


Enhancing Community-Based Participatory Research Through Human-Centered Design Strategies

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Introduction. *The purpose of this review is to compare and contrast the values, purpose, processes, and outcomes of human-centered design (HCD) and community-based participatory research (CBPR) approaches to address public health issues and to provide recommendations for how HCD can be incorporated into CBPR partnerships and projects. Review Process. By consulting published literature, source materials, and experts on both approaches, a team of researchers completed a three-phased process of synthesizing key similarities and differences between HCD and CBPR and generating recommendations for ways to integrate HCD strategies in CBPR projects. Results. There are five HCD strategies that can be readily incorporated into CBPR projects to improve outcomes: (1) form transdisciplinary teams, (2) center empathy, (3) recruit and work with “extreme users,” (4) rapidly prototype, and (5) create tangible products or services. Conclusions. Integrating HCD in CBPR projects may lead to solutions that potentially have greater reach, are more readily adopted, are more effective, and add innovation to public health services, products, and policies.*

Keywords: *behavior change; community intervention; health promotion; health research; community-based participatory research; health research; partnerships/coalitions;*

Health Promotion Practice

January 2020 Vol. 21, No. (1) 37–48
DOI: 10.1177/1524839919850557

program planning and evaluation; community assessment; program planning and evaluation; evaluation design; program planning and evaluation

► INTRODUCTION

Human-centered design (HCD) and community-based participatory research (CBPR) are two people-centered approaches to addressing real-world problems. Traditionally, HCD has been used in the private sector, whereas CBPR has been used more commonly by academic and community organizations, often in partnership. The

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public sector has started to embrace HCD to guide product development, service development, and public policy (Nanos, 2016). While HCD is being explored in health research, few studies describe the full HCD cycle or include actionable, replicable strategies for applying HCD in health promotion and disease prevention efforts (Bazzano, Martin, Hicks, Faughnan, & Murphy, 2017). This review fills these gaps by comparing and contrasting HCD and CBPR and providing recommendations for how HCD can be incorporated into CBPR partnerships and projects.

HCD and CBPR approaches are not mutually exclusive; in fact, they may offer complementary strategies for solving problems. Recently, public health researchers have started to integrate HCD and CBPR (Kia-Keating, Santacrose, Liu, & Adams, 2017), yet no published literature to date explores the commonalities and distinctions between HCD and CBPR or provides recommendations to public health practitioners and researchers for how to integrate HCD strategies into CBPR to create more effective and efficient public health solutions. As we discuss the integration of HCD and CBPR, this article will first present both approaches as *worldviews* (Trickett, 2011) to give readers an understanding of the fundamentals of the approaches in their purest forms. Then, we (1) compare and contrast HCD and CBPR as *instrumental strategies* (Trickett, 2011) by discussing how HCD and CBPR elements are often implemented in practice and (2) suggest five recommended HCD strategies that can be used in CBPR and other public health promotion efforts.

Community-Based Participatory Research Definitions and Examples

Drawing on Paulo Freire's notions of empowerment education and critical consciousness (Freire, 1970), CBPR is a research approach that integrates education and social action to improve health and reduce health inequities (Wallerstein & Duran, 2006). CBPR is centered on intentional relationships between academic and community partners and includes the principles of co-learning, mutual benefit, and long-term commitment. CBPR is a cyclical and iterative process that includes building partnerships and community trust, community assessment, problem definition, development of research methodology, data collection and analysis, interpretation of data, determination of action and policy implications, dissemination of results, action, and plans for sustainability (Israel, Schulz, Parker, & Becker, 1998; Lewis, Shain, Quinn, Turner, & Moore, 2002). CBPR projects can increase the relevance and appropriateness of intervention designs, improve the quality of data

collected, facilitate participant recruitment, address issues that are relevant to community members, and build trust and partnership between researchers and community members (Salimi et al., 2012).

CBPR has been applied to many different types of health problems and used extensively to develop public health solutions. For example, researchers, practitioners, and community members in Durham, North Carolina, collaborated on a CBPR project to reduce transmission of sexually transmitted infections and HIV (Lewis et al., 2002). The program involved training local barbers and beauticians to serve as peer educators and distribute condoms and educational materials in their shops. In collaboration with community members, researchers used participant observation and qualitative interviews to conduct a needs assessment to determine how the program could be further developed to better meet community needs. Other CBPR projects have focused on different health behaviors and/or outcomes (e.g., smoking cessation or healthy eating), been conducted in diverse geographic settings (e.g., New York City, rural Alaska), used different methods to enhance participation between community members and researchers (e.g., relying on community advisor boards, working with local community organizations), involved community members to varying degrees (e.g., community members had full control or community members were consulted), and used different measures and indicators to evaluate success (e.g., individual or community-level changes) (Peterson & Gubrium, 2011; Salimi et al., 2012).

For example, CBPR was used to improve hand washing among farmworkers in California (Salvatore et al., 2009). University and community partners of the Center for Children's Environmental Health Research at the University of California at Berkeley designed a worksite intervention to protect farmworkers and their families from the toxic effects of agricultural pesticide exposure (Salvatore et al., 2009). Researchers, academics, and representatives from health centers, the health department, farmworkers, and the agricultural industry collaboratively developed and evaluated an intervention targeting individual-level factors (i.e., worker education) and environmental factors (i.e., provision of warm water, soap, protective equipment) (Salvatore et al., 2009). Two advisory boards—a community advisory board (CAB) and a Farmworker Council (which was formed to participate in the development and analysis of the intervention study)—participated throughout the project to help design the intervention, develop data collection instruments and protocols, hire staff, recruit and retain participants, collect and interpret data, and disseminate findings (Israel et al., 2005). The intervention improved

several behaviors (e.g., hand washing at midday break and before going home) and the authors suggest “the CBPR orientation and participation of growers and farmworkers in the development of the intervention likely strengthened the intervention’s relevance” (Salvatore et al., 2009). This example illustrates the principles and practices of CBPR and demonstrates how CBPR can affect project outcomes.

Human-Centered Design Definition and Examples

HCD (i.e., design thinking) is a repeatable, creative approach to problem solving that brings together what is desirable from a human point of view with what is technologically feasible and economically viable (IDEO.org, 2015). The concepts central to design thinking have evolved through diverse disciplines ranging from computer science to visual design to architecture over the past several decades (McKim, 1980; Rowe, 1987). Related peer-reviewed literature sometimes refers to this approach as “user-centered design” (Durand, Alam, Grande, & Elwyn, 2016; Kia-Keating et al., 2017; McCurdie et al., 2012); however, it is important to note that “user-centered design” focuses specifically on the development of technological products (Usability.gov, 2018). For the purposes of this article, the authors rely on the HCD process as defined by IDEO, a leading global design company, that has successfully used HCD to create groundbreaking products such as Palm pilots and Oral-B toothbrushes (T. Brown & Wyatt, 2010).

IDEO’s HCD process for problem solving consists of three distinct phases: the inspiration phase, the ideation phase, and the implementation phase (T. Brown & Wyatt, 2010; IDEO.org, 2015). After identifying a particular problem for which a solution is desired, designers first aim to build empathy within the design team for individual users and their lived experiences. The purpose of this first phase is not to arrive at a solution; instead, the goals are to more completely understand the intended users, the barriers (i.e., “pain points” in HCD) they have experienced given the problem, and the solutions (i.e., “workarounds”) they have embraced (IDEO.org, 2015). Second, in the ideation phase, designers use the users’ thoughts, feelings, and experiences to generate numerous ideas for how to solve the problem. Third, in the implementation phase, designers then quickly prototype, that is, test the different ideas with users to solicit immediate feedback through designing short experiments with low-fidelity prototypes. Low-fidelity prototypes are simple versions of a solution, often paper-based, that are quickly produced to test broad concepts (IDEO.org, 2015). Most prototypes represent components or

aspects of the solution, and prototyping allows for the recombination and refinement of ideas into a solution that is tailored for a specific set of users. These short iteration cycles help secure buy-in by repeatedly engaging collaborators, which also allows for a smoother, wide-scale roll out of the solution at the conclusion of the project (T. Brown & Martin, 2015).

HCD is an important tool for social innovation, as evidenced by its successful application to numerous public health problems, and HCD strategies help achieve broad impact and scale (Bazzano et al., 2017; T. Brown & Wyatt, 2010; Matheson, Pacione, Shultz, & Klügl, 2015; Sonney, Duffy, Hoogerheyde, Langhauser, & Teska, 2018). We present the example of SwipeSense, a Chicago-based start-up focused on hand hygiene that used HCD to improve hospital staff handwashing techniques to prevent unnecessary infections, as a parallel example to the farmworkers’ hand washing example presented in the CBPR section (IDEO, 2013). The SwipeSense team worked closely with doctors and nurses to better understand their motivations and barriers to handwashing to gather inspiration. Altogether, SwipeSense went through 70 iterations in their ideation phase and then implemented several trials in real hospitals to test out their ideas. Today, SwipeSense integrates sensors in personnel badges to track staff members’ visits to existing hand sanitizer dispensers in a cloud-based platform to increase accountability and to build habits among staff members (SwipeSense, 2017).

Combined Human-Centered Design and Community-Based Participatory Research Example

Kia-Keating et al. (2017) have explicitly integrated HCD and CBPR to address violence-related health disparities among Latinx youth. Their recent publication is an applied example of how HCD strategies from the inspiration and ideation phases can be used in the early stages of a larger CBPR project. In this project, the research team assembled a CAB of diverse stakeholders, including both adults and youth, organized three interactive community forums and used HCD activities (e.g., drawing, photojournaling, conversation starters) to better understand community members’ needs and barriers, and then codesigned potential solutions to decrease violence and strengthen the community using other HCD activities (e.g., storyboarding) with community members (IDEO.org, 2015; Kia-Keating et al., 2017). Results from this formative work will inform the next phase of the research project focused on the last phase of HCD (implementation) where Kia-Keating et al. plan to prototype, iterate, and create a sustainable intervention model that best meets the needs of their partner community.

In support of the growing interest in combining HCD and CBPR in public health research and practice, we reviewed published literature and source materials on the two approaches. In the following section, we describe our review process and consensus-based analysis. We then compare and contrast the approaches and identify five HCD instrumental strategies that can strengthen CBPR projects and partnerships.

► REVIEW PROCESS

Our team consisted of four public health researchers with training and applied experience in both CBPR and HCD. For this review, we sought resources that described the CBPR and HCD processes. We began by referencing source materials used to train professionals in both CBPR and HCD, including seminal academic works, case studies, and training manuals. HCD did not originate in academia, therefore much of the resources on the design thinking process came from training and materials produced by IDEO. Most of the literature we reviewed on CBPR came from peer-reviewed articles or seminal book chapters. Next, we supplemented our review by conducting an online search to identify peer-reviewed articles on HCD in public health. We searched the key words “human-centered design” and “design thinking” in PubMed and reviewed the titles and abstracts for initial search results. Much of the peer-reviewed literature focused on applying this approach rather than discussing HCD as a framework or methodology, and almost none focused on integrating HCD with CBPR (for an exception, see Kia-Keating et al., 2017).

We reviewed the literature on both CBPR and HCD in three distinct phases. In the first phase of our analysis, we applied HCD’s systematic protocols for brainstorming, downloading our learnings, bundling ideas, and finding themes (IDEO.org, 2015). Each of the four authors individually brainstormed lists of similarities and differences between the two approaches across four dimensions (values, purpose, process, and outcomes) and then systematically shared these lists with the other authors (i.e., brainstorming and downloading our learnings). Next, all four authors collaboratively synthesized these lists through in-person discussion to identify common ideas and to begin identifying preliminary themes (i.e., bundling ideas and finding themes). All four authors then discussed each preliminary theme, came to consensus about similarities and differences between HCD and CBPR, and drafted the first table to synthesize results.

In the second phase, we sent the draft table to experts in the field for review: two university faculty members with extensive research and teaching experience with

CBPR and one design researcher at IDEO who was trained in CBPR. All four authors then collaboratively reviewed the expert feedback, came to consensus about changes needed to more accurately reflect both approaches, and then revised the table. In the third phase, we sent the revised table back to our experts to ensure the revisions captured their recommendations, and then finalized Table 1.

Next, we underwent a process to generate recommended HCD strategies that could be applied to CBPR projects. Our team reviewed the HCD column in Table 1, independently answered a set of guiding questions found in the Supplemental Appendix, and then discussed our responses as a group to come to consensus about which HCD strategies to recommend. We then considered how these five recommended actions would be useful in CBPR projects. We chose to use the RE-AIM (reach, efficacy, adoption, implementation, maintenance) framework to organize our recommendations because it is one of the most commonly used frameworks for evaluating the impact of public health interventions. RE-AIM specifies five dimensions that can be used to evaluate programs, policies, and interventions, which operate at multiple levels (individual, organization, and community) (Glasgow, Vogt, & Boles, 1999).

► FINDINGS

HCD and CBPR in their purest forms (i.e., as worldviews, Trickett, 2011) each have distinct emphases, but also overlap in important ways in terms of their values, purpose, and process. We chose to describe similar and different emphases of HCD and CBPR, rather than universal similarities and differences, in acknowledgment that these statements about HCD and CBPR are not absolute, but rather represent how each approach is typically applied in the field. Table 1 illustrates the similar and different emphases of these two approaches. In the text below, we first describe the similarities between the emphases of these two approaches and then discuss their differences.

Similarities

Values and Purpose. HCD and CBPR are similar in that they both value a bidirectional exchange of knowledge and cocreation (Israel et al., 1998). Both approaches rely on close collaboration between the design team or research team and the beneficiaries, and include the deliberate use of cocreation practices, whereby the team and the beneficiaries both contribute directly to the design and development of the final outcome or product (IDEO.org, 2015; Israel et al., 1998). Both HCD

TABLE 1
Similar and Different Emphases of Human-Centered Design and Community-Based Participatory Research

<i>Dimension</i>	<i>Human-Centered Design</i>	<i>Both</i>	<i>Community-Based Participatory Research</i>
Values	<ul style="list-style-type: none"> • Empathy • Creativity • Delight 	<ul style="list-style-type: none"> • Co-creation 	<ul style="list-style-type: none"> • Relationship-building • Shifting power dynamics
Purpose	<ul style="list-style-type: none"> • Generating action • Scalable solutions 	<ul style="list-style-type: none"> • Engages users/partners in all stages • Provides a benefit to intended stakeholders 	<ul style="list-style-type: none"> • Generating research for future action • Localized, contextual solutions
Process	<ul style="list-style-type: none"> • Short timeline • Rapid iteration cycles with low fidelity prototypes • Focus on individual extreme users • Transdisciplinary team 	<ul style="list-style-type: none"> • Systematic • Flexible/adaptable • Generalizable • Iterative • Requires training to execute • Clients/partners sustain efforts at project conclusion 	<ul style="list-style-type: none"> • Long timeline • Focus on communities • Interdisciplinary team
Outcomes	<ul style="list-style-type: none"> • Product/service • Sole ownership of product/service 	<ul style="list-style-type: none"> • Bidirectional knowledge exchange 	<ul style="list-style-type: none"> • Research/knowledge • Co-ownership of research/knowledge • Capacity building

NOTE: The table displays distinct emphases of human-centered design (left) and community-based participatory research (right) as well as common emphases between the two (center) across four different dimensions: values, purpose, process, and outcomes.

and CBPR have the explicit purpose of engaging users/participants in all stages of the development process by seeking constant feedback and guidance as the project evolves (Minkler & Wallerstein, 2011). Another common purpose is to provide a benefit to the intended stakeholders, meaning that both approaches aim to move beyond information gathering or assessment to create something new and useful or to inform action that will benefit the participants.

Process. Both approaches follow a similar systematic process that begins by identifying a central issue or problem that informs the research questions or design challenge. Both approaches then select appropriate research methods and collect and analyze data. We acknowledge that HCD and CBPR are not defined by a single data collection method and incorporate a variety of approaches (i.e., both quantitative and qualitative). However, qualitative methods play an essential role within both HCD and CBPR (Clark & Ventres, 2016; Salimi et al., 2012). This allows for inductive learning aimed at discovery and insight that is contextualized within individual lived experiences (Ulin, Robinson, &

Tolley, 2005). Within this systematic process, both HCD and CBPR also allow for flexible, iterative development of solutions. Teams commonly revisit prior steps in the process as they gain new insights and adjust their scope of work accordingly (IDEO.org, 2015; Minkler & Wallerstein, 2011). Consequently, it is not the findings or outcomes of these projects that generalize to other settings, but rather the process itself that can be applied to new challenges. Furthermore, both approaches require specific training and skills to execute them effectively, and both rely on community partners or clients to sustain the project once the core work has been completed.

Differences

Despite these similarities, HCD and CBPR also differ in important ways across their values, purpose, process, and outcomes. Three key differences are described below.

Values. Both approaches have distinct values that affect the nature of their work and goals. HCD centers its work on cultivating deep empathy, thinking creatively, and instilling delight in their users. These values direct the

design team to immerse themselves in the lives of others for a limited time and then rapidly design innovative solutions that not only address users' needs but are also enjoyable to use (M. Brown & Longanecker, 2013; Kola-wole, n.d.; Norman, 2002). In contrast, CBPR is typically a longer process that values building relationships and trust with community partners, identifying priorities together, and generating information of value to the community. CBPR intentionally aims to shift power from researchers to communities (Christopher, Watts, McCormick, & Young, 2008; Israel et al., 1998). One example of this value is co-ownership of the knowledge generated by academic and community partners (Wallerstein & Duran, 2010).

Purpose and Outcomes. The differences in values are reflected in the differences in purpose and outcomes for the two approaches. HCD's primary purpose is to actively test and build solutions intended to scale across a larger user base, far beyond participants in the original project. HCD aims to create a product or service—a tangible solution—that can be widely and successfully implemented immediately on conclusion of the project, with a specified business model to support its implementation and dissemination. As a result, research and data collection comprise a smaller proportion of the process, with most effort directed toward building and testing solution prototypes.

In contrast, CBPR emphasizes generating research findings and uncovering highly localized, contextual insights for and with the participating community. While CBPR may contribute to a solution, it is essentially a research process and, as such, its primary goal is to generate new knowledge that can inform future action. Significant effort is spent on collecting, analyzing, and interpreting data (Israel et al., 1998) and instead of developing a *product* to address a problem faced by community members, CBPR aims to build *capacity* within the community to address existing and future challenges.

Process. These differences in purpose also contribute to important differences in process, primarily with regard to allocation of time, composition of teams within each approach, and participants of interest. First, HCD occurs over a much shorter period of time (usually 6-12 weeks) compared with CBPR (over months, or even years) (Blumenthal, 2011). This stems in part from the emphasis on relationship building that is central to CBPR but also results from the way in which HCD quickly tests and iterates on low-fidelity prototypes rather than waiting for all elements of a solution to be determined before testing.

Second, the makeup of the design team in HCD differs from the research team in CBPR. HCD utilizes *transdisciplinary* teams from a diverse range of fields, including business, engineering, design, and research, and they focus primarily on translational application of their results (IDEO.org, 2015). In contrast, CBPR often forms *interdisciplinary* teams anchored by academic researchers. In this case, the required diversity is inclusion of nonacademic partners such as members of a community organization or a specific community. Although CBPR practice often includes partners across academic disciplines (Lucero et al., 2018; Wallerstein, Yen, & Syme, 2011), it is not as intentionally diverse as in an HCD approach.

Third, the type of participants selected in each approach is distinct. Since its primary unit of analysis is the community, CBPR typically seeks broad and inclusive participation, prioritizing central tendency over unusual or outlier experiences. In contrast, HCD focuses primarily on individual user experiences. HCD prioritizes “extreme users,” which means that the design team seeks data from individuals who fall on the far ends of the spectrum for a given characteristic (IDEO.org, 2015). This technique is advantageous because it allows the team to generate ideas and identify opportunities that may have been otherwise missed if the team only worked with those who are “mainstream”; a solution designed with “extreme users” in mind will also likely work for the majority of other users because a wider range of needs will be met with this more inclusive product or service.

HCD and CBPR are complementary approaches for addressing real-world problems and we believe that combining these two approaches will lead to more effective, scalable, and sustainable public health solutions. In the section below, we recommend specific HCD strategies that can strengthen CBPR projects, increase creativity and delight centered on individuals' experiences, and hold CBPR researchers accountable to delivering solutions to communities by the conclusion of their projects.

Recommendations

We have identified five *instrumental strategies* (Trickett, 2011) that researchers and practitioners can draw from HCD when conducting CBPR projects: (1) form transdisciplinary teams, (2) center empathy, (3) recruit and work with “extreme users” as participants and partners, (4) rapidly prototype elements of the product or service, and (5) create tangible products or services that can be tested. For instance, imagine that

you are serving as the principal investigator of a CBPR project to decrease rates of teen pregnancy through the use of digital technology among teenagers living in a rural area. How might you incorporate these HCD strategies into the planning and execution of your research project? Table 2 describes HCD strategies and rationales that align with the RE-AIM framework (Glasgow et al., 1999) and example applications given the context of the research project described above.

Form Transdisciplinary Teams. Transdisciplinary teams increase collaboration across sectors and can potentially open up more funding streams for joint projects. According to IDEO.org, it is important to recruit a diverse set of people and talent on a design team with seemingly unrelated expertise, as projects “won’t get unexpected solutions with an expected team” (IDEO.org, 2015). Depending on the project, it is helpful to map out the expertise and fields that core team members represent and then strategically select additional team members that not only bring a different set of knowledge and skills but also different life experiences; it is not sufficient for team members to all be researchers of different disciplines. This diversity will likely lead to more innovative ideas, increasing the effectiveness of the identified solutions, as well as their adoption in the real world. For example, the previously mentioned Kia-Keating et al. (2017) study had a CAB that included members from the community’s school district, religious organizations, mental health organizations, and the police department. While the CAB was involved in organizing and facilitating the three community forums, an HCD perspective would suggest that the project leadership team (i.e., the team recruiting the CAB and executing the research) be transdisciplinary, too. In our teen pregnancy example (Table 2), a transdisciplinary team could include a high school junior who captains the football team, a local pastor with skills in computer programming, and a public health researcher, among others.

Center Empathy. Explicitly centering empathy early and often will increase the appropriateness of interventions by understanding what people *actually do*, not just what they *say* they do, thus also increasing effectiveness and adoption of the final solution. While the nature of CBPR partnerships and activities may naturally result in increased empathy for participants, HCD explicitly incorporates specific activities designed to cultivate empathy for users and assist the design team in seeing the users’ experiences in a broader context (IDEO.org, 2015). For example, Kia-Keating et al. (2017)

combined a HCD activity called *conversation starters* with photos taken by youth to gather insights during community forums (IDEO.org, 2015). The photos were shown to community members, and some of the conversation starters they used to spark discussion included the following: (1) What do these pictures say about your community? (2) What visions for change do these pictures suggest? (3) What memories do these pictures bring up for you? (Kia-Keating et al., 2017). Design team members then immersed themselves in these data to develop empathy for the experiences of the potential users of their design.

With our teen pregnancy example (Table 2), empathy-centering interview questions could include the following: (1) Tell us about yourself. (2) Where did you grow up? (3) What do you like to do outside of school? These interactive activities will lead the researchers to be able to deeply understand their participants holistically—not just in the context of the problem they are trying to solve. As a result, researchers learn about existing workarounds (makeshift solutions) participants employ and can more clearly envision how a potential solution may fit into the person’s everyday life (IDEO.org, 2015).

Recruit and Work With “Extreme Users”. Recruiting and working with “extreme users” who are intentionally chosen for their different backgrounds, beliefs, and behaviors will ensure that a wide range of wants and needs are considered in all phases of the research project. IDEO believes that gathering inspiration from “extreme users” can spark creativity in other phases of the research project by exposing researchers to other scenarios, workarounds, and opportunities that otherwise would not be considered if they only focused on understanding mainstream users. For example, Kia-Keating et al. (2017) held their three community forums in three low-income and predominantly Latinx neighborhoods. Some examples of types of “extreme users” that their team could have purposively sampled include individuals who are new to the community and individuals whose families have lived in the community for generations; those who believe that violence is solvable and those who do not; and those who own firearms and those who do not own firearms. For our teen pregnancy example (Table 2), “extreme users” could include teens who have multiple social media accounts and teens who have no social media accounts, parents who speak openly with their teens about sexual health topics and parents who never speak with their teens about sexual health topics, and religious leaders who offer sexuality education through their religious organizations and religious leaders who do not offer sexuality education

TABLE 2
Potential Ways to Integrate HCD Strategies Within CBPR Projects and Apply RE-AIM to Evaluate Outcomes

<i>Recommended Action</i>	<i>Descriptions</i>	<i>RE-AIM Constructs</i>	<i>Example Applications</i>
<i>Form transdisciplinary teams</i>	Include individuals with complementary skill sets from “unexpected” (seemingly unrelated) fields.	Increase efficacy Increase adoption	Assemble a team with different training and life experiences who are committed to the teen pregnancy prevention project: <ul style="list-style-type: none"> • A television producer who was a teen parent and grew up in the rural community • A local pastor who self-taught himself basic computer programming • High school junior who is captain of the football team at an area high school • A graduate student enrolled in an MBA program • A public health researcher
<i>Cultivate greater empathy</i>	Collect qualitative data from users in the context of their everyday lives, not just the problem to be investigated. Value all that they share.	Increase efficacy Increase adoption	Interview teens in the comfort of their home or school and experience their daily life with them (e.g., going to a high school football game, sitting in a classroom, attending a church youth group session). In addition to asking them questions about technology use and teen pregnancy, ask them questions like <ul style="list-style-type: none"> • Tell us about yourself. • Where did you grow up? • How would you describe your childhood home? • What do you like to do outside of school? • What does a typical weekend look like for you? • Compensate them like you would experts in the fields.
<i>Recruit and work with extreme users</i>	Gather data from users who fall on the far end of the spectrum on a given characteristic. List the demographic attributes, beliefs, and behavioral attributes for typical (“mainstream”) and atypical (“extreme”) users and recruit these extreme users in your research, especially for intervention development.	Increase reach Increase efficacy	List out and recruit teens and adults (for interviews and feedback sessions) who represent the end of different spectrums. For example, <ul style="list-style-type: none"> • Teens who have had 0 sexual partners ever and teens who have had 5+ sexual partners • Teens who are very religious and teens who are agnostic • Teens who do not have access to a smartphone at home and teens who have constant access to a smartphone at home • Teens who have 3+ social media accounts and teens who have 0 social media accounts • Teen parents and teens who are not teen parents • Parents who speak openly with their teens about sexual health topics and parents who never speak with their teens about sexual health topics • Educators who specialize in sexuality education and health educators who refuse to teach sexuality education in schools • Religious leaders who offer sexuality education formally/informally through religious organizations and religious leaders who do not offer or condone sexuality education

(continued)

TABLE 2 (CONTINUED)

<i>Recommended Action</i>	<i>Descriptions</i>	<i>RE-AIM Constructs</i>	<i>Example Applications</i>
<i>Rapidly prototype</i>	Test different ideas quickly for immediate feedback and quickly refine, build, and iterate.	Increase efficacy Increase adoption	Use basic supplies (e.g., paper, markers, cardboard) to put together physical representations of ideas and ask participants to give you immediate feedback. Consider asking teens (individually or in groups) to cocreate (by drawing, telling, building) aspects of the product or service. Print out pictures of smartphones with blank screens and ask teens to design their own app to improve sex education with guidance on what they might want to think through the following: <ul style="list-style-type: none"> • What is the name of the app? • How does the app improve sex education for teens? • What does the home screen look like? • What do the buttons do? • Why would a teen want to use this app? Ask teens to share their ideas with the research team and each other and note similarities and differences across the ideas put forth.
<i>Create tangible products or services</i>	Create a tangible solution that can be actually implemented and tested at the end of the research project (it can even be a piece of a product or service).	Increase reach Increase efficacy	Hire a web developer to build a website version of the app you ultimately plan to develop and recruit teens to test out the web prototype and provide feedback. Collect data on key indicators (process, usability, outcome) early and often and continue making revisions to your ideas through the web prototype before moving on to hiring an app developer. In a matter of weeks (not months/years), you will have gone from inspiration to ideation to implementation culminating in a testable product that can be improved on.

NOTE: HCD = human-centered design; CBPR = community-based participatory research; RE-AIM = reach, effectiveness, adoption, implementation, maintenance.

through their religious organizations. Designing solutions with a greater range of people at the table can lead to greater reach and effectiveness.

Rapidly Prototype. HCD's rapid prototyping is an efficient use of time and resources since ideas are tested in real-world settings with real users quickly and frequently before investing in the final solution to be implemented. Incorporating this into CBPR will require a shift in expectations of time and degree of development prior to engaging community members with the emerging tool or intervention. HCD emphasizes testing *multiple* solutions with real users before committing to a single solution for further testing instead of only testing *one* solution with real users (e.g., in a pilot study) before progressing to a larger trial. With rapid prototyping, iteration cycles for products or services are accelerated and delivered in days or weeks instead of months or years. For example, Kia-Keating et al. (2017) could take some of the ideas gathered from their community forums like a radio public service announcement, an information campaign, or a neighborhood watch program and test pieces of them at a small scale and then iterate on these concepts. In our teen pregnancy example (Table 2), we could ask teens to draw their own sexual health mobile app using paper, pens, and colored markers and then ask teens to share and react to the different ideas put forth by others. The spirit of rapidly prototyping is aligned with existing rapid appraisal research methods such as the Plan Do Study Act (PDSA) cycle that is used in quality improvement research (Agency for Healthcare Research and Quality, 2008). Lessons learned from rapid prototyping can inform future iterations of the products and services so the interventions developed may be more readily adopted than those developed through the more traditional research piloting of already well-developed designs. In fact, IDEO analyzed data from more than 100 companies in 2017 and found that when teams iterated five or more different solutions, they were 50% more likely to launch a product successfully (Schwab, 2017).

Create Tangible Solutions. Last, creating tangible solutions (e.g., products, services, programs, policies) in real time like the intervention suggested from Kia-Keating et al.'s (2017) formative research prioritizes action to evaluate empirical results of the emerging solutions. Our teen pregnancy example (Table 2) could result in the development of a web prototype, such as a website that looks like an app when accessed on a smartphone. Then, we could take this web prototype to real users to get more feedback to further refine the

solution. Creating tangible solutions early on and welcoming several iterations will likely improve the solutions' ultimate effectiveness. In addition, the creation of early, tangible prototypes that are ready to be evaluated will strengthen community faith in the CBPR process and partnerships because community partners would be able to see immediate benefit to their community, perhaps leading to even more productive longer-term outcomes.

► DISCUSSION

The worldviews of HCD and CBPR offer rich approaches for approaching complex public health problems. This article identifies opportunities to use specific instrumental strategies (Trickett, 2011) drawn from HCD to enhance CBPR projects. More broadly, however, design thinking has intriguing implications for health promotion practice and public health research.

Implications for Health Promotion Practice

HCD can be applied to a variety of practical approaches to public health problems at the individual, organizational, or community levels. For example, HCD strategies can be incorporated into patient-centered outcomes research, rapid health impact assessments, research on trauma-informed care and interventions, and CBPR methods such as Photovoice. HCD principles can be used to bridge needs assessment and pilot testing, divide implementation into more nuanced and iterative phases, or engage more diverse experiences in problem identification or solution evaluation. Incorporating HCD strategies, particularly centering empathy, can deepen the formative stages of team development, enhance staff training, guide data collection and reporting processes, and help shape the transition or ending stages of a community-based project.

Implications for Public Health Research

As more researchers choose to integrate HCD as an instrumental strategy into the development of public health solutions, other institutional structures will need to evolve. First, traditional funding mechanisms will need to be open to, and even promote, HCD in public health. A handful of public health funders have already started to earmark funding for HCD-specific projects. For example, the Office of Adolescent Health funded the Innovation Next accelerator program, hosted by *Power to Decide*, whereby teams applied HCD to create a technological solution to prevent teen pregnancy. The Robert Wood Johnson Foundation also

has a similar funding opportunity to use design thinking to build child-centered communities (Robert Wood Johnson Foundation, 2017). However, none of these funding mechanisms explicitly linked HCD with CBPR.

Second, more public health training institutions should consider integrating HCD training into their courses of study, particularly as innovation becomes a greater priority for public health and medical training institutions. In fact, Matheson et al. (2015) argue that integrating HCD training into traditional medical training will “bring the kind of substantial results in disease prevention that have eluded the healthcare industry for decades” (p. 477). Some public health training institutions already integrate HCD into their course, program, or school offerings, including the University of Michigan’s School of Public Health and Yale’s School of Public Health; Tulane University even has the Phyllis M. Taylor Center for Social Innovation and Design Thinking. Additionally, schools of public health can partner with other professional schools (e.g., business schools, schools of social work, urban planning programs) or design firms to make existing HCD courses and resources available to public health students.

Limitations and Next Steps

While we reviewed dozens of articles and source materials on HCD and CBPR, we did not employ the methods of a systematic review or formal meta-analysis; this was not the purpose of our inquiry. A systematic or scoping review of the applications of HCD in public health research is an opportunity for future research. We also recognize that our five recommended instrumental HCD strategies cover the inspiration (form transdisciplinary teams, cultivate greater empathy, recruit and work with “extreme users”) and implementation (rapidly prototype, create tangible products or services) phases of design thinking but not the ideation phase. This is not to say that HCD’s ideation strategies cannot or should not be integrated into CBPR, but they were not prioritized in the top five strategies that emerged through our consensus-driven analysis. Future research should explore how HCD’s ideation strategies can be applied to health promotion research and practice. Last, additional research should consider how CBPR’s instrumental strategies might inform HCD for further integrated efforts to solve public health problems.

CONCLUSION


In this article, we identified commonalities and distinctions between HCD and CBPR, and provide recommendations to public health practitioners and

researchers for how to employ HCD as an instrumental strategy into CBPR partnerships and projects. In addition, we suggested strategies to adapt public health training and funding mechanisms to accommodate combined HCD/CBPR approaches to address public health concerns. Given the complex and multifaceted nature of the health and social issues facing the world today, solutions that incorporate complementary paradigms and methods are critical.

SUPPLEMENTAL MATERIAL

Supplemental material for this article is available online at <https://journals.sagepub.com/home/hpp>.

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