the following terms were included in the PubMed search, with similar terms used in the other databases: "telehealth," "Telemedicine," "mobile health," "ehealth," "mhealth," "Metabolic Syndrome X," "Cardiovascular Disease(s)," "cardiac risk factor," "risk factors."

Studies were included if they: (*a*) were published in English, (*b*) used an mHealth intervention, (*c*) addressed self-care of any type of CMRF, (*d*) sampled adults, and (*e*) were conducted in the United States. Articles were excluded if they: (*a*) were abstracts, (*b*) were non-research articles (e.g., review articles, editorial, protocol papers), and (*c*) investigated mHealth but did not relate to self-care of CMRF (e.g., clinician-delivered intervention, health coaching via telephone) (see Figure 2).

Inter-rater agreement. Two authors independently reviewed titles, abstracts, and full texts to determine eligibility. For title and abstract screening, the levels of agreement were moderate ranging from 47.3% to 55.8%.[4] For full-text screening, the indices of agreement were all considered to be good, ranging from 60% to 69.2%. A third rater adjudicated any discrepancy or conflicts between reviewers. Two reviewers independently assessed risk of bias for each study. An 85% agreement rate between reviewers was reached. Discordance was resolved by a vote from a third reviewer.

RESULTS

Screening and selection of articles

Figure 2 shows the article screening and selection process. The electronic search returned 2,713 articles, of which 323 were duplicates. Of the remaining 2390 articles, 2082 did not meet the inclusion criteria. The remaining 308 articles were pulled for full-text screening, of which

284 were excluded for reasons indicated in Figure 2. Four new articles were added via hand search for full-text review in November 2018. A total of twenty-eight articles were included in this review.

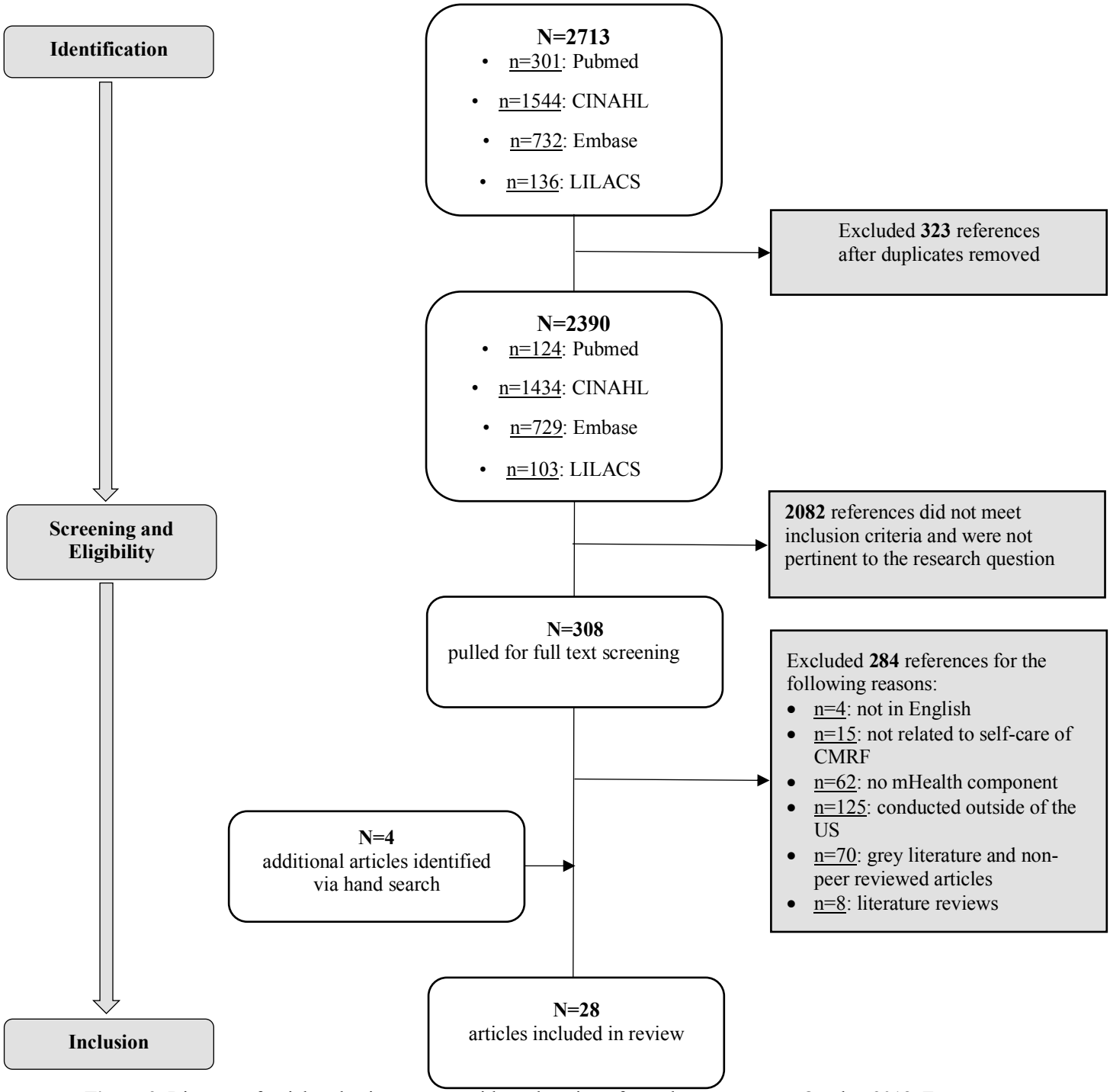


Figure 2. Diagram of article selection process with explanation of search strategy up to October 2018. Four additional articles were identified via hand search in November 2018. 28 articles included in literature review.

Characteristics of included studies

The designs of the 28 mHealth-related studies were the following (Table 1): Quantitative (n=25): randomized controlled trials (n=19)[13-15, 18, 20-26,28-31,33, 38-40] and quasi-experimental studies (n=6),[16,17,27,32,34,35] Qualitative interviews (n=1),[36] and Mixed methods (n=2).[19, 37]

The studies investigated mHealth interventions targeting various CMRF, including high blood pressure (HBP), high cholesterol, overweight and obesity, and diabetes, as well as cardiovascular disease, congestive heart failure, and kidney disease. The follow-up period for the randomized controlled trials and quasi-experimental studies ranged from 30 days to 24 months. Follow-up periods averaged within 1-, 3-, and 6-month increments, with only one study having shorter weekly posttest windows.[29]

Six studies were conducted in urban settings[13,26,27,29,32,35] and one in a rural setting.[35] Participants were recruited from large academic and medical centers (n=8);[14,15,17, 30,31,33,39,40] primary care and outpatient clinics (n=13);[19–26,28,35–37,39] cardiac rehabilitation (n=1);[18] churches (n=3); [13,16,38] and an online community (n=1).[34] Clinical conditions contributing to cardiovascular diseases included general cardiac risk factors (n=5),[13,16-18, 25,29] hypertension (n=9),[22,27,28,30,31,35,37-39] coronary heart disease (n=2),[28,33] congestive heart failure (n=2),[19,20] diabetes (n=11),[14,17,20–23,25,26,28,34,35] kidney disease (n=1),[36] and obesity/overweight (n=6).[23–25,32,34,40] All of the studies included participants 18 years and older, with a range of 26 to 65 years. Sample sizes ranged from 11 to 411 with a mean of 109. Most studies had representation from both men and women, whereas three studies targeted a female-only sampling frame.[13,24,39] Given this article's focus on health disparities, we also report how many studies recruited from underserved populations: federally qualified health center (n=1),[30] Women, Infants, and Children clinic (n=1),[24] uninsured (n=1),[21] safety-net emergency department (n=1),[14] veterans (n=1),[17]

mentally ill (n=2),[22,32] and low-income individuals (n=3).[14,21,22] In terms of ethnicity, 24 studies had a heterogeneous sample of ethnic minorities with the exception of a few that sampled only white (n=1),[32] black (n=3)[13,16,39] or Hispanic/Latino (n=1) participants.[27] Overall eight studies culturally tailored their intervention to vulnerable groups.[13,16,20,25,27,37–39]

Quality appraisal

The Johns Hopkins Research Evidence Appraisal Tool was used to assess the quality of the included studies (Table 1).[41] Two team members (SD and KW) independently reviewed and scored the studies identified from the literature search. The quality ratings were then combined and any studies that lacked a clear majority agreement were resolved by discussion. Remaining disagreements were adjudicated by a third author (HH). Among the selected studies, those without interventions or with a qualitative component were ranked level III.[19,32,36,37] Articles ranked level II were quasi-experimental studies, where there was a lack of control group and/or no randomization.[13,16,17,27,34,35] Nonetheless, despite some minor limitations, the quasi-experimental studies were strong in design and statistical analysis, because they controlled for confounding variables and systematic bias. Studies with sample sizes that were sufficient for their study design, conducted with robust methods and had strong analyses yielding statistical significance were given high-quality ratings and ranked level I.[14,15,18,20–26,28–31,33,38–40]

Raters standardized the score to range from 0 to 10 because not all questions were applicable. The average rating of quality scores for the 19 randomized controlled trials was 8.8 of 10 (range, 7–10). 26 out of 28 studies were rated high-quality (6.68 or higher), one study was medium-quality category (scores of 3.34-6.67),[13] and one was rated low (0-3.33).[19] Seven quasi-experimental studies had an average quality rating of 8.5 (range 7.5–10; maximum possible score, 10) and they all met the criterion of high-quality (7 or greater).[13,16,17,27,32,34,35]

Table 1. Summary of selected studies, quality rating, design, follow up, study characteristics and purpose

Author, Year	Setting	Study Design/ Duration	Study characteristics and Demographic Information					Purpose	Level of evidence: [I II III IV]
			N	Mean age, years	Sex, n [%]	Ethnicity, n [%]	Disease		Quality rating: [low, good, high]
Alshurafa et al., 2017[13]	One church and the surrounding community in an urban LA area	RCT 3- and 6-month follow up visits	37	Mean age not reported Range: 25-45	Female [100]	Black [100]	Risk factors for CVD	To describe an enhanced Remote Health Monitoring system, Wanda-CVD, that provides wireless coaching to participants.	Level II Medium
Arora et al., 2014 [14]	ED at LA County Hospital of the University of Southern California	RCT 6 months	128	50.7	Male [36], Female [64]	Hispanic/ Latino [87], Black [9], White [2], Asian/ Pacific Islander [2]	DM	To evaluate a daily text message intervention, TExT-MED, for resource-poor ED patients.	Level I High
Austin et al., 2012 [15]	Private not-for-profit hospital in Charleston, South Carolina	RCT 6 months	60	64.5	Male [38.3], Female [61.7]	White [51.7], AA [46.7], Hispanics [1.7]	CHF	To determine if an interactive voice response system (IVRS) with daily messages would be well accepted by patients and reduce 30-day CHF readmissions.	Level I High
Brewer et al., 2018 [16]	Five AA churches in southeast Minnesota	Quasi Experimental 6-months	50	49.6	Male [30], Female [70]	AA [100]	CVDs	To deliver health education and motivational support to users to improve CV health via *FAITH!* app.	Level II High
Dang et al., 2010 [17]	Telehealth clinic at the Veterans Affairs (VA) Medical Center (VAMC) in Miami, FL	Prospective quasi-experimental cohort (no control group) comparing baseline Framingham risk score (FRS) to FRS at 2 years.	41	68.7	Male [93], Female [7]	White [41.5], AA [26.8], Hispanics [31.7]	T2DM, HBP, high cholesterol	To determine the impact of teleheath care coordination (T-Care) program on CHD risk in older veterans.	Level II High
Duscha et al., 2018 [18]	Cardiac rehab (CR) center at Duke University Medical Center, Durham, NC.	RCT; 3:1 randomization to mHealth vs UC. 12-weeks	25	59.9 in mHealth arm, 66.5 in UC	Male [81.2] in mHealth arm, Male [66.7] in UC	Black [31.2], Non-Hispanic White [68.8]	CVDs	To determine the effects an mHealth based program using smartphones, physical activity (PA) trackers & health coaching for graduates of a center-based CR program on PA and peak oxygen uptake	Level I High

Ferguson et al., 2010 [19]	CHF clinic, University of Rochester Medical Center in Rochester, NY.	Cross-sectional; Focus group (FG), survey	9 FG/ 63 sur- vey	Range 35-82 in FG, 54.8 in survey	Not stated	Not stated	CHF	To describe the prototyping and design process of a conversational assistant to help monitor subjective and objective observations.	Level III Low
Forjuoh et al., 2014 [20]	Seven regional clinics of a university-affiliated HMO practice in Central TX.	4 arm non-blinded RCT 12- and 24- month follow up visits	376	57.6	Male [44.9], Female [55.1]	Hispanic [20.2], non-Hispanic Black [16.2], non-Hispanic White [60.1], Other [3.5]	T2DM	To compare the effectiveness of classroom-based versus mHealth delivered DM education on HbA_{1c} in an ethnically diverse health maintenance organization (HMO).	Level I High
Fortmann et al., 2017 [21]	Clinics within a network of federally qualified health centers in San Diego and Riverside CA.	2-arm non-blinded RCT 3- and 6-month follow up visits	126	47.8 in Dulce digital (DD), 49.1 in UC	Male [13.5] Female [36.5] in DD arm, Male [11.9] Female [38.1] in UC	Mexican [91], US- born [5], Other [4]	T2DM	To evaluate the effect of DD, a SMS-delivered diabetes education intervention versus UC.	Level I High
Frias et al., 2017 [22]	13 outpatient primary care facilities across CA and CO.	3-arm, cluster-RCT 12 weeks	109	57.8 in Combine d DMO, 61.6 in UC	Female n=45 in Combined DMO arm, Female n=10 in UC	In Combined DMO: AA [12.8], Hispanics [33.9], White [48.6], Asian [11.9] In UC: AA [2.75], Hispanics [12.8], White [17.4], Asian [1.83]	HBP and T2DM	To assess the impact on clinic-measured BP and glycated hemoglobin (HbA_{1c}) using a digital medicine offering (DMO) that measures medication ingestion adherence, PA, and rest using digital medicines (with ingestible sensor), wearable sensor patches, and a mobile device application.	Level I High
Fukuoka et al., 2015 [23]	Primary care clinics in San Francisco and Berkeley, CA.	RCT 5 months	61	55.2	Female [77]	Racial/ethnic minorities [48].	T2DM and OW	To examine the feasibility and efficacy of a DM prevention intervention combined with a mobile app (mDPP) and pedometer in English-speaking OW adults at risk for T2DM.	Level I High
Gilmore et al., 2017 [24]	Women, Infants, and Children services (WIC) clinics in Baton Rouge, LA.	Prospective, parallel-arm, RCT 16 weeks	35	26	Female [100]	In E-Moms: Black n=14, White n=2, Asian n=0 In WIC Moms: Black n=12, White n=6, Asian n=1	OW and OB	To test the efficacy of a smartphone- based intervention, “E-Moms” versus UC or “WIC Moms” to promote postpartum weight loss.	Level I High

Glasgow et al., 2011[25]	Primary care clinics within Kaiser Permanente CO	Three-arm RCT 4 months	270	57.8	Female [48.1]	American Indian/ Alaska Native [4.2], Asian [1.5], Black [18.1], White [67.4], Other [8.9] Latino ethnicity [22.3]	DM, OW, CVD risk factor	To report on: (1) the overall rate of use of the My Path/Mi Camino diabetes self-management website (2) frequency of engagement with website components (3) participant characteristics and their associations with greater engagement with the website; and (4) the relations between measures of engagement and 4-month outcomes.	Level I High
Graziano, 2008[26]	2 Clinics (primary care clinic, and endocrinology clinic) at urban medical center in the Midwest.	RCT 3 months	120	60.1 in Telephone group (TG) 63 in CG	In TG: Male n=33 Female n=28, In CG: Male n=33 Female n=25	In TG: White n=43 Nonwhite 18 In CG: White n=49 Nonwhite=9	T2DM	To evaluate the effect of an easily implemented automated telephone intervention on glycemic control in patients with type 2 DM.	Level I High
Han et al., 2018[27]	Community locations in an urban inner city.	Quasi Experimental; Feasibility 16 weeks	11	54.7	Female [63.6]	Hispanic, 11[100]	HBP	To develop a health literacy-focused HBP intervention for Spanish-speaking Latinos—PLAN 4 Success-HBP	Level II High
Kim et al., 2016 [28]	Scripps Health clinics	RCT, 2 group, pre-post trial 6 months	95	57.6	Female [68]	Caucasian [80], AA [6], Hispanic [5], Asian [5]	HBP, DM, Cardiac arrhythmia	To determine utility of wireless self-monitoring program on patient activation and health behaviors, medication adherence, and control of BP vs. control group	Level I High
Martin et al., 2015 [29]	Outpatients at an academic CVD prevention center in Baltimore, MD	Sequential randomization 5 weeks	48	58	Female [46]	White [79], non-white [21]	CVD	To evaluate an mHealth intervention, mActive, that provides individual encouragement and foster feedback loops increases PA.	Level I High
McGillicuddy et al., 2015 [30]	Medical University of Charleston, SC.	Retrospective RCT 12 months	18	42.44 IG, 57.89 CG	Female n=13, Male n=5	Black n=14, White n=3, Hispanic n=1	HBP in kidney transplant recipients	To evaluate preliminary indications of sustainability of improved BP in kidney transplant recipients 12 months after completion of a 3-month RCT of mHealth pilot program.	Level I High
Morawski et al., 2017 [31]	Large medical center in Boston, MA	Prospective RCT 12 weeks	411	52	Female [60]	Black [25]	HBP	To evaluate impact of mHealth application (Medisafe) on BP and medication adherence. Patients randomized in 1:1 fashion to UC vs. Medisafe mHealth platform.	Level I High
Naslund et al., 2016 [32]	Urban community mental health center in southern NH.	Exploratory study, single arm (pre/post) 6 months	34	50.2	Female [61.8]	Non- Hispanic White= 34 [100]	OW and OB	To examine whether daily step count measured using a wearable accelerometer is associated with weight loss and improved fitness	Level III High
Park et al., 2014 [33]	Non-profit, community hospital in northern CA.	Prospective, three-arm RCT 30 days	90	59.2	Male [76]	Non-White [22]	Chronic heart disease	To test the efficacy of an mHealth intervention using text messaging to improve medication adherence	Level I High

Sepah et al., 2015 [34]	Internet based diabetes prevention program	Quasi Experimental Prospective, single-arm, pre- and post-intervention study 2 years	220	43.6	Male n=38	White = 108 [50.2], Black = 63 [29.3], Hispanic = 23 [10.7], Other = 21 [9.8]	Pre-DM; OW and OB	To investigate the long-term outcomes and sustainability of an Internet-based DM Prevention Program	Level II High
Shane-McWhorter et al., 2014 [35]	4 rural, 2 urban primary care clinics, and 1 urban stroke center, UT	Quasi Experimental Prospective, observational pre– and post study 6 months	109	50.6	Female [64]	Primary language: Spanish= 72 [66.1], English= 37 [33.9]	DM, HBP	To use telemonitoring devices to expand and improve chronic disease management of patients with DM and/or HBP	Level II High
Sieverdes et al., 2015 [36]	Dialysis Clinic, Inc (DCI) facilities in Charleston, SC	Qualitative interviews	22	46	Female [45]	AA [82]	Kidney disease	To explore barriers and perceptions of physical activity (PA) behaviors and gauge interest in using mHealth in a PA wellness program for patients waiting for kidney transplant.	Level III High
Sieverdes et al., 2017 [37]	Family medicine practice and college campus in a southeastern coastal city in the USA.	Mixed methods A qualitative approach consisting of four focus groups and a battery of questionnaires were used.	34	43.1	Female [58.8]	White n=18 [52.9], AA n=15 [44.1], Other n=1 [2.9]	Adults with pre-essential HBP (preEH)	To identify if a culturally tailored approach is needed in the design and preferences between groups of preEH African American and White adults toward using a smartphone BAM app, the Tension Tamer (TT) app.	Level III High
Skolarus et al., 2018[38]	Churches in Flint, Michigan.	Randomized, pilot intervention trial	94	58	Female n=90 [79]	AA n=92 [97]	HBP	To assess the feasibility of the Reach Out processes, a faith-collaborative, mobile health, randomized, pilot intervention trial of four mobile health components to reduce high blood pressure (BP) compared to usual care.	Level I High
Staffileno et al., 2018[39]	University medical center and community clinics	Randomized, pre-post design 12 weeks	26	In DASH arm 35.3, In PA arm 35.1	Female [100]	AA [100]	PreEH	To evaluate a healthy lifestyle intervention delivered using an eHealth platform, targeting young AA women at risk for developing HBP to promote a healthy lifestyle through increased PA and improved nutrition	Level I High
Svetkey et al., 2015[40]	Locations in three specific counties in North Carolina (Durham, Orange and Wake)	RCT 24 months	365	Mean not stated, Range: 18-35 years	Male [30]	AA [30], Latinos [6]	OB	To compare two interventions (1. Cell phone intervention, 2. Personal coaching intervention) for weight loss to a usual-care control group	Level I High

AA—African-American, BMI—body mass index, CG—control group, CHD—Coronary Heart Disease, CHF—coronary heart failure, CVD—Cardiovascular disease, DASH—Dietary Approaches to Stop Hypertension, DM—diabetes mellitus, ED—emergency department, HbA_{1c}—hemoglobinA_{1c}, IG—intervention group, HBP—High blood pressure, OB—obesity, OW—overweight, PA—physical activity, RCT—Randomized Control Trial, SMS—text messages, T2DM—Type 2 Diabetes Mellitus, UC —usual care.

Report on Risk of Bias

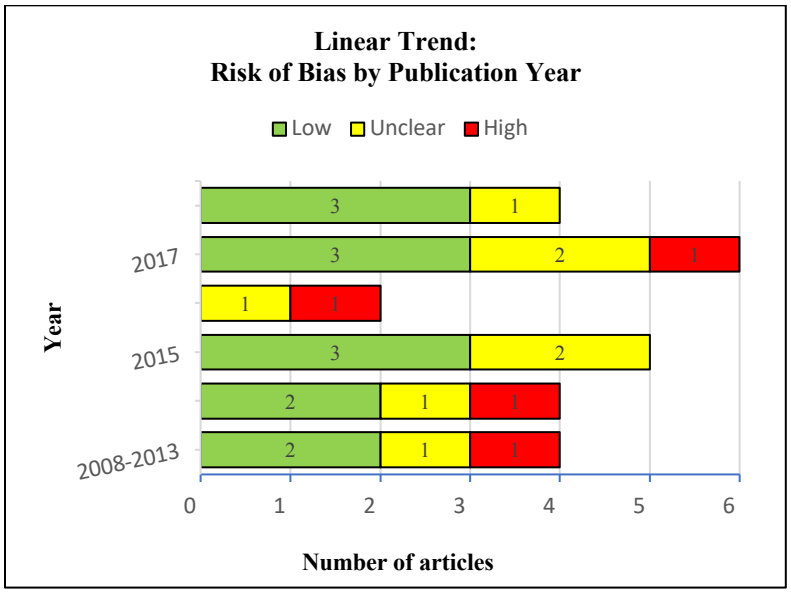
The Cochrane Collaboration's Risk of Bias tool for randomized controlled trials[42] was used to evaluate risk of bias across the following domains: allocation concealment, blinding (participants, outcome assessors, investigators) for subjective outcomes and justification for incomplete outcome data (Figure 3).

Figure 3. Risk of bias for selected studies

1st author (Year)[Ref]	Random sequence generation	Allocation concealment	Blinding of participants and	Blinding of outcome assessment	Incomplete outcome data	Selective reporting	Other bias	Overall evaluation
Alshurafa (2017)[13]	?	?	?	+		+	-	-
Arora (2014) [14]	+	-	-	+	+	+	+	+
Austin (2012) [15]	?	-	-	-	-	-	+	-
Brewer (2017) [16]	?	?	?	-	+	+	-	?
Dang (2010) [17]	?	-	-	+	+	+	-	?
Duscha (2018) [18]	+	-	-	+	+	+	+	+
Forjuoh (2014) [20]	+	-	-	-	-	+	-	-
Fortmann (2017) [21]	+	-	-	+	-	+	-	?
Frias (2017) [22]	+	+	-	+	-	+	+	+
Fukuoka (2015) [23]	+	+	+	+	+	+	-	+
Gilmore (2017) [24]	?	?	-	+	+	+	+	+
Glasgow (2011) [25]	+	?	-	+	?	+	+	+
Graziano (2008) [26]	+	+	+	-	+	+	+	+
Han (2018) [27]	?	?	-	?	-	+	+	?
Kim (2016) [28]	+	+	-	-	-	-	-	-
Martin (2015) [29]	+	+	+	+	+	+	+	+
McGillicuddy (2015) [30]	?	?	?	?	?	+	+	?
Morawski (2017) [31]	+	+	+	?	+	?	?	+
Naslund (2016) [32]	?	?		+	-	+	-	?
Park (2014) [33]	+	+	-	+	+	+	+	+
Sepah (2015) [34]	?	?	?	-	+	+	?	?
Shane-McWhorter (2014) [35]	?	?	-	?	-	+	-	?
Skolarus (2018) [38]	+	+	+	+	-	+	-	+
Staffileno (2018) [39]	+	+	-	+	-	+	-	+
Svetkey (2015) [40]	+	+	+	+	+	+	+	+

Key: " + " Low risk of bias, " ? " Unclear risk of bias, " – " High risk of bias

Of the 25 randomized controlled trials and quasi-experimental studies, 12 studies had a low risk of bias,[14,18,22-26,29,31,33,38-40] nine had unclear risk of bias,[16,17,21,27,30,32,34,35] and four had high risk of bias. [13,15,20,28] A linear trend was performed with descriptive statistics to assess validity of the randomized controlled trials and quasi-experimental studies over time.[28,43] Data on risk of bias were merged for all years below 2014 and summarized by year and type of bias. We calculated bias percentage within year and reported the results in frequency and proportions (Figure 4). We found risk of bias for mHealth studies decreased over a decade (2008-2018), suggesting that researchers are becoming more diligent about randomization, blinding and allocation procedures in this burgeoning research arena.



	2008-2013	2014	2015	2016	2017	2018
Low	2	2	3	0	3	3
Unclear	1	1	2	1	2	1
High	1	1	0	1	1	0

Mobile Health Interventions: modalities and features

Mobile Health Modalities

We report on whether the study designs were theory based, the types of mHealth modalities used, and study outcomes in Table 2. Ten studies were driven by health

promotion theories or a theoretical framework.[14,16,24-26,29,30,38-40] Mobile health modalities included websites (n=4),[21,28,34,39] text messages (n=11),[13,14,18,21,25-27,29,30,33,38] smartphone apps (n=12),[13,16,18,20,22-24,28,30-32,40] voice technology (n=4),[15,17,26,35] and digital medication tracking system (n=3).[22,30,33] Given the focus on promoting self-care, participants were encouraged to use different forms of wearable technologies (n=8),[13,18,22,24,29,32,39,40] such as sensor-enabled devices, wireless or Bluetooth-enabled scales, and smart fitness trackers.

Mobile Health Features

Mobile health features entailed communication mechanisms, decision support, activity monitoring, and motivation techniques. Most studies were designed to deliver personalized messages that varied in communication mode: automated text messages,[13,14,21,27,32,37] tailored text messages,[18,24,29,30,33,38] and prerecorded audio files/interactive voice response.[21,24-26,35] Some participants received messages multiple times a day[14,15,21,23,26] or on a weekly basis.[27,32,38] The researchers allowed participants to choose the number of messages they would receive per day and time of receipt.[34,35]

Most decision tools were used in studies with tracking devices and accelerometers. Pre-defined prompts were sent to participants for tracking BP, blood glucose, weight, dietary intake, and physical activity. Outside of receiving data entry instruction,[20,21,27,30,35] decision support was also provided when the data reached a critical value.[27,38] Overall, some coaching was implemented;[13,18,29,34,39,40] mostly in the form of support and motivation to encourage patient activation, which is defined as having the knowledge, skills, and confidence for self-managing health.[44]

Table 2. mHealth modalities, self-care outcomes and use of theories to guide study components in intervention-based studies

Author	Theory-based	mHealth intervention(s)	Self-care measure(s)	Outcomes/Results
Alshurafa* [13]		Smartphone-based Remote Health Monitoring system, SMS, Tracking	CVD risk, healthy eating	Factors such as the variation in first month intervention response to the consumption of nuts, beans, and seeds in the diet help predict patient RHM protocol outcome success in a group of young Black women ages 25–45.
Arora [14]	**Social Cognitive Theory**	Daily unidirectional text-message	HbA_{1c} and MA	Median HbA_{1c} decreased by 1.05% in the TExT-MED group compared with 0.60% in the CG (D=0.45; 95% CI –0.27 to 1.17). MA was improved from 4.5 to 5.4 in the TExT-MED group compared with a net decrease of –0.1 in the controls (D=1.1; 95% CI 0.1 to 2.1).
Austin [15]		Daily voice messages	CHF readmissions	Readmission rate of 10% compared with the Roper baseline CHF readmission rate of 21% (P=0.047).
Brewer [16]	**Behavioral Theory**	Faith App	HL	Participants had high EHL (84.8% [39/46] with eHEALS score ≥26) with no differences by sex.
Dang [17]		In-home messaging device	CHD risk via FRS	Significant reductions in FRS (23.4±13.5 to 18.2±10.4, p=0.007), systolic BP (140±22.7 to 128.2±18.5mm Hg, p=0.05), and diastolic BP (74±13.8 to 68.7±13.9mm Hg, P=0.07), but not in LDL cholesterol (100.2±30.1 to 91.2±26.6 mg/dL, p=0.7).
Duscha [18]		Coaching via the Vida mobile app, Fitbit, SMS messages	PA and peak VO2	Change in peak VO2 after 12 weeks was different between mHealth (+4.7±13.8%) and UC (-8.5±11.5%, p<0.05). Low and high PA decreased in UC (p<0.05). Nonsignificant increase in of moderate-high activity in the mHealth IG.
Forjuoh [20]		PDA-delivered diabetes self-care software	GC	HbA_{1c} reductions at 12 months for the groups averaged 1.1%, 0.7%, 1.1%, and 0.7%, respectively but did not differ significantly from baseline (P = .771). No marked reductions in HbA_{1c} for minority persons but rather a reduction for all racial/ethnic groups.
Fortmann [21]		Daily SMS messages	GC	The Dulce Digital group had a significantly greater reduction in HbA_{1c} over time compared with UC (p=0.03). The number of blood glucose values texted back by participants predicted month 6 HbA_{1c} (p<0.05).
Frias [22]		Digital medicines, wearable sensor patch, and mobile app	HBP and GC	At week 4: - Combined DMO had a mean change in SBP of –21.8 mmHg compared to –12.7 mmHg for UC. -More DMO participants achieved their BP goal (81%) compared with UC (33.3%). -DMO participants had a greater reduction in DBP compared with UC, but the results were not significant. At week 12: -98% of DMO participants achieved their BP goal compared with 51.7% of UC participants. -At week 12, DMO had a nonsignificant difference in HbA_{1c} reduction compared to UC. Both Week 4 &12 DMOs with a baseline HbA_{1c} of 8% of more showed larger HbA_{1c} decreases than UC.
Fukuoka [23]		Mobile phone app; pedometer	WL, WC, PA, HBP, healthy eating and cholesterol	IG lost an average of 6.2 kg between baseline and 5-month follow-up compared to the CG's gain of 0.3 kg. The IG's steps per day increased by 2,551 compared to the CG's decrease of 734 steps per day. The IG had greater reductions in hip circumference, BP and intake of saturated fat and sugar-sweetened beverages. The intervention had no significant effect on fasting lipid or glucose levels.
Gilmore [24]	**Self-Efficacy**	Smartphone- based application, Fitbit	Postpartum WL, WC, HC, BP	No difference in WL and WC between IG and CG; however, those who had >70% adherence to the intervention, had significant WL (−3.6 ± 1.6 vs. 1.8 ± 0.9 kg; $p = 0.005$) and change in HC (-5.0cm, p=0.006). No change from baseline SBP (p=0.96) and DBP (p=0.54) between the CG and IG.

Glasgow [25]	**Social-Ecological Theory**	Website support; SMS messages, phone calls	PA, healthy eating, MA, HL	Website use was most consistently related to the dietary measures. There was also a significant relation between self-monitoring and improvement in physical activity but not with medication adherence.
Graziano [26]	**Health-Behavior Theory**	Prerecorded daily voice message and SMS	GC	No significant differences between the telephone and CG on mean change HbA_{1c} level (P = .84), suggesting no treatment effect.
Han [27]		Monthly phone counseling; optional text messaging	HL, HBP and MA	Mean changes in SBP and DBP were decreases of 24.1 mm Hg and 11.3 mm Hg, respectively; 91% participants achieved BP control (<140/90 mm Hg). For health literacy, the effect sizes ranged from 0.1 to 1.7 in absolute value. The number of participants taking HBP medication increased from baseline to 16 weeks (from n=3 to n=5).
Kim [28]		Web-based disease management program; mobile app for monitoring & education	MA and HBP	Improvements in patient activation were associated with improvements in BP control (beta=0.04, P=.02). This relationship was further strengthened in reducing cigarettes (beta=−0.60, P<.001), alcohol drinking (beta=−0.26, P=.01), and SBP (beta=−0.27, P=.02) and DBP (beta=−0.34, P=.007). No differences were observed with respect to MA. .
Martin [29]	**Behavior Change Theory**	mHealth intervention with tracking; texting components	PA	The phase I change in PA was not significantly higher in unblinded participants versus blinded controls by 1024 daily steps (95% confidence interval [CI], 580 to 2628; P=0.21). In phase II, participants receiving texts increased their daily steps over those not receiving texts by 2534 (95% CI, 1318 to 3750; P<0.001) and over blinded controls by 3376 (95% CI, 1951 to 4801; P<0.001).
McGillicuddy [30]	**Self Determination & Behavior Change Theories**	Smartphone application, electronic medication tray, SMS messages	HBP	The IG group exhibited lower SBP at the 12-month follow-up visit (P= .01) compared with the CG. At 12-month follow-up, success in establishing and sustaining control of SBP (<131 mm Hg) was greater in the IG (50%) than in the CG (11%).
Morawski[31]		mHealth application (Medisafe)	BP and MA	After 12 weeks, the mean (SD) score on the MMAS improved by 0.4 (1.5) among IG and remained unchanged among CG (between-group difference: 0.4; 95% CI, 0.1-0.7; *P* = .01). After 12 weeks, the mean (SD) SBP decreased by 10.6 (16.0) mm Hg among IG and 10.1 (15.4) mm Hg among CG (between-group difference: −0.5; 95% CI, −3.7 to 2.7; *P* = .78).
Naslund [32]		Wearable accelerometer & Fitbit application	WL, PA and Fitness	Every 1000 step increase in participants' daily average step count was associated with a decrease of 1.78 pounds (p=0.0314). An increase of 1000 steps corresponded to an increase of 18.79 feet on the 6-Minute Walk Test; however, it was not significant (p=0.176)
Park [33]		Daily SMS messages, medication monitoring via electronic pills	MA	- SMS Reminders + SMS Education group had higher percentage of prescribed doses taken (p=0.02) and percentage of doses of taken on schedule (p=0.01) for antiplatelet medications - SMS Education alone group had a higher percentage of number of doses taken compared to the No SMS group (p=0.01). No significant differences were found among the 3 groups over time for self-reported medication adherence. - Comparing the SMS Reminders + SMS Education and No SMS groups, the effect size of the intervention was medium to large (Cohen's d = 0.69)
Sepah [34]		Internet-based education	GC, WL	<u>Weight Change:</u> - Program starters (n=187, completed at least 4 core lessons) achieved a mean weight loss of 4.2% from baseline to year 2 - Program completers (n=155, completed at least 9 core lessons) achieved a mean weight loss of 4.3% from baseline to year 2 <u>Hemoglobin A1C:</u> - Program starters (n=187) reduced their A1C by 0.43% from baseline to year 2 - Program completers (n=155) reduced their A1C by 0.46% from baseline to year 2
Shane-McWhorter [35]		Interactive voice response (IVR)	CV health, GC, HBP, MA	Mean A1C decreased from 9.73% at baseline to 7.81% at the end of the program (P < 0.0001). SBP also declined significantly, from 130.7 mm Hg at baseline to 122.9 mm Hg at the end (P = 0.0001). LDL content decreased significantly, from 103.9 mg/dL at baseline to 93.7 mg/ dL at the end (P = 0.0263). MA improved, but not significantly.

Skolarus [38]	**Self-Determination Theory**	Tailored SMS messages	HBP, MA	There were no between-group differences in the change from pre- to post intervention SBP or DBP (−3.1, 95% confidence interval [−14.4,8.3], p = .60. The within-IG change in SBP was −11.3 mmHg (SD = 22.9mmHg) and within the CG was −14.4 mmHg (SD = 26.4 mmHg). Similarly, the within-IG change in DBP was −8.6 (SD = 15.9) and within the CG was −9.5 mmHg (SD = 12.9 mmHg); this between-group difference was not significant (−0.9,95% confidence interval [−7.7, 5.9], p = .79). Within the IG, there was no change in MA (p = .69). Focus groups: Tailored SMS received unanimous positive responses. Participants reported using their texts to keep a record of their BPs to take to their primary care providers. Overwhelmingly, participants did not want text messages supplemented with phone calls, workshops, cooking demonstrations, or Internet modules. Participants did not want religious content included in their SMS.
Staffileno [39]	**Social Cognitive Theory**	Web-based education, Pedometer	HBP, WL, healthy eating, PA	SBP, DBP, weight, and BMI did not differ across treatment groups. However, on average, there was a -1.2 and -5.6 lb weight loss in the DASH and PA groups, respectively. There was a 0.18 and 0.84 within-group effect sizes for weight in the DASH and PA groups, respectively. Among DASH participants, total DASH scores improved 1.5 +/- 0.5 to 2.9 +/- 1.1 (P = .001). The largest effects noted were associated with increases in vegetables (0.84), nonfat dairy (0.71), and fruits (0.62), which contributed to a very large total DASH score effect (1.68). With regard to PA participants, the change in daily average steps was trending significance (P = .055) and corresponded to a favorable (+39%) change in daily steps.
Svetkey [40]	**Social Cognitive Theory & Transtheo-retical Model of Change**	Mobile phone application	WL	IG lost significantly more weight than Controls at 6 months (net effect −1.92 kg [CI −3.17, −0.67], *P* = 0.003), but not at 12 and 24 months.

Abbreviations: BMI—body mass index; LDL—; TG—; TC—; HBP—high blood pressure; SBP—systolic blood pressure; DBP—diastolic blood pressure; LDL—Low-density lipoprotein; HgA1c—Hemoglobin A1c (glycated hemoglobin); MA—Medication adherence; HL —health literacy; GC—glycemic control; WL—weight loss; PA—physical activity; FRS—Framingham Risk Score; Peak VO2—peak oxygen uptake; UC—Usual care; CG— control group; IG—intervention group

[a]Used as part of questionnaire not theory informed intervention

Another innovative feature was gamification, where interactive self-quizzes and trivia were offered on the different mHealth platforms.[14,16,23] Other studies included reward-based motivators in their programs, such as goal setting challenges.[16,25] Virtual communities, social network sites, and accountability groups were used to provide encouragement and reinforcement, including computer-assisted social support group,[25] discussion forums for participants,[16] and buddy system component in within applications to bolster ongoing social support.[40]

Usability and Acceptability

Perceived Ease of Use

Eight studies identified the different mHealth modalities as easy to use.[15,19,22,29,33,35,38,40] In one study, 81% of participants reported that they "did not mind wearing the patch."[22] One study affirmed that less demanding application features with "the simplest interactions" were utilized the most.[40] To ensure ease of use, participants recommended resolving technical issues, such as bugs and damaged memory cards, prior to releasing a system.[37] They suggested mHealth systems should have short tutorials with access to technical support, while also being "intuitive to use, should someone wish to skip any training."[37]

Perceived Usefulness

Participants from 14 studies expressed that mHealth was useful for their daily self-management practices.[17,18,22,24,25,30-32,34-38,40] Interviewees from a qualitative study "perceived that technology may be useful in increasing their awareness of eating patterns."[36] Developers customized systems to meet the users' needs[31] of vulnerable populations, such as individuals with mental health needs,[32] low-literacy,[16,29,32] and low English proficiency.[25,35] Interventions with instantaneous feedback were also deemed useful,[36] most notably in studies measuring

physical activity.[18,24,32] In cases where high usefulness was reported, participants remained engaged in the program even after completion.[34]

Attitude Towards Use

Researchers employed various strategies to increase participants' desire towards use, including regularly adding new content,[40] and personalization features.[37] Participants endorsed having positive attitude in studies that offered information in multiple languages, especially with high proportions of ethnic minorities.[25] One study reported participants had a positive attitude towards mHealth in relation to self-care, but were "very concerned about the privacy of their data."[19] Overall, participants from five studies endorsed high satisfaction with using mHealth,[19,35] especially tailored text messages.[29,33,38]

Intention to Use Mobile Health

Only two studies explored participants' intention to use mHealth.[36,37] In one study, most of the participants surveyed reported that they would use mHealth to prevent or manage chronic diseases if it was of no cost to them (i.e. smartphone and app were free).[36] Meanwhile, participants in a qualitative study expressed interest in using activity trackers to monitor their physical activity, stating that this could help them increase their physical activity.[37] None of the studies included in this review explored the association between intention to use and the actual adoption of mHealth.

Mobile Health Adoption and Engagement

Studies that targeted promoting patient activation and changing lifestyles using motivational strategies had high adherence to mHealth.[13,17,29,31] Participants who had higher perceived disease risks were more adherent to the treatment protocol,[28] except for kidney transplant recipients.[30] One paper attributed poor adherence to mHealth with low socioeconomic status and

health disparity issues, where participants had competing life priorities: lack of childcare, work schedules, and poor health care access.[24]

Some studies used various engagement metrics, such as descriptive and correlation statistics, to monitor mHealth use. Glasgow and colleagues[25] stated: "We calculated the percent of days for which tracking data were entered on the website for each of the three target behaviors. Time spent on the site for each visit was calculated as follows (excluding page view times exceeding 30 minutes): total time on site per visit = (last page visit time – log-in time) + (last page visit time – log-in time)/(n – 1 total pages visited)." They found a low association between patient characteristics and website use (Spearman $r<.20$). Their Latino participants, who had low to moderate health literacy, were as equally engaged (number of visits, time spent on the website) in the program as the other participants. This was attributed to their efforts to make the website more culturally appropriate.[25]

Graphs were able to show participants their progress,[20,24,31,37] which displayed their target goal versus actual steps taken.[24] Progress bars were added to computer-assisted programs for subjects to track their progress;[25] or received a weekly report describing the percentage of time pills was missed.[31] Engagement decreased over time for all randomized controlled trials, especially those with longer duration and follow-up periods.

Effect of mHealth interventions

Primary study outcomes included glycemic control[14,20-22,24,26,34,35]; weight loss, including change in anthropometrics such as waist-to-hip ratio,[13,23,24,32,34,39,40] physical activity/fitness,[18,23,25,29,32,39] medication adherence,[14,25,27,28,31-33,35,38] overall cardiac risk factors,[13,17,23,35] and hypertension control.[5,22-24,27,28,30,31,35,38] Effect estimate statistics were not performed given the clinical and methodological heterogeneity of the data. Glycated hemoglobin (HbA_{1c}) and

hypertension were the only two outcomes that were measured consistently across studies; however, the number of studies was not enough to run a meta-analysis. Intervention impact is reported descriptively and is also summarized in Table 3.

Table 3. Identified research gaps

Elements of evidence gaps	Gaps identified
Intervention	▪ Lack of programs to manage diet
Sample	▪ Lack of mHealth research specifically assessing immigrant populations
Modalities	▪ Lack of studies using less clinician coaching and more focus on patient activation/self-care
Approach	▪ Lack of CBPR approach ▪ Lack of theoretically driven research
Setting	▪ Lack of research in inner city or resource poor settings
Outcomes	▪ Lack of outcomes related to chronic disease self-management ▪ Lack of studies looking at patient engagement with application ▪ Lack of studies looking at health literacy and digital literacy

Clinical Outcomes

Five out of eleven studies had significantly effective interventions that focused on reducing HbA_{1c}[17,21,22,34,35] with differences ranging 0.43% to 1.92% at three and six months in intervention groups. Most of the studies had an unclear risk of bias,[17,21,34,35] with the exception of one study[22] with low risk of bias. Only one study reported whether participants were taking oral antihyperglycemics (e.g. Metformin) versus insulin injections.[22] Although Furjuoh and colleagues[20] found no marked reductions in HbA_{1c} for minority persons, there was a reduction in HbA_{1c} for all racial/ethnic groups from baseline to a two-year follow up. Similarly, Arora and

colleagues'[14] text-based program did not render a significant reduction in HbA_{1c}; however, their results revealed less emergency department utilization among their Spanish-speaking subgroups.

Of the nine studies measuring hypertension as an outcome, four studies reported no change in systolic and diastolic blood pressure across treatment groups.[22,24,38,39] For the studies that were successful, reduction ranged from 7.8 mm Hg[35] to 24.1 mm Hg[27] for systolic blood pressure and 11.3 mm Hg for diastolic blood pressure.[27] Some studies reported the percentage of participants achieving their goal, as follows: 81% at week 4 and 98% at week 12,[22] 50%,[27] 91%.[30]

Six studies researched outcomes in anthropometric measurements. [23,24,32,34,39,40] They found between- or within-group differences in weight loss or a decrease in waist/hip circumference. Weight loss ranged from 0.81 kg (≅1.78 lbs)[32] to 6.2kg (≅13.67 lbs).[23] Mobile health modalities for these studies were smartphone applications [23,24,34,40] and wearable technologies such as a pedometer[39] and Fitbit.[32] The greatest change was noted beyond 6 months; however, one study reported no changes at 12 and 24 months compared with 6 months.[40]

Behavior/lifestyle Modification Outcomes

Four out of six studies reported an increase in physical activity.[23,25,29,39] Studies using trackers/wearable sensors as part of their interventions found significant increases in steps per day.[23,29] Two studies that monitored physical activity did not have significant results.[18,32] On the contrary, web-based programs used to promote self-management of CMRF were successful. For example, one study used a highly reliable and validated self-report questionnaire, the Community Healthy Activities Model Program for Seniors. Its items measure physical activity, and the participants reported increase in physical activity as compared with baseline. While there was a

significant relationship between self-monitoring and improvement in physical activity, there was no correlation between engagement strategies and physical activity (Spearman r=.14, P>0.05).[25]

The two studies that focused on improving eating habits[23,39] were very successful. One study had greater reductions in intake of saturated fat and sugar-sweetened beverages[23] and the second study reported that total Dietary Approaches to Stop Hypertension scores improved 1.5 ± 0.5 to 2.9 ± 1.1 (P= .001)[39] between intervention and control groups. The largest effects were correlated with increases in vegetables (0.84), nonfat dairy (0.71), and fruits (0.62), which led to a large total score effect (1.68). While Glasgow and colleagues[25] did not study diet as an outcome, they noted that website use was highly related to dietary measures.

Five out of seven studies measuring medication adherence[25,28,33,35,38] saw no difference between the intervention group versus the control group. Han et al. reported the number of participants taking antihypertensives increased from baseline to 16 weeks (from n=3 to n=5). Another study saw an improvement on the mean (standard deviation) Morisky Medication Adherence Scale score by 0.4 (1.5) among the intervention group while the score remained unchanged among the control group (between-group difference: 0.4; 95% CI, 0.1-0.7; P= .01).[31]

Other Outcomes

For the two papers studying health literacy, one study reported a high health literacy score (84.8% [39/46] with eHEALS score ≥26) and found no differences by sex;[16] the second study described effect sizes for hypertension related health literacy improvement from 0.1 to 1.7.[27] Austin and colleagues investigated readmission rates for their patients with congestive heart failure and found a 10% readmission rate compared with the Roper baseline rate of 21% (P=0.047). Another study saw a change in peak oxygen uptake after 12 weeks was different between mHealth group (+4.7±13.8%) and the usual care group (-8.5±11.5%, P<0.05).[18]

DISCUSSION

To the authors' knowledge, this is the first paper to systematically review mHealth interventions promoting self-management of CMRF and how they impact vulnerable populations. Overall, the 28 mHealth studies reviewed were successful in improving physical activity, managing diet, optimizing HbA_{1c} levels, maintaining hypertension control, and promoting weight loss.

Only three papers specifically targeted ethnic minorities,[23,27,39] but most studies did not report on outcome differences between racial and ethnic groups.[14,15,17,18,23-26,29,34,35,38-40] African Americans have the highest prevalence for type II diabetes[45,46] and are often understudied in diabetes research.[47] Likewise, approximately 17% of Latinos within the US have Type II diabetes, compared to almost 8% of non-Hispanic Whites[48,49] and diabetes disproportionately affects Latino individuals.[48] Populations with CMRF often face barriers to healthcare due to social and structural barriers in the community such as transportation, insurance status, and language barriers.[3,50] Additionally, ethnic minorities have low digital literacy compared to non-Hispanic Whites.[51,52] While researchers are often limited to self-report measures of digital health literacy (e.g., eHEALS),[53] future studies should also measure operational skills of digital literacy with novel self-report tools, such as the Digital Health Literacy Instrument.[54] Digital literacy requires both cognitive and operational skills and this tool measures both. Given the known health disparities in CMRF that exist between non-native English speakers and native English speakers,[3] mHealth interventions targeting racial/ethnic minorities should also be culturally sensitive. For example, one study showed that sending culturally-tailored motivational text messages in Spanish improved high blood pressure outcomes for Latinos.[27] Indeed, the interventions available in multiple languages were regarded as highly useful by participants.[27]

The public health of Latinos is especially a concern for the United States, given that the Latino population is the largest minority group and is expected to become the largest ethnic group by 2050.[55] More effort should be made in meeting participants where they are in the community. Additionally, more research is needed to explore the effect of immigrant status or generational differences on the use of mHealth in CRMF management.

The intervention studies reporting high satisfaction and ease of using mHealth were inclusive of their users in the research process.[19,38] Community based participatory research offers a comprehensive approach for building rapport with participants, maintaining trust within communities and developing culturally sensitive interventions.[56] End users should be collaborators in the mHealth research process, as they can provide genuine feedback on user experience.[57] Only two studies in this systematic review used such approach to improve CMRF management.[16,40] Besides leveraging partnerships with participants, researchers in mHealth should also employ qualitative and mixed methods research. A comprehensive review of more than 600 studies using mHealth and text messaging for health interventions identified no studies using qualitative research and only one study that employed mixed methods.[58] More research is needed to understand the context of using mHealth to manage CMRF, such as how patients with CMRF incorporate mHealth into their lifestyles, when they use mHealth, and how they use and/or adapt mHealth to their unique chronic condition needs.

This review found that only 10 of the 28 articles employed a theoretical framework, and some constructs investigated did not have operational definitions. Without a precise definition, relationships among variables cannot be determined or tested, which limits the heuristic property of the study design. Most studies reported results on participants' willingness to use mHealth as evidenced by its ease of use and usability; yet, there was limited information on attitude and

engagement. Some studies used various definitions for engagement,[25,29] perhaps because there is no tool available to measure how a user actually interacts with mHealth.[59] While it is important to understand mHealth adoption, it would be useful to determine how participants engage with mHealth beyond the novelty phase. Longitudinal studies should monitor engagement over a longer period of time as compared to the average of 3 to 6-month follow-up noted in these studies. In addition to measurement variability, engagement in mHealth should also be evaluated accordingly by monitoring fidelity. Two studies measured engagement by calculating the percent of days for which tracking data were entered[25] and by recording the number of log-in times or data usage.[29] Engagement has predicted better health outcomes in those who use mHealth versus those who do not.[59] Future research should involve using the Technology Acceptance Model as a framework to guide future mHealth research by considering each construct when discussing engagement with mHealth. For better dissemination, we would be able to propose key mechanisms by which mHealth interventions can influence and sustain behavior change.

Limitations

While this study provides a thorough review of available mHealth research for self-management of CMRF, there are some limitations of the studies that need to be addressed. We restricted studies to those performed in the United States only to explore underserved populations, racial and ethnic minorities. Due to the paper's focus on vulnerable populations, it is possible that the synthesis of this review may not be comprehensive. We were unable to estimate the risk of bias over time because there were only 25 records eligible, which was not enough observations for the trend analysis. Instead, we merged all years below 2014, summarized the data by year and discussed them descriptively. Moreover, due to clinical and methodological heterogeneity, we did not have enough studies addressing the same outcomes to run meta-analyses. Even though

there were studies in a larger number addressing hypertension, diabetes, and obesity, because of the vast diversities in terms of study design and sample characteristics, we were not able to run meta-analyses in the end.

Strengths

Despite these drawbacks, our review included both quantitative and qualitative articles, which enhanced knowledge on barriers and facilitators to self-management of CMRF using mHealth. This review is also in line with the aims of the National Institutes of Health All of Us program,[60] by revealing gaps in mHealth research with vulnerable populations, as well as specific factors contributing to the uptake, engagement, or efficacy of mHealth in these populations with CMRF. Although a large number of the studies extracted were randomized controlled trials, with a high level of quality. Nevertheless, they included large sample sizes, which demonstrated efficacy. The literature search was very thorough, given that all review team members had prior experience conducting systematic reviews. The search was inclusive as possible, consisting of studies published in indexed journals, as well as those found in additional hand search.

CONCLUSION

Despite burgeoning mHealth research, this systematic literature review supported that there have been limited mHealth interventions applied to underserved groups. mHealth presents a promising avenue for eliminating cardiovascular disease health disparities.[19] The results of this review suggest the need to develop more patient-facing mHealth approaches such as community based participatory approach, patient-centered research, qualitative inquiry, and mixed methods research. The findings of this review also demonstrate that more theoretically-supported mHealth research is warranted. This could serve not only to increase our understanding of how to manage CMRF but also improve outcomes in health promotion research through mHealth.

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CHAPTER 3

Barriers to and facilitators of high blood pressure self-management among inner-city Latinos in the United States: A focus group study

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Abstract

The purpose of this study is to explore barriers and facilitators of high blood pressure (HBP) self-management among inner city Latinos. We conducted four focus groups in varying community locations with samples including Latinos with HBP (n=7), health educators (n=8), and community health workers (n=3). Focus group data were analyzed using an inductive content analytic approach. Perceived barriers included lack of HBP knowledge or understanding, low HBP self-efficacy, lack of time, limited access to care and health information, cultural differences and lack of understanding from providers, which leads to dissatisfaction with healthcare. Family and adequate social support were perceived as the main facilitators to HBP management. Focus group participants suggested that in addition to basic disease knowledge, future interventions should focus on using technologies for effective health education. Nurses can help Latinos manage their HBP by improving their health literacy and incorporating technology in their plan of care.

Keywords: Hypertension, Latinos, Qualitative research, Community health

Introduction

Latinos remain the fastest growing demographic group in the United States (US Census Bureau, 2010) and the Center for Disease Control (2015) predicts that they will reach 23% of the U.S. population by 2035. The growth of this group carries huge disparity consequences in the healthcare arena. For example, Latinos have higher rates of risk factors for cardiovascular diseases (CVDs) than non-Hispanic Whites; 68.5% of Latino adults are overweight and obese, 14.2% have high cholesterol, and 29.7% have high blood pressure (Mozaffarian et al., 2016). Amongst these CVD risk factors, uncontrolled high blood pressure (HBP) remains a significant risk factor to developing cardiac pathologies. Latinos in the United States are experiencing increasing incidences of HBP, where they are two times more likely to experience a stroke than non-Hispanic Whites, pointing to the issue of differences in prevalence for uncontrolled HBP (Fryar et al., 2017; Daviglus et al., 2012; Yang, Queadan, & Smith-Gagen, 2009). Self-management is a determining factor for adequate HBP control among Latinos yet, it is unclear what barriers and facilitators they face.

Focus groups involving HBP management are usually explored solely from the perspective of health promotion agents themselves or patients with HBP (Aroian, Peters, Rudner, & Waser, 2012; Horowitz, Tuzzio, Rojas, Monteith, & Sisk, 2004; Russell et al., 2010). Focus groups that involve both CHWs and Latino clients have been conducted in a way where the CHW functions as the focus group facilitator and not as participants (Ingram, Murietta, de Zapien, Herman, & Cavajal, 2015). One study did conduct a focus group with health promoters and Latino patients (Deitrick et al., 2010); however, the questions were focused on how the health promoter role influenced diabetes care for Latinos and not necessarily delving into the experience of the patients. Due to their unique linguistic and cultural needs, health promotion

programs targeting Latinos with chronic conditions, such as HBP, are often delivered by lay educators or CHWs. Despite their crucial role, the perspectives of those involved in Latino HBP care have not been investigated. The purpose of this study is to explore the multi-level perspectives of patients, CHWs and health educators concerning barriers and facilitators for self-management of high blood pressure among patients in an inner-city Latino population.

Methods

Participants were purposively sampled based on the following eligibilities: 1) age 18 years or older; 2) working as a CHW or a health promoter for Latino patients with HBP at the time of the study (for health practitioners only); and 3) hypertensive Latinos with systolic BP > 140 and/or diastolic BP > 90 mm Hg or on HBP medication (for patients only). Health promoters and CHW participants were identified through direct referrals from the study site, Mary's Center, a federally-qualified health clinic in central Washington, DC. Patient participants were identified via BP screening at health fairs and through study flyers at community sites. A total of 18 Latino patients, health educators and CHWs participated in the focus groups.

Trained bilingual moderators conducted a total of four focus group interviews in either Spanish or English: two groups with Latino patients (n=7), one group with Latino CHWs (n=3), and one group with bilingual health educators (n=8). The protocol for recruitment and implementing sessions was approved by the medical institution's Institutional Review Board. The interviews were conducted for the health educators and CHWs in English, whereas the interviews with patients were done in Spanish. Moderators completed in-person and HIPAA training prior to facilitating the sessions. The moderators followed a semi-structured interview guide (Table 1) with topics ranging from health care needs of Latinos with HBP, barriers and facilitators of their HBP management to effective health promotion programs. Each session

lasted between 60 to 90 minutes and was held at a community location (i.e., Mary's Center, ethnic church). Prior to the start of the focus group sessions, participants completed a brief demographic survey. Each focus group was audio-recorded and transcribed verbatim for thematic qualitative analysis. For the focus groups conducted in Spanish, a bilingual staff member who did not participate in the interview translated the Spanish transcripts into English. Another bilingual staff person reviewed the original and the translated transcripts then checked for any discrepancy between the two language versions. Data collection stopped once there was a saturation of themes.

Table 1. Main topics and sample questions used in the semi-structured focus groups

Topic	*Sample questions*
Health care needs of a typical Latino HBP patient	• How, if at all, has your practice as a [Health Educator/Community Health Worker] relating to Latino clients with high blood pressure (HBP) changed in recent years?
Barriers and challenges in HBP management	• Why do some Latino patients do worse than others in managing their HBP?
Facilitators in HBP management	• What are some factors that may help Latino patient's management of HBP?
Planning for effective health promotion program	• What is your suggestion about health promotion program for Latinos with HBP?

Ethical considerations

The protocol for recruitment and operation of the sessions was approved by the Institutional Review Board at the Johns Hopkins Medical Institute, Baltimore, MD, USA. All participants had knowledge that the sessions were audio recorded and gave informed written consent to participate in the study. Consent forms were available in both English and Spanish

and were approved by the IRB. Participants were compensated with $30.00 for participating in the focus groups.

Data Analysis

We used descriptive statistics to summarize sample characteristics. Focus group data were analyzed using an inductive content analysis approach (Hsieh & Shannon, 2005). This allowed us to search for commonalities leading to conceptual reduction of data. In this respect, we were able to identify major themes and subthemes that informed the study team. Methodological rigor was achieved by using a variety of methods. Specifically, after each focus group the moderators documented and debriefed on initial thoughts and experiences. Field notes were created to document observations, activities and events during the sessions. Memos were also maintained as a means of maintaining a reflexive stance in tandem to the investigative process. This allowed moderators to reflect and record assumptions and perceptions about the study phenomena. Such varied analytical modes allowed us to gather different sources of raw data in addition to having transcription. Each transcript and field notes were read multiple times by three reviewers, who independently identified emerging themes and subthemes. The investigators identified representative quotes to reflect each identified theme. Next, the coders met and differences in coding were resolved by consensus. Initial agreement was 80% requiring about 20% of codes to be settled by consensus. After a series of team discussions, overarching themes emerging from each of the four focus groups were finalized.

Results

Table 2 summarizes the characteristics of the focus group participants. Most of the sample was female (72.2%), middle-aged (mean=42.5 ± 14.3 years), and had a college or higher level of education (61.1%). About 78% of the sample identified themselves as Latino/Hispanic,

with 27.8% from El Salvador, 16.7% from Mexico, and with the remaining participants mostly originating from other countries in Central and South America such as Nicaragua, Argentina, Uruguay, Bolivia and Columbia. For those who originated from the countries outside the U.S., they had lived a mean of 19.2 (± 10.5) years in the U.S. Health educator and CHW participants reported to have worked an average of 2 to 3 years with HBP patients. The patients reported living with HBP for a mean of 9 (± 9.3) years and less than one third (28.6%) of them were taking HBP medication at the time of the study.

Table 2. Characteristics of focus group participants (N=18)

Characteristics	*Mean ± SD*
Age (range= 23-69), years	42.5 ± 14.3
Female, %	72.2
Spanish speaking, %	100.0
College graduate+, %	61.1
Latino/Hispanic ethnicity, %	77.8
Country of origin, %†	
El Salvador	27.8
Mexico	16.7
Other	33.3
Years in the US (range=6-47)†	19.2 ± 10.5
Years working with HBP patients/living with HBP	
Health educators (n=8)	2.9 ± 2.7
CHWs (n=3)	2.3 ± 2.3
HBP patient (n=7)	9.0 ± 9.3
Currently taking HBP medication, %††	28.6

†Those of Latino/Hispanic ethnicity only; ††HBP patients only.

Table 3 presents the themes and subthemes emerged from the focus groups. The themes emerged from the four focus groups were similar across the groups hence we merged them and present them together. Specifically, themes and identified quotations from the focus groups were categorized as the following: 1) health care needs of a typical Latino patient with HBP, 2)

barriers to HBP self-management, 3) facilitators to HBP self-management and 4) facilitators to effective health education.

Table 3. Themes and Subthemes from focus groups

Theme	*Subthemes*	*Supporting Quotes*
Healthcare needs of a typical patient with HBP	Healthy eating knowledge	"With regard to food, my wife has risk of diabetes due to her last pregnancy. So she changed the food in our diet, everything. Like, she doesn't use a lot of grease or salt, she always tries to put vegetables in the food… I stopped drinking coffee, stopped smoking, stopped being...I left a lot of things that gave me high blood pressure." (Male patient ID 005)
		"a woman that lives with me, she did not know she had [HBP and diabetes]. She ended up in the hospital with her sugar up really high and her blood pressure super elevated. And the doctor told her, "You have to avoid all this," but she didn't. So, not everyone takes care of themselves, you get me? [...] Knowing is good, but avoiding it, we [Latinos] do not do it." (Male patient ID 002)
	Poor HBP knowledge and practice	"I think that there is something or a lot of lack of awareness, because even when a lot of patients say 'I have high blood pressure,' but they really don't know what it is when you ask that. And I think that is a lack of knowledge like you were saying and basic understanding of what it is, is another barrier to them to actually take action, to mitigate to the problem." (Female health educator ID 008)
	Low HBP self-efficacy	[Latinos] used to believe that when you talk about HBP that you are talking about stress, they don't think it's a cardiovascular condition. So they are thinking 'Well I just have too much

		problems, so there is nothing that I can do because I have economic problem and other issues, […], I don't need pills for this kind of condition, I need to fix my economic life my family issues.' You know, there is a misunderstanding." (Male health educator ID 010)
	Lack of time	"…what happens at times is that we do not [eat healthy] for different reasons, all day we are running around and we eat the first thing that we find even if it is not healthy." (Female CHW ID 001)
Theme	Subthemes	Supporting Quotes
Healthcare needs of a typical patient with HBP (continued)	Cultural differences	"Back home, like, you know, where my parents come from, being able to sit with the family for morning, lunch, dinner is very important. These different foods are home cooked meals versus fast foods here. It has a big impact on the younger generation, because, you know, the lifestyle is completely different in this country and you know, I think that has a lot to do with […] actually acquiring hypertension at a very young age versus acquiring hypertension at 50." (Female CHW ID 014)
Healthcare needs of a typical patient with HBP (continued)	Poor patient-provider communication	"Yes…perhaps one…one of the things is that when a person goes to consult a doctor, they only prescribe pills, but they don't explain how to go about avoiding the pills in the future. Instead they tell you, no, this is something you will take for life." (Female patient ID 016)
		"…if my doctor comes and tells me, 'here take these pills,' and you are not explaining to me the things I want to hear then you are not a good doctor." (Male patient ID 004)

		"…there are times doctors say, look I am going to give you some medicine. He does not explain anything. I think the doctor is only about giving pills, and they don't tell you what you need to do. For them the best solution is pills. 'This will lower your blood pressure,' and that is it. That also makes the patient think that well that there is no other option. Then that person is not being helped by the doctor. (Male patient ID 004)
	Limited access to care and health information	"..being disconnected from the PCP just because of not having (health insurance), and being disconnected even meaning not having medication, which makes it hard to fully comply." (Female CHW ID 014)
		"I came here to a consult at one center and they told me that there they could not attend me because that was not their area, "you need to get a consult in Catonsville", and I don't know any center that speaks Spanish because the problem many have is that they don't know English very well and there is no one to translate and there you are… that's why people don't go." (Male patient ID 005)
Theme	Subthemes	Supporting Quotes
Facilitators for HBP self-management	Family and good social support	"I'll do anything for my family, that is the main reason [I exercise]. Not really for myself, with the high prices of the basic necessities…it´s one way of improving your wellbeing, for your health, you get me? Saving money and for the family." (Male patient ID 004)
		Female health educator ID 006: "I think that people that come in with a good support network have an easier time." Male health educator ID 010: I think that [family] is key... I have the opportunity to see the man and he is coming with his wife. In our

	culture the person who is in charge of the cooking is the woman. You know? So I want her to understand how important it is to decrease the intake of salt or sodium, you know? So I always go and explain to them the importance of nutrition and blood pressure. And when they come back, almost always, if I saw the couple they are always doing better than if I only saw the man or the woman. Female health educator ID 009: "I agree … that [including family] creates a better support for the patient who is hypertensive."
Utilization of interactive media, graphics/visuals and technologies for education	"[Texting] is best, because for example yesterday morning someone called but I was at work and I could not answer. However, when they send me a message and even if I am sleeping already I could still see the message. Therefore, it is a good form of communication, or rather a good way to communicate." (Female CHW ID 003)

Theme 1: Healthcare needs of a Latino patient with HBP

Focus group participants communicated their views on the healthcare needs of a typical Latino patient with HBP. Healthy eating and understanding HBP as a chronic disease were mentioned most often across all four groups Participants also underscored the importance of having both knowledge (knowing what to do) and practice (taking action of the nutrition knowledge) in HBP as an essential area for a Latino patient to address:

"I take care of what foods I eat, I do not eat pork, or red meat, sometimes once a week, but baked. I do not drink soda, I do not eat a lot of oil. Did you know that… canola oil is good oil? Scientifically, they say it is good for your health. I take care of myself and my son, since I cook and we eat the same meals." (Female health promoter ID 011)

Participants noted that Latino patients have to overcome several impediments of understanding in order to maintain a controlled BP given it is chronic in nature. One patient participant stated:

> "*[…] what I would like to know, is whether those are the symptoms of my blood pressure, but in reality I am not sure if that's how you detect it. But to recognize what they are, what symptoms, what is it that indicates that I am not well, and what I can do in addition to that*."*(Male Latino patient ID 002)*

Theme 2: Barriers to HBP management

The decision to manage HBP requires the typical HBP patient to have internal and external motivation given that this disease is asymptomatic. Several subthemes emerged for this theme: Poor HBP healthcare knowledge, low HBP self-efficacy, lack of time, cultural differences, poor patient-provider communication, and limited access to care.

Poor HBP healthcare knowledge. Health educators and Latino patients reported poor self-care behaviors involving medication noncompliance and inconsistent monitoring of BP. They felt that this was attributable to poor understanding of HBP chronicity and knowing basic self-care skills such as measuring BP. None of the Latino patients knew their most recent BP reading. Health educators corroborated poor HBP knowledge in the Latino community by disclosing that their patients usually do not know nor understand their BP readings. In addition to not understanding BP measurements, all groups reported poor knowledge about healthy eating in terms of knowing what to eat and taking proper action of the nutrition knowledge. One CHW noted:

> "*They [Latino patients] need to control their blood pressure because sadly, the Latino community do not prioritize their health. We aren't persistent. Only when we are really bad do we go running to the doctor because afterwards we won't have time.*

There's always work in the way or friends. They [patients] have time for everything except taking care of their health." (Female CHW ID 003)

Low HBP self-efficacy. Most patient participants reported low self-efficacy when it comes to managing their HBP. A participant stated: "It means you have to stop doing everything you like, like smoking, stop drinking coffee and you have to start exercising regularly and eating healthier (Female CHW ID 003)." Participants felt that Latinos were not empowered enough by clinicians to be willing and ready to make such a change. They reported that if they were provided with tools and resources such as BP monitor, they would be more empowered to self-manage their disease.

Lack of time. CHWs and health educators reported that their patients often work multiple jobs or long hours and do not have the time to take care of themselves properly.

"[…] they do not have time to cook so they go to 7/11 and take a bag of salties […] they do not have any other option than to go to McDonalds because it is fast, and it is cheaper, and maybe they are working too many hours." (Female CHW ID 013)

Another health educator commented:

"Because of time constraints usually people are looking for a fast food if not in the drive-thru or maybe, you know it is very popular […] the little- the sopas de vaso [instant cup-a-noodles]-the Maruchas, they are very popular and because, you know, they feel that it is an easy way, you know, it is a complete meal for them, they eat that. Because you know it has the veggies in there, but they do not realize the amount of salt that they have and, you know, just they empty carbs. So certainly time, it's an issue because even those that are working are not eating at the right time and what they eat it is whatever

they can get a hold of, which is usually a vending machine or anything that is quick on the go." (Female health educator ID 009)

Patients discussed how difficult it is to manage the disease and be a parent. They felt that their priority was centered on meeting their children's needs and caring for the household. Additionally, a CHW recounted such circumstances of one of her female clients expressing that by the time the patient was through with cooking, helping her children with homework and cleaning the house, the patient would not have time to exercise. Most of these obligations were conveyed as major deterrents to self-care because patients expressed the need to work to keep up with bills and the majority of them articulated that they were not able to afford childcare so the available parent had to be present.

Cultural differences. CHWs stated that Latinos tend to seek alternative options like home remedies for HBP care. They also commented on the Latino patient's lack of risk perception. CHWs noted how Latinos believe that since HBP is asymptomatic, they do not fear it as a major problem. Health educators discussed that Latinos are sedentary especially during cold winter months. Adverse weather conditions such as a colder environment than what they are accustomed to back in their native land, makes it more difficult when evaluating whether to go outside to exercise or head to the gym. One participant gave the example of creating more campaigns for HBP education as was done with AIDS in order for Latinos to understand the severity of the diagnosis:

"We see, for example in the case of AIDS, everyone believes it is necessary to use a condom, and now everyone goes around saying they need a condom for any sort of sexual relations, right? Ever since we were in school, they started telling us why you have to use

them. However, when it comes to blood pressure, you don't hear anything, or rather, it's like very quiet." (Female CHW ID 001)

Poor patient-provider communication. Latino patients identified poor patient-provider communication as a key driver to patient dissatisfaction. Lack of sufficient explanation by the provider was discussed as a cause of such poor therapeutic doctor-patient relationships. Patients reported that their primary care providers do not fully explain dose and prescription and therefore making it more difficult for the patient to remain compliant. One participant reported that the doctor would prescribe medications but would not fully explain instructions on how to take them to the patient. The CHW and health educator groups endorsed that the patients oftentimes do not understand why they were prescribed a certain medication in the first place and what potential side effects could occur as a result. They also noted that the doctors' first line of treatment is always medication instead of working with the patients to make an individualized plan of care by making lifestyle changes. A health educator stated:

"The doctor will first prescribe a low dose then over time the patient is required to have a higher and higher dose. The patient doesn't like the fact that they are so dependent on medicine for the rest of their life. What Latinos need is individualized goal setting and support without judgment" (Female health educator ID 004).

Limited access to care and health information. Access to care and health information was a significant barrier noted among the focus group participants. Patient participants reported that they were notified that they could not be seen at a certain medical center because they were too far from the area. A CHW reported that Latinos have to "wait a long time to see a provider" and a lot of centers "do not have Spanish-speaking staff" (ID 014). Participants also noted that Latino patients often lack health insurance and they cannot

afford transportation costs, which make it difficult to afford clinic appointments. Health educators felt that there is a lack of culturally appropriate information. CHWs reported that their patients usually have low literacy levels which would make challenging for the Latino patients access abundant health information available in the mainstream media.

Theme 3: Family as the key facilitator of HBP management

Participants discussed facilitators of HBP management in the Latino community. Participants endorsed family as the main motivator of adequate HBP self-management. Latino patients kept their family as the focal point in terms of their daily priorities. The consensus among the participants was that family was the primary incentive for having a healthier lifestyle in relation to diet change and family support would be essential to remain on track. One participant stated: "If [my wife] cooks healthy foods with vegetables without grease and salt then I am less likely to eat unhealthy" (Male Latino patient ID 002). Another participant who cooks for herself and her son indicated that she makes "sure that [she] cook[s] healthy meals since it may affect [her] son and also stopped putting salt in [her] food" (Female Latino patient ID 003). Overall, family was perceived as a vital motivation for lifestyle change.

Theme 4: Facilitators to effective health promotion

Participant discussed numerous ways in which health promotion programs focused on Latino patients with HBP could be designed and delivered (e.g., interactive media using DVD or open group education). All agreed that culturally relevant education materials using graphics and visuals is a must, given the low literacy level in the community. Participants also underscored the importance of a "wellness focused" framework as opposed to an "illness oriented" framework in designing and providing health promotion programs. Patients suggested that in order for health promotion program for Latino HBP care to be delivered effectively, it must be executed in an

interactive way where the participant can have hands-on activities. They mentioned that they would appreciate more of a learn-by-doing approach and the integration of technology. CHWs and health educators also felt that it would be more effective to use technology such as text messages in educational interventions. One patient stated:

> *"I think [texting] is fantastic, I don't know why they don't do the whole sending messages thing because what the text says, number 1, is captured right there, and you can show it to someone. Or me for example, I can show it to a friend and if he's not around, I can translate it. There are lots of programs for translating. I think it's great!" (Male Latino patient ID 002)*

Discussion

Lifestyle changes such as increasing physical activity, reducing sodium intake and adhering to a medication regimen are necessary for HBP self-management (Rocha-Goldberg et al., 2010); however, several barriers exist for proper HBP self-management in the Latino community. In this study, participants indicated that *poor HBP healthcare knowledge, lack of time, low HBP self-efficacy, cultural differences* and *poor patient-provider communication* were the main barriers in HBP self-management for Latinos. In particular, prior research revealed that Latinos have difficulty adhering to their medication (Manias & Williams, 2010; Schoenthaler et al., 2015) and this could be because of poor instructional clarity from providers as noted by the participants in the focus groups. Betancourt, Carrillo, Green, & Maina (2004) reported that Spanish speaking patients experience multiple structural barriers to care with poor patient provider communication being one of the pervasive barriers Latino patients face leading to dissatisfaction with the US healthcare system. The findings coincide with results from previous research studies involving vulnerable populations with HBP (Krousel-Wood, 2009; Rimando,

2015; Moczygemba, 2013; Flynn 2013), where poor medication adherence is linked to poor didactic teaching by providers, leading to negative perception of the health care system. These findings suggest that more culturally appropriate healthcare interventions are needed to help Latinos with HBP self-management.

The most reported facilitators to HBP self-management were having family and social support. Family as the main facilitator of adequate HBP self-management builds on familism, defined as the concept of family is core to the Latino community (Savage, Foli, Edwards, & Abrahamson, 2016). The concept of family, or familism, is one of the most pervasive values in this demographic group (Moczygemba, 2013; Savage, 2016). A qualitative study exploring limitations and facilitators to HBP in African Americans by Flynn et al (2013) also yielded a similar finding to suggest that encouraging family support may aid patients' HBP self-management. These results imply that health education that is inclusive of the family may be more effective than attempting to provide education for individuals separately. On a clinical level, family members can provide support by accompanying patients to appointments or by holding them accountable to their medication regimen (Flynn, 2013).

There was a strong preference for interactive learning and use of technology in our focus group participants. While Krousel-Wood (2009) reported that "didactic teaching" is one of the most effective ways to teach patients about HBP, our focus group data suggest that didactic teaching may not be the best way to deliver educational interventions to Latino patients. All focus groups reported that they would prefer if there was individualized and culturally tailored teaching methods. A patient-focused individualized approach should incorporate skill building, knowledge enhancing and be tailored to the Latino culture (Mitrani, 2009) as a way to empower and educate this community about HBP self-care since our patient participants reported that they

did not have the self-efficacy to manage their disease. Culturally tailored interventions to control HBP in other ethnic minority communities have been shown to be effective (Jones, 2011; Kim, 2011; Beune, 2014). Similarly, the use of innovative technologies should be incorporated in future educational interventions for Latinos since our participants reported the ease of use and usefulness of text messages for health care education. A multifaceted culturally tailored intervention program using SMS in components of the study showed that Latino text responders had lower diastolic blood pressure showing the value of technology in HBP control (Han et al., 2018).

Limitations

Social desirability bias might have been present because CHWs and health educator respondents may have felt the need to respond favorably since they were known staff at a community clinic. Our focus group sample size of four might be considered low. Nevertheless, since the entire sample included Latino patients or those who worked with Latino patients with HBP regularly, it was more feasible to reach saturation in a small sample size. Finally, given that this sample included participants from specific Latin American countries living in the inner city, findings may not be generalizable to other Latino populations such as those living in rural regions in the U.S.

Strengths

This study contributes to science by allowing us to explore social and cultural barriers to and facilitators of Latino HBP self-management using a qualitative approach involving multi-level stakeholders such as health practitioners and patients. Through this study, we were able to identify gaps in knowledge regarding effective management of BP among Latinos in the U.S.,

identify common barriers to effective management of HBP among Latinos and describe the need for culturally relevant approaches to management of HBP among Latinos.

Conclusion

We have described a unique qualitative study exploring multiple perspectives on barriers and facilitators to HBP self-management in Latinos. The following themes were identified as barriers to HBP control for inner city Latinos: poor patient provider communication, lack of time, limited access to care, cultural differences and poor self-efficacy. The following themes were identified as facilitators to HBP control for inner city Latinos: increased healthcare knowledge, family as a motivator and the use of interactive tools/media for education delivery.

Practice Implications

Scientists should aim at developing and testing culturally relevant interventions with a community engaged approach to promote optimal HBP self-management in this vulnerable population. Findings from the focus groups can provide a framework for developing future educational interventions in the clinical setting to improve self-care of HBP management in terms of disease knowledge, medication adherence and delivering effective teaching. Specifically, educational delivery should incorporate interactive and innovative methods such as text messaging. Future efforts should also focus on helping nurses create individualized treatment plan for Latinos with HBP targeted to helping them overcome the barriers while building on the strength of the facilitators.

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CHAPTER 4

Adoption of mHealth among Latinos with Cardiometabolic Risk Factors

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Abstract

Purpose of the Study: The aim of this explanatory mixed methods study was to understand what factors motivate Latinos with cardiometabolic risk factors (CMRF) to use mHealth.

Design and Methods: Data from N=101 participants (63=Female, 38=Male) in the cross-sectional survey and N=17 respondents in the semi-structured interviews were used to be analyzed and evaluated in the mixed methods phase. Survey items consisted of demographic information, clinical history, smoking and alcohol use, and predictors of mHealth use (Perceived health risks, Health Consciousness, Perceived usefulness, and mHealth literacy). In-depth interviews were conducted with Latinos with CMRF and transcripts of the interviews were analyzed for thematic content. Relationship between predictors of mHealth use was tested using regression and chi-squared analysis. Transcripts were analyzed using qualitative content analysis.

Results: Health consciousness was found to be a statistically significant predictor of Perceived usefulness (β=0.24, *P*=0.050). Both Health consciousness and Perceived Usefulness were positively associated with mHealth use (β=0.15, *P*=0.151), (β=0.90, *P*=0.000) respectively. mHealth literacy moderated the relationship between Perceived usefulness and mHealth use (β=-2.05, *P*=0.046), and was related to both barriers and facilitators to mHealth use even though the interaction effect was negative. Seven major themes emerged with three facilitators of mHealth use: (1) Intrinsic motivation to learn how to improve health, (2) Availability of social resources, (3) Personalized features to meet their needs; and four barriers: (4) Lack of self-efficacy to operate devices, (5) Concern over affordability and financing mHealth, (6) Competing priorities lead to sedentary behaviors, and (7) Navigating a new country.

Conclusion: In Latinos with CMRF, there is a strong awareness of perceived disease risk and the need to take care of oneself. mHealth was qualitatively reported as an important tool that

can help with disease self-management. Yet, mHealth literacy was needed to moderate the relationship between how participants appreciate its utility and their actual uptake. Given that such barriers are unique to the Latino community, researchers should create mHealth interventions that are literacy focused, culturally tailored, and affordable since they all influence mHealth use and CMRF self-management.

Introduction

Despite their higher CMRF morbidity compared to non-Hispanic whites, Latinos in the US face significant challenges in managing their health conditions. For instance, 42.5% Latinos are obese compared with 34.5% non-Hispanic whites, 13.1% have high total cholesterol compared to 12.5% non-Hispanic whites, and 12.8% have diabetes compared to 7.6% for non-Hispanic whites.[1-6] Latinos with CMRF often have difficulty managing their health condition due to a number of financial (e.g., lack of health insurance, low income), structural (poor geographic access to providers, lack of transportation) and cultural/linguistic barriers.[7]
In particular, cultural and linguistic barriers include: cross-cultural miscommunication, where a clinician who is unfamiliar with Latino patients may perceive Latinos to be noncompliant, uninterested in preventive exams, or superstitious with a preference for medicinal herbs.[7] All of these socioeconomic and cultural barriers have been associated with adverse CVD risk factors in Latinos. [9-10] The total cardiovascular costs in the year 2016 were approximately USD 555 billion, largely attributable to CMRF treatment. [10] Given the higher CVD risk burden of Latinos and the costly health care estimates associated with CMRF, it is important to address this prevalent yet devastating health condition in this vulnerable population. Moreover, Latinos are the fastest growing demographic group in the country with a projected growth of 30% of the total population by 2050; [11-13] therefore, their public health is uniquely important to the US.

mHealth is an opportunity to not only bridge the gap of digital divide, but also eliminate cardiovascular health disparities. For an extended period of time, ethnic minorities had been deprived of accessing health information online and via mobile phones due to the digital divide, which is differential access to information and communication technology.[14] Now that technology has become more ubiquitous; there has been an increase in mobile phone ownership and internet access among minorities, especially Latinos where 87% own cellular phones. [15,16] mHealth interventions have been shown to be effective in improving treatment adherence and health outcomes when adopted,[17,18] especially in improving CMRF.[17,18] For example, a study using mHealth to support exercise prescription in patients with CMRF showed increase in compliance to exercise protocol, better self-management of disease and lower CMRF outcomes in the intervention group compared to the control group.[17] Additionally, two systematic reviews of literature regarding the use of digital health interventions aimed at improving self-care of patients with cardiovascular risk factors found that interventions using cell phones, smartphone apps, telephone counseling and text messaging resulted in improved self-care in patients with CMRF and adherence to treatment.[18, 19] In fact, adequate use of mHealth led to cost savings in a study focused on improving self-management of uncontrolled hypertension.[20] Specifically, the intervention group not only had lower blood pressure outcomes, but they also had overall healthcare cost savings of $23,692 versus $5,923 in the usual care group.[20]

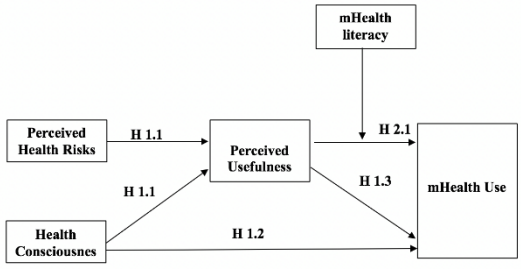
This study will be the first to provide empirical evidence investigating the relationship among health beliefs and perceptions that influence Latinos' use of mHealth. Latinos have a higher disease burden with CMRF, therefore there is a critical need for primary prevention among this vulnerable group. Death is often the first presentation in CVD and in many cases, this occurs with people who have limited contact with the health care system i.e. Latinos.[21] Managing

established risk factors for disease using low-cost strategies such as mHealth has proven to reduce morbidity in CMRF.[17,18] Therefore, this study will add to the limited body of evidenced-based mHealth knowledge in Latinos' use of mHealth in their self-management of non-communicable diseases such as CMRF. Findings have the potential to support the need for researchers to develop and assess theory-based interventions applying high quality research design targeting Latinos with CMRF.

Conceptual Framework

The Technology Acceptance Model (TAM) has been one of the most popular models to understand mHealth use among disadvantaged populations such as the elderly, less educated folks and ethnic minorities.[44-47] The TAM provides a comprehensive framework to explore the intricate relationship among health beliefs (e.g., Perceived Health Risks), Perceived Usefulness, mHealth Literacy and mHealth Use.[48,49] The original TAM was modified for the purpose of the study (Figure 1) to add a health belief construct, Health Consciousness. Health Consciousness, "the extent to which a person takes care of his or her health,"[50] is a particularly relevant concept to Latinos most of whom are first generation immigrants. Latinos recognize family as the locus of control in decision making and place low priority in caring for their own health resulting in poor health consciousness.[1,51] According to the study framework, both Perceived Health Risks and Health Consciousness influence the person's perception of usefulness. mHealth literacy is defined as one's ability to understand and use mobile phone-based health related applications.[52,53] Despite the positive cardiovascular health outcomes in mHealth and the potential to reach marginalized populations, successful mHealth programs require that patients have the knowledge to access and

Figure 1. Modified Technology Acceptance Model



use the functions their phones have.[52,53] Limited health literacy is negatively associated with the use of preventive services, management of chronic conditions (e.g., CMRF) and self-reported health. [54,55] One proposed way to reduce health disparities is to close the gap in health literacy and increase the use of health information and communication technology to support patient self-management.[54] In the TAM, levels of mHealth literacy moderate the relationship between Perceived Usefulness and mHealth and mHealth use in Latinos with CMRF.

Methods

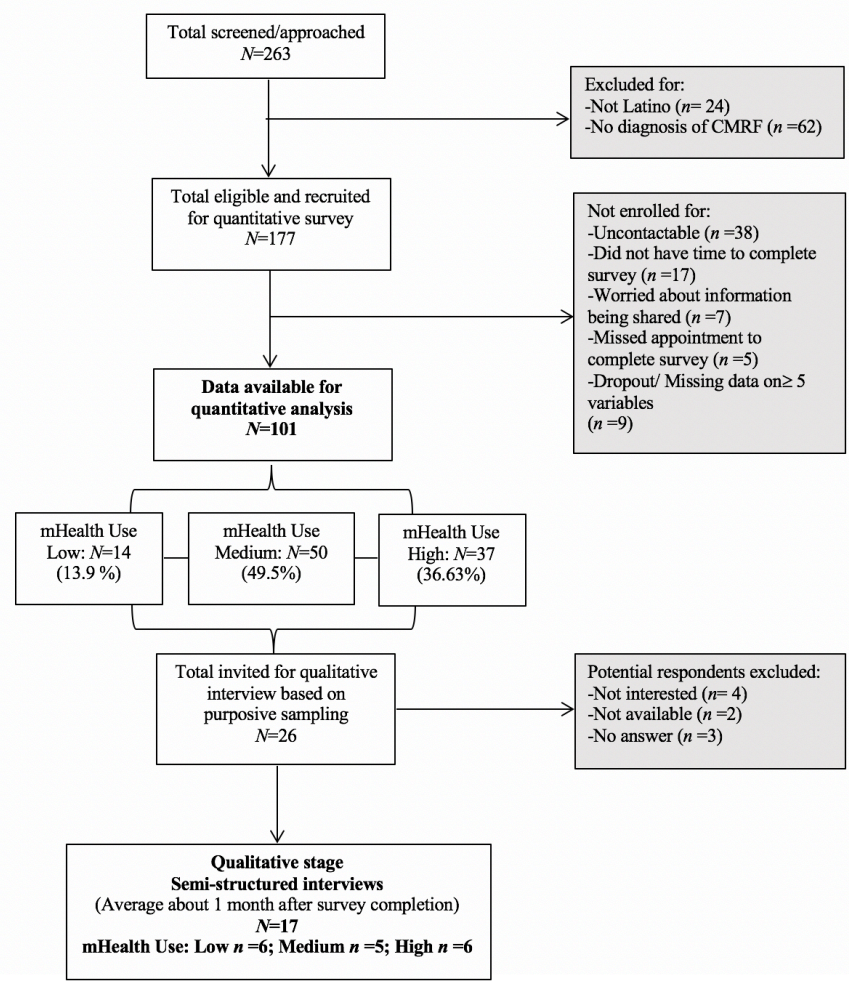
Data collection

An explanatory mixed-methods design involving two recruitment methods was used. Among the 101 Latino adults recruited, 40 were recruited from the community (health centers, markets, restaurants) and 61 were referred to the study team from providers. All procedures were approved by the Johns Hopkins School of Medicine Institutional Review Board. Latino adults recruited in the community were approached and screened. They were included in the study if they expressed interest and met inclusion criteria. For those who were referred to the study team by a provider, screening was completed at the clinic and the study team followed up with the potential participant via telephone to gauge whether there was continued interest.

To be included in the study, participants had to: a) identify as a Latino(a), b) be 18 years or older, c) have a diagnosis of at least one cardiometabolic risk factor and) have access to a wireless device (e.g. smartphone, tablet). Our sample size of 101 for the quantitative phase was determined to be optimal based on 80% power to detect statistical significance at an alpha level of 0.05 yielding an effect size of 0.18. After the protocol of the study was reviewed with the potential participant, written informed consent was obtained. For participants who were interviewed via telephone, an abbreviated script of the informed consent was reviewed, and

verbal consent was obtained. Data collection materials were available in English and Spanish. The bilingual study team ensured that participants were in a stress-free interview environment by collecting data in a private, comfortable setting for in-person interviews or ensured that devices were silenced and household members not present in the same room for telephone interviews. An mHealth Use score was calculated once participants completed the cross-sectional survey. 26 potential participants were purposively sampled and invited to complete the semi-structured interviews based on their level of mHealth use. The entire recruitment and selection process are highlighted in Figure 1. Participants were compensated $10 for completing each phase of the study.

Figure 1. Flowchart of the participant recruitment, selection and data collection process.



Survey Instruments

Socio-demographic items designed by the researcher included: age, native country, education level, English proficiency, marital status, occupation status, insurance status, smoking history, alcohol use, BMI, waist hip ratio and blood pressure. The TAM variables were measured using four scales. The Integrated health belief model and technology acceptance model was used to measure Perceived health risk[22]: 6 items 5-point Likert scale, Chronbach's α 0.92. The same model[22] was used to measure Perceived usefulness with 2 items on a 7-point Likert scale (Chronbach's α 0.93). mHealth literacy was measured using the Digital Health Literacy Instrument on a 5-point Likert scale (Chronbach's α 0.87).[23] Health consciousness was measured using the Health consciousness Scale by Dutta-Bergman,[24] which is a 5-point Likert scale consisting of 5 items (Chronbach's α 0.84). The Unified Theory of Acceptance and Use of Technology was used to measure mHealth use.[25] It consisted of three items on a 5-point Likert scale (Chronbach's α 0.87). Since all scales were translated to Spanish, interviews were conducted with seven key informants prior to start of the study to ensure proper translation of the study items and to minimize threats to validity. Four experts from the study team gave a rating for the degree of relevance of each translated item (1, not relevant; 4, very relevant). An I-CVI of 0.9 was calculated by dividing the rating with the number of experts.[26] Items were finalized once a consensus was reached.

Data Analysis

For the quantitative arm, descriptive analyses were conducted to describe socio-demographic and other characteristics of the participants. Means and standard deviations (SDs) were used to describe continuous variables and percentages and frequencies were used for categorical variables. Chi squared (χ^2) tests were used to compare characteristics between males

and females for categorical characteristics and *t* tests for continuous characteristics. Survey data was analyzed using Stata (version 14). Data was explored using correlation techniques and simple linear regression. The main analysis was done by hierarchical multivariate regression. Study covariates (age, sex, income comfort, education, insurance, CVD risk score) was entered in the first block. In the second block, study variables *Perceived usefulness* was entered to examine its associations with *mHealth Use* after adjusting for the effect of the covariates. To test the moderating effect of mHealth literacy, an interaction term was created (*mHealth literacy*Perceived Usefulness*) and was tested with a multiple linear regression analysis (Hypothesis 2.1) in predicting *mHealth use*. A significant regression coefficient for the interaction term indicated whether the relationship between *Perceived Usefulness* and *mHealth Use* differed by the level of *mHealth literacy*.

A descriptive qualitative inquiry was implemented to understand the motivating factors that leads to use of mHealth from the individual experiences of the participants. Interviews lasted between 45 minutes to an hour. To bring closure to the study, participants were debriefed on important points. In-depth individual audio files were transcribed verbatim and translated. An inductive analysis of the data was performed to identify major themes and subthemes. Similar and different themes were categorized in a cross-thematic matrix independently by two study team members (SD & PI). An inter-coder reliability was computed with Cohen's kappa of 82% indicating substantial agreement. The qualitative data was managed and analyzed using procedures of theme development using the software of NVivo. 12.

To generate a comprehensive understanding of how cultural and social norms of Latinos with CMRF influence their mHealth use, participants were categorized by levels of mHealth use (low, medium, and high) using the scores from the study instrument.[25] Specifically, those with

scores ranging from 0-4 on the mHealth use scale were categorized as low, 5-8 as medium and 9-12 as high mHealth users. Cultural norms and beliefs were compared and contrasted by the levels of mHealth use. A joint display table was used to integrate findings and display data from both strands.

Results

Quantitative findings

Between April 2019 and July 2020, 101 Latino participants were enrolled in the study (sample mean age 47 years ±12, 62% Female). The sample was predominantly from El Salvador (37%), Honduras (19%), Mexico (15%), Guatemala (11%). Four participants were US-born and were also second-generation where both parents were foreign-born. 90% of the participants were uninsured and 40% were unemployed. There was a significant difference in employment status by gender (P=0.005). 49% reported that their cost of living was difficult to maintain with their income. 37% of the participants completed elementary school and 37% were educated at a high school level. For the TAM variables, 53% of participants reported high *Perceived health risks*, 57% reported high *Health consciousness*, 24% reported high *Perceived usefulness*, 41% reported high *mHealth literacy* and 46% reported high *mHealth use*. Stratified analyses revealed that women scored higher on each of the TAM constructs than men (Table 1).

The study revealed that 32% of the participants were overweight according to a BMI of 25-30 kg/m^2 and 64% were obese with a BMI greater than 30 kg/m^2. 39% had an unhealthy waist to hip ratio (WHR), which is considered to be a WHR >0.9 for males and >0.85 for females recruited in the community (N=40). The most reported cardiometabolic risk factor (CMRF) were hypertension (48%), Type II diabetes (41%) and dyslipidemia (58%). The proportion was higher in females compared to males for BMI, WHR and CMRF. A global coronary heart disease risk score was calculated and stratified into three groups: low risk (less than 6%), moderate risk

(between 6 and 10%) and high risk (greater than 10%). 36% of participants were concluded to have high coronary heart disease risk scores. Overall 70% of the Latinos with CMRF were prescribed medications and 4% had a history of depression, as shown in Table 2. A chi-square test of independence showed there was no significant association between gender and all the aforementioned clinical variables, except for smoking history where 9% of males smoked cigarettes compared to 2% females (P=0.001).

Table 1. Sample Characteristics of Latinos with Cardiometabolic Risk Factors by Sex, N = 101

	Total n (%)	**Male (n=38)**	**Female (n=63)**	***P* value**
Recruitment sites				
Community (market, salons, etc)	15 (14.8)			
Esperanza Center	5 (5.0)			
CASA Maryland	20 (19.8)			
Proyecto Salud*	61 (60.4)			
Age (yrs) – mean (SD)	47 (12.0)	48 (11.0)	47 (12.0)	0.711*
Education				0.658**
Elementary or less	37 (36.6)	16 (42.1)	21 (33.3)	
High School grad or less	37 (36.6)	14 (36.8)	23 (36.5)	
Vocational/Technical school	5 (4.95)	1 (2.63)	4 (6.4)	
College grad or less	20 (19.8)	7 (18.4)	13 (20.6)	
Employment				**0.005****
Full-time	27 (26.7)	7 (18.4)	33 (52.4)	
Part-time	31 (30.7)	15 (39.5)	16 (25.4)	
Unemployed	40 (39.6)	13 (34.2)	14 (22.2)	
Insurance				0.203**
Uninsured	90 (89.11)	37 (97.4)	53 (84.1)	
Medicaid	6 (5.9)	1 (2.6)	5 (7.9)	
Private	4 (4.0)	0 (0)	4 (6.4)	
English proficiency				0.104**
Low	87 (86.1)	30 (78.9)	57 (90.5)	
Moderate-High	14 (13.8)	8 (21.0)	6 (9.5)	
Income comfort				0.143**
Difficult to manage	49 (48.5)	22 (57.9)	27 (42.8)	
Comfortable to manage	52 (51.4)	16 (42.1)	36 (57.1)	
Country of origin				0.613**
US born	4 (4.0)	1 (2.6)	3 (4.7)	
El Salvador	37 (36.6)	12 (31.6)	25 (39.7)	
Honduras	19 (18.8)	6 (15.8)	13 (20.6)	
Mexico	15 (14.8)	8 (21.1)	7 (11.1)	
Guatemala	11 (10.9)	6 (15.8)	5 (7.9)	
TAM Variables				
Perceived health risks (1 High, 0 Low)	53 (52.5)	18 (47.4)	35 (55.5)	0.425**
Health consciousness (1 High, 0 Low)	57 (56.4)	24 (63.2)	33 (52.4)	0.290**
mHealth literacy (1 High, 0 Low)	41 (40.6)	15 (39.5)	26 (41.3)	0.859**
Perceived usefulness (1 High, 0 Low)	24 (23.8)	6 (15.8)	18 (28.6)	0.144**
mHealth Use (1 High, 0 Low)	46 (45.5)	13 (34.2)	33 (52.4)	0.076**

*For continuous variables, mean and SD were reported and compared with *t* test

**For categorical variables, frequencies (percentages) were reported and compared with χ^2 test

P values are in bold based on α significance level of 0.05

Table 2. Clinical Profile of Latinos with Cardiometabolic Risk Factors by Sex, N = 101

	Total %(n)	**Male (n=38)**	**Female (n=63)**	***P* value**
Smoker (1, yes; 0, no)	11 (10.9)	9 (23.7)	2 (3.2)	**0.001****
Alcohol Use				0.310**
Never	78 (77.2)	27 (71.0)	51 (80.9)	
One to four times per month	22 (21.8)	11 (28.9)	11 (17.5)	
Two or more times a week	1 (1.0)	0 (0)	1 (1.6)	
BMI				0.666**
BMI 18.5-25 kg/m^2	5 (5.0)	2 (5.3)	3 (4.7)	
BMI 25-30 kg/m^2	32 (31.6)	14 (36.8)	18 (28.6)	
BMI>30 kg/m^2	64 (63.4)	22 (57.9)	42 (66.7)	
Waist-Hip ratio (unhealthy)†	39 (38.6)	14 (36.8)	25 (39.7)	0.426**
Cardiometabolic risk factor				
Hypertension (1, yes; 0, no)	48 (47.5)	21 (55.3)	27 (42.8)	0.226**
Type II Diabetes (1, yes; 0, no)	41 (40.6)	19 (0.5)	22 (34.9)	0.135**
Dyslipidemia†† (1, yes; 0, no)	58 (57.4)	23 (60.5)	35 (55.5)	0.625**
Renal disease (1, yes; 0, no)	4 (3.96)	1 (2.6)	3 (4.7)	0.595**
Coronary Heart Disease Risk				0.223**
Low risk 6%<	47 (46.5)	16 (42.1)	31 (49.2)	
Moderate risk 6-10%	18 (17.8)	10 (26.3)	8 (12.7)	
High risk >10%	36 (35.6)	12 (31.6)	24 (38.1)	
History of Depression (1, yes; 0, no)	4 (4.0)	1 (2.6)	3 (4.7)	0.595**
Medication prescriptions (1, yes; 0, no)	70 (69.3)	28 (73.7)	42 (66.7)	0.459**

*For continuous variables, mean and SD were reported and compared with *t* test

**For categorical variables, frequencies (percentages) were reported and compared with χ^2 test

† Unhealthy is considered WHR>0.9 for males and >0.85 for females recruited in the community

††Dyslipidemia is diagnosis of hypercholesterolemia (or most recent cholesterol ≥200 mg/dl or triglycerides≥150 mg/dl

P values are in bold based on α significance level of 0.05

Multilinear regression was conducted to test Hypothesis 1.1 (Table 3), 1.2 and 1.3 (Table 4). Based on the output, *Perceived Health Risks* and *Health Consciousness* were both positively associated with *Perceived Usefulness e*ven after adjusting for age, sex, income, education, English proficiency, and cardiovascular disease (CVD) risk score; however, only the relationship between *Health Consciousness* and *Perceived Usefulness* was significant (β=0.24, *P*=0.050).

Table 3. Regression results for testing the relationship between *Perceived health risks* and *Health consciousness* with *Perceived usefulness* after adjusting for covariates

Predictor variables	**β (SE), *P* value**
Age	-0.004 (0.005), 0.474
Gender	
Male	Reference group
Female	0.130 (0.127), 0.308
English proficiency	
Low	Reference group
High	0.187 (0.191), 0.331
Education completed	
Elementary	Reference group
High school	0.095 (0.424), 0.824
Vocational/Technical	0.104 (0.485), 0.831
College	-0.053(0.434), 0.903
Income comfort	
Difficult	Reference group
Comfortable	-0.162 (0.118), 0.173
BMI	
18.5-25 kg/m^2	Reference group
25-30 kg/m^2	0.611 (0.287), **0.036**
>30 kg/m^2	0.575 (0.280), **0.043**
Coronary heart disease risk	
Low risk 6%<	Reference group
Moderate risk 6-10%	-0.011 (0.160) 0.944
High risk >10%	-0.317 (0.130), **0.017**
Perceived health risks	0.010 (0.082), 0.901*****
Health consciousness	0.237 (0.122), **0.050***

Hypothesis 1.1

P values are in bold based on α significance level of 0.05

Health Consciousness was positively associated with *mHealth Use* (Hypothesis 1.2); however, the result was not significant (β=0.153, *P*=0.151). Hypothesis 1.3 was supported showing that *Perceived Usefulness* was positively associated with *mHealth Use* after adjusting for covariates (β=0.899, *P*=0.000).

Table 4. Regression results for testing the relationship between *Health consciousness* and *Perceived usefulness* with *mHealth use* after adjusting for covariates

Predictor variables	**β (SE), *P* value**
Age	-0.016 (0.022), 0.476
Gender	
Male	Reference group
Female	-1.223 (0.548), **0.028**
English proficiency	
Low	Reference group
High	-1.618 (0.835), **0.050**
Education completed	
Elementary	Reference group
High school	1.437 (1.939), 0.461
Vocational/Technical	1.724 (1.905), 0.368
College	1.805 (2.178), 0.410
Income comfort	
Difficult	Reference group
Comfortable	-0.682 (0.527), 0.200
BMI	
18.5-25 kg/m^2	Reference group
25-30 kg/m^2	1.512 (1.291), 0.245
>30 kg/m^2	1.927 (1.247), 0.126
Coronary heart disease risk	
Low risk 6%<	Reference group
Moderate risk 6-10%	-0.694 (0.698) 0.323
High risk >10%	-0.523 (0.584), 0.373
Health consciousness	0.153 (0.105), 0.151*
Perceived usefulness	0.899 (0.156), **0.000****

Hypothesis 1.2
****Hypothesis 1.3***
P values are in bold based on α significance level of 0.05

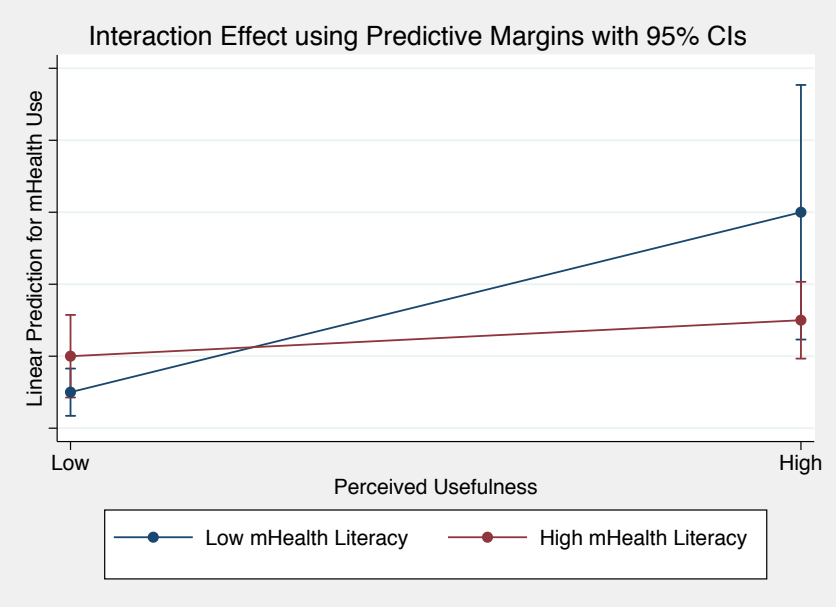
Hierarchical regression analysis of the predictors for mHealth Use showed a significant increase in explained variance (R^2 change) as a function of adding the predictors from the TAM model (Table 5). The first block consisted of age, gender, education, income comfort, English proficiency, BMI and coronary disease risk. Perceived usefulness was added to the second regression to explore its effect without accounting for mHealth literacy (*P*=0.043). After adding Perceived usefulness and the interaction term (mHealth literacy x Perceived usefulness) to the model, 24% (*P*=0.054) of variance was explained in the second model compared to 14% in the first model (*P*=0.319). The interaction model added 4% variance to the third block and supported Hypothesis 2.1 that *mHealth literacy* moderated the relationship between *Perceived Usefulness* and *mHealth Use* (β=-2.047, *P*=0.046). It can be concluded that the relationship between Perceived usefulness and mHealth Use decreased with High levels of mHealth Literacy (Figure 2).

Table 5. Hierarchical regression analysis of predictors of mHealth use among Latinos with CMRF

Predictor variables	**Regression 1** **β (SE), *P* value**	**Regression 2** **β (SE), *P* value**	**Regression 3** **β (SE), *P* value**
Age	-0.011 (0.012), 0.347	-0.015 (0.012), 0.196	-0.014 (0.012), 0.246
Gender			
Male	Reference group	Reference group	Reference group
Female	-0.033(0.295), 0.911	-0.139 (0.292), 0.635	-0.161 (0.287), 0.578
English proficiency			
Low	Reference group	Reference group	Reference group
High	-0.364 (0.445), 0.416	-0.460 (0.438), 0.294	-0.422 (0.428), 0.327
Education completed			
Elementary	Reference group	Reference group	Reference group
High School	0.934 (1.028), 0.366	0.612 (1.010), 0.637	0.589 (0.992), 0.554
Vocational/Technical school	2.720 (1.172), **0.023**	2.034 (1.178), 0.087	2.088 (1.157), 0.075
College	1.317 (1.053), 0.214	1.058 (1.033), 0.308	1.0554 (1.046), 0.301
Income comfort			
Difficult	Reference group	Reference group	Reference group
Comfortable	0.479 (0.281), 0.093	0.378 (0.281), 0.183	0.366 (0.277), 0.190
BMI			
18.5-25 kg/m^2	Reference group	Reference group	Reference group
25-30 kg/m^2	-0.528 (0.686), 0.443	-0.442 (0.668), 0.510	-0.547 (0.648), 0.689
>30 kg/m^2	-0.779 (0.657), 0.239	-0.597 (0.644), 0.356	-0.686 (0.634), 0.282
Coronary heart disease risk			
Low risk 6%<	Reference group	Reference group	Reference group
Moderate risk 6-10%	-0.163 (0.377), 0.666	-0.072 (0.370), 0.845	-0.079 (0.364), 0.829
High risk >10%	0.341 (0.305), 0.267	0.277 (0.300), 0.358	0.263 (0.294), 0.374
TAM Variables			
Perceived usefulness (1 yes, 0 no)		0.822 (0.400), **0.043**	2.529 (0.929), **0.008**
mHealth literacy (1 yes, 0 no)		0.056 (0.337), 0.869	0.293 (0.351), 0.406
Interaction term: mHealth literacy x Perceived usefulness		--	-2.047(1.010), **0.046*****
R^2 *(P value)*	0.137 (0.319)	0.200 (0.114)	0.238 **(0.054)**
R^2 change	--	0.063	0.038

Hypothesis 1.2;* ***Hypothesis 1.3;**** ***Hypothesis 2.1*;*****
P values are in bold based on α significance level of 0.05

Figure 2. Interaction plot testing moderation relationship of mHealth literacy and mHealth use



Qualitative findings

N=17 participants were interviewed for the qualitative arm (12 females, 5 males). Based on the scores from the study instrument, n=6 scored low on the mHealth use scale, n=5 scored medium and n=6 scored high. An inductive thematic analysis reduced the data to four dominant themes: engagement in use of the app; technical functionality of the app; ease of use and design features; and management of consumers' data. To generate a comprehensive understanding of how cultural and social norms of Latinos with CMRF influence their mHealth use, participant themes were organized by the modified TAM theory constructs and were categorized by levels mHealth use, as shown in the joint display matrix (Table 5). The display 1) provided insight on how Latino society and culture influenced the use of mHealth, 2) explored the themes' relation to perceived health risks, perceived usefulness, health consciousness and mHealth literacy, and 3) compared how these norms motivated actual mHealth use.

Qualitative findings identified three facilitators of mHealth Use. The first theme, 1) *Intrinsic motivation to learn how to improve health*, was reported by 88% of the 17 participants, the second theme, 2) *Availability of social resources*, was reported by 76.5% of participants, the third theme, 3) *Personalized features to meet their needs,* was reported by 100% of participants. The following four barriers were reported by participants: 1) *Lack of self-efficacy to operate devices* (76.5%), 2) *Concern over affordability and financing mHealth* (94.1%), 3) *Competing priorities leads to sedentary behaviors* (64.7%), 4) *Navigating a new country* (82.3%).

Facilitators of mHealth Use

Intrinsic motivation to learn how to improve health

An intrinsic motivation to be educated on how to improve health was noted among participants who were taking an active role in managing their cardiometabolic risk factors. This thought

process aligned with the Health consciousness and Perceived health risks constructs from the TAM model. The following participant talked about how using the information found on the internet, such as healthy meals, helps in controlling Type II diabetes:

> *"I am diabetic so it helps me a lot. It allows me to read about foods and how many carbohydrates and sugars some foods have. I take some advice from the internet. For example, the clinic gives me handouts sometimes and I read more on the information they give me online. I also like to look up my medications. I am still learning and discovering new things online, it makes me excited that I can literally find anything on the internet, no matter where I am." (SID086, High mHealth use)*

Being health conscious led to an increased engagement with mHealth:

> *"I also use a calorie count application and an application to help me count my steps when I walk around the block sometimes" (SID051, High mHealth Use).*

Availability of social resources

Participants were more likely to leverage mHealth technology if they had the social support to impart knowledge and skills. This aligns with the mHealth literacy construct from the TAM, which involves one's ability to understand and use digital health tools. Interviewees who were more digitally naïve felt more encouraged to use mHealth if they had younger family members nearby to offer technology support:

> "*I am not sure how to adjust settings on my phone. So, I get my son to help me… I know how to open the application …on my phone, of course, but I get lost" (SID094, Low mHealth use).*

"My daughter helps me a lot with technology if I need it. Okay actually I need the help most of the time. If everything was in Spanish it would be easier if it were in my language" (SID012, Medium mHealth use).

Those who were more frequent users of mHealth reported that living in a neighborhood that was a cultural enclave helped because there were people who spoke the same language available if they needed assistance with mHealth:

"I stay surrounded in a community where there are a lot of Latinos, I think maybe that is why I have not had many difficulties" (SID051, High mHealth Use).

A participant revealed that technology impacted the way her family communicates. In fact, the desire to stay in touch with family members nearby and those in their native land was noted among majority of the interviews:

"My family influences my use of technology a lot. For example, we have a group chat with my daughter and other family" (SID085, High mHealth use).

Personalized features to meet their needs

Personalization of mobile technology functions was appreciated by all of the participants. This related to the Perceived usefulness and mHealth literacy constructs of the TAM. They brought up the point that mHealth would be more beneficial to them if it were available in Spanish. Respondents felt that the contents were not useful to them if they were not able to understand them, which made it harder to navigate and often led to abandonment of certain functions:

"What makes it easier for me is having my phone in Spanish, I am glad it is this way because if not, I would not use my phone at all" (SID075, Low mHealth Use).

"There are some applications I do not even open. They serve no purpose for me as a Latino. Quite honestly, I do not even know the names of them anymore. They probably could be deleted" (SID091, Medium mHealth use).

A participant expressed that most technologies were not user friendly for folks with low vision or with vision impairments. This was important to note since diabetes can be complicated by diabetic retinopathy:

"My vision is low and it is difficult sometimes to see what is on the phone. I need a lot of brightness on it at all times. Sometimes, I use Netflix on my TV to watch documentaries and learn about foods and cultures. My son leaves my Pandora ready to press the play button and also leaves the TV on the correct setting with things I might like to watch in Spanish. It is very convenient when it is set up the way my son sets it up." (SID063, Low mHealth use)

Participants engaged mHealth to promote good mental health by using apps with contents curated with spiritual or religious messages:

"I watch a lot of YouTube for my mental health. It relaxes me and I find videos on meditation and on the word of God" (SID084, Medium mHealth use).

Barriers of mHealth Use

Lack of self-efficacy to operate devices

Participants endorsed low self-efficacy when it came to operating mHealth devices. They expressed feeling incapable of accessing and using digital platforms which aligns with the mHealth literacy construct of the TAM:

"And for me, someone who does not know how to read or write even in Spanish, you can imagine that it is even more difficult." (SID063, Low mHealth use)

They proposed that if they were educated on how to use mHealth, they would be able to use it more effectively. This standpoint was implied by the following accounts:

> *"I need one-on-one sessions to learn new things on my phone. What makes it hard for me is that you must be quick in learning. I need someone to sit down with me and teach me the basics" (SID075, Low mHealth use).*

Participants felt that it was difficult to master technology as adult learners and reported being slow to learn:

> *"The only difficulty is learning new thigs when they come…like the smart watches which is not that often but for some reason it takes me longer than others to keep track of new changes (SID086, High mHealth use).*

Concern over affordability and financing mHealth

While mHealth was presumed to be cost-effective, most participants expressed that they have limited digital accessibility due to high prices. High costs were barriers, which discouraged them from considering mHealth as a useful tool:

> *"Honestly, it is not even about culture, it is all about money. It is not like these things do not exist in Honduras, it is because it is expensive compared to our money here" (SID090, Low mHealth use).*
>
> *"The price matters a lot. I cannot have the luxury to have the most up to date phone. I stick to the phone I have and it will stay with me until it is dead or nonfunctional" (SID094, Low mHealth use).*
>
> *"I go to the community library to use the internet. We [Latinos] don't have the money to pay for Internet, especially for people who don't have papers. When they don't have*

papers, they are underpaid…but in the library the Wifi is free" (SID012, Medium mHealth use).

They reported that Latinos often experience financial strains which make it hard to afford mHealth. Most of their income was dedicated to caring for their families and paying for other important expenses (i.e. food, rent, utilities):

"A barrier is not always having stable internet connection at home. Some months, we do not pay for the bill and we have it off" (SID075, Low mHealth use).

"[Latinos] are just looking for ways to make money to get through and to make money for their families" (SID084, medium mHealth use).

Competing priorities leads to sedentary behaviors

Several participants indicated having competing priorities such as working multiple jobs leading to a limited schedule. Feelings of being unable to take time off from work were prevalent throughout the interviews, whether it was to carve out time to manage their health or to learn how to use different features on their smartphones:

"Another barrier is my schedule. So, with my current job, it is hard for me to also go to school to get a better job. I work with a lot of Latinos at my job, most of them are in my same situation" (SID084, Medium mHealth use).

"[Latinos] spend more time at their job than their own home. Most people have 2-3 jobs" (SID012, Medium mHealth use).

Navigating a new country

Participants compared their experience using technology back home in their country of origin to their experience living in the US. They expressed that technology was not as ubiquitous as it is in the US:

"I would not even need these technologies if I was back home. It is not something we are used to, and I mean for us older ones who grew up in another country that is not America" (SID063, Low mHealth use).

"Back where I grew up in, children do not have technology like they do here in the United States…Over in Honduras you do not find just anyone having a phone or laptop" (SID054, High mHealth use).

Others felt that technology allowed them to stay in touch with friends and family back home:

"*You can communicate with people living here and people in your home country. This is also true of my family and friends" (SID035, Low mHealth use).*

Respondents expressed that technology, such as smartphone applications, is useful in helping them acculturate to a new environment, as one participant stated:

"There are a lot of opportunities for Latinos in Baltimore. You can get your Driver's license even if you don't have papers. I have the app "Nextdoor." I use it to see what's going on in my neighborhood... I also use Googlemaps because I am not too familiar with the streets" (SID012, Medium mHealth use).

Discussion

This is the first research to empirically investigate factors that motivate Latinos' use of mHealth guided by a modified TAM framework. This study is also novel in that it used a mixed methods approach to answer research aims. Integrating the qualitative and quantitative arms, allowed for a deeper understanding of the dynamic relationship between the modified TAM model constructs and adoption of mHealth among Latinos with cardiometabolic risk factors. The Creswell method of mixed methods analysis was implemented, which resulted in both convergent and divergent data.

Perceived Health Risks

The survey data revealed that 53% of participants reported high *Perceived health risks* and the regression output showed that *Perceived health risks* was positively associated with *Perceived Usefulness*; however, it was not statistically significant (β=0.010, *P*=0.901). The quantitative findings converged with the qualitative data because *Perceived health risks* was associated with a facilitator of mHealth Use in the qualitative themes. Participants who perceived that their CMRF put them at risk of a chronic illness were motivated to use mHealth so that they could be better educated about their disease process. The findings from this study coincide with previously published studies where perceived disease threat predicted patients' intention to use technology for diabetes[27] and hypertension management.[28] It is well known that intention to use mHealth predicts actual mHealth use.[29,30] Therefore, although the relationship between *Perceived health risks* was not statistically significantly associated with *Perceived usefulness*, a proven mediator of mHealth use,[31] more participants in this sample had high risk perception scores compared to perceived usefulness. Lower perceived usefulness could potentially heighten their resistance to actual mHealth use. Studies have shown that ethnic minorities, especially Latinos, with multiple risk factors and comorbidities have high disease risk perception.[32,33] Despite having high Perceived health risks, Latinos may not find utility in mHealth unless they believe that their family is vulnerable to CMRF or they have multiple risk factors. Hovick et al. reported that Latinos have higher lifetime risk perception scores when they learned that they had more than one risk factor and an elevated predisposition to familial heart disease and diabetes.[34]

Health Consciousness

The relationship between Health consciousness and Perceived usefulness can also add to our understanding of how Latinos' personal health needs are prioritized and how it relates to

mHealth utility. Our results indicate that more than half Latinos with CMRF prioritize their health, where 56% of participants reported high Health consciousness, even though it is reputed that primary needs and interests of Latinos are generally centered on family welfare.[35] Health consciousness was positively associated with *Perceived Usefulness* in the regression analysis (β β=0.24, *P*=0.050). Consistent with findings in Chen and Lin, Health consciousness had a positive effect on usefulness of mHealth apps.[36] This could be due to the fact that individuals with high health consciousness have a higher tendency to seek health information using various avenues,[37] and therefore mHealth users may find such sources useful. Conversely, the relationship between Health consciousness and mHealth use was not statistically significant (β=0.153, *P*=0.151). This finding diverged with our qualitative data, where Health consciousness was related to a facilitator of mHealth Use. While the literature purport that Health consciousness predicts mHealth use,[36,37] the construct is usually mediated by either perceived usefulness or perceived ease of use. In our modified TAM model, we tested the relationship between Health consciousness and mHealth use (Hypothesis 1.3) without considering perceived usefulness as a mediator in that pathway.

Perceived Usefulness

Perceived usefulness was deduced to be statistically significantly associated with *Perceived health risks* (β=0.90, *P*=.000). This was supported by the qualitative interviews where positive attitude regarding Perceived Usefulness was noted among facilitators of mHealth use and negative attitude of this construct was reported as a barrier of mHealth use. A focus group study with working class Latinos reported that participants considered technology useful for achieving daily tasks; however, the greatest value was placed on whether the device enabled interpersonal communication, especially with family.[38] The authors concluded that Latinos have a culture

where family is the most important unit for the individual also known as familism.[39,40] Familism is espoused among Latinos, where needs of the family outweighs the needs of the individual.[39,40] This outlook was evident in the qualitative quotes where individuals who endorsed low perceived usefulness generally stated that they bought devices only if their children needed it for school or if they needed to communicate with members of their church. Overall, findings regarding Perceived usefulness converged with the quotes and themes from the qualitative interviews.

mHealth Literacy

mHealth literacy survey findings was consistent with themes from the interviews. There was a statistically significant relationship between *Perceived Usefulness* and *mHealth use* when *mHealth Literacy* was used as a moderator (β=-2.047, *P*=.046). In the qualitative interviews, *mHealth Literacy* appeared several times as a barrier and a facilitator of mHealth Use across themes. Only 41% of study participants had high mHealth literacy scores and mHealth literacy was related to several barriers indicating that Latinos may lack the necessary skills to use mHealth. While the digital divide is narrowing for Latinos,[14] having access to a device does not necessarily mean that users have the skills/resources to use mHealth to its full capability. A systematic review of technology use among underserved populations published that beyond the digital divide, low health and computer literacy led to poor consumer health informatics adoption.[41] They also found that having a proxy person to provide support helped to increase mHealth uptake. This finding is supported by our qualitative study results, where the availability of social resources to impart knowledge and skills was a facilitator of mHealth use.

General mixed findings

Barriers and facilitators were reported across mHealth Use levels (low, medium, high). Despite

spending more time using mHealth, Medium and High users still experienced similar difficulties as lower users. This suggests that social and cultural factors play a role in how the Latino population navigate mHealth despite their level of familiarity with technology. Participants stated that mHealth was important, but they were limited by socioeconomic strains: time, money and digital literacy. This is supported by the quantitative data where many of the survey respondents struggled to live comfortably with their income, were unemployed, had low English proficiency and low mHealth literacy.

Limitations

Since quantitative data was collected at one point in time using a cross sectional survey, causal relationships cannot be established. For the participants recruited in the community, data on diagnosis of cardiometabolic risk and the number of medications may not be accurate because it was self-report compared to chart data of participants who were referred to the study team by a clinician. Due to the current political climate in the US, Latinos are experiencing a sense of fear of detainment, arrest and deportation. [42,43] Participants (n=7) who were eligible to enroll in the study reported that they feared that their information would be shared either with a medical institution or the government since they were undocumented immigrants. Therefore, these perceptions of legal status could have had recruitment implications. Nevertheless, we worked closely with our community partners to identify additional recruitment strategies and enhance our initial recruitment approach using direct community site referral. Moreover, the quantitative phase of this study also had a relatively small sample size, but was adequately powered to detect the effects needed for the statistical analyses conducted.

Strengths

Despite these limitations our study has several strengths. To the best of our knowledge, this is the first study to investigate the relationship among health beliefs and perceptions that influence Latinos' use of mHealth for disease self-management. We tested the role of mHealth literacy as a moderator in mHealth use. We also used mixed methods to better understand individual beliefs and behaviors unique to the Latino community. Integrating findings from both the quantitative and qualitative arms strengthened the rigor and enriched the analysis and findings of the study.

Conclusion

The goal of this research was to understand factors that motivate adoption of mHealth among Latinos with cardiometabolic risk factors. Findings from this study addressed all research aims, even though not all hypotheses were supported from our statistical analyses. The qualitative themes spanned all of the modified TAM constructs, which demonstrates the congruence between the predictors' influence on mHealth use and the participants' response regarding social and cultural norms of Latinos. It was encouraging to discover that Latinos with CMRF have social networks and support system that can help them navigate mHealth. Also, they have a high sense of health consciousness and want to be better educated about their disease process. Alternatively, this population have to overcome multiple barriers in order to use mHealth. One potential way to tackle such barriers is to create mHealth that is user friendly, available in Spanish, provide education that will activate self-efficacy, develop mHealth that does not require Wifi or data. This will not only help to continue to bridge the gap of digital inequities but also decrease disparities in cardiovascular and metabolic health.

Table 5. Joint display comparing themes from the N=17 interviews and survey findings guided by the modified TAM constructs

Themes from one-on-one interviews	Frequency cited (%)	Representative quote (ID, mHealth use)	Modified TAM construct	Survey question	β (*P* value)
Facilitators of mHealth use					
1-Intrinsic motivation to learn how to improve health	15 (88.2)	"I go on Google and search for medications…herbal remedies. A lot of people don't know the benefits of avocado seed. It's good if you have a poor circulation or cholesterol. It's an anti-inflammatory…it'll lower cholesterol levels. There's also chamomile, which helps with headaches or stomachaches. It fights spasms. I like looking up information on herbs and plants…natural remedies. I know they're good because I've tried them myself and I feel so much better. I know there are exercise apps on the phone but I mostly try exercises that someone shares me with via Whatsapp." (SID035, Low mHealth Use)	Health consciousness Perceived health risks	Eating right, exercising, and taking preventive measures will keep me healthy for life. Using the Internet for health information is useful in managing my daily health.	0.24 (0.050) 0.010 (0.901)
		"I use YouTube to learn about exercises and healthy recipes, like different salads and other things that are low in fat." (SID045, Medium mHealth use)			
		"Everything is virtual for my children so that is not a problem. I also give my children daily vitamins to keep healthy. I read about that on the internet." (SID051, High mHealth Use)			
2-Availability of social resources to impart knowledge and skills	13 (76.5)	"I know a lot of Latinos in my neighborhood who are very good at technology, they even fix phone and put them together, with only months of learning how to do these things." (SID090, Low mHealth Use)	mHealth literacy	I know **how to use** the Internet to answer my questions about health.	-2.047 (0.046)
		"If I lived alone or had no family, maybe there would be more of a motivation for me to learn these things, which of course I am sure I can like any other person, but I will leave the technology savviness to the younger ones." (SID090, Low mHealth use)			
		"I know some friends who have gotten in trouble with the law before, and honestly it really was not			

		about the law. I cannot tell you exactly what situations because it is personal to them, but it gives you an example of how some of us living here in Maryland do experience discrimination to some extent. To my benefit, having my family here with me really make a difference. I cannot imagine being here alone to help me." (SID094, Low mHealth use)			
		"Sometimes I try to translate if it is in English but that takes up a lot of time and it can be exhausting and frustrating for me." (SID085, High mHealth Use)			
		I think what makes my experience better than others maybe is because most people here on my street speak Spanish." (SID086, High mHealth Use)			
3-Personalized features to meet their needs	17 (100)	"I don't have any issues using the computer but the words aren't in Spanish. I'm learning to speak English now. But if the oration is in Spanish I can understand it. (SID035, Low mHealth use)	Perceived Usefulness	How **important** is it for you to be able to access health resources on the Internet?	0.899 (0.000)
		I don't really use health apps or manage my health using my phone. See the thing is I struggle a lot in English so I would prefer to use mHealth apps that are available in Spanish. Most of these things are in English. Plus, I'd want a lot of visuals and audios…kinda like Youtube. Something in simple language for people who are not as educated. These things are too complicated. (SID006, Low mHealth use)	mHealth literacy	I know **how to use** the Internet to answer my questions about health.	-2.047 (0.046)
		"For those who are home and have the application, we use it on Friday nights to go live with my church." (SID091, Medium mHealth use)	Perceived Usefulness	How **useful** do you feel the Internet is in helping you in making decisions about your health?	0.899 (0.000)
Barriers of mHealth Use					
4-Lack of self-efficacy to operate devices	13 (76.5)	"I feel like I cannot learn than what I know unless I attend a class specifically for that, with people who know how to teach me." (SID075, Low mHealth Use)	mHealth literacy	I know **how** to find helpful health resources on the Internet.	-2.047 (0.046)
		For example, I may be trying to press a button on the screen, and it presses something else because of my fingers. You have to be really careful with this type of screen. And after a while, I just			

		become frustrated and lose interest. (SID094, Low mHealth use)			
		"But it takes me a while to get used to an application, it is something I have never been used to my whole life, unlike those who have been exposed to it since they were small children." (SID051, High mHealth use)			
5-Concern over affordability and financing mHealth	16 (94.1)	I don't have access to the Internet in my house. Actually, a lot of Latinos don't have Internet in their house. It's too expensive. I just use Wifi when it's free." (SID012, Medium mHealth use)	Perceived usefulness	How **important** is it for you to be able to access health resources on the Internet?	0.899 (0.000)
		"If it were not for my son's school, I'm not sure if we could have afforded a personal laptop like he has right now." (SID051, High mHealth use)			
		"My situation does not allow me to buy things that are expensive. I go more towards things that are comfortable in price for me." (SID085, High mHealth use)			
6-Competing priorities leads to sedentary behaviors	11 (64.7)	Another thing is Latinos believe everything they hear. They don't have time so when they hear something they can't check online whether it's true or not." (SID012, Medium mHealth use)	--	--	--
		"Life obligations until now have made it hard to learn the language and other things like new technology." (SID045, Medium Mhealth use)			
7-Navigating a new country	14 (82.3)	"Kids over in my country do not use technology until they are in University. I certainly did not own one until I was much older. They are at a disadvantage because they learned technology later in life and may not be the most proficient in using it." (SID079, High mHealth use)	--	--	--
		"I never used a cellphone before coming to the United States. Back in El Salvador, we barely used phones. I have always seen it and borrowed it before in El Salvador, but it was never my own." (SID051, High mHealth use)			

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CHAPTER 5

Summary of research findings

Mobile technologies are a useful platform for the delivery of health behavior interventions and reduce health disparities, especially among Latinos with cardiometabolic risk factors (CMRF). Yet, little work has been done to understand what factors will influence the uptake of mHealth in this vulnerable population. This cross-sectional, sequential explanatory mixed-methods study sought to examine the factors that motivate adoption of mHealth among Latinos with CMRF. Our work was guided by the modified Technology Acceptance Model which is comprised of five constructs: Perceived Health Risks, Health consciousness, Perceived Usefulness, mHealth literacy and mHealth use.

N=101 Latino adults living in Maryland completed the quantitative survey, and a purposive subsample of N=17 end-users across the mHealth use spectrum (low: n=6, medium: n=5, high: n=6) also participated in the qualitative arm. Descriptive statistics and regression analysis were used to examine relationship among variables and constructs with the following results:

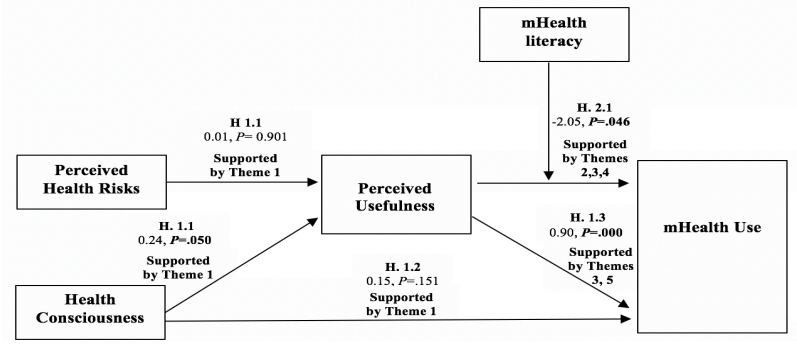
H 1.1 (partially supported by quantitative analysis): *Perceived Health Risks* and *Health Consciousness* will be positively associated with *Perceived Usefulness* even after adjusting for age, sex, income, education, English proficiency, and cardiovascular disease (CVD) risk score.
H 1.2 (not supported by quantitative analysis): *Health Consciousness* will be positively associated with *mHealth Use* even after adjusting for age, sex, income, education, English proficiency, and CVD risk score.
H 1.3 (supported by quantitative analysis): *Perceived Usefulness* will be positively associated with of *mHealth Use* even after adjusting for age, sex, income, education, English proficiency, and CVD risk score.

H 2.1 (supported by quantitative analysis): *mHealth literacy* will moderate the relationship between *Perceived Usefulness* and *mHealth Use*.

Descriptive qualitative inquiry was used to understand social and cultural phenomena within the context of mHealth use. Through an iterative process, we identified barriers and facilitators to the use of mHealth for Latinos with CMRF. The following themes have enhanced our understanding of technology acceptance among Latinos with CMRF, where 1-3 are facilitators and 4-7 are barriers: (1) Intrinsic motivation to learn how to improve health, (2) Availability of social resources, (3) Personalized features to meet their needs, (4) Lack of self-efficacy to operate devices, (5) Concern over affordability and financing mHealth, (6) Competing priorities lead to sedentary behaviors, and (7) Navigating a new country. We also employed a mixed methods approach to get a generalized understanding of how the themes converged or diverged with the survey findings. A summary of the results is also illustrated in Figure 3.

With the exception of themes 6 and 7, which are more socially and culturally specific, every TAM construct was mentioned by participants across levels of mHealth use. mHealth was qualitatively reported as an important tool that can help with disease self-management even though quantitatively only 24% of the sample appreciated its perceived utility. However, theme #1 revealed that participants' intrinsic motivation to learn how to use mHealth (theme 1) was encouraged by their Health consciousness and Perceived health risks. Although only Health consciousness was statistically supported in Hypothesis 1, quotes from

Figure 3. Modified TAM with hypothesis testing results and supporting themes Regression coefficients are shown with associated P values.



qualitative interviews showed that participants do consider their cardiometabolic risks as a motivator to use mHealth. In this case, there was clinical significance despite the low degree of evidence in favor of rejecting the null hypothesis. Given that Health consciousness was noted to be a facilitator of mHealth adoption, it supports the empirical data confirming the statistical significance of its relationship to mHealth use (β=0.90, *P*=000).

When the interaction effect was tested, it was determined that mHealth literacy was a moderator of the relationship between Perceived usefulness and mHealth use. This was also illustrated in the qualitative themes where mHealth was reported across various barriers and facilitators. The interaction effect was negative indicating that the relationship between Perceived usefulness and mHealth Use decreased with high levels of mHealth Literacy. This discrepancy can be explained by the literature where users with high literacy had privacy issues and negative attitude towards technology usage, which can lead to late or no adoption.[1,2] It was reported that those users were concerned about phone embedded tracking where third parties would potentially collect personal information. [1,2] Additionally, it is probable that the mHealth literacy tool was not specific enough in capturing how participants use specific devices since multiple modalities of mHealth were explored. Research shows that instruments measuring health literacy should be context specific and less generic. [3,4,5] If a particular mHealth modality was studied, for example a smartwatch, potential questions can be: "Are you able to count steps with your smartwatch? Do you know how to monitor your heart rate during fitness activities?" It is difficult to anticipate change in an outcome unless the instrument is sensitive enough because that could introduce instrument bias. Although all instruments used in the study were highly reliable it does not necessarily translate to comparable sensitivity.

Contribution to Related Field of Science

Mobile apps have significant potential to help Latinos with cardiometabolic risk factors manage their health. Given that Latinos often experience limited access to care, mHealth can be used to help with several lifestyle habits such as diet management, fitness, and medication adherence. Latinos are health conscious and enjoy using technology but are often burdened by social and financial strains. In order for this population to consider mHealth useful and actually adopt the technology, mHealth should be available at affordable prices, culturally relevant, and user friendly for folks who are not as digitally savvy. This study provides an overview of the perspectives of Latinos with cardiometabolic risk factors who are understudied in the literature, describing how certain health belief constructs influence their motivation to use mHealth for disease self-management. Findings have the potential to support the need for researchers to develop and assess theory-based interventions applying high quality research design to reduce CMRF among Latinos at risk.

Findings from this study also have clinical implications, where mHealth can be integrated into the healthcare system to facilitate clinician patient communication and to help facilitate adherence to treatment. In order to integrate mHealth into the health care system it demands successful scaling of digital health initiatives. Based on study themes: Latinos with cardiometabolic risk factors want to have more self-efficacy and learn more about mHealth. The literature has reported that including end users in the design process will help to enhance patient agency while also overhauling an inequitable health care system.[6] Our study participants also reported the need to have extra support as indicated in qualitative themes; therefore, mHealth developers must ensure there is adequate technical support to enhance self-efficacy among the digitally naïve. This can be in function of a chat or video call function where the support is

available in the participant's native language.[7] Often times departmental silos can hinder successful implementation of mHealth in the healthcare system. Clinical leaders can create multidisciplinary teams that include both clinical and digital experts to disrupt this status quo.[8]

To accelerate adoption of mobile health services and to ensure that they fulfill their promise, it is important to put in place supportive policies and regulations. As an early step, reimbursements should be used to encourage new approaches that extend traditional practices, such as using email or telemedicine for consultations. Applications can range from targeted text messages that promote healthy behavior to wide-scale alerts about disease outbreaks. Governmental agencies should fund more mHealth research that will add to the evidence base. This would enable scientists to develop more remote patient monitoring protocols, which can provide a more holistic view of a patient's health over time, increase visibility into a patient's adherence to a treatment, and enable timely intervention. It should be noted, that literacy was an important driver of mHealth use in the Latino population, and it is important that policymakers create a strategic plan for improving health literacy among vulnerable populations. Even though there are initiatives in place to tackle this public health problem (e.g., Affordable Care Act of 2010, National Action Plan to Improve Health Literacy of the Department of Health and Human Services),[9] there remains a plan to carry out these policies. If all of these major stakeholders, developers, clinicians, health care leaders, and policy-makers, work towards creating mHealth that is culturally tailored, user-friendly and affordable, then marginalized groups such as Latinos can be encouraged to use mHealth to help with lifestyle and behavior change.

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Curriculum Vitae

PERSONAL

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EDUCATION AND TRAINING

YEAR	DEGREE	INSTITUTION/LOCATION
2015-2020	Doctor of Philosophy	Johns Hopkins University Baltimore, MD
2017-2018	Nurse Faculty for the Future Fellowship	Johns Hopkins University School of Nursing, Baltimore, MD
2016-2020	Certificate for Community Based Participatory Research	Johns Hopkins University School of Public Health, Baltimore, MD
Summer 2010	Summer University	Haute École Cantonale Vaudoise de la Santé & Haute École de la Santé La Source Lausanne Switzerland
2007-2011	Bachelors of Science (BSN)	Boston College Chestnut Hill, MA

LICENSE

YEAR	SOURCE	TYPE
January 2012-present	Massachusetts State Board of Nursing	Registered Nurse
January 2018-present	Maryland State Board of Nursing	Registered Nurse
Active until 10/2020	American Heart Association	ACLS-BLS

PROFESSIONAL EXPERIENCE

YEARS	POSITION	INSTITUTION/ LOCATION
January 2019-present	Clinical Research Nurse	National Institutes of Health Bethesda, MD
January 2018- May 2020	Nurse Clinician IM	Johns Hopkins Hospital Baltimore, MD
October 2015-January 2017	Research Team Coordinator	Johns Hopkins University Baltimore, MD
April 2012-Present	Registered Nurse	Massachusetts General Hospital Boston, MA

November 2012- May 2015	Visiting Nurse	Jewish Family and Children's Services Boston, MA

HONORS AND AWARDS

YEAR	
April 2019	Johns Hopkins University Edward A. Bouchet Graduate Honor Society *Inducted into the inaugural class*
October 2018	Scholl Foundation *Dissertation Data Collection Award*
January 2018	Johns Hopkins 2nd Annual Excellence in Diversity Symposia *Poster presentation award*
April 2017- October 2018	Maryland Higher Education Commission *Nurse Faculty for the Future*
2016-2017	Johns Hopkins University School of Nursing *Alumni Association Student Awards* *(For the Doctoral Student Organization titled "Doctoral Student Professional Development Speaker Series)*
September 2016	Johns Hopkins University School of Nursing *Nursing Student Shining Star Award*
May 2016	Johns Hopkins University School of Nursing *Professional Development Award*
April 2016	Center for Disease Control 2016 Public Health Ethics Forum *Poster Award*
September 2012	Massachusetts General Hospital *Association of Multicultural Members (AMMP) Scholarship*
January 2012	Brigham and Women's Hospital *AMMP Scholarship*
December 2011	Boston College Nursing Convocation Awards *Leadership and Volunteer Service Awards*
April 2011	Boston College Keys to Inclusive Leadership in Nursing *Leadership Award*

SPONSORED PROJECTS

YEAR	
2018-2020	Adoption of mHealth among Latinos with Cardiometabolic Risk Factors. The purpose of this study is to understand what factors motivate Latinos to use mobile technologies to manage their CMRF. **PI: Delva, S.** Funding source: National Institutes of Health (1F31NR017566). $138,312
2018-2019	

Adoption of mHealth among Latinos with Cardiometabolic Risk Factors. **PI: Delva, S.** Funding source: Scholl Foundation Dissertation Data Collection Award, $1000.

2017-2018 Predoctoral Clinical Research Training Program (PI: Ford, DE), Research Fellow, National Institute of Health (5TL1TR001078-05)

2016-2017 Co-investigator, 10% effort, total direct costs $32,000, *Seeking Feasible Solutions for Sustaining Water Sanitation in Rural Haiti: a Development Project.* Funding Source: Global Established Multidisciplinary Sites, Johns Hopkins Center for Global Health, Baltimore, MD

UNSPONSORED PROJECTS

YEAR

2017-2019 MiCore Study-a mobile health (mHealth) collaboration between Johns Hopkins and Apple.
The goal of this study is to improve heart attack recovery and hospital discharge to reduce length of stay and prevent readmissions.
PI: Seth Martin
Johns Hopkins University School of Medicine, Johns Hopkins Hospital
Role: Participant recruitment, data collection and management. **Cultural expert**: responsible for targeting Latino patients by translating content on the mHealth application to ensure that the information is comprehensible to Latinos and that contents are at appropriate literacy levels.

2016-2017 Prime Time Sister Circle- a Randomized Control Trial
The goal of this study is to deliver a community-based intervention to reduce blood pressure in hypertensive African American women in the DMV area.
PI: Darrell Gaskin
Johns Hopkins University School of Public Health, Health Disparities
Role: Collect valid study instruments, help with recruitment and dissemination of research findings.

2015-2017 The Health Literacy Self-help Intervention for High Blood Pressure Among Hispanics-Phase II.
The goal of this study is to deliver a multiphase intervention to reduce blood pressure in hypertensive Hispanics in Baltimore.
PI: Hae-Ra Han
Agency: Centro Sol
Role: Research team coordinator. Collect and evaluate data. Facilitate communication among team members.

SCHOLARSHIP

Peer Reviewed (*data-based)

Published

1. Baptiste, D., Hamilton, JB., Foronda, C., Sloand, E., Fahlberg, B., Pfaff, T., **Delva, S.,** Davidson, P. (2018). Hypertension among adults living in Haiti: An integrative review. *Journal of Clinical Nursing*. 2018 Jul;27(13-14):2536-2545. doi: 10.1111/jocn.14320.
2. *Han, HR., **Delva, S.** Vergano Greeno, R.V., Negoita, S., Cajita, M., Will, W. (2018). Health literacy-focused intervention for Latinos with uncontrolled hypertension. *HLRP: Health Literacy Research and Practice*, *2*(1), e21-e25.
3. Hughes, V., **Delva, S.,** Spaulding, E., Nkimbeng, M., Turkson-Ocran R., Cudjoe, J., D'Aoust, R., Han, HR. (2019). Not Missing the Opportunity: How can Institutions Train Prospective Nursing Faculty to be Champions of Cultural Humility? *Journal of Professional Nursing.*
4. **Delva, S.,** Nkimbeng, M., Chow, S., Renda, S., Han, HR, D'Aoust, R. (2019). Views of Regulatory Authorities on Standards to Assure Quality in Online Nursing Education. *Nursing Outlook.*
5. Cudjoe, J., **Delva, S.,** Cajita, M., Han, HR. (2020) Empirically tested Health Literacy Frameworks. *Health Literacy Research and Practice,* 4(1), *e*22-e44.
6. **Delva S,** Mendez KJ, Cajita M, Koirala B, Shan R, Wongvibulsin S, Vilarino V, Gilmore DR, Han HR. Efficacy of Mobile Health for Self-management of Cardiometabolic Risk Factors: A Theory-Guided Systematic Review. *Journal of Cardiovascular Nursing.* 2020 May 8; 36(1):34-55.

In Press

Submitted/Under Review

7. ***Delva, S.,** Vergano Greeno, R., Pistulka, G., Han, HR. (2020). Barriers and Facilitators of High Blood Pressure Self-management among inner-city Latinos in the United States: A focus group study. *Clinical Nursing Research*.
8. **Delva, S.,** Baptiste, D., Pfaff, T. (2020) Exploring Hand Hygiene Practices in Low and Middle-Income Caribbean and Latin American Countries. *Waterlines*.

In Preparation

9. ***Delva, S.,** Rivera, T., DeCamp, L. Use of Technologies among Latino Families in Baltimore, City.
10. Commodore, Y., Rives, S., **Delva, S.** Hill, M., Levine, D. Bone, L. Systematic Review of Application of the Hill-Bone Scale.
11. **Delva., S.,** M., Machirori, Salomon, B., Turkson-Ocran, R.A., Rodney, T., Abshire, M., Alders, M., Jones, A., Repo, HM., Strandell-Laine, C., Forde, R., Fitzpatrick, J. Enriching the PhD Experience through International Doctoral Student Seminars.
12. **Delva, S.,** Baptiste, D., Warren, N., Yori, P., Pfaff, T. Exploring Water, Sanitation, and Hygiene Practices in Gatineau Haiti: Lessons Learned from the Field.

13. ***Delva, S.,** Budhathoki, C., Han, HR. Adoption of mHealth among Latinos with Cardiometabolic Risk Factors: a mixed methods study.

Non Peer-Reviewed

2014-2015	Edited/Published articles for the American Nurses Association, Massachusetts newsletter, *Massachusetts Report on Nursing*
2012-2014	Featured on Massachusetts General Hospital *Caring Headlines* magazine for works regarding the proposed ballot question "Patient Safety Act" and for Nurses Week † *Spotlight on the cover of Caring Headlines May 2014 issue*

PRESENTATIONS *(*Published abstract)*

International

YEAR	
2018	Baptiste, D., Goldstein, N., Patch, M., **Delva, S.,** Carbo, C., Pfaff, T. Application of Havelock's Theory of Planned Change for increasing STTI chapter membership, and retention. Sigma Theta Tau International 29th Nursing Research Congress. Melbourne, Australia. July 19-23, 2018. (Poster Presentation).
2018	**Delva, S.,** Han, HR. Adoption of mHealth among Latinos with Cardiometabolic Risk Factors. Translational Science Conference. Washington, DC. April 19-21, 2018. (Poster presentation).
2017	Salomon, B., Turkson-Ocran, RA, **Delva, S.,** Abshire, M. Reaching Across Three Countries: Establishing the International Doctoral Student Collaboration. International Network for Doctoral Education in Nursing 2017 Biennial Conference. Dublin, Ireland. July 26-27, 2017. (Oral and Poster presentation).
2017	**Delva, S.** Advancing Science in Community-Engaged Research: Increasing Capacity to Reach Diverse Populations and Address Health Disparities. Sigma Theta Tau International 28th Nursing Research Congress. Dublin, Ireland. July 27-31, 2017. (Oral presentation-symposium).
2017	Salomon, B., Turkson-Ocran, RA, Rodney, T., **Delva, S.,** Abshire, M., Alders, M., Machirori, M., Jones, A., Repo, HM., Strandell-Laine, C., Forde, R, Fitzpatrick, J. Enriching the PhD Experience through International Doctoral Student Seminars. Sigma Theta Tau International 28th Nursing Research Congress. Dublin, Ireland. July 27-31, 2017. (Poster presentation).
2017	Baptiste, D, **Delva, S.,** McCormick, C., Dallman, E. Pfaff, T. Exploring Water, Sanitation, and Hygiene Practices in Gatineau Haiti. Sigma Theta Tau International 28th Nursing Research Congress. Dublin, Ireland. July 27-31, 2017. (Poster presentation).
2016	**Delva, S.,** Han, HR. Barriers and facilitators of high blood pressure self-management among inner-city Latinos in the United States: A focus group study. Sigma Theta Tau International 27th Nursing Research Congress. Cape Town, South Africa. July 21-25, 2016. (Poster presentation).

National

YEAR	
2019	**Delva, S.**, Driessnack, M., Ellenbecker, CH. Partnering with Students Who are Planning an Academic Career. American Association of Colleges of Nursing. Nursing Science and the Research Focused-Doctorate PhD Pre-Conference. January 16, 2019. (Oral Presentation).
2018	Baptiste, D., Goldstein, N., Patch, M., Delva, S., Pfaff, T. Application of Havelock's Theory of Planned Change for increasing and sustaining Nu Beta chapter member engagement and retention. Sigma Theta Tau International 44th Biennial Convention. Indianapolis, IN. October 28-November 1, 2018. (Poster Presentation).
2018	Cudjoe, J. **Delva, S**. Han, HR. Empirically tested health literacy frameworks - A systematic review. 10th Annual Health Literacy Research Conference. October 22-23, 2018. Bethesda, MD. (Poster Presentation)
2016	**Delva, S**. Review of Community-Based Participatory Research Approaches to Improve Cardiovascular Health in Hispanic Immigrants. 2016 International Council on Women's Health Issues Congress. Baltimore, MD, November 06-November 09, 2016. (Oral presentation)
2016	**Delva, S.,** Vargas, G., Pistulka, G., Han, HR. Barriers and facilitators of high blood pressure self-management among inner-city Latinos in the United States: A focus group study. American Public Health Association 2016 Annual Meeting and Expo. Denver, CO, October 29-November 02, 2016. (Poster presentation)
2016	**Delva, S.** Center for Disease Control 2016 National Minority Health Month Public Health Ethics Forum. Atlanta, GA, April 22, 2016. (Poster presentation winner)
2014	**Delva, S.** American Nurses Association Massachusetts Career Connections Networking Social. Boston, MA, November 6, 2014. (Oral Presentation)
2014	**Delva, S.,** & Jeffery, D. Senior Seminar: Synthesis of Nursing Practice. The Value of Professional Associations. Curry College, Milton, MA, November 3, 2014. (Oral Presentation)
2014	**Delva, S.,** Minshall, M., Smith, J. Veroneau, M., &Von Glahn, H. Boston College Transitions to Professional Nursing New Graduate Panel, Chestnut Hill, MA, September 8, 2014. (Panel)
2014	Abbatiello, R., Breda, K., **Delva, S.,** Getchell, M., Kelly, L., Pugsley, L., Weitz, M., & Wendt, J. Strategizing Your New Graduate Job Search. Massachusetts General Hospital Institute of Health Professions Upsilon Lambda Chapter of Sigma Theta Tau International, Boston, MA, June 24, 2014. (Panel)
2014	Aponte, F., Aylesbury, G., Bufano, A., **Delva, S.,** Lamos, P., Lucin-Maietta, J., Makodzeba,O., Melay, J., Mohamoud, F., Vega-Barachowitz, C., Valentin, M., & Wilson, E. Massachusetts General Hospital Institute of Health Professions

	Cultural Competence Course for Students in Speech Language Pathology Master's Program, Boston, MA, July 7, 2014. (Panel)
2013	Chan, S., Chau, N., **Delva, S.,** Etienne, J., Fenty-Scotland, J., Miklosz, P., & Tellez, S. Boston College Keys to Inclusive Leadership in Nursing Alumnae Panel, Chestnut Hill, MA, April 8, 2013. (Panel)
2013	**Delva, S.** American Nurses Association Massachusetts Career Connections Networking Social. Boston, MA, December 11, 2013. (Oral Presentation)
2013	**Delva, S.,** Smith, J. & Veroneau, M. Boston College Transitions to Professional Nursing New Graduate Panel, Chestnut Hill, MA, September 10, 2013. (Panel)
2012	**Delva, S.,** Lamousnery, D., & Fenty-Scotland, J. Boston College Keys To Inclusive Leadership in Nursing May Seminar. Chestnut Hill, MA, May 8, 2012. (Panel)
2011	***Delva, S.,** Miklosz, P., Lamousnery, D., & Tellez,S. Fostering the Development of Future Leaders in Global Health Through the Keys to Inclusive Leadership in Nursing Program. Sigma Theta Tau International 41st Biennial Convention. Grapevine, TX, October 29-November 2, 2011. (Symposium)

Local

YEAR	
2017	**Delva, S.,** Vilarino, V., Spaulding, E., Marvel, F., Martin, S. Cultural Competency of the Johns Hopkins Corrie Smartphone Application to Address Disparities in Latino Outcomes after Myocardial Infarction. Johns Hopkins Diversity Postdoctoral Alliance Committee. 2nd Annual Excellence in Diversity Symposium. Baltimore, MD. November 6, 2017. **(Poster winner)**
2016	Roqué, N., Negoita, S., Galusha, K., Will, W., **Delva, S.,** Cajita, M., Han, HR. Health Literacy Self-Help Intervention for High Blood Pressure (HL-SHIP) Among Latinos Living in Baltimore: A Pilot Study. Johns Hopkins School of Public Health Latino Public Health Network. Baltimore, MD. March 31, 2016. (Poster)

TEACHING ACTIVITIES

YEAR	
September 2019-December 2019	NR.210.607 Context of Health Care for Advanced Nursing Practice, Johns Hopkins University School of Nursing [Online], 96 MEN students, *Course Coordinator*
January 2019-May 2019	NR.210.607 Context of Health Care for Advanced Nursing Practice, Johns Hopkins University School of Nursing [Online], 95 MEN students, *Teaching Assistant*
September 2018-December 2018	NR.210.607 Context of Health Care for Advanced Nursing Practice, Johns Hopkins University School of Nursing [Online], 70 MEN students, *Teaching Assistant*
May 2018-August 2018	NR.210.607 Context of Health Care for Advanced Nursing Practice, Johns Hopkins University School of Nursing [Online], 53 MEN students, *Teaching Assistant*

May 2018- August 2018	NR.210.607 Context of Health Care for Advanced Nursing Practice, Johns Hopkins University School of Nursing [Online], 48 MEN students, *Teaching Assistant*
January 2018- May 2018	NR.210.600 Advanced Physiology/Pathophysiology, Johns Hopkins University School of Nursing [Online], 39 DNP students, *Teaching Assistant/NFF Fellow*
January 2018- May 2018	NR.110.502 Physiological/Pathological Basis for Advanced Nursing Practice I, Johns Hopkins University School of Nursing [Online], 10 MEN students, *Teaching Assistant*
January 2018- May 2018	NR.210.607 Context of Health Care for Advanced Nursing Practice, Johns Hopkins University School of Nursing [Online], 71 MEN students, *Teaching Assistant*
January 2018 & February 2018	Facilitator monthly Inter Professional Education (IPE) on "Interprofessional communication and Roles & responsibilities," 10 nursing, pharmacy and medical pre-licensure students.
October 2017- December 2017	410.631.01 Introduction to Community Based Participatory Research: Principles and Methods, Johns Hopkins University School of Public Health [In Person], 22 students, *Teaching Assistant and Lecturer*
November 2017	Facilitator monthly IPE on "Opioid", 8 nursing, pharmacy and medical pre-licensure students.
September 2017- December 2017	NR.210.610.8201 Health Promotion and Disease Prevention, Johns Hopkins University School of Nursing [Online], 26 MEN students, *Teaching Assistant*
September 2017- December 2017	NR.210.610.8201 Health Promotion and Disease Prevention, Johns Hopkins University School of Nursing [Online], 18 MSN-NP students, *Teaching Assistant*
May 2016- August 2016	NR.120.510.0201 Health Promotion and Risk Reduction Across the Lifespan, Johns Hopkins University School of Nursing [In Person], 42 MEN students, *Teaching Assistant and Lecturer*

COMMUNITY SERVICE

YEAR	
May 2016- present	Johns Hopkins University School of Nursing, Dunbar Hopkins Enrichment Program • Conducted mock interviews for high school students who are interested in careers in health care.
2016-present	Johns Hopkins Medicine Community Research Advisory Council Day at the Market and the East Baltimore Fall Fest, *Volunteer* • Conduct blood pressure screenings and education for East Baltimore residents
2016- 2018	Johns Hopkins University School of Nursing, GEMS Water Sanitation project

- Conducted needs assessment for hygiene and water sanitation solutions in Jérémie, Haïti.
- Conducted literature review of hygiene practices in Jérémie, Haïti

05/11/2016 Johns Hopkins Medicine Community Research Advisory Council Henrietta Lacks High School Symposium, *Volunteer*

2013-2015 Organization for the Support and Development of Plateau Central. Mobile Medical Outreach Program, August 2013

- *Mobile Clinic*: Conducted health screenings, women's health and nutrition workshops in the village of Montegrande, Marmont, and La Belone.

Lecturer at College Jean Price Mars, Hinche, Haïti: Developed the curriculum for a weeklong intensive mental health seminar for nursing students.

PROFESSIONAL ACTIVITIES *(†Notable achievements)*

YEAR

January 2017-December 2018 American Nurses Association – *Elected Nominations and Elections Committee*

September 2016-June 2018 Johns Hopkins University School of Nursing Doctoral Student Nursing Organization- *Elected Vice President/President-Elect*

April 2016-December 2018 Johns Hopkins University School of Nursing Diversity and Inclusion Committee, *Appointed Student Representative*

September 2015-present Sigma Theta Tau International Nu Beta Chapter-*Appointed Publicity/Newsletter chair*

September 2014-April 2015 American Nurses Association Massachusetts-*Appointed Secretary of the Board of Directors*

April 2014-July 2015 American Nurses Association Massachusetts- *Elected Board Director*

March 30, 2014-April 1, 2014 Nurse in Washington-*Health Policy Internship*
†Met with MA Congressional staff on Capitol Hill, Washington DC, requesting support for the:

- *Nursing Workforce Development Programs (Title VIII, Public Health Service Act) to have nursing programs funded at $251 million in FY 2015.*
- *National Institute of Nursing Research to be funded at $150 million in FY 2015.*

- *Nurse-Managed Health Clinics to be funded at $20 million in FY 2015.*
- *Modernization of the Veterans Health Administration Nursing Handbook to ensure veteran access to high quality care.*

2013-2015 Organization for the Support and Development of Plateau Central-*Health Committee*

2012-2015 American Nurses Association Massachusetts-*Health Policy Committee & Newsletter Committee Member*

2012-2013 American Nurses Association Massachusetts-*Elected Nominations and Elections Committee Member*

2012-2015 American Nurses Association Massachusetts- *Coordinator for the Career Connections Program*

MEDIA *(†NOTABLE ACHIEVEMENTS)*

2014 Massachusetts General Hospital-*Media Nurse Representative*
†One of five nurses selected to represent the hospital regarding the proposed ballot question "Patient Safety Act"
†Video interview released via world wide web
†Testified at State House in front of the Massachusetts Joint Committee on Health Care Financing in opposition to Senate Bill 557, House Bill 1008, and House Bill 3843
†Participated in intense media training

2013-2014 Telemagazine. Five-minute health education segment in Haitian Creole at local TV station to educate the Boston Haitian Community about health promotion, 2 Episodes.

MENTORING

YEAR January 2017-Present Mentor for the Medical Education Resources Initiative for Teens (MERIT) program, where a high school student from an underprivileged background is provided guidance to prepare for a future career in biomedical fields.

January 2016 Office of Multicultural Affairs JUMP (Johns Hopkins Underrepresented in the Medical Professions): collaborative program whose purpose is to support the success of students from underrepresented populations that are pursuing careers in medicine or other health professions.

September 2016	Dunbar Hopkins Enrichment Program: mentor high schools students interested in pursuing a career in health care fields.

LANGUAGES

Haitian Creole	Native language
English	Native language
French	Speak fluently and read/write with high proficiency
Spanish	Speak/write (intermediate competency) and read with high proficiency

SERVICE

Massachusetts General Hospital Doctoral Forum 2016-Present

Johns Hopkins University School of Nursing

-PhD Student Organization, President 2017-2018

-PhD Student Organization, VP/President-elect 2016-2017

-Diversity and Inclusion Committee, Student Representative 2016-2018

-Nursing Senate, Vice President of InterSchool Relations 2017-2018

-Johns Hopkins Institute for Clinical and Translational Research Community Research Advisory Council

-Student Board Member 2016-2018

PROFESSIONAL ORGANIZATIONS

American Nurses Association: Nominations and Elections Committee member, 2016-2018

Sigma Theta Tau International Honor Society

Alpha Chi Chapter, member, 2014-Present

Nu Beta Chapter

-Secretary 2016-2017

-Newsletter Chair 2015-2016

-Publicity Chair 2015-2016

Mixed Methods International Research Association 2017-2019

American Association for the Advancement of Science 2018-2019