Implementing Hypertension Management Interventions in Immigrant Communities in the U.S.: a Narrative Review of Recent Developments and Suggestions for Programmatic Efforts

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Accepted: 16 November 2020 / Published online: 22 January 2021
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Abstract
Purpose of Review To outline intervention efforts focused on reducing hypertension disparities in immigrant communities in the U.S. and to identify areas in the design, implementation, and evaluation of these interventions that warrant further exploration guided by an implementation science framework.
Recent Findings Studies examined (n = 11) included immigrant populations of African, Hispanic, and Asian origin. Men were underrepresented in most studies. Culturally tailored group-based educational sessions in religious or community spaces were common. Intervention agents included research assistants, registered nurses, community health workers, and faith-based organization volunteers. Community stakeholders were engaged in most studies, although most commonly for recruitment efforts. Surveys/interviews were used for intervention evaluation, and documentation of intervention activities and trainings was used to assess fidelity.
Summary Identified pathways for further intervention innovation included gender or migration-status–based targeting, diversifying intervention agents, enhancing mixed-method process evaluations, and tailoring to emerging needs during the COVID-19 pandemic.

Keywords Hypertension · Immigrants · Intervention · Implementation science · Community-based participatory research · COVID-19

Introduction
Hypertension affects more than 108 million adults in the United States (U.S.) and is considered a major risk factor for various non-communicable diseases and a significant contributor to morbidity and mortality in the country, including among immigrants [1±, 2–4]. In recent years, immigrants have been a significant driver of population growth in the U.S. [5]; however, there are also significant socio-economic disparities both between and within immigrant groups of certain national origins [6]. Likewise, representation of diverse immigrants in the U.S. across research intervention efforts has been limited [7]. Importantly, certain immigrant communities have higher prevalence of hypertension, including undocumented immigrants [8], and immigrants originating from South, Southeast, Central and East Asia, Russia and/or Eastern Europe, the Dominican Republic, and the Caribbean [1, 9–11]. Higher levels of acculturation [12±], including increased length of time in the U.S. [10], has similarly been associated with greater prevalence of hypertension among immigrants, although this association has not been consistent in all immigrant communities [13]. These mixed findings may be attributed to the fact that prevalence of chronic conditions in immigrants in the U.S. is likely reflective of disease burden in sending countries and point to the importance of considering such conditions rather than applying a uniform “healthy immigrant effect” assumption.
In understanding these hypertension disparities among U.S. immigrants, it is important to identify and intervene on factors related to hypertension incidence, progression, and management faced by these communities. Access to healthcare remains a major obstacle across immigrant communities [14, 15]. Factors attributed to these barriers in healthcare access include interconnected structural and individual-level barriers, including ineligibility for certain healthcare programs [16], limited in-language support for culturally appropriate healthcare services [17], lack of knowledge of the healthcare system [18], distrust of the U.S. healthcare system [19] and, particularly among undocumented immigrants, fears related to deportation due to policies linking documentation status with use of public services [15, 20]. Access-related issues often intersect with other barriers to healthcare utilization and health behaviors among immigrants, including specific customs or unique cultural or religious understandings of health and disease [19, 21]. These various influences also underpin hypertension outcomes among immigrants; U.S. immigrants are more likely to be unaware of their hypertension [22], have undiagnosed or uncontrolled hypertension [23], and display lower treatment rates of hypertension, particularly among those without a usual source of care or health insurance [3].

Given the distinct factors driving hypertension disparities among immigrants in the U.S., intervention and programmatic efforts to address this burden must meet the unique needs of these diverse communities. Modifiable lifestyle behavioral risk factors of hypertension (including diet, physical activity, and stress) have been the common targets of hypertension reduction interventions [24, 25]. However, intervention research must consider many of the upstream and cultural factors driving hypertension in immigrant communities, including certain gender roles [26], perceptions about physical activity [26], demanding work schedules [27], neighborhood environment barriers to healthy living [27], and limited physical and financial accessibility to appropriate spaces for healthy activities [28]. To appropriately design, implement, and evaluate lifestyle behavior interventions in immigrant settings, community-engaged approaches [29–31], health behavior theories [32, 33], and implementation science frameworks [34] that contextualize behaviors and advocate for engaging with communities throughout different stages of the intervention are necessary.

Given the common lifestyle–related drivers of non-communicable diseases (NCDs), many lifestyle intervention studies among U.S. immigrant populations focused on other NCDs such as obesity [30] and diabetes [31]. These studies have assessed reductions in blood pressure as one part of a broader set of study outcomes; however, given that disparities in hypertension may not directly align with those of other NCDs in immigrant populations [1•] and the unique role that specific lifestyle behaviors (e.g., dietary salt intake) have in hypertension incidence [25], the need for tailored hypertension interventions in immigrant settings has become apparent. Likewise, aligning with community-based participatory research (CBPR) principles, it is vital to examine how the current and changing drivers of hypertension in immigrant communities can be addressed through innovative intervention strategies, particularly given the significant social, economic, and health disruptions that have occurred globally since the COVID-19 pandemic in 2020. These concerns are particularly heightened given the connection between hypertension and severe illness or mortality resulting from COVID-19 [35, 36].

Therefore, the aim of this narrative review is to summarize recent developments in hypertension intervention research among U.S. immigrant population to identify (1) key areas of recent innovation in the design, implementation, and evaluation of hypertension interventions to meet the unique needs of this community and (2) identify areas that warrant further exploration to enhance intervention research that meets current and future needs of the rapidly growing immigrant population in the U.S.

Methods

Scope and Definitions

Based on the aims of this review, articles included in final analysis were any intervention studies with a primary aim of reducing hypertension through individual behavior change in a study population that was either majority or exclusively composed of immigrants living in the U.S. The scope thus included intervention studies aimed at modifiable behavioral risk factors of hypertension (e.g., diet, exercise, alcohol consumption, or tobacco consumption) in which blood pressure control or reduction was an explicit study aim.

Search Strategy

A search was conducted on PubMed, Google Scholar, and Scopus for peer-reviewed studies and gray-literature published in English between 1 January 2017 and 1 November 2020. A search strategy was developed with combinations of keywords related to the three dimensions of the study aims: immigrants in the U.S. (e.g., migrant, immigrant, minorities, United States, American), hypertension (e.g., blood pressure, hypertension, diastolic, systolic), and interventions (e.g., program, trial, intervention, pre-post, quasi-experimental). The database search was supplemented by employing snowballing methodology to identify further studies by using reference lists of studies and past reviews identified in the database search. Titles and abstracts of studies identified through the search strategy were then screened; reviews and most observational studies were excluded, as well as studies focusing on
non-U.S. populations. Observational studies that described the characteristics or processes of an intervention, or other themes relevant to program implementation were included. Full-text reviews were conducted on studies that passed preliminary screening; intervention studies involving a U.S.-based sample population that was majority immigrant in which change in blood pressure as an explicit primary or secondary goal of the study were included. Information from relevant observational studies was also extracted to provide supplemental analysis on intervention implementation and characteristics.

Synthesis of Literature

The information identified from included studies was informed by principles of the Consolidated Framework for Implementation Research (CFIR), developed by Damschroder et al. to guide the systematic assessment of interventions and identify different factors influencing intervention design, implementation, and evaluation [34]. These factors include (1) characteristics of individuals (e.g., sample size, sex/age, country of origins, migration, and socioeconomic status), (2) intervention characteristics (e.g., setting, recruitment, components, development, and adaptations), (3) inner setting (e.g., types of program staff, training), (4) outer setting (e.g., community collaborations), and (5) process (e.g., planning process and formative research, evaluation procedures, and intervention fidelity). Additional information relevant to the characteristics, barriers, and facilitators of the included interventions was also reviewed and compiled.

Results

Overall, 11 studies representing 10 distinct hypertension interventions were identified (Table 1). Populations of focus included immigrants of African [37**, 38], Filipino [39**, 40], Hispanic or Latino (unspecified nationalities) [41, 42**, 43], Chinese [44], South Asian [45**, 46], and multiple Asian descendants. Most studies (n = 6) did not involve a control group and employed a pre-post quasi-experimental study design [37, 38, 42**, 43, 44, 47], including one stepped-wedge quasi-experimental intervention [45**, 46] and two randomized controlled trials [39**, 41]. Diverse regions of the U.S. with large populations of immigrants were represented, including California [37**, 44], Texas [38, 42**], Pennsylvania [39**], South Carolina [41], Florida [43], and New York [40, 45**, 46, 47**]. One protocol for a hypertension intervention in immigrant adults during the COVID-19 pandemic was also identified [37**].

With respect to characteristics of individuals, most studies had a majority female study sample (n = 8) with an average age of above 40 years (n = 6). Although migration or citizenship status of participants was rarely reported, three studies which reported length of time in the U.S. had an average of 10 years or longer [39**, 40, 44]. Common intervention settings including religious (n = 4) and community spaces (n = 5), using word-of-mouth or event-based venues for recruitment. Other common intervention characteristics included group educational sessions focused on hypertension-related lifestyle behaviors (notably diet and exercise) and the cultural adaptation of evidence-based curricula developed in largely non-immigrant communities; intervention length varied significantly from a 30-min intervention [37**] to one spanning 5 years [45**]. Program staff who delivered the interventions included registered nurses, students, community-health workers (CHWs), health department consultants, and certified fitness instructors. Most of these intervention agents received training on program logistics, responsibilities, and use of technology. Outer setting engagement, informed by principles of CBPR, was also common; community-based organization (CBO), faith-based organization (FBO), and other community stakeholders largely engaged in either recruitment or some aspects of the intervention development (n = 6), although some interventions directly involved community leaders in intervention implementation [38, 39**]. With respect to the CFIR process construct, fidelity assessments were identified in multiple interventions and conducted through training checklists, participant tracking cards, and participant-CHW interaction evaluations. Intervention evaluations largely occurred at the end of interventions and included mixed-method process evaluations (e.g., semi-structured interviews or clinical and participant survey data).

Discussion

Based on the key findings observed across research intervention studies, a number of key suggestions for future programmatic efforts (including those related to new considerations regarding the COVID-19 pandemic) are summarized in Table 2.

Innovating to Meet the Unique and Diverse Hypertension-Related Needs of Immigrants

The unique and constantly changing social-, cultural-, economic-, and health-related needs of immigrants in the U.S. requires that researchers innovate to enhance the efficacy and sustainability of health programs [7, 26–28]. Among recent efforts, much of this innovation has centered around cultural adaptations of existing health promotion curricula, involving community members in various ways to tailor intervention experiences, or adapting interventions to the unique context of the lives of immigrants in the U.S. For example, many immigrants in the U.S. face long working hours, poor job security, limited vacation or sick days, and other...
| Study | Characteristics of individuals | Intervention characteristics | Inner setting | Outer setting | Process |
|-------|--------------------------------|-----------------------------|---------------|--------------|---------|
| Oshunluyi et al. (2020) | African immigrants diagnosed with self-reported hypertension. | Setting: Church in southern California. Intervention: Group-based culturally adapted hypertension educational sessions, including storytelling. | Program staff: Volunteers, registered nurse, student investigator. | Collaborations: Meeting with church members and leadership to discuss project, answer questions. | Evaluation/Adaptions: Phone-based follow-up survey, create forum to share stories about their experience. |
| Enike et al. (2020) | African immigrants (from sub-Saharan Africa). 64% female, 37.2 mean age, 52% full-time employed, 41% not health insured. | Setting: Church in Dallas, Texas. Intervention: Group-based culturally adapted hypertension educational sessions. | Program staff: Student investigator, project assistants, faculty advisor, data scientist. | Collaborations: Project was discussed with various church, organization, and business leaders in local area. Community leaders also acted as project facilitators. | Evaluation/Adaptions: Participants provided opportunity to give general feedback about experiences with project after its completion. |
| Ma et al. (2020) | Filipino Americans at risk of hypertension. 66–75% female, 55.3–43.5% employed, 100% lived in the U.S. for more than 10 years. | Setting: CBOs, local libraries, churches, homes in greater Philadelphia area. Intervention: Group-based culturally adapted hypertension educational sessions. Mobile app based physical activity, salt intake monitoring. Physical activity sessions. | Program staff: CHEs, CBO leaders. | Collaborations: Meetings with community leaders to develop intervention, assist in recruitment, coordinate workshops. | Evaluation/Adaptations: Feedback regarding educational materials was sought from CBO leaders throughout intervention. |
| Chandlet et al. (2019) | Hispanic adults with hypertension. 62–71% female, 44.4–46.8% mean age, 62–71% annual income less than $25,000. | Setting: Remote. Intervention: GSM electronic medication tray, and Bluetooth-enable BP measuring device with smart-phone app to assist. Text message reminders to measure BP were sent to participants. | Program staff: Clinical research staff, healthcare providers. | Collaboration: Iterative design process involved input from Hispanic adults to develop pool of text messages. | Evaluation/Adaptations: Healthcare providers made titration changes for participants throughout intervention. |
| Li et al. (2019) | Chinese immigrants with hypertension. 67% women, 70.9 mean age, 29.8 average years in the U.S. | Setting: Participants’ homes, senior home community center. Intervention: Video-based culturally adapted hypertension educational session focused on storytelling. | Program staff: Nurse, research assistant, principal research investigator. | Collaborations: Community leaders in local area were involved in participant recruitment. | Evaluation/Adaptations: Semi-structured post-intervention interviews to receive participant feedback on usefulness of videos and suggestions for further refinement. |
| Yi et al. (2019) | Asian American adults. 64% female, predominantly aged 55+ years, 48.3% Korean. | Setting: 12 FBOs in NYC/NJ. Intervention: Culturally tailored lifestyle counseling and hypertension care confidence building, BP “passports” for participants to document information to share with providers. | Program staff: Trained bilingual consultants, FBO volunteers. | Collaborations: Pre-existing coalition partners assisted in study site selection. Community partners met with FBO leadership and members to develop implementation plan aligning with organizational structure. | Evaluation/Adaptations: Weekly meetings with community partners to troubleshoot and adapt protocols if necessary. |
| Lopez et al. (2019) | South Asian adults with hypertension. (EHR intervention) 46.6% female, 49.8% aged 40–59 years. | Setting: PCP clinics, community spaces in NYC. Intervention: (1) Group-based culturally adapted hypertension educational sessions, including one-on-one follow-ups, (2) EHR intervention to enhance physician hypertension care. | Program staff: PCPs, clinic staff, CHWs, research staff, and assistants | Collaborations: Coalition of South Asian CBOs provided regular feedback in development and implementation of intervention. Independent EHR consultant higher for technical assistance. | Evaluation/Adaptations: Mixed method surveying and interviewing of participating PCPs and research staff on experience with intervention. |
| Ursua et al. (2017) | Filipino Americans with hypertension. 64.9% women, 53.9 mean age, | Setting: Churches, social service agencies, workplaces, homes in NYC. Intervention: Group-based culturally adapted | Program staff: CHWs employed by | Collaborations: Community coalition provided feedback to identify study sites and discuss project development. | Evaluation/Adaptations: Monthly meetings to assess and enhance intervention efforts and |
| Study | Intervention characteristics | Inner setting | Process |
|-------|-----------------------------|--------------|---------|
| Langabeer et al. (2018) | Hispanic adults with elevated, stage 1, or stage 2 hypertension educational sessions, including one-on-one follow-ups. | Program staff: Program director, health educators, health navigators, nurses, patient advisors. | Collaborations: Interventions was organized by the AHA Southeast Affiliate. Evaluation/Adaptations: (not reported). |
| Kling et al. (2018) | Majority (53.8%) Hispanic adults aged 55 or older. Diabetes prevalence, 85.8% male, 61.9% had diabetes. Mean age 67.8 years. | Program staff: Certified fitness instructors, wellness specialists. | Collaborations: Miami-Dade County Department of Parks, Recreation and Open Spaces trained or employed for intervention agents. |

**Table 1 (continued)**

| Study | Intervention characteristics | Inner setting | Process |
|-------|-----------------------------|--------------|---------|
|      | CHW, community health workers; CHE, community health educator; GSM, global systems for mobile; BP, blood pressure; FBO, faith-based organizations. |      |      |

In the context of hypertension management, the importance of tailor-able interventions to meet the unique needs of immigrant communities cannot be overstated. Efforts to engage patients, particularly those from underserved populations, have consistently yielded positive outcomes, as evidenced by the evaluation of hypertension knowledge both pre- and post-session and the observed improvements in related outcomes [38].

However, the complex interplay between race, ethnicity, and socioeconomic status poses significant challenges. Disaggregation of race and ethnicity data across immigrant communities, as exemplified by the studies of Langabeer et al. [43] and Kling et al. [42], underscores the importance of considering these factors in the design of hypertension interventions [26, 49].

Moreover, given the economic and job-related restrictions faced by many immigrants, particularly undocumented individuals [15, 51], interventions must be designed to be cost-neutral and mindful of the financial constraints of these communities. The need for such interventions is underscored by the significant economic and job-related restrictions faced by many communities, particularly those with direct ties to undocumented immigrants [7, 48].

Acknowledging these challenges, the review highlights the potential for targeted interventions to mitigate hypertension disparities among immigrant communities. Through a focus on gender and migration status, as well as the consideration of additional dimensions of gender, the development of interventions that are inclusive and accessible to all populations is essential. This approach not only addresses the unique needs of diverse groups but also contributes to the enhancement of overall health outcomes [50].

*Correspondence to: CBO, community-based organization; CHW, community health workers; CHE, community health educator; GSM, global systems for mobile; BP, blood pressure; FBO, faith-based organizations. NYC, New York City; NJ, New Jersey; EHR, electronic health record; PEP, primary care provider; AHA, American Heart Association.*
resources given the community’s already existent financial strains and high out-of-pocket expenses.

Finally, while a range of intervention agents (e.g., CHWs, registered nurses, FBO volunteers, health department consultants, etc.) were explored across research intervention efforts, there were some notable gaps. Interpersonal (i.e., family-level) interventions have been explored in immigrant settings [33, 52] in part driven by the strong role family members have been observed to play in impacting socio-cultural and economic factors relevant to immigrant health and behavior change [53, 54]. However, few interventions utilized family members as change agents themselves. For example, U.S.-born children of certain immigrant communities, who also display significant and disproportionate lifestyle and health-related disparities compared to both their first-generation parents and the wider U.S. population, may also represent important intervention agents in their household with respect to health outcomes [55]. One approach to family-level lifestyle interventions relevant to hypertension reduction has been engaging with different family members in a single intervention [33]. However, another area worthy of exploration includes interventions aimed at either the health needs of one family member (e.g., children) as a means of indirectly fostering wider family-level health improvements, which has been explored in the context of hypertension prevention in China [56], or potentially training select family members as intervention agents themselves to foster family-wide improvements. Given the unique social, cultural, linguistic, and often trust barriers associated with interventions conducted in immigrant communities [7], innovation in the context of intervention agents has a particular potential to meet the hypertension needs of this population.

### Enhancing the Design, Adaptability, and Evaluation of Immigrant Hypertension Interventions

In examining recent developments in immigrant hypertension interventions through the CFIR framework, a number of future considerations with respect to design, implementation, and evaluation of these programs were identified. At the design level, the role of outer-setting stakeholders (such as community or organizational partners) was most commonly centered around participant recruitment efforts, although multiple interventions (informed by principles of CBPR) also engaged with these stakeholders throughout the intervention development and implementation process. Importantly, efforts to both maintain these collaborations after the intervention period and foster long-term community collaborations are pivotal to not only sustaining blood pressure control, but also enhancing efficacy and reach of future intervention efforts. For example, pre-existing community-coalitions from past research intervention efforts were used by Yi et al. in identifying study sites [47••], with the design of the intervention itself also tailored to align with the organizational structure and priorities of community partners. Indeed, the health needs of immigrants are diverse and interconnected [57], thus collaborating with community stakeholders across multiple integration efforts and designing hypertension interventions to both build upon past coalitions as well as set up the framework for future sustained partnerships can be instrumental in demonstrating that the

| CFIR construct | Future considerations (general) | Future considerations (COVID-19 related) |
|----------------|---------------------------------|---------------------------------------|
| Characteristics of individuals | - Targeted recruitment of men - Needs of second-generation immigrants or by acculturation level (e.g., undocumented vs. citizens) - Considering migration status in intervention design | - Community and personal trauma related to COVID-19 - Income, employment changes related to COVID-19 |
| Intervention characteristics | - Exploring both shorter and longer formats of hypertension interventions - Expanding beyond group-based educational sessions by incorporating culturally sensitive activities | - Designing and testing virtual or tele-based interventions - Incorporating principles on the link between hypertension and infectious diseases such as COVID-19 |
| Inner setting | - Diversifying intervention agents, including community-sourced agents | - Virtual forms of network and communication, training. - Considering changed ability to meet goals among program staff |
| Outer setting | - Engaging with community and other stakeholders in the direct implementation and evaluation of interventions - Building and sustaining long-term community coalitions | - Considering new community priorities and adapting to changing needs and policies - Using virtual platforms to sustain and enhance diverse community networks |
| Process | - Ensuring consistent reflective adaptation of intervention through mixed-method evaluation of implementation both during and post-intervention - Examining fidelity/consistency of intervention during different stages (e.g., recruitment, implementation, evaluation) | - Planning for rapidly changing needs and circumstances as a result of COVID-19 - Adapting fidelity assessments to consider virtual or semi-virtual interventions, and evaluating unique role of COVID-19 as a barrier in meeting intervention goals |
broader wellbeing of immigrant communities is at the core of research.

Likewise, enhancing the evaluation of hypertension intervention implementation in immigrant contexts is an area for future research, particularly with respect to allowing for adaptations during an intervention to meet evolving participant needs or circumstances. While multiple interventions were observed to assess general participant feedback regarding intervention implementation and components following their completion, establishing protocols for feedback from both participants and community members throughout an intervention can significantly enhance efforts to refine and adapt. Ursua et al., for example, met with a community coalition monthly and used these meetings to constantly refine recruitment, outreach, and intervention procedures [40]; these evaluations resulted in identifying new study sites and partners (e.g., engaging Filipino chess groups for recruitment), as well as neighborhood and organizational level changes to support CHW health promotion efforts for participants (e.g., church-based line dancing and yoga classes for participants to attend). Thus, allowing for adaptability in intervention approach through feedback loops and evaluation procedures may not only help identify new ways of enhancing intervention efficacy but also ensure the evolving and complex socio-ecological factors involved in immigrant hypertension disparities are appropriately addressed.

COVID-19 and New Challenges and Opportunities in Immigrant Hypertension Interventions

Finally, the COVID-19 pandemic of 2020 has evolved into one of the most disruptive global health crises in modern history, placing a significant health, economic, and social burden on immigrant communities (such as those in the U.S.), and exacerbating many health disparities [58, 59]. The disproportionate impact of the COVID-19 pandemic on immigrants has been understood through medical (e.g., lack of insurance, higher prevalence of co-morbidities), economic (e.g., more likely to have jobs with higher risk of the SARS-CoV-2 virus exposure), legal (e.g., fears regarding healthcare system), and social (e.g., crowded, multigenerational households, limited Internet or English proficiency, anti-immigrant rhetoric/xenophobia) factors [58]. Lifestyle behavioral changes have also been observed across the U.S. and globally [60], which has contributed to growing concerns on the rise of NCDs, including hypertension [61]. Importantly, COVID-19 patients with hypertension are also at an increased likelihood of severe symptoms [35] and death [36], adding an additional burden to hypertensive immigrants.

Thus, the COVID-19 pandemic has not only shed a greater light on the health disparities faced by immigrants in the U.S. (particularly those with NCDs such as hypertension) but creates a new set of considerations vital in the design, implementation, and evaluation of hypertension interventions in these communities. These considerations will not only need to consider the changing social, economic, and health needs of immigrants during and after the COVID-19 pandemic but also simply how to safely and appropriately engage with these communities in the pandemic context (as well as adapt to future, post-COVID-19–related fears and concerns). Early evidence of this was observed in the intervention designed by Oshunluyi et al. occurring during the COVID-19 pandemic [37••]. The intervention involved 20 participants and four volunteers sitting 6 ft apart (to maintain social distancing) with everyone being provided masks, hand washing supplies, and hand sanitizer [37••]. Importantly, in their protocol, researchers also planned for an alternative virtual format of the intervention (as well as data collection) in case local or state restrictions were placed during the study period for in-person gatherings [37••]. Indeed, the future of immigrant hypertension interventions both during and post-COVID-19 may necessitate new degrees of flexibility with respect to intervention format; not only will greater scrutiny be needed on the immediate safety concerns of participants but also greater unpredictability with respect to policy and funding environments, and new, evolving, and potentially lingering concerns related to in-person contact. Likewise, the dramatic social and financial impact that has been observed among U.S. immigrant communities during COVID-19 [58] may present important new barriers to recruitment in hypertension interventions; interventionists may need to consider new ways of connecting hypertension reduction aims with other community needs or concerns (e.g., awareness regarding the link between hypertension and COVID-19 morbidity and mortality).

However, while virtual public health interventions aimed at specific drivers of hypertension disparities, such as mobile health (mHealth) approaches to salt consumption reduction [62•] and home blood pressure monitoring [63], had become more common even before the COVID-19 pandemic, their application has been limited in immigrant communities due to the unique socio-economic barriers faced by immigrants (e.g., limited Internet access and ownership of electronic devices to allow for video-based interfaces). However, these limitations may also pave the way for new, innovative, tailored approaches to engage with immigrants in virtual settings. For example, though Hispanic adults in the U.S. remain much less likely than White adults to own a computer or have high-speed Internet, a rise in smartphone usage among Hispanic Americans has significantly helped bridge the digital divide they face in the U.S. [64]. Indeed, increased use of mHealth technologies in immigrant interventions has been observed in recent years [65], and coupled with the fact that many video-conferencing software such as Zoom and Webex are being explored in research interventions during the COVID-19 to allow for smartphone-based or phone-based interfaces as well [66], mHealth-based hypertension
interventions (particularly during the era of COVID-19) have a strong potential in immigrant settings. WhatsApp is another mobile-based platform which has been increasingly explored in U.S. immigrant health intervention design due to its particular popularity among immigrant communities compared to other populations [67, 68]; the important potential of exploring WhatsApp-based hypertension intervention designs may be particularly heightened during and after the COVID-19 pandemic.

Conclusion

To meet the complex and emerging hypertension-related burden faced by immigrants in the U.S., researchers and public health professionals face a unique set of challenges in the design, implementation, and evaluation of community-based public health interventions to address these needs. Recent efforts in immigrant hypertension interventions have shed light on new and multi-faceted ways of addressing this hypertension burden, as well as pin-point areas of further consideration. The CFIR framework provided a useful lens to examine these developments and explore the need for innovation across different stages of intervention research, including characteristics of participants (disaggregating immigrant health needs and adapting to the unique sociodemographic circumstances faced by communities), intervention characteristics (exploring new intervention designs and sources, as well as enhancing recruitment methods), inner setting (engaging with different types of intervention agents), outer setting (collaborating with a diverse set of stakeholders throughout multiple stages of the research process, including in intervention implementation and evaluation), and process (enhancing mixed-method assessments of an intervention throughout its implementation to allow for efficient adaptability). The need for this innovation is further compounded by the emerging challenges that the COVID-19 pandemic places on both immigrant communities and research intervention efforts. Indeed, through intervention development efforts that are reflective of both these immigrant needs and the various key components of intervention design outlined, addressing hypertension disparities faced immigrants both during and after the COVID-19 pandemic can be more effectively conducted.

Compliance with Ethics Guidelines

Conflict of Interest The authors declare no conflicts of interest relevant to this manuscript.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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• Of importance
• Of major importance

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Publisher’s Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.