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Bringing Health Care Equity to Diverse and Underserved Populations in Sleep Medicine and Research Through a Digital Health Equity Framework

Judite Blanc, PhD^a, Kaitlyn Hahn, BS^b, Bruno Oliveira, BS^c,
Ro'Mya Phillips, BS^d, Lunthita M. Duthely, EdD^e, Laura Francois, BS^b,
Mary Carrasco, BS^{b,f}, Jesse Moore, MS^{b,f}, Candice A. Sternberg, MD^g,
Girardin Jean-Louis, PhD^h, Azizi A. Seixas, PhD^{a,b,f,*}

KEYWORDS

• Sleep health • Equity • Digital health • Population health

KEY POINTS

- By collecting and analyzing data on sleep health outcomes, health care providers can identify disparities in sleep quality, duration, and disorders. This can lead to targeted interventions that improve sleep health equity.
- Improving access to care, promoting patient engagement and empowerment, providing personalized care, coordinating care, and using data-driven decision making can all contribute to promoting sleep health equity.
- Addressing the unique cultural, social, and economic factors that affect a patient's sleep health can help reduce disparities in sleep health outcomes.

INTRODUCTION

The declaration of the novel coronavirus disease 2019 (COVID-19) pandemic in 2020 disrupted

biomedical research and clinical care practices in medicine, most notably in sleep medicine and research.¹ Minoritized communities (racial, ethnic minorities, and low-income individuals) were

^a Department of Psychiatry and Behavioral Sciences, University of Miami Miller School of Medicine, Center for Translational Sleep and Circadian Sciences (TSCS), Clinical Research Building, 14th Floor 1120 Northwest 14th Street, Room 1448, Miami, FL 33136, USA; ^b Department of Psychiatry and Behavioral Sciences, University of Miami Miller School of Medicine; ^c Department of Psychiatry and Behavioral Sciences, University of Miami Miller School of Medicine, 1120 Northwest 14th Street, 14th Floor, Suite 1451A, Miami, FL 33136, USA; ^d Florida Atlantic University, 777 Glades Road, Boca Raton, FL 33431, USA; ^e Obstetrics, Gynecology & Reproductive Sciences, Department of Public Health Sciences, University of Miami Miller School of Medicine, Don Soffer Clinical Research Center 1162; ^f Department of Informatics and Health Data Science, The Media and Innovation Lab, 1120 Northwest 14th Street, Room 1452, Miami, FL 33136, USA; ^g Department of Infectious Diseases, University of Miami Miller School of Medicine, Clinical Research Building, 1120 Northwest 14th Street #858, Miami, FL 33136, USA; ^h Department of Psychiatry and Behavioral Sciences, University of Miami Miller School of Medicine, CRB, Translational Sleep and Circadian Sciences (TSCS), 14th Floor 1120 Northwest 14th Street, Room 1449, Miami, FL 33136, USA

* Corresponding author. University of Miami Miller School of Medicine, 1120 NW 14th Street Miami, FL 33136. E-mail address: azizi.seixas@med.miami.edu

disproportionately affected by COVID-19, with high infection, hospitalizations, and mortality rates and restricted access to health services.² These poor health outcomes are partly caused by the high rate of medical comorbidities and increased mistrust toward medical professionals.³ To overcome these health differences and disparities, it is imperative to include individuals from diverse and minoritized populations (eg, racial/ethnic and low-income groups) who are less likely to participate in biomedical research and underutilize health care services.⁴ There are unique challenges associated with engaging, enrolling, and treating individuals from minoritized populations in medicine, particularly sleep research and health care. Some of these challenges are caused by deep structural and social determinants of health (eg, safe housing and neighborhoods, transportation, racism, discrimination, and violence, education, job opportunities, low income, limited access to healthy foods, polluted air and water, language barriers, and low health literacy skills).⁵ Since the onset of the pandemic, digital solutions, mobile health, and telehealth solutions have proliferated to increase patients' access to research and clinical care services. However, wide-scale implementation and dissemination of these solutions, especially in minoritized populations and communities, have been hindered by the limited access to quality Internet access, low digital literacy and self-efficacy (knowing how to and feeling comfortable using digital devices), and significant mistrust in the privacy and security of technology, which the authors classify as the digital divide. To solve this digital divide in biomedical research and clinical care, the authors created a digital health equity model that identifies and solves unique intrapersonal, interpersonal, institutional, and community-based barriers that prevent access to and participation in biomedical research and clinical care.

Intrapersonal and Psychosocial Barriers

Interpersonal and psychosocial barriers, like an individual's life circumstances (social demands) and their attitudes, beliefs, and knowledge (health literacy), have prevented minoritized communities from accessing quality health care and participating in biomedical research. Structurally and administratively, biomedical research and medicine are not patient-centric, as they are time-consuming, burdensome, and inconvenient for participants and patients. For example, long and inconvenient commutes to clinical and research settings, inflexible and restrictive appointment scheduling and operational hours, and rigid eligibility research criteria systematically disqualify minoritized

communities from participating in research or clinical care (eg, sleep medicine).⁶ Attitudes, beliefs, and knowledge (health literacy) are another category of intrapersonal barriers that negatively affect participation in biomedical research and clinical care. For many individuals from minoritized communities, low literacy about the importance of sleep health, the inability to identify sleep disturbances and understand their potentially adverse effects on overall health and well-being, and low health-seeking behaviors for sleep problems can lead to severe and seemingly intractable health disparities.⁷ Low health literacy has been linked with unhealthy lifestyle behaviors and poor clinical outcomes.⁸ Historically, individuals from minoritized and immigrant communities report lower levels of health literacy relative to majority white populations.^{9,10}

Interpersonal Barriers

One significant interpersonal barrier that prevents minoritized communities from participating in biomedical research and clinical care is the implicit bias of research and health care teams. Implicit biases are unconscious and automatic associations that affect the attitudes, decisions, judgments, and behavior of research and clinical teams. In a systematic review, one-third of the 65 studies revealed that researchers' perspectives and implicit biases negatively impacted interpersonal interactions between research participants and research teams. Minoritized groups felt discouraged from participating in research studies.⁵ Positive interpersonal interactions between participants and researchers are necessary for building trust through transparency and accountability. Research teams with low cultural intelligence and competence (eg, drive, action, knowledge, and strategy) are more likely to engender mistrust among patients and research participants, resulting in lower participation of minoritized individuals. Employing a digital equity model may allow teams to address implicit biases and raise cultural intelligence.^{11,12}

Other interpersonal barriers include language and cultural differences, which may impede participation in biomedical research and engagement in the health care system. Language barriers negatively affect communication between medical providers and patients.¹³ Individuals who experience language barriers are primarily neglected in biomedical research and health care, as research and clinical teams usually focus on recruiting anglophones. Recruitment of minoritized groups requires time and resources to learn what methods may work in certain communities to improve

community acceptance of biomedical research and clinical services. To address language barriers, the authors' team ensures that all patient/participant-facing materials are culturally and linguistically tailored. This process entails translating all written and external communication materials into the target communities' preferred and accepted languages and ensuring that all engagement materials are delivered by culturally trained and competent staff. Having culturally trained and competent staff allows research and clinical teams to identify and understand barriers minoritized communities face that prevent them from participating in research and engaging with the health care system.¹⁴ Although assessing the perceived barriers to research participation for minoritized groups is critical, it is equally important to ensure that research and clinical teams are diverse, because patients/participants in research or clinical care have less mistrust and are more willing to participate if teams are racially or culturally congruent with them. This does not mean that "skin folk makes kin folk," where having diverse representation on teams automatically earns trust by minoritized communities. Having a diverse team communicates an invaluable message of inclusivity to participants/patients, where difference is acknowledged, accepted, and welcomed. Over 2 decades of leading a health equity research program, the authors have learned that having a diverse team makes participants/patients feel safe and, thus, more motivated and willing to participate in biomedical research.

Institutional and Systemic Barriers

The third category of barriers is institutional/systemic. The long history of medical mistreatment of minoritized communities has impacted how individuals engage with research and health care.⁴ To overcome deep-seated mistrust among individuals from minoritized communities, building trust between communities and biomedical and health care institutions and systems is critical.¹⁵ A trusting environment may be promoted by encouraging high transparency between researchers, participants, providers, and patients. This is partially achieved by ensuring that potential participants/patients comprehend the entire research and clinical care journey. First, the informed consent process must be presented transparently and understandably. Participants/patients must be aware of the protections to prevent mistreatment and feel that the study staff is accessible if any questions or issues arise.¹⁵ The authors' group implements a novel informed consent process in which a community steering committee (CSC)

cocreates the informed consent document to ensure that empowering language is embedded. For example, participants/patients are always given the flexibility to personalize their experience in biomedical research studies, as long as the fidelity of key procedures is not compromised. The authors' recruitment process is also novel, as the authors pursue a robust community engagement program, recruiting at community-based organizations, barber shops/salons, faith-based organizations, food pantries, health fairs, sporting events, and other community venues. Re-examining recruitment and participation processes has successfully increased the representation of minoritized communities in biomedical research and clinical care **Fig. 1**.

SOLUTIONS TO INCREASE PARTICIPATION OF MINORITIZED COMMUNITIES IN SLEEP RESEARCH AND MEDICINE

Despite substantial efforts to address sleep disparities and inequities, the fields of sleep research and medicine still have a far way to achieving health equity and justice for all. To achieve equity and justice in sleep research and medicine, the authors' research group in tandem with the Sleep Health Disparities Workgroup (a group of community stakeholders) has spent decades implementing community-based strategies to achieve sleep health equity.^{16,17} In its sleep health equity program, the authors' group identified sleep health equity barriers and proposed policies solutions and workgroup initiatives that have the potential to advance sleep health equity (**Table 1**).

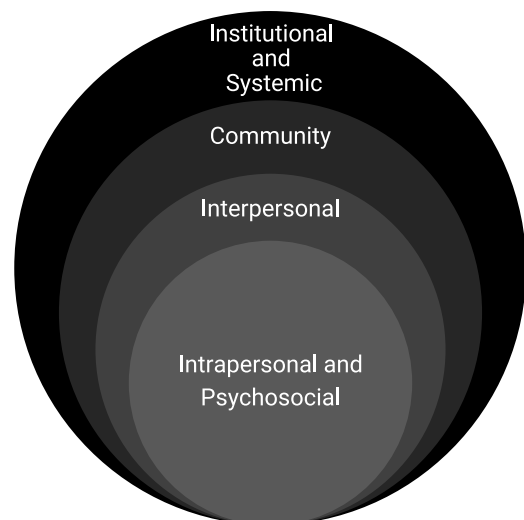


Fig. 1. Barriers in participating in sleep medicine and research.

Table 1
Ten ways the Sleep Health Disparities Working Group advanced sleep health equity

Symbols	Sleep Health Equity Barrier	Proposed Policies	Sleep Health Disparities Workgroup Initiatives
 Children	1. Higher prevalence of sleep-disordered-breathing (SDB) among African-American children	Implementation of programs for sleep health literacy, early screening, and treatment for sleep disorders beginning in elementary schools Require schools at all levels to include a module on sleep health in their curriculum and referrals of at-risk youth to sleep health centers	Implementing an intervention to evaluate the effect of sleep aid and mobile applications to advance sleep health among children from low-income communities in the United States Audio-based mobile sleep aid solutions have proven to improve sleep health in a racially diverse parent and child dyad sample ¹⁸
  Adults	2. Greater exposure to environmental risk factors for poor sleep among racial/ethnic minorities living in disadvantaged neighborhoods	Implementing a multilevel approach to reducing ecological factors that disturb sleep, such as inadequate light, noise, allergens and irritants, and air pollution. Suggestions of limitations or suppression of all sources of inadequate light, noise, allergen, irritants, and air pollution during the sleep period in identified communities	<i>Determinants of Insufficient Sleep Among Blacks, and Effects on Disparities in Health Outcomes (ESSENTIAL) Study</i> The study aims to ascertain the psychosocial (social network and psychological health) and environmental determinants (social capital, neighborhood, and built environment) of insufficient sleep <i>Mechanisms of Sleep Deficiency and Effects on Brain Injury and Neurocognitive Functions Among Older Blacks (MOSAIC) study</i> The purpose of this study was to assess the determinants of sleep deficiency and delineate their potential role in explaining observed disparities in the brain health of older Black people, indexed by novel Alzheimer disease (AD) brain biomarkers and examinations of cognitive impairment in a multicultural community sample <i>Determinants of Insufficient Sleep in Rural-Urban Settings (DORMIR) study</i> This study provides multilevel evidence supporting epidemiological findings of greater rates of insufficient sleep among Latinos/as that may explain their disproportionate burden of cardiovascular diseases (CVD) risk; the findings can lead to actionable clinical, lifestyle, and policy interventions to improve health ¹⁹

Adults	<p>3. A higher rate of short sleep duration increases cardiovascular risk among individuals of African descent and other minorities</p>	<p>Adopt a multilevel community-oriented sleep health and promotion education campaign (eg, PEERS-ED, TASHE, and MetSO)</p> <p>Provide incentives to corporate wellness programs that promote sleep and population health among racial/ethnic communities</p>	<p><i>Metabolic Syndrome Outcome Study (MetSO)</i> The MetSO trial has shown that phone-delivered sleep education addressing impediments to OSA (obstructive sleep apnea) care among Blacks was successful in increasing OSA evaluation; the trial demonstrated that tailored OSA education is critical to increasing adherence to recommended OSA care</p> <p><i>Tailored Approach to Sleep Health Education (TASHE)</i> In the TASHE trial, the authors found that Web-based sleep education significantly increased OSA self-efficacy among Blacks</p> <p><i>PEERS-ED</i> This randomized controlled trial examined the role of congruent peer sleep educators and social support PEERS-ED in navigating Blacks seeking OSA care⁷</p>
	<p>4. Racial/ethnic minorities, particularly Blacks, are exposed to higher rates of racial discrimination, which induce stress that undermines sleep</p>	<p>A national campaign to raise awareness of the harmful effects of racial bias, racial profiling, and discrimination on health</p> <p>Increase the severity of sanctions against racial discrimination nationwide</p>	<p>To advance data on the impact of discrimination, the level of exposure to daily discrimination is captured through the ESSENTIAL, MOSAIC, and DORMIR community-based sleep studies investigated among Blacks and Hispanics</p>
	<p>5. Blacks are disproportionately concerned with the effects of particular work shifts, and need stronger work schedule regulations</p>	<p>Limitations of shift length, regulation of time between shifts, and regulation of the degree of circadian phase changes in consecutive workdays</p>	<p>Advancing research at the community level; the authors' team measured the impact of shift work and lifestyle on sufficient sleep among Blacks and Latinos This problem is captured through ESSENTIAL, MOSAIC, and DORMIR, which started before COVID</p> <p>The ESSENTIAL and MOSAIC projects are tailored to Blacks between the ages of 18 and 65 years old who experienced insufficient sleep, while DORMIR focuses on Hispanic/Latinos</p>

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Table 1
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Symbols	Sleep Health Equity Barrier	Proposed Policies	Sleep Health Disparities Workgroup Initiatives
Adults	6. Cultural and language barriers limit access to sleep health literacy among racial/ethnic minorities	Establishment of sleep centers with multiethnic and multilingual staff in vulnerable communities Require health care facilities in vulnerable communities to have a multiethnic and multilingual staff	The sleep health disparities workgroup evolved into a project of a multiethnic center to advance the science of sleep and circadian sciences (TSCS) in low-income communities The study PREDICT - <i>Precision Recruitment and Engagement of Diabetics and Hypertensives in Clinical Studies</i> - aimed to form/educate, engage, support, and navigate participants and providers through the process of clinical trial participation via personalization Ultimately, the authors aimed to develop solutions addressing patient, provider, and system-level barriers preventing clinical trial participation This study provides a foundation for future research to circumvent barriers preventing vulnerable communities from participating in clinical trials
	7. Poor adherence to treatment of sleep disorders among minorities, particularly Blacks at risk for OSA	A tailored behavioral intervention to increase adherence to physician recommendations (eg, MetSO and PEERS-ED studies) Requirement for cultural competency training in sleep medicine programs	In the METSO trial, the authors observed phone-delivered sleep education addressing impediments to OSA care among Blacks that successfully increased OSA evaluation <i>PEERS-ED</i> In this randomized controlled trial, the authors examined the role of congruent peer sleep educators and social support (PEERS-ED) in navigating Blacks seeking OSA care

Adults	8. Lack of racial/ethnic minorities in the field of sleep medicine	<p>Implementation of training programs at the high school to faculty levels to increase minority representation in sleep medicine (eg, PRIDE, COMRADE & T32 programs)</p> <p>Requirement for a specific quota of racial/ethnic minorities in the recruitment of future sleep specialists</p>	<p>Over the past decade, the authors' Behavioral Medicine & Sleep Disorders Research (PRIDE) program trained 62 under-represented minoritized (URM) scholars</p> <p>The Congruent Mentorship to Reach Academic Diversity (COMRADE) Summer Institute trained 22 URM scholars</p> <p>Through the T32 mentored-research training program, 12 URM postdoctoral fellows have been trained</p>
Adults 	9. Lack of research on epigenetic factors associated with sleep problems among children and adults	<p>Implementation of multilevel research that explores links between individual and household/neighborhood factors with poor sleep</p> <p>Allocate funding to advance epigenetic studies on factors associated with poor sleep health.</p>	<p>In line with this specific policy, a genetic assessment component is included in the DORMIR study</p>
	10. Lack of research on psychological resilience factors that are protective against factors that negatively affect sleep and CVD	<p>Implementation of multilevel research that explores links among stress exposure and individual, social, cultural, and physical factors that affect sleep</p> <p>Allocate funding to advance research on sleep health resilience</p>	<p>Preliminary data from the authors' study on resilience factors, race/ethnicity, and sleep disturbance among diverse older women with hypertension suggest that resilience factors might be a more critical protective factor for sleep disturbance among diverse older women²⁰</p> <p>Another study investigated the relationships among psychological resilience, peritraumatic distress, post-traumatic stress disorder (PTSD) and depression symptom severity, and sleep disturbances among survivors of the 2010 earthquake in Haiti 2 years later</p> <p>The findings support the importance of sleep in interventions aiming to improve the affected population's daily functioning²¹</p>

IMPLEMENTING AND CONDUCTING COMMUNITY-BASED RESEARCH DURING CORONAVIRUS DISEASE 2019 THROUGH A DIGITAL HEALTH EQUITY FRAMEWORK

Overcoming sleep health disparities and inequities was already a challenge before the COVID pandemic, and became more challenging to address during the pandemic as sleep research laboratories, clinics, and practices had to adopt remote telehealth monitoring and treatment. Although telehealth monitoring and treatment proved to be initially successful in maintaining regular research and clinical operations in sleep medicine and research, it became apparent that minoritized communities did not benefit equally as white populations. The pandemic highlighted a digital divide between minoritized and nonminoritized communities and the need for a digital health equity model for sleep research and medicine.

Digital Divide

Novel approaches are needed to address the aforementioned barriers. Digital communication has become critical in remotely reaching participants and addressing key health care barriers. However, the demographic profile of Internet and social media users varies across platforms. Relying solely on digital communication may restrict the diversity of the participant pool. During the COVID-19 outbreak, 53% of Americans reported that the Internet was crucial. Nevertheless, lower-income Americans reported concerns about the digital divide and the digital homework gap. According to Pew Research Center, Black and Hispanic adults in the United States were less likely to have traditional computers and home broadband than non-Hispanic white populations. Americans with disabilities are less likely to own traditional computers and smartphones than those without them.²² According to Pew Research Center, rural Americans have narrowed some digital gaps in the past decade by adopting digital technology. However, rural adults remain less likely than suburban adults to have home broadband and less likely than urban adults to own a smartphone, tablet computer, or traditional computer.²³

This digital divide particularly affects older Black individuals. Less than half of Black adults over 65 year old use the Internet consistently. Instead, social network platforms like Facebook and Twitter may provide better opportunities to engage minoritized communities about sleep medicine and research as 61% of Black Internet users over 50 use these social network platforms.²⁴ However, the use of social network platforms is not consistent across all ages, and thus one

cannot rely exclusively on social networks as the only method or media to engage individuals, especially among older minorities.²⁵ However, social network platform usage may be enhanced in these groups, and has proven particularly effective in conjunction with community-based efforts in the authors' work.²⁶

Digital Health Equity and Inclusion in Sleep Medicine and Research

According to Healthy People 2020, health equity is achieved when everyone has the fair and just opportunity to attain their full health potential.^{27,28} Digital health equity and inclusion, defined as the fair and just opportunity to engage with digital health tools to support good health outcomes, is equally crucial as health equity in sleep medicine and research.²⁹ To achieve comprehensive digital health equity and inclusion entails adequate digital health literacy, unrestricted access to digital resources, and the belief that digital solutions can be helpful for an individual's health.^{30,31} Of the 3 factors, digital health literacy—the ability of an individual to obtain, process, and understand digital services and information—has proven to be one of the most important, as it can influence the other 2 factors, access of and belief in digital solutions.^{30,31} To increase digital health literacy, technology solutions must be developed within a human-centric



Fig. 2. The MILBox remote sleep and health monitoring solution.

Table 2
Implementing digital health equity framework in sleep research and medicine

Training	Training staff on processes and procedures for safely engaging, recruiting, and screening participants during the COVID-19 pandemic via various digital media such as video conference, phone, introductory e-mails, pamphlets, and word of mouth
Adaptation of study materials	Updated study manual, materials, and procedures manual (eg, data acquisition, processing, and storage using customized REDCap modules) to include staff and participant safety and preventive measures
Modification of study protocols	<p>Profiles, PREDICT, ESSENTIAL, MOSAIC, and DORMIR performed entirely remotely, allowing the team to complete recruitment of participants even during the lockdown and work-from-home periods</p> <p>Profiles and PREDICT studies were conducted with participant sample sizes of 100 and 30, respectively, and recruitment targets were accomplished, even while enforcing social distancing and work-from-home periods in 2020, at the height of the COVID-19 response</p> <p>This remote methodology may be instrumental in reaching disadvantaged communities that would be otherwise unable or unwilling to participate in research in a clinical setting</p> <p>WIFI-enabled iPhones or iPads are provided to participants who do not have access to such devices or the Internet</p>
Utilization of CSC	<p>A CSC of health champions and/or community organizers from diverse backgrounds was created to act as an independent advisory group to the investigatory team</p> <p>The CSC provides guidance on community engagement, the use of technology, data sharing, and dissemination plans</p> <p>CSC key responsibilities are:</p> <ol style="list-style-type: none"> 1. Provide feedback on modifying protocol procedures and feasibility and uptake of study procedures 2. Provide feedback on recruitment and retention procedures 3. Act as conduits and facilitators in onboarding and maintaining recruitment sites in the community 4. Assist with advertising and some public relations of the project 5. Provide concrete dissemination and implementation strategies to increase widespread community empowerment. <p>The Community Steering Committee meets quarterly to discuss and provide guidance on all study related processes that impact participants and the community. The governance structure of the CSC consists of a chair, an Executive Secretary, and at least two other members.</p> <p><i>Eligibility and selection of CSC.</i> To serve on the CSC, the member cannot have any conflict of interest with any of the collaborating or competing products or entities (devices, labs, firms, or other organizations) involved in the studies that constitute a potential conflict of interest. All CSC members are provided a nominal stipend for their efforts.</p>

design focus, emphasizing better usability of digital devices and services and communicating tangible benefits of using these technology solutions to users. Using a human-centric design approach, the authors' team underwent a process of developing a remote health and sleep monitoring solution, The MIL BOX (see [Fig. 1](#)) to support 3 National Institutes of Health (NIH)-funded community-based projects (ESSENTIAL [R01HL142066], MOSAIC [NIH R01AG067523], and DORMIR [NIH R01HL152453], see [Table 1](#)) all aimed at investigating multilevel determinants of insufficient sleep

and its related heart and brain health consequences among Black and Latino populations [Fig. 2](#).

In addition to creating The MIL Box, the authors also revamped their entire recruitment and retention strategy for minoritized participants during the COVID-19 pandemic to accommodate the new federal and state guidelines of social distancing to keep participants and staff engaged and safe ([Table 2](#)). [Table 2](#) describes the authors' implementation of a digital health equity and inclusion framework across the research process and

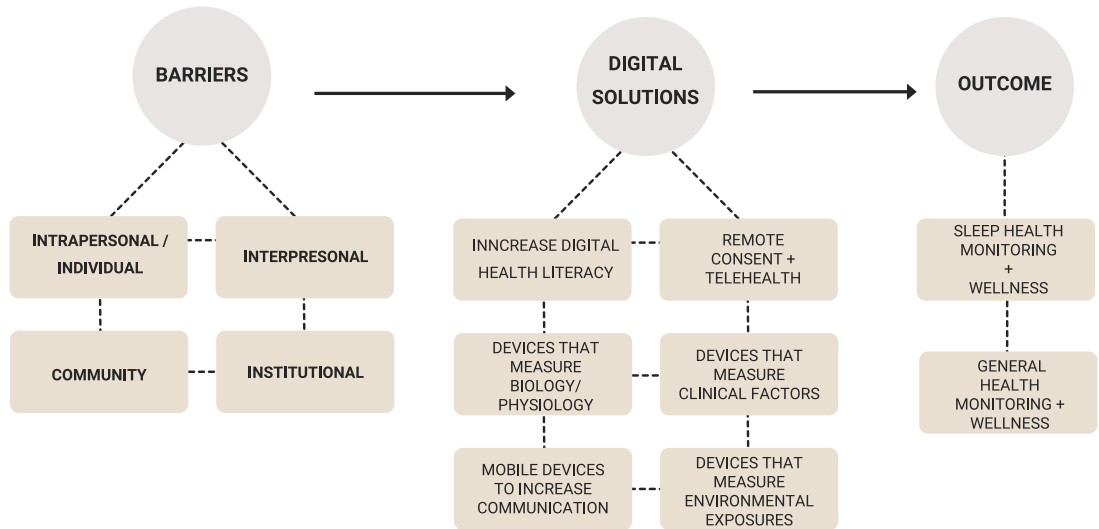


Fig. 3. Digital health equity and inclusion model.

Table 3
Digital health equity and inclusion model addresses research barriers

Phase of Research Process	Traditional Approaches	Barriers	Digital Health Equity and Inclusion Model
Engagement	Phone calls Field visits	Intrapersonal and psychosocial Time-consuming Low literacy Attitude Beliefs	Establishes stronger relationships Improves comprehension Reduces time
Recruitment	Community recruiters Field visits Community events	Interpersonal Mistrust Language Cultural	CSC Robust community engagement and recruitment program
Screening/consent	In-person contact	Institutional and systemic mistrust	Informed consent form cocreated alongside CSC for ultimate transparency Screening and consent process conducted over the phone for flexibility
Surveys	Filled out in person	Interpersonal Language Cultural differences Low literacy	All materials are translated Culturally trained and competent staff Raises cultural intelligence
Study execution and dissemination	In-person laboratory visits	Intrapersonal and psychosocial barriers Time-consuming Inconvenient Burdensome	Inclusive eligibility criteria focusing on minoritized groups Flexible operational hours 7-day home recording

journey, including training of staff, adaptation of study materials, modification of study protocols, and utilization of the CSC.

Revamping a Culturally Tailored Community Outreach Program to Meet the Challenges of the Coronavirus Disease 2019 Pandemic

In addition to implementing a digital health equity and inclusion model for sleep medicine and research, the authors revamped their culturally tailored community outreach program to meet the challenges of the COVID-19 pandemic. Guided by their mission to achieve sleep health equity and digital health equity and inclusion, throughout the COVID-19 pandemic the authors developed a culturally tailored community outreach program (COP) with several components to support the aforementioned NIH research projects: ESSENTIAL, MOSAIC and DORMIR. The focus of these studies is to investigate multilevel determinants of poor sleep among marginalized communities in the New York tristate and Florida. Outside of successfully executing the deliverables of the 3 projects, the authors' ultimate goal is to create a robust research and clinical infrastructure to enable and increase the inclusion of minoritized communities in research and clinical care. Increasing access to cost-effective digital health solutions is a critical mission of the authors' community-based research program (Fig. 3). Accordingly, the main objective of the authors' digital health equity and inclusion model is to leverage the latest digital technologies devices and innovations to measure multilevel factors that affect sleep and health among minoritized communities:

Biological/physiological (eg, blood pressure, apnea hypopnea index, oxygen saturation, weight, and body composition)

Behavioral (eg, sleep-wake patterns and physical activity)

Clinical (eg, cognitive functioning, hemoglobin A1c [HbA1c], lipid profile, and inflammatory markers)

Environmental (eg, temperature, humidity, carbon levels, and particulate matter)

Table 3 describes how together the authors' culturally tailored COP and digital health equity and inclusion model addressed intrapersonal, interpersonal, community, and institutional barriers to participating in sleep medicine and research. Specifically, the table describes significant barriers along 5 key processes in the research journey (engagement, recruitment, screening/consent, survey administration, and study execution and

dissemination) and highlights how key strategies in the culturally tailored COP and digital health equity and inclusion models addressed these barriers.

SUMMARY

The COVID-19 pandemic spotlighted and magnified long-standing sleep health disparities among minoritized communities in the United States, with worsening sleep health during the pandemic and restricted access to sleep medicine.² Increasing the participation of individuals from minoritized communities in sleep medicine and research is essential to reduce sleep health disparities. However, the current sleep medicine and research models are replete with intrapersonal/psychosocial, interpersonal, community and institutional/systemic barriers making participation difficult for minorities communities. The COVID-19 pandemic provided an opportunity to address these barriers through digital technology. Despite the promise of digital technologies to improve sleep medicine and research in minoritized communities, issues around lack of access to devices, low digital health literacy, and high cost of digital technologies may thwart plans to achieve equity in sleep medicine and research. Steeped in a community-based participatory research framework, the authors created a digital health equity model and remote health monitoring solution to address the aforementioned barriers. The authors have successfully incorporated this digital health equity model in all of their biomedical research projects, which helped them to overcome acute barriers to participation in sleep medicine and research caused by the pandemic, as well as long-term barriers around access. Utilizing a digital health equity model and strategy enabled the authors to overcome obstacles in recruitment while ensuring equal access to individuals from minoritized groups.

CLINICS CARE POINTS

- Utilize telemedicine and other technology tools to improve access to care for under-represented groups facing transportation or other barriers to care. Remote patient monitoring can be an effective way to achieve this.
- Provide education materials in the patients' preferred language and format to ensure they understand the purpose and use of technology tools like sleep tracking applications, wearable devices, and Internet of things

(IoT) devices that capture bed environment data.

- Address cost and accessibility concerns related to technology tools and help patients identify resources and support to overcome these barriers.
- Respect cultural norms related to privacy and confidentiality when using technology tools like video conferencing, electronic health records, and IoT devices.
- Take into account the patient's technological literacy and comfort level when selecting and recommending technology tools.
- Provide clear instructions and support to help patients use technology tools effectively and troubleshoot any issues that arise, including IoT devices that capture bed environment data.
- Address any potential cultural barriers to using technology, such as concerns about the accuracy of technology tools, preference for in-person care, or discomfort with IoT devices that capture bed environment data.
- Utilize IoT devices that capture bed environment data to gather more accurate and detailed information about a patient's sleep environment and how it may impact his or her sleep health. This information can be particularly valuable for under-represented groups experiencing disparities in their sleep environment.
- Use these data to develop personalized sleep plans that address any issues related to a patient's sleep environment and to track the effectiveness of interventions over time.
- Use evidence-based guidelines and best practices to inform the selection and use of technology tools in sleep medicine, including IoT devices that capture bed environment data, while also being responsive to the patient's cultural needs and preferences.

POTENTIAL CONFLICTS OF INTEREST

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