



# Shaping Education and Training to Advance Transdisciplinary Health Research

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**D**espite at least two decades of effort, the United States has made little progress in addressing the health disparities experienced by its most vulnerable residents. For many diseases, the gaps in health between groups continue to grow. In this paper, we first build a case for the importance of a transdisciplinary approach to eliminating health disparities, based on the premise that executing successful disparities research depends on the ability to visualize the multiple influences on health and health disparities and understand the complex ways in which they interact with one another to produce worse outcomes for some groups than others. We argue that our failure to prepare investigators to conduct transdisciplinary research has greatly impeded our progress toward eliminating the nation's disparities. Finally, we articulate the challenges to implementing transdisciplinary education and training and recommend elements of a successful transdisciplinary educational program in health.

**Keywords:** transdisciplinary, cancer, education, training.

## 1 Introduction

Despite at least two decades of effort, the United States has made little progress in addressing the health disparities experienced by its most vulner-

able residents. These health disparities occur in incidence, mortality, and survivorship for a range of serious health conditions, including heart disease, cancer, HIV/AIDS, and diabetes. They occur by race/ethnicity, socioeconomic status, disability status, and geography. Racial/ethnic disparities have received the greatest attention and can be summed as the gap in life expectancy between urban black males and Asian males (15.4 years) [1].

Despite elegant quantification of health disparities and advances in our understanding of their determinants, we have made little headway in reducing the nation's disparities. For many diseases, the gaps in health between groups continue to grow through time. As an example, although cancer mortality decreased between 1975 and 2004 for the U.S. population as a whole, significant African-American and white gaps persist [2]. The disparity in breast cancer mortality, in fact, has grown since the mid-1980s, with the improvements in mortality experienced by white women not reflected in similar improvements for African-American women.

Although health disparities by race and ethnicity have been acknowledged since at least the 1970s, it was not until the 1990 U.S. Census, when data on race/ethnicity became available for all fifty states, that the full extent of these disparities became apparent. The federal government reacted with a number

of programs, such as President Clinton's 1998 Racial and Ethnic Health Disparities Initiative, which set an ambitious goal of eliminating racial and ethnic disparities by 2010. In response to this challenge, the National Institutes of Health (NIH) began rethinking its approach to health research.

The National Cancer Institute (NCI) was the first NIH institute or center to incentivize a transdisciplinary approach to health research. Its Transdisciplinary Tobacco Use Research Center (TTURC) initiative was launched in 1999 and three center initiatives followed in the early 2000s: the Centers of Excellence in Cancer Communication (CECCR) and Centers for Population Health and Health Disparities (CPHHD) in 2003 and Transdisciplinary Research in Energetics and Cancer (TREC) centers in 2004. All aim at eliminating cancer disparities and preparing the next generation of transdisciplinary investigators.

In this paper, we first build a case for the importance of a transdisciplinary approach to eliminating health disparities. Executing successful disparities research depends on the ability to visualize the multiple influences on health and health disparities and understand the complex ways in which they interact with one another to produce worse outcomes for some groups than others. This can be done neither by a single investigator nor by a single discipline. Yet, despite a growing emphasis on transdisciplinary research in the United States, few research teams can say that they have achieved transdisciplinary functioning. We argue that our failure to prepare investigators to conduct transdisciplinary research has greatly impeded our progress toward eliminating the nation's disparities. Finally, we articulate the challenges to implementing transdisciplinary education and training and recommend elements of a successful transdisciplinary educational program in health. In all, we draw upon the author's experience as director of the CPHHD at the University of Chicago (2003 to 2010) and co-director of the TREC at Washington University in St. Louis (2011 to present) for illustration.

## 2 The Centers for Population Health and Health Disparities

The eight Centers for Population Health and Health Disparities (CPHHD) that were funded in 2003 represented a range of racial and ethnic populations

and cancer types. The group of investigators collaborated to define a model that would help frame research and speed understanding across disciplines [3]. The major implication of the model is that multiple levels of influence, from the molecular to the societal, interact in complex ways to produce cancer disparities. The framework for analysis includes three primary levels of determinants, namely distal, intermediate, and proximal. Distal determinants include population-level social conditions such as variation in rates of poverty or racial and ethnic segregation. Their roots are embedded in societal norms about health or social practices and socioeconomic disadvantage. Intermediate determinants include the immediate social and physical contexts and social relationships in which the distal effects are experienced, such as communities and neighborhoods. These social contexts include opportunities for social interaction to temper the effects of distal factors. Also included is the accessibility of local health care resources to residents, availability of transportation, and attributes of built or physical environments. The intermediate determinants are the links through which the environment affects individual demographic factors as well as the biologic responses that compose the proximal determinants. Demographic factors refer to both contexts and individuals and in the model can have independent effects. Proximal determinants include biological and genetic factors. They also include individual-level factors such as demographics and health behavior.

Research has evolved from merely describing disparities to beginning to address them with public health interventions. Multi-level conceptualizations such as the CPHHD shared model, with components that range from the intracellular to the societal, represent a challenge to researchers. The multiple levels of investigation suggested by the CPHHD model [3] map across a range of scientific disciplines, from the biological/genetic to the social, each potentially bringing its own separate approach and unique way of executing and reporting research. Lacking, however, is the capacity to promote and sustain communication across disciplinary boundaries, thus impeding our progress in understanding and eliminating disparities. Capturing the complexity of health disparities requires not only taking into account all levels that impact those disparities but also the interactions that occur between levels, such as the complex interplay of genes and environment

that occur in a number of diseases [4,5]. Yet few health researchers are prepared to work on teams that span disciplines, diminishing our capacity to address disparities.

### 3 The Center for Interdisciplinary Health Disparities Research

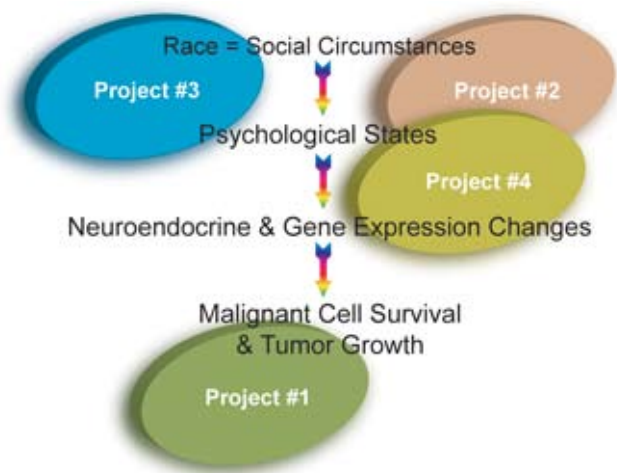
The Center for Interdisciplinary Health Disparities Research (CIHDR) at the University of Chicago was one of the original eight CPHHDs, with a mission of understanding and addressing the African-American and white disparity in mortality from breast cancer in the United States. The disparity has grown since the mid-1980s, with the improvements in mortality experienced by white women not reflected in similar improvements for African-American women. The four research projects of CIHDR were led by social, behavioral, biological, and clinical researchers organized around a shared research questions, namely how features of the social environments of African-American women contribute to the African-American and white disparity in breast cancer mortality. Despite their disparate backgrounds, this was a question that united the group.

The four CIHDR projects provide an ideal mechanism for investigating the pathways through which the social environment shapes biology and health, for two major reasons. First, the team of CIHDR investigators comes from a variety of disciplinary backgrounds, allowing them to consider social, behavioral, and biological aspect of health in the same shared projects and analyses. Second, in testing it's shared model (see Figure 1), CIHDR investigators take a multilevel and multifactorial approach to health that considers influences from within the cell to the level of society [5].

CIHDR's approach is transdisciplinary. According to Rosenfield's definition, transdisciplinarity occurs when the exchange of information and sharing of resources alters discipline-specific approaches, thereby integrating disciplines to achieve a common scientific goal [6]. Each CIHDR project, two of which use animal models and two which work with African-American women living on Chicago's South Side, explores part of the shared model.

This mutually-informative, iterative approach to science allows the CIHDR team to fully explore all components of their shared model, from elements of the social environment, especially features of urban

neighborhoods, to psychological responses to those features, to gene and hormone expression within tumors. By giving each project equal weight, the transdisciplinary approach allows investigators to explore all hypothesized determinants of hormone and gene expression changes, as well as those changes themselves, in equal depth, without favoring any one element of the model [7].



**Figure 1:** Center for interdisciplinary health disparities research (CIHDR) shared model across disciplines, with the position of its four research projects demonstrated.

The projects' investigators represented a range of disciplines. A rodent model involving Sprague-Dawley rats was led by a biopsychologist who is an international expert in open-cage experimentation. The second was led by a breast oncologist who is also a molecular biologist. These two projects use rodent models that mimic human breast cancer to identify pathways by which the social environment influences a particularly aggressive form of breast cancer. Working with animal models allows social conditions to be manipulated and biological outcomes assessed throughout the life cycle. McClintock et al. [4,8] found that normally highly-social rats that were socially-isolated from the time of weaning became hyper-vigilant to novel phenomena in their environments and developed more malignant spontaneous mammary gland tumors at a much earlier age than their non-isolated peers. Even prior to tumor growth, both isolated transgenic mice [9] and inbred rat strains [8] developed heightened stress hormone response to an acute stressor. Perhaps more important for the study of human psychosocial functioning

was the discovery that within a group, those rats isolated from reciprocal care and support, particularly in the face of stressors, were more likely to die at an earlier age with mammary tumors [10]. Those with reciprocal support relationships survived the longest with mammary tumors, which may mirror discrimination among humans.

The larger CIHDR study enrolled African-American women living in neighborhood areas on Chicago's predominantly African-American South Side. Women were enrolled at the time of diagnosis with first-episode breast cancer and tumor tissue was collected at the time of biopsy or tumor excision. This project was led by a breast oncologist who is also expert in the genetics of breast cancer among women of West African ancestry. The fourth project, led by the author who is a social scientist, followed a group of African-American women newly diagnosed with their first episode of breast cancer. These women lived on Chicago's South Side, in 15 neighborhood areas with largely African-American residence. Although geographically homogenous, the sample of women varied by socioeconomic status, from women who were homeless and those with median family incomes higher than the Chicago average.

Women were interviewed twice in their homes beginning four to six months after surgery by specially-trained African-American women interviewers. The team measured a variety of social environmental factors, psychosocial responses, and ways of conceptualizing stress, collecting both intrapersonal and biological measures [11]. Additional data were obtained by observations in neighborhoods and publically-available data geo-coded to women's addresses. In order to compare across women in the study, a team was assembled to assess the built environment of the four-block area around each women's home. Scales were developed for measuring vacant lots and building in the four-block areas to assess for features that would either enhance or discourage women's social interactions.

Figure 1. Center for Interdisciplinary Health Disparities Research (CIHDR) Shared Model across Disciplines, with the Position of its Four Research Projects Demonstrated.

## 4 Challenges to Transdisciplinary Functioning in Health Disparities Research

Challenges to transdisciplinary functioning were identified at a number of levels. Transdisciplinarity presented a number of challenges to individual CIHDR investigators, as it became clear that the group represented a number of perspectives, modes of communication and operation, and ways of knowing. These differences were most apparent when team members were deciding upon shared conceptual frameworks, research designs, and methods of analysis. Individual investigators often operated outside their comfort zones.

Tensions resolved once sufficient trust had developed for group members to accept that others' different ways of knowing or operating represented good science. Over time, the group was able to develop a lexicon shared across projects that allowed members to describe CIHDR's work as a whole and how their own project contributed to that work. They began to pool the best of their disciplinary theories and methods, which often required concerted negotiations.

The task of establishing and maintaining a balance among disciplines generally falls to the leader of a transdisciplinary team, as it did in CIHDR. Without this balance, certain disciplinary ways of knowing and operating might have been privileged over others, obscuring the holistic perspective needed to fully capture the determinants of health disparities and their interactions. The tendency is for investigators to fall back on their old modes of operation, requiring the leader to remind them of their shared questions and goals (i.e., to force the bigger picture). A task of transdisciplinary leadership is to build consensus and foster the cooperation among members that allows for the free exchange of ideas.

## 5 The Role of University Administrations in Fostering Transdisciplinary Health Research

Operating transdisciplinarily is not intuitive, but instead requires training and education as well as Institutional supports to yield maximum benefit. A

general lack of attention to the transdisciplinary education of students is mirrored in the governance of faculty by institutional administrators. There is a general lack of recognition within the academy of the potential for transdisciplinary science to improve the health outcomes of all members of society. Academic advancement has traditionally been a solo journey, and the tenure clock is not set to incorporate the time that it takes to build and maintain transdisciplinary teams. Likewise, the time lines of federally funded grants, which influence academic timeleins, do not include the time that it takes for transdisciplinary teams to begin functioning smoothly as units. Also, promotion and tenure committees traditionally focus on new advances in understanding and research that changes the field, ascribing lower status to the application of scientific advances to improve the health of communities. Appointment and promotion guidelines that emphasize the contribution of transdisciplinary research and the time required for integrating research with practice will help set the standard for these activities to be valued and rewarded. Likewise, a metric that captures the impact on health associated with research, teaching, and service may help to create demand for the investment of time and shed light on the contributions of transdisciplinary research. A recognition of the need to develop promotion and tenure guidelines for transdisciplinarity is beginning to appear in institutions of higher education in the United States, but has yet to reach its full form.

It is important to note that, although transdisciplinary education would move us forward on the path to ameliorating health disparities, we also need to breach the divide between research and practice. It does not matter how well a new drug or treatment works if it cannot be implemented within communities. Yet there is a general lack of communication between researchers who focus on discovery and practitioners who implement evidence-based practices in real-life situations. Integrating transdisciplinary research into practice also requires substantial teamwork and time, in part through forging relationships with the communities who bear a disproportionate burden of health disparities. These activities may be harder to quantify in a way that can be consistently measured as contributions by individual faculty members.<sup>12-13</sup> Developing metrics that can be reported for promotion and tenure will again be essential for fostering research with the potential to

address health disparities.

## 6 Transdisciplinary Education and Training

Although fostering transdisciplinary functioning among already-funded center investigators and helping university administrators to recognize its importance are very worthy tasks, we must also find ways to educate the next generation of transdisciplinary researchers. Although such education has been recommended since at least 2000 [14], disciplinary scholars for the most part continue to be trained primarily in the language and methods of their individual fields of training. Although scattered transdisciplinary training programs exist, they operate almost exclusively within professional schools, and have yet to be systematically integrated into formal educational curricula at either the undergraduate or graduate levels. This lack of systematic education in transdisciplinary science reinforces what has been referred to as the siloed nature of research, and hinders the transfer of knowledge across disciplines.

The following recommendations for transdisciplinary education have been derived from a review of existing transdisciplinary training programs and from reports by the National Academy of Sciences, National Academy of Engineering, and Institute of Medicine [14,15]. They fall into six categories: structure, socialization, content, pedagogy, evaluation, and resources.

### 6.1 Structure

Support from a university's central administration can facilitate the diffusion of transdisciplinary culture across its units (i.e., departments and schools). This facilitation has the potential to break down barriers to uptake and implementation, such as different schedules and degree requirements for students and insufficient time to develop and implement seminars and courses that expose students and trainees to a range of perspectives. Clark [16], for example, recommends that directors of transdisciplinary programs report to academic vice presidents or provosts rather than to deans, in order to embed the program in the culture and functioning of the university as a whole.

Institutions can help maximize the success of their transdisciplinary programs by recognizing that teaching in such programs is more time-consuming than

teaching within a single discipline, especially if instruction involves problem-based learning and group projects. Pellmar and Eisenberg [17] suggest that universities maximize the successes and sustainability of their transdisciplinary educational programs by distributing the costs across departments and sharing facilities. They argue that universities should consider creating and supporting independent transdisciplinary centers and institutes to conduct such training, rather than housing them within existing departments.

University administrations should encourage a broad base of faculty to engage in transdisciplinary education and research, so that programs are not dependent on small cadres of faculty for success. The Outreach and Training Core at the TREC at Washington University requires its trainees to develop a three-member mentoring team that spans disciplines, so that each trainee will be exposed to a range of perspectives on cancer and obesity. Mentors are oriented to the program initially and meet as a group at regular intervals.

A 2005 report of the National Academy of Sciences, National Academy of Engineering, and Institute of Medicine [15], recommends five attributes to maximize the success and sustainability of transdisciplinary educational programs:

- Flexible departmental and school budgets and cost-sharing policies;
- Financial support to start programs, and bridge funding for programs in between external funding opportunities;
- New faculty recruitment that is shared across departments, schools, and colleges;
- Faculty incentives for transdisciplinary scholarship and training;
- Tenure and promotion policies and procedures that accommodate transdisciplinary work and the unconventional teaching, service, and research demands of such work.

## 6.2 Socialization

In addition to structural supports, successful transdisciplinary team educational programs socialize trainees to be members of transdisciplinary teams. This can be done by introducing the transdisciplinarity as early in the continuum of education as possible,

as well as offering more formal training at the undergraduate, graduate, doctoral, and postgraduate levels [15].

Transdisciplinary team functioning is enhanced if students learn basic skills of group process, communication, and negotiation and conflict resolution early in their educations [18]. These skills are not intuitive. These skills can be taught using group exercises such as role playing and rehearsal and orientation to different disciplinary culture and approaches. Faculty should also immerse themselves in the languages, cultures, and knowledge of their collaborators [15, p. 4].<sup>1</sup> Transdisciplinary collaboration in research and teaching by faculty members likewise can serve as a model this behavior for students.

Bronstein argues that transdisciplinary training programs are most successful when students are trained to be dependent on one another in shared projects, with each providing a piece of the puzzle [19]. This can be accomplished through formal and informal interactions and by creating program goals that emphasize collective ownership of products among investigators. Other joint social interactions across disciplines might include shared on-site cafeterias, lounges, and other more public spaces that are designed to attract students, trainees, staff, and investigators from a variety of disciplines.

## 6.3 Content

The most successful transdisciplinary training programs include courses taught or co-taught by faculty from a variety of schools, departments, and colleges and include a wide range of topics such as:

- Transdisciplinary theory
- Transdisciplinary team roles
- Transdisciplinary training and research process
- Communication skills
- Collaboration skills
- Conflict resolution
- Multi-level determinants of health and health care delivery
- Research methods
- Practice and research ethics
- Medical terminology

**Table 1:** Transdisciplinary problem-solving course offered by the master's in public health (MPH) program of Washington University in St. Louis.

Course	Focus
Chronic Disease, Policy and Prevention in Public Health	The prevention and control of obesity considered from social, behavioral, and biological perspectives
Strategies for Eliminating Health Disparities	The integration of public health and social services to eliminate health disparities
Tobacco Control in Public Health	The examination of tobacco control from a wide variety of disciplinary perspectives
Child Maltreatment	The prevention of child maltreatment seen through a variety of disciplinary perspectives
Livable Lives	The creation of the conditions so that low and moderate income families can lead lives with a reasonable degree of stability, support, and resources to take care of their basic needs, find children successfully

Oandasan and Reeves suggest the following competencies to foster the goals of transdisciplinary education, namely the ability to: (1) describe one's roles and responsibilities clearly to other professionals and community stakeholders; (2) recognize and observe the constraints of one's role, responsibilities, and competencies, yet perceive needs in a wider framework; the ability to recognize and respect the roles, responsibilities, and competencies of other professionals; and, (3) work with other professionals to effect change and resolve conflict in the provision [20, p. 31]. Nash also suggests that faculty encourage the development of the common values and cooperative behaviors that are necessary for successful transdisciplinary team functioning [21].

## 6.4 Pedagogy

Transdisciplinary coursework and experiences should be distributed throughout curricula, rather than being restricted to elective courses. This integration has only been achieved in a few universities in the United States, such as the University of California, Berkeley, Claremont Graduate University, and Washington University (see Table 1). Transdisciplinary education is perhaps best accomplished through didactic and experiential teaching methods. Technology can be a valuable tool for expanding the program capacity through the use of case scenarios, vignettes, or experiential simulation laboratories to create real-world examples of patient problems.

A common pedagogical tool used to supple-

ment problem-based learning in successful transdisciplinary training programs is experiential and service learning facilitated by community stakeholders in real-world settings. The University of California, San Diego, for example, provides transdisciplinary student training in three community clinics for vulnerable patients [22]. These community experiences afford trainees the opportunity to practice their classroom learning in real-world healthcare settings. As part of their training program, trainees participate in a daily learning circle in which everyone reflects on what they learned in the clinic that day.

## 6.5 Evaluation

Scholars agree that the success of transdisciplinary educational programs depends on comprehensive evaluation of program processes and outcomes. This is essential for achieving sustainability and ensuring ongoing support from administrations and funders. This evaluation should include longitudinal follow-up of program graduates to assess their career trajectories and the impact of the educational program on their career trajectories. These assessments benefit from the use of qualitative and quantitative measures of program outcomes. Trainees' progress can be measured through time using a more traditional bibliometric approach in which transdisciplinarily-prepared manuscripts, presentations, and funding proposals are tracked over time and compared with those of investigators working independently. Metrics have as yet not been developed, however, to mea-



sure improvement in the quality of research through working transdisciplinary teams.

## 6.6 Resources

The Study Group on Interprofessional Education of the World Health Organization has undertaken the task of preparing an evidence-based recommendations for the education and training of transdisciplinary health care team members [23]. In 1998, the U. S. Congress created the Advisory Committee on Interdisciplinary, Community-Based Linkages (ACI-CBL) to help guide the Secretary of the Department of Health and Human Services on policy and program development around cross-disciplinary training involving community research which through time has become transdisciplinary in nature and scope. Authorized by the Public Health Service Act, the ACI-CBL includes representation from Area Health Education Centers, geriatrics, chiropractic, podiatry, social work, psychology, and rural health. Since their first report, this organization has made recommendations that all training and grants funded by the U.S. Health Resources and Services Administration (HRSA) must include a transdisciplinary approach to patient care and research.

## 7 Conclusions

Although they are challenging to implement and maintain, transdisciplinary research teams confer a distinct advantage over other disciplinary collaborations in their ability to understand and ameliorate health disparities. At the most fundamental level, these teams of biological, social, behavioral, and other scientists bring specialized knowledge from a variety of disciplines that reflect the multiple levels at which health disparities occur. Yet merely having knowledge of the biological, behavioral, and social contributors to group differences in health is not sufficient to capture the complex interactions among determinants that characterize health disparities.

It is the unique mode of functioning of transdisciplinary teams that confers their advantage. Rather than operating in silos representing the separate levels of influence on disparities, as is customary with multidisciplinary and interdisciplinary approaches, transdisciplinary teams operate as a mutually informative unit above and beyond individual disciplines. The new intellectual space created allows them to

visualize the range of influences on a particular disparity. Practical gains occur in addition to scientific gains. Being part of a research group that represents a number of disciplines exposes teams such as CIHDR and TREC to a wider range of subsequent funding possibilities and venues for disseminating their work.

Successful transdisciplinary research occurs when disciplinary scholars are able to visualize all of the determinants of complex social problems such as health disparities. The same processes must be created to prepare the next generation of transdisciplinary scientists in health. Trainees must be able to take a holistic view of health and health disparities and learn the skills needed to operate in the spaces between disciplines. Transdisciplinary education that combines exposure to a range of disciplinary knowledge and methods with effective instruction in processes for working on teams to transform knowledge and methods into solutions for complex social problems is the gold standard. We have suggested a number of successful methods to guide institutions and organizations to achieve these ends.

At the present time, true transdisciplinary team functioning remains an ideal. If we truly want to end disparities and, in the words of President Clinton in 1998, “to make sure all Americans, no matter what their background, have a better opportunity to lead healthier lives,” it behooves us all to work together to address the barriers to transdisciplinary health research.

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