ADVANCING SCIENCE FOR THE HEALTH OF WOMEN

The Trans-NIH Strategic Plan for Women's Health Research

2019-2023

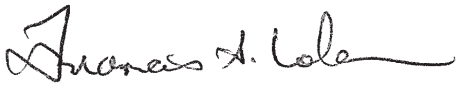
NIH National Institutes of Health
Office of Research on Women's Health

Foreword

The National Institutes of Health (NIH) is driving continued progress in biomedical research that is improving the health of people across the United States and around the world. Many advances in medicine have emerged from NIH-funded research, yet certain populations of U.S. women continue to suffer high rates of ill health compared either with U.S. men or with women in high-income peer countries. Moreover, we continue to find that sex and gender influences on health and disease pervade all disciplines of medicine. For these reasons, research focused on understanding scientifically important sex and gender differences as well as investigations of the many factors underlying the health of women are integral to NIH's mission to seek fundamental knowledge about the nature and behavior of living systems and the application of that knowledge to enhance health, lengthen life, and reduce illness and disability.

Three years ago, NIH announced a policy to factor sex as a biological variable into research designs, analyses, and reporting for NIH-funded vertebrate animal and human studies. This effort is part of our commitment to promote rigorous and transparent research in all areas of science. The NIH Office of Research on Women's Health is leading collaborations across NIH Institutes and Centers in implementing this policy and providing important leadership in developing research programs that address sex and gender factors affecting health and disease, such as the Specialized Centers of Research Excellence on Sex Differences program. Other examples include programs that provide supplemental funding to ongoing NIH-funded research to promote studies of sex and/or gender influences on health and disease or investigations of populations of women that are underrepresented in clinical research.

Research that is relevant to the health of women is supported across NIH Institutes and Centers. The Office of Research on Women's Health, as the focal point for this crucial trans-NIH endeavor, has developed a 5-year strategic plan to provide a framework for coordinating NIH efforts to advance science for the health of women. This plan—which I endorse enthusiastically—is the result of months of engagement with the NIH community, our external stakeholders such as the NIH Advisory Committee on Research on Women's Health, and the public. I am confident this plan will enhance the basic, preclinical, and clinical foundations of women's health research; fuel new scientific initiatives to address pressing needs in women's health; and bring disciplines together for integrated research to improve the health of women and, therefore, our nation.



Francis S. Collins, M.D., Ph.D.
Director, National Institutes of Health

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Preface

The NIH Office of Research on Women's Health led the development of this *Trans-NIH Strategic Plan for Women's Health Research* with a bold vision in mind: Picture a world in which the biomedical research enterprise thoroughly integrates sex and gender influences; every woman receives evidence-based disease prevention and treatment tailored to her own needs, circumstances, and goals; and women in science careers reach their full potential. Through an iterative process of stakeholder engagement, we developed a strategic plan that maps out a multipronged approach for realizing this vision. We are grateful for the tremendous input and broad engagement of the NIH Institutes, Centers, and Offices and external partners to produce this plan.

The goals and objectives of the following plan apply to the critical work being carried out in any NIH Institute, Center, or Office to improve the health of women. The plan recognizes that breakthroughs in women's health research will be facilitated by moving beyond merely the inclusion of women in clinical research to the intentional integration of sex and gender considerations into all NIH research, at every stage of the biomedical research continuum.

Advancements in women's health research increasingly depend on interdisciplinary approaches for understanding the interwoven effects of biological, social, and life course factors on disease prevention, presentation, progression, and treatment. Within this strategic framework, interdisciplinary research initiatives, which harness expertise and advances from several fields, can far exceed the sum of their parts. As such, they have the potential to help better drive research advances, lay the groundwork for innovative investigative approaches, and improve health care tailored to women of all ages and backgrounds.

I look forward to continued engagement with the biomedical research community on our common goal of advancing science for the health of all women. I am optimistic that there will be many opportunities for scientists to come together for this shared purpose over the next five years and many fruitful outcomes from our efforts.

Janine Austin Clayton, M.D.
NIH Associate Director for Research on Women's Health
Director, NIH Office of Research on Women's Health

Overview

The NIH Office of Research on Women's Health

NIH established the Office of Research on Women's Health (ORWH) on September 10, 1990, to expand women's health research as described by the U.S. Public Health Service Task Force on Women's Health. ORWH was reaffirmed by statute in the NIH Revitalization Act of 1993 (Public Law No. 103-43, Section 486) and charged with serving as the focal point for coordinating women's health research at NIH. Congress mandated that the ORWH Director:

1. Advise the NIH Director and staff on matters relating to research on women's health
2. Strengthen and enhance research related to diseases, disorders, and conditions that affect women
3. Ensure that research conducted and supported by NIH adequately addresses issues regarding women's health
4. Ensure that women are appropriately represented in biomedical and behavioral research studies supported by NIH
5. Develop opportunities and support for the recruitment, retention, reentry, and advancement of women in biomedical careers
6. Support research on women's health issues

The NIH Reform Act of 2006 (Public Law 109-482) paved the way for ORWH to become part of the Division of Program Coordination, Planning, and Strategic Initiatives (DPCPSI) within the NIH Office of the Director. DPCPSI coordinates trans-NIH initiatives and identifies emerging scientific opportunities, rising public health challenges, and scientific knowledge gaps that merit further research. Being located within DPCPSI, ORWH is well positioned to coordinate NIH Institute and Center (IC) efforts to highlight gaps in women's health–related research and set the agenda for new research on the health of women (Figure 1).

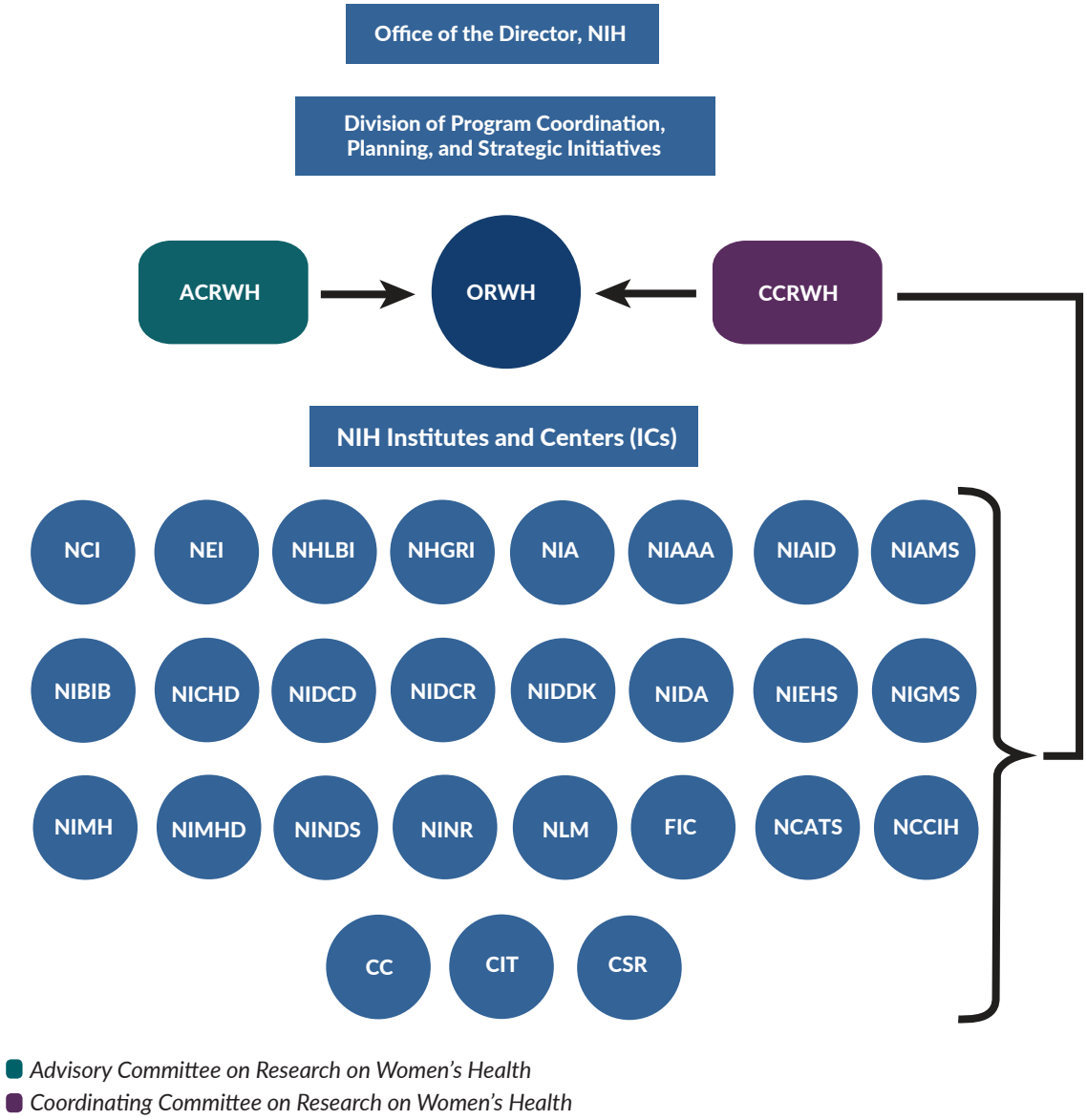

Figure 1: ORWH Organizational Advisory Structure.

Signed into law on December 13, 2016, the 21st Century Cures Act (Public Law No. 114-255) reaffirms NIH's commitment to women's health. Specifically, the Act endorses the importance of including women in clinical research and considering sex as a biological variable in research using humans and non-human vertebrate animals. Further, the Act requires that people of all ages be represented in clinical research, expands sex- and gender–based and race- and ethnicity–based results reporting requirements for phase III clinical trials, and incorporates changes to encourage research collaboration among NIH ICs, with the goal of improving the health of all people (https://www.nih.gov/research-training/medical-research-initiatives/cures).

Health of Women

NIH has been the driving force behind many scientific advances that have improved the health of women. Nevertheless, women in the United States experience myriad health disparities compared with men in the United States or with women in other high-income countries. For example, the average life expectancy of U.S. women increased at a slower rate than that of U.S. men between 1985 and 2010 (Wang et al., 2013), and the life expectancy of U.S. women now lags far behind women's life expectancy in high-income peer countries (Ho and Hendi, 2018). On average, women have higher rates of obesity (Kelly et al., 2008; Hales et al., 2018) and more simultaneous chronic conditions (Abad-Díez et al., 2014; Buttorff et al., 2017) than men. Women also experience more pain (Bartley and Fillingim, 2013; Rovner et al., 2017) and greater physical disability (Murtagh and Hubert, 2004; Freedman et al., 2016). Alarmingly, the overall rate of maternal mortality is on the rise in the United States, even as other high-income countries enjoy continued declines in rates of pregnancy-related deaths (GBD 2015 Maternal Mortality Collaborators, 2016).

In 2015, ORWH convened a workshop titled "Improving the Health of Women in the United States" (National Academies of Sciences, Engineering, and Medicine, 2016) to examine the health of U.S. women in the context of a multitude of factors that influence health. Consensus from the workshop emphasized the concern that many analyses of health data are not stratified by sex or gender, making it difficult to understand fully the relevance of research findings to the health of women. Additionally, many gaps in our understanding of diseases and conditions in women result from continued overreliance on male models (e.g., animals, cells) and the historical overreliance on men as participants in clinical research. Workshop participants concluded that interdisciplinary approaches, routine sex-disaggregation of data, refined measurement tools, and integrative approaches are critical to addressing the health challenges of women today.

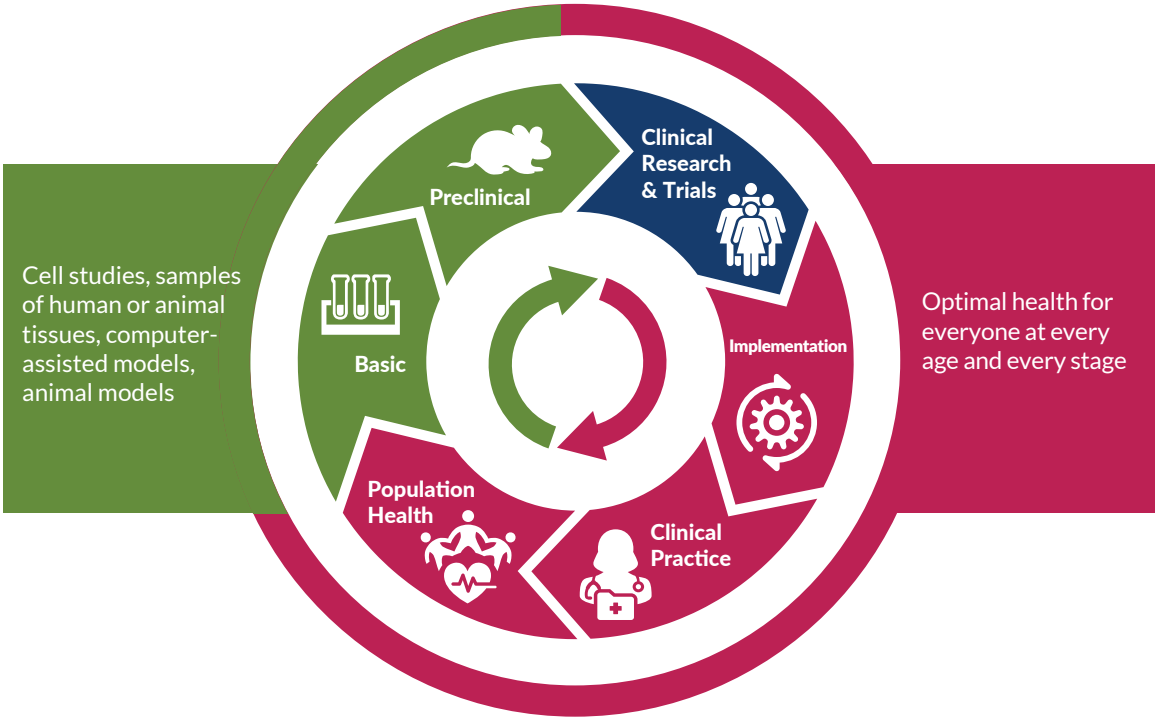

Figure 2: Integration of the influences of sex and gender throughout the biomedical research continuum generates evidence to improve the health of women.

To inform this strategic plan, NIH critically assesses how women's health is defined. The term "women's health" was once considered synonymous with reproductive health. Today, the biomedical community recognizes that the health of women encompasses all diseases and conditions that affect women. Research to improve the health of women requires a comprehensive consideration of the many factors that influence women's health, such as sex and gender, race and ethnicity, and a host of other internal and external factors. Moreover, it is critical to consider these factors and their potential interactions across the life course. Understanding the influences of sex and other biological factors across the entire biomedical research continuum—as well as social factors across as much of the research continuum as possible—is crucial to improving health for women (Figure 2).

This trans-NIH plan, *Advancing Science for the Health of Women*, represents NIH's commitment to filling gaps in knowledge about the health of women across a wide range of diseases and conditions. It does so in a way that keeps pace with rapid changes in science and technology and evolving public health needs and is consistent with recent legislative mandates, such as the 21st Century Cures Act (Public Law 114-255). The development of this Plan was led by ORWH, on behalf of NIH, in collaboration with NIH's

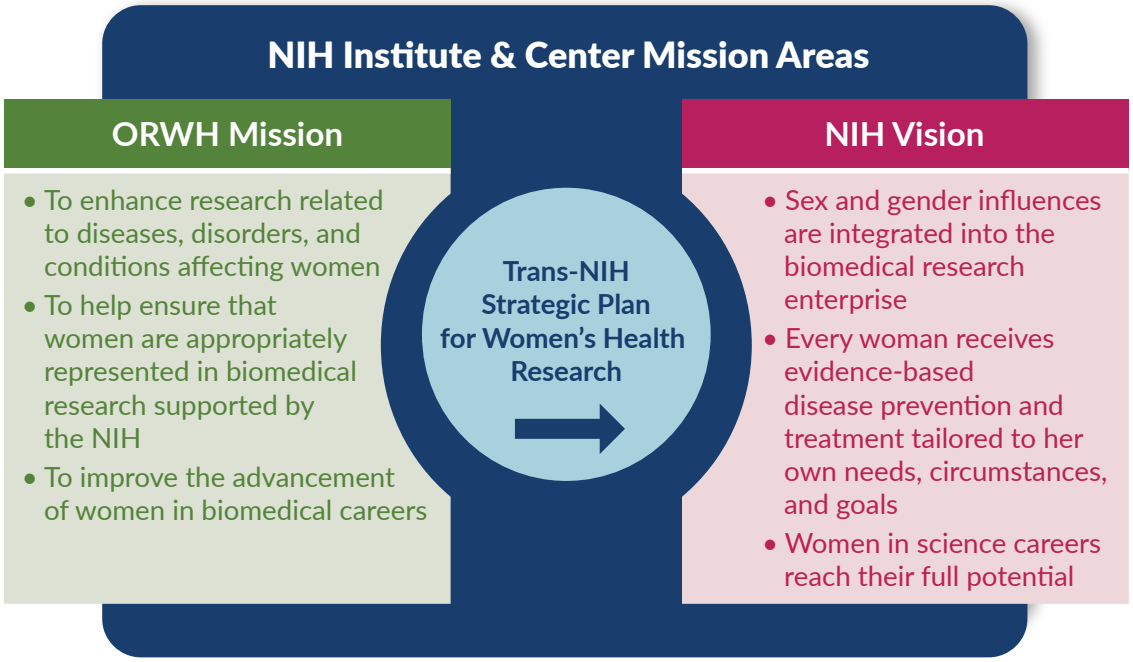

Figure 3: The *Trans-NIH Strategic Plan for Women's Health Research* incorporates the missions of the NIH ICs with ORWH's mission to pave the way toward scientific and workforce efforts that ultimately benefit the health and biomedical research careers of women.

Institutes and Centers (ICs) and Office of the Director (OD). The strategic planning process also considered input from numerous stakeholders and scientists outside NIH (Appendix A).

Advancing Science for the Health of Women is a multipronged approach to advance a vision in which sex and/or gender influences are integrated into the biomedical research enterprise; every woman receives evidence-based disease prevention and treatment tailored to her own needs, circumstances, and goals; and women in science careers reach their full potential (Figure 3). This *Trans-NIH Strategic Plan for Women's Health Research* serves as a framework that integrates the congressionally mandated mission of ORWH with the scientific expertise of the ICs; it operates in synergy with the NIH-wide strategic plan, *Turning Discovery Into Health*.

The Trans-NIH Sex as a Biological Variable (SABV) Working Group was established on September 11, 2014, and is chaired by the ORWH Director. Members include senior staff members from the ICs and OD. The mandate is to inform SABV policy development and implementation.

Partnerships: Key Elements of Advancing Science for the Health of Women

Partnerships among ICs and ORWH ensure rigorous research, training, and programs that are relevant to the health and careers of women (Appendix B). Convening and leveraging expertise, visionary thinking, and collaborative funding across NIH catalyzes breakthroughs in basic, translational, and clinical research. Additionally, such partnerships promote and facilitate training, career development, and small business opportunities. Innovative efforts (1) to communicate broadly about sex and gender influences on health and disease and (2) to disseminate research on the health of women in forums such as conferences and in publications are critical to accelerating scientific progress to improve the health of women.

The NIH Revitalization Act of 1993 (Public Law 103-43) formed two committees representing partnerships within or with NIH to advise the ORWH Director on issues related to research on the health of women. The first partnership, the NIH Coordinating Committee on Research on Women's Health (CCRWH), is a trans-NIH group of IC Directors or their senior-level designees who serve as direct liaisons between ORWH and ICs. CCRWH provides valuable guidance, collaboration, and support for ORWH program goals, including ORWH's career development programs and outreach efforts (U.S. Department of Health and Human Services, 2013). The second partnership, the NIH Advisory Committee on Research on Women's Health (ACRWH), comprises physicians, scientists, and other health professionals who are not Federal employees and whose clinical practice, research specialization, or professional expertise enables them to advise the ORWH Director on NIH women's health research (Appendix C).

Guiding Principles to Advance Science for the Health of Women

Advancing Science for the Health of Women is guided by three principles: (1) consideration of the complex intersection among multiple **factors** affecting the health of women, foremost sex and gender; (2) inclusion of diverse **populations** of women in clinical research, especially populations known to experience a disproportionate burden of illness; and (3) active engagement to integrate **perspectives** from a diverse workforce of scientists with differing skills, knowledge, and experience. Applying these principles across the entire research continuum—from basic and preclinical research to clinical investigations and implementation science—is critical to addressing the strategic goals of this plan and to improving health for women.

***Sex** is a biological variable defined by characteristics encoded in DNA, such as reproductive organs and other physiological and functional characteristics.* (*https://orwh.od.nih.gov/sites/orwh/files/docs/NOT-OD-15-102_Guidance.pdf*)

> *"**Gender** comprises the social, environmental, cultural, and behavioral factors and choices that influence a person's self-identity and health." (Clayton and Tannenbaum, 2016)*

Factors

The health of women is affected by many internal and external factors acting across the life course. The internal factors include biological systems, processes, and traits, such as sex, age, and hormonal and reproductive phases. The external factors are contextual aspects of a woman's life, which comprise environmental and social factors. Exposures to toxins and physical and mental stressors are common examples of environmental factors. Social factors such as gender, sexual orientation, and other social determinants of health manifest on several levels, including the individual, family, community, and society (Bird et al., 2010; Early, 2016; Montez et al., 2016; Singh et al., 2017). A complex intersection of a multitude of these internal and external factors affects the health status, disease presentations, and treatment responses of women as well as the effects of diseases and conditions on women's quality of life. Thus, consideration of a multidimensional framework (Figure 4) is needed to improve the quality of women's lives, reduce their disease burden across the life course, and address health disparities for populations of women at greatest risk for certain diseases (Schweinhart and Clayton, 2018).

Several NIH policies support the consideration of multiple factors across the biomedical research continuum. In 2015, NIH launched an initiative to enhance reproducibility through rigor and transparency (NOT-OD-15-103). There is growing recognition that the quality and generalizability of biomedical research depends on the consideration of key biological variables, such as sex. Therefore, NIH announced a policy, *Consideration of Sex as a Biological Variable (SABV) in NIH-funded*

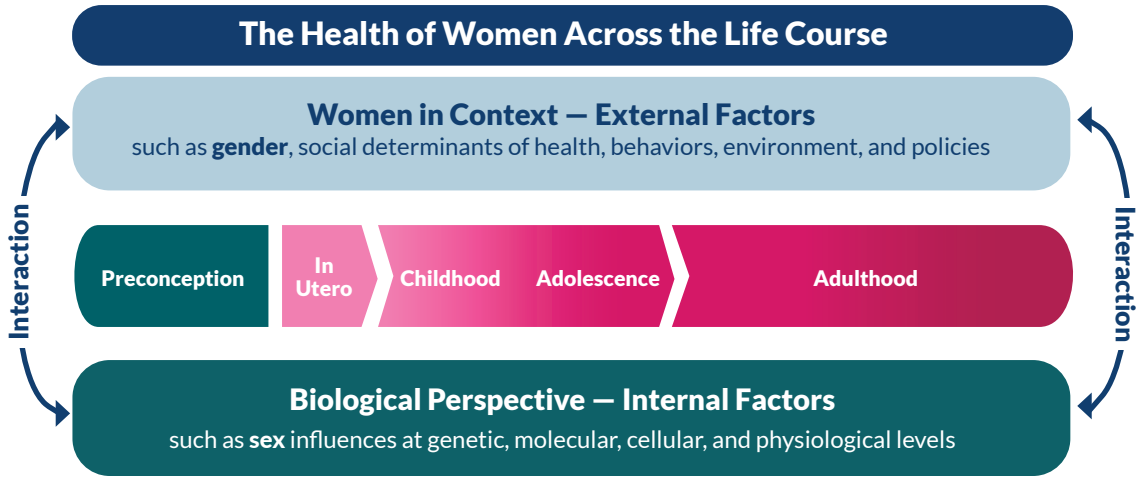

Figure 4: The multidimensional framework represents the intersection of multiple biological factors in the context of a woman's life over the entire course of her life.

Q. WHY IS SEX AS A BIOLOGICAL VARIABLE IMPORTANT?

A.

Sex and gender play important roles in how health and disease affect individuals. Understanding their influences improves the health and lives of women and men.

Research (NOT-OD-15-102), to ensure accountability for SABV in NIH-funded research. Effective January 2016, NIH grant applications are required to explain how relevant biological variables, such as sex, are factored into research designs and analyses for studies using vertebrate animals and humans (NOT-OD-16-011). Strong scientific justification, preliminary data, or other relevant considerations must be provided for investigations proposing the use of only one sex. The policy also stipulates that NIH scientific peer reviewers evaluate grant applications for adequacy in addressing SABV as part of their overall impact scores.

In 2017, NIH released an amendment to the *NIH Policy and Guidelines on the Inclusion of Women and Minorities as Subjects in Clinical Research* (NOT-OD-18-014) in compliance with 21st Century Cures Act requirements. According to the amendment, NIH grant recipients conducting applicable phase III clinical trials must submit valid analyses of results by sex/gender and race/ethnicity to ClinicalTrials.gov. The amended policy applies to competing grants and cooperative agreements awarded on or after December 13, 2017.

NIH also expanded the *Inclusion of Children as Participants in Clinical Research Policy* to become the new *Inclusion Across the Lifespan Policy* (NOT-OD-18-116). According to this policy, clinical research proposals must address the age-appropriate inclusion or exclusion of individuals. Proposals must also contain plans for including individuals across the life span or a justified rationale for selecting a specific age range. This policy aligns with the 21st Century Cures Act, requiring NIH to consider age as an inclusion variable in research involving human subjects, to identify criteria to justify age-related exclusions in NIH-funded research, and to provide data on the age of participants in clinical research studies.

The consideration of sex, gender, age, and other key factors, as emphasized by the aforementioned policies, are fundamental to achieving the goals and objectives outlined for *Advancing Science for the Health of Women*.

Populations

To advance science for the health of women, we must recognize that all women are not the same. In addition to considering the influence of sex,

gender, and age on the health of women, it is crucial to consider race and ethnicity, socioeconomic status (SES), education, geographic location, gender identity, and disability status among other contributing factors to understand better and address the health of all populations of women, especially those that bear a disproportionate burden of illness. NIH-designated U.S. health disparity populations include African Americans or Blacks, Hispanics or Latinos, American Indians or Alaska Natives, Asian Americans, Native Hawaiians and Other Pacific Islanders, socioeconomically disadvantaged populations, underserved rural populations, and sexual and gender minorities. Individuals are often excluded from clinical research based on pregnancy status, lactation status, advanced age (>65 years), young age (<18 years), and intellectual disability (Spong and Bianchi, 2018). Thus, individuals in such groups may not have the benefit of clinical research findings arising from study populations similar to themselves.

Perspectives

Interdisciplinary research initiatives integrating perspectives from multiple disciplines—as well as researchers with diverse skills, knowledge, and experiences—are crucial to capturing the complex interplay of multiple factors affecting the health of all women. The National Academies of Sciences, Engineering, and Medicine (2005) defines interdisciplinary research as "a mode of research by teams or individuals that integrates information, data, techniques, tools, perspectives, concepts, and/or theories from two or more disciplines or bodies of specialized knowledge to advance fundamental understanding or to solve problems whose solutions are beyond the scope of a single discipline or area of research practice."

Using an interdisciplinary approach has a large scientific impact, generates high levels of innovation, and improves productivity, including numbers of publications with broad reach and uptake (Stokols et al., 2008). Interdisciplinary research stimulates novel ways to study female biology and has the potential to solve increasingly complex, multilevel, and multifactorial problems encountered in research on the health of women that cannot be addressed by any one discipline alone.

Coordinated teams of investigators with diverse skills and knowledge may be especially useful for studies of complex problems with multiple underpinnings (National Cancer Institute, 2018). Interdisciplinary research teams necessarily include people from different disciplines and professions. The output of interdisciplinary research teams is catalyzed by the team members' different perspectives and methodologies. Moreover, the performance, innovation, and collective intelligence of research teams may be further enhanced by increased team diversity regarding sex and gender, race and ethnicity, and background (Nielson et al., 2017).

> *"Bringing an interdisciplinary approach to women's health research would provide communication and collaboration across medical and other scientific and social science disciplines that might help to set the stage for a more comprehensive approach to women's health care." (Pinn, 2018)*

Strategic Goals

Advancing Science for the Health of Women is guided by principles that consider the intentional integration of a multidimensional framework, inclusion of diverse study populations in clinical research, and active engagement of a diverse workforce of scientists with differing skills and experiences. Applying these principles across the entire research continuum—from basic and preclinical research to clinical investigations and implementation science—is critical to addressing the strategic goals of this plan and to improving the health of women (Figure 5).

Advancing Science for the Health of Women: The Trans-NIH Strategic Plan for Women's Health Research contains five goals essential to supporting rigorous research and improving the health of women:

1. Advancing rigorous research that is relevant to the health of women
2. Developing methods and leveraging data sources to consider sex and gender influences that enhance research for the health of women
3. Enhancing dissemination and implementation of evidence to improve the health of women
4. Promoting training and careers to develop a well-trained, diverse, and robust workforce to advance science for the health of women
5. Improving evaluation of research that is relevant to the health of women

Figure 5: *Advancing Science for the Health of Women* includes five interdependent strategic goals.

Strategic Goal 1

Research

Advance rigorous research that is relevant to the health of women.

GOAL

Advancing Science for the Health of Women aims to advance rigorous research that is relevant to the health of women. This goal encourages research that will foster innovation, expand emerging areas of science, and address issues of public health importance. Research is necessary to improve the fundamental understanding of how sex and gender, among other critical factors, influence health and disease, and to extend this knowledge to translational and clinical studies. Adhering to high standards of scientific rigor is critical for generating reproducible results. Research that is rigorously designed, including consideration of the influences of sex and gender, will contribute to the NIH agenda for women's health research and improve the health of women.

OBJECTIVES

1.1 Discover basic biological differences between females and males.

Studying female and male cells, organs, and biological systems is necessary to improve our understanding of the mechanisms by which sex influences health and disease. Research that examines the possible influences of sex on both normal biology and pathophysiology is critical. Generating fundamental knowledge about female biology and scientifically meaningful sex differences in both normal and abnormal processes strengthens the foundation for the design of rigorous preclinical and clinical studies that account for sex as a biological variable, enhancing their relevance to the health of women.

1.2 Investigate the influence of sex and gender on disease prevention, presentation, management, and outcomes.

Sex and gender influence the course of many diseases, including risk and protective factors, presentation, treatment, and recovery. Gaps in knowledge about these influences remain for many illnesses and chronic diseases affecting women, including the effects of comorbidities. Identifying meaningful effects of sex and gender on diseases and understanding how these influences affect the health of women will address sex- and gender-based disease burden, contribute to a more individualized approach to health care, promote disease prevention, and improve quality of life.

Sex differences research explores "sex and gender differences in all areas of biological, medical, and behavioral science" (https://ossd.memberclicks.net/history)

1.3 Identify the immediate, mid-, and long-term effects of exposures on health and disease outcomes.

Various types of exposures affect disease risk across different timescales, ranging from an immediate outcome at the time of exposure to a delayed outcome that becomes evident at a later stage in life. Exposures include, but are not limited to, factors such as the microbiome, exogenous hormones, environmental toxins, the built environment, and behavior-related exposures such as physical activity, sleep, and nutrition. Additional exposures include social and psychological exposures such as stress and trauma across the life course; discrimination and stigma; caregiving; and factors linked to resilience, such as social support and family cohesion. Socioeconomic exposures such as poverty, family and community resources, educational attainment, and access to health care are also relevant to the health of women. Identifying the effects of exposures can inform the use of preventive interventions to reduce disease risk and promote well-being.

1.4 Promote research that explores the influence of sex and gender on the connection between the mind and body, and its impact on health and disease.

Research is needed to understand the mechanisms of mind and body connections, including their dysregulation, and their impact on behavior and cognition. Such studies are particularly relevant to certain conditions that differentially affect women such as pain, depression, sleep disorders, obesity, cardiovascular disease, and metabolic disturbances. Investigating the relationship between mental and physical factors and health outcomes can help identify opportunities for prevention, mitigate disease risk, and manage disease progression.

1.5 Expand research on female-specific conditions and diseases, including reproductive stages, and maternal and gynecologic health.

There is a need for focused investigation of female reproductive health and illness, including menstruation (normal and dysfunctional), infertility, pregnancy, lactation, and menopause. Additionally, there is a need for increased attention to research gynecologic health and disease in women of all ages. Maternal health is critically important to the health of a woman during pregnancy and throughout her life course, and for the health of her children. Because the maternal mortality rate in U.S. women is on the rise (GBD 2015 Maternal Mortality Collaborators, 2016), particularly in women of color, investigation of disparities in mortality and morbidity related to pregnancy is needed (Nelson et al., 2018).

Strategic Goal 2

Methods

Develop methods and leverage data sources to consider sex and gender influences that enhance research for the health of women.

GOAL

Advancing Science for the Health of Women requires methods that consider the influences of sex and gender, leverage relevant data sources, and include underrepresented women. Research to improve the health of women also depends on creative and rigorous approaches to study design, participant recruitment and retention, measurements, and analytic techniques that identify findings of relevance to women. Intentional application of such methodologies, along with enhanced data sharing and harmonization, will increase the speed with which research can inform health care for women.

OBJECTIVES

2.1 Expand and develop advanced and innovative approaches for study design, data collection, and analysis to optimize data quality and the ability to detect the influences of sex and gender on health and disease.

The ability to detect sex and gender influences on research outcomes is critical to advancing science for the health of women. Needs exist to utilize and improve current methods and develop more advanced, innovative approaches and models to increase the impact of research supported by and/or conducted by NIH. Improved methods for identifying sex-specific effects in basic and preclinical research and sex and gender influences in clinical and population-level studies will hasten the progress of research. Research based on rigorous and sensitive methods will maximize the relevance of knowledge gained to improve the health of women.

> *"When a study is not powered to test for differences by sex, the estimates of the effect in women and men can still be reported. These estimates for women and men can then be combined with estimates from other studies in a meta-analysis."*
>
> *—Dr. David M. Murray, Director, Office of Disease Prevention*

2.2 Develop and adapt reliable and valid measures relevant to the health of women.

Reliable, valid, and cost-effective measures that can be used to evaluate constructs, conditions, or diseases relevant to women are an important component of research on the influence of sex and gender on health and disease. The development of endpoints,

biomarkers, and other measures that are empirically solid, theoretically grounded, and scientifically feasible enhances this research. Ideally, the application of such measures to clinical research questions considers life course and sociodemographic factors.

2.3 Leverage secondary data sources for research on the health of women through a big data enterprise that includes data sharing and analytic strategies.

Accessing big data to investigate the influences of sex and gender on health and disease will accelerate research advances for women. Sharing large data sets and developing analytic support for those data will minimize duplicated efforts, thereby saving resources such as time and money. Further, research on the health of women will benefit from NIH efforts to promote the development of efficient, sustainable, and secure processes to enhance the sharing of existing data and allow access to data from a wide range of sources. Such research will also benefit from improved data interfaces and interoperability, the establishment of data standards, the creation of metadata, and the expansion of infrastructure to support routine disaggregation and analysis of data by sex and gender.

2.4 Expand and refine methodologies to improve the recruitment and retention of women underrepresented in clinical research.

Efforts are needed to develop and apply new methods for increasing the recruitment and retention of groups of women who are understudied in clinical research and for whom data on clinically relevant outcomes are lacking. These methods will facilitate more research that examines health disparities stemming from differences in factors such as race and ethnicity, age, SES, gender identity, and urban-rural living, and their influence on health, health behaviors, and access to screening and therapeutic interventions.

Strategic Goal 3

Dissemination and Implementation

Enhance dissemination and implementation of evidence to improve the health of women.

GOAL

Advancing Science for the Health of Women depends on efficient dissemination and effective implementation of evidence to improve women's health. Implementation science has an important role in translating research into effective practices, interventions, and policies to eliminate disparities in care for women so they receive individualized, sex- and gender-appropriate, evidence-based health care. Partnerships with researchers, educators, providers, advocates, and the community are essential to communicate evidence-based health information effectively and to understand existing real-world challenges.

OBJECTIVES

3.1 Design and test approaches to promote the adoption, adaptation, and integration of evidence-based interventions in public health, clinical practice, and community settings.

Expanding implementation science capacity will accelerate the delivery of effective evidence-based interventions to improve the health of women. Intervention delivery depends on multiple contextual factors related to the target population as well as its setting. Designing and conducting research to improve the structure, process, and outcomes related to an intervention will advance science by identifying effective approaches as well as barriers to translating the best evidence into health care for women.

3.2 Identify collaborative opportunities and leverage partnerships to disseminate research that improves the health of women.

Many analyses of health data are not stratified by sex or gender, making it difficult to understand fully the relevance of research findings to the health of women. Adopting approaches that synthesize research findings across NIH will facilitate the comprehensive integration of key evidence to improve shared decision making between provider and patient and enhance participation of women in clinical research. Leveraging new and existing opportunities for multi-sector collaboration with researchers and other community and relevant partners will better inform clinicians and thus improve the health of women.

Strategic Goal 4

Training and Careers

Promote training and careers to develop a well-trained, diverse, and robust workforce to advance science for the health of women.

GOAL

Advancing Science for the Health of Women requires a well-trained, diverse, and robust workforce, which is the engine of scientific progress. Building interdisciplinary research careers in women's health and training scientists, clinicians, and other health professionals on sex and gender influences in health and disease will accelerate the translation of knowledge into improved health care for women. The development and effective implementation of innovative programs that attract, retain, and advance women in biomedical science careers will increase gender diversity in the biomedical research workforce at all career levels, and coordinated efforts are needed to increase representation of women at the senior faculty and leadership levels.

OBJECTIVES

4.1 Enhance knowledge of sex and gender influences on health and disease among all scientists, clinicians, and other health professionals to accelerate the translation of that knowledge into practice.

The training of exemplary biomedical researchers at all career stages is critical to advancing research on the health of women. As part of this training, knowledge of sex and gender influences should be integrated with the skills that nurture effective researchers. As the pace of biomedical research accelerates, development and implementation of educational training programs will be needed to update the knowledge and skills of current biomedical researchers as well as those returning to or entering the workforce.

4.2 Develop the next generation of researchers to advance science on the health of women.

Science for the health of women will advance with strengthened recruitment of the next generation of researchers focused on women's health and the development of their careers. Gaps in research exist for many of the diseases and conditions that predominantly affect women, and there is a continued need for further research on newly discovered sex differences in normal biology and pathophysiology. With the increasing importance of precision medicine, the research workforce will be required to study diseases and conditions as well as risk factors, mechanisms, and diagnostic and treatment outcomes that are unique to or especially relevant to all women.

4.3 Enhance and develop programs to recruit, support, retain, and advance women at all stages of their research careers, from early career to leadership positions.

NIH programs should improve the recruitment and retention of women into biomedical research as well as the advancement of women in biomedical research careers. Doing so, particularly enhancing and developing programs to improve the retention and advancement of women in biomedical careers, will yield dividends for research on the health of women, interdisciplinary research efforts, and the broader biomedical research enterprise.

4.4 Promote and support policies, mentoring and networks, collaborations, and infrastructure to retain and advance women in their careers.

There is a need to improve the current infrastructure and systems so that women are encouraged and enabled to enter, remain, and advance to leadership positions in the field of biomedical research. Institutional climate needs to support women to allow them to reach their full potential and contribute to leading organizations. For example, programs and policies that standardize performance evaluation metrics and facilitate mentoring and networking support for women will likely increase the advancement of women to leadership positions.

4.5 Promote and disseminate research on barriers to the retention and advancement of women in biomedical careers and on interventions to improve their retention and advancement.

Research is needed to develop and test interventions that improve recruitment, retention, and advancement of women in biomedical research careers. Additional research and evaluations are also required to define the types and components of programs that substantially increase women's participation and advancement in biomedical research. These needs extend to all career levels in certain science, technology, engineering, and mathematics fields. Particular attention should be given to underrepresented women who face specific challenges that may require tailored approaches. Other priorities include identification of the remaining barriers to women in biomedical fields, identification of barriers to systematic or institutional implementation of effective interventions, development of new and innovative interventions, and development of effective approaches for disseminating and deploying evidence-based interventions.

The NIH Working Group on Women in Biomedical Careers is a trans-NIH effort to help remove barriers to women in science and to develop innovative strategies to promote the entry, recruitment, retention, and sustained advancement of women in biomedical and research careers.

Strategic Goal 5

Evaluation

Improve evaluation of research that is relevant to the health of women.

GOAL

Advancing Science for the Health of Women depends on identifying gaps in knowledge about women's health and delineating opportunities for scientific advancement. Employing innovative strategies to address these gaps and opportunities makes research more relevant to the health of women.

OBJECTIVES

5.1 Optimize the identification of research that is relevant to the health of women.

Improving the availability of information regarding the range of research that is relevant to the health of women will facilitate the identification of gaps in women's health research. The application and enhancement of existing approaches, models, and tools to provide information about the women's health research landscape are critical to discern where additional studies are needed to fill the gaps in our knowledge and improve the health of women.

5.2 Identify priority areas for additional study to advance the health of women.

Improving research that is relevant to the health of women depends on the identification of critical gaps and key research priorities. Identifying such gaps and priorities involves understanding emerging public health needs and prevailing trends in women's health. Cutting-edge technology and scientific advances should be applied to these significant challenges to improve the health of all women.

Alignment of the *Trans-NIH Strategic Plan for Women's Health Research* With the NIH-Wide Strategic Plan

Advancing Science for the Health of Women: The Trans-NIH Strategic Plan for Women's Health Research aligns with the four objectives outlined in the NIH-wide strategic plan, *Turning Discovery Into Health*.

The first objective of the NIH-wide strategic plan is to **Advance Opportunities in Biomedical Research**. This aim embodies a commitment to research that advances fundamental science, treatments, and cures of diseases and disorders as well as the promotion of health and prevention of diseases. The first goal of the *Trans-NIH Strategic Plan for Women's Health Research*, **Advance Rigorous Research That Is Relevant to the Health of Women**, supports this NIH objective by encouraging well-designed research to improve the basic understanding of how sex and gender influence health and disease and to extend this knowledge to translational and clinical studies. This includes the influences of sex and gender on disease prevention, presentation, management, and outcomes.

The second objective of the NIH-wide strategic plan is to **Foster Innovation by Setting NIH Priorities**. The establishment of these priorities must balance the best science; public health needs, including the relative burden of disease on health and well-being; and NIH's unique ability to address otherwise neglected health challenges, such as rare diseases. The fifth goal of the *Trans-NIH Strategic Plan for Women's Health Research*, **Improve Evaluation**, addresses this NIH objective in several ways. First, this goal optimizes the identification of research relevant to the health of women. Second, this goal also identifies critical gaps and key research priorities in light of recent scientific advances and current public health priorities. Third, a guiding principle of the *Trans-NIH Strategic Plan for Women's Health Research* is consideration of the impact of diseases and conditions on multiple populations, especially women known to experience a disproportionate burden of illness, which ensures that research priorities are set, and innovations are fostered, for all women.

The third objective of the NIH-wide strategic plan is to **Enhance Scientific Stewardship**. This objective encompasses several steps that NIH is taking to strengthen and sustain the scientific workforce; to strive for the highest level of integrity, public

accountability, and social responsibility in the conduct of science; and to maximize the long-term public benefit of NIH-funded science. These steps include efforts to strengthen the biomedical research workforce as well as new approaches for ensuring rigor and reproducibility in the conduct of science, an essential component of which is the consideration of key biological variables such as sex. The fourth goal of the *Trans-NIH Strategic Plan for Women's Health Research*, **Promote Training and Careers**, focuses on attracting, retaining, and advancing women in biomedical science careers; building interdisciplinary research careers in women's health; and training scientists, clinicians, and other health professionals on sex and gender influences in health and disease. A well-trained, diverse, and robust workforce—which is the engine of scientific progress—will accelerate the translation of knowledge into improved health care for women. Additionally, the third goal of the *Trans-NIH Strategic Plan for Women's Health Research*, **Enhance Dissemination and Implementation of Research**, reflects how important efficient dissemination and effective implementation of evidence are for maximizing the value of biomedical research for women. Accordingly, pursuit of this goal advances the third objective of the NIH-wide strategic plan.

The fourth objective of the NIH-wide strategic plan is to **Excel as a Federal Science Agency by Managing for Results**. This objective emphasizes the importance of using transparent, scientific approaches in NIH's decision-making. The second goal of the *Trans-NIH Strategic Plan for Women's Health Research*, **Develop Methods and Leverage Data Sources,** addresses the importance of creative and rigorous approaches to study design, participant recruitment and retention, measurements, and analytic techniques to increase the relevance of research findings and, therefore, the return on research

investments for women. In turn, this goal will ensure that NIH is excelling as a government agency that is accountable to the American public.

Advancing Science for the Health of Women: The Trans-NIH Strategic Plan for Women's Health Research positions NIH to set an updated agenda for expanding research on the health of women. This plan will harness the scientific expertise within NIH's ICs and provide a unifying framework to optimize interdisciplinary collaboration to advance research on the health of women. By operating in synergy with the NIH-wide strategic plan, the *Trans-NIH Strategic Plan for Women's Health Research* advances NIH's overall mission to seek fundamental knowledge about the nature and behavior of living systems and to apply that knowledge to enhance health, lengthen life, and reduce illness and disability for all.

Appendix A: Process for Developing the *Trans-NIH Strategic Plan for Women's Health Research*

ORWH took a multi-resource, iterative approach to strategic planning, with a strong focus on stakeholder input. The development of *Advancing Science for the Health of Women: The Trans-NIH Strategic Plan for Women's Health Research* began with ORWH's effort to mine data from multiple sources to determine potential topics and goals of current importance to women's health research.

ORWH engaged multiple NIH stakeholders and non-NIH partners. These stakeholders were active participants throughout the development of the plan and made invaluable contributions to the final plan. These stakeholders included:

- NIH Raising the Bar Working Group on Women's Health
- Trans-NIH Sex as a Biological Variable Working Group
- Coordinating Committee for Research on Women's Health
- Advisory Committee on Research on Women's Health (Appendix C)
- ORWH Strategic Plan Organization Team (SPOT)*

Additionally, ORWH sought feedback from external researchers and health care providers. This included over 250 participants who attended the 2017 Congress on Women's Health and participants at Virginia's 20th Annual Conference on Women's Health. Discussions included the most pressing unanswered questions about women's health that health care providers encounter in their daily work and the areas of women's health research currently in need of the most attention.

The NIH Raising the Bar Working Group also conducted a comprehensive analysis of mortality and prevalence trends—by sex, race, and ethnicity—as major causes of morbidity and mortality in the United States. Based on stakeholder engagement, the trends analysis, and other feedback, the Raising the Bar Working Group produced a list of its top 10 priorities for research on women's health.

Building on the outcomes of the NIH Raising the Bar Working Group, ORWH's SPOT developed a strategic plan framework with an emphasis on the refined priorities identified from internal and external stakeholder input. The resulting framework consisted of three cross-cutting themes that were published as a Request for Information (RFI), notice number NOT-OD-17-108, to solicit input on the themes and goals from basic, clinical, and translational scientists, as well as from advocacy and patient communities with key stakes in women's health research (https://grants.nih.gov/grants/guide/notice-files/NOT-OD-17-108.html).

*ORWH SPOT Members: Rajeev Agarwal, Monica Basco, Lisa Begg, Margaret Bevans, Gretchen Buckler, Rebecca DelCarmen-Wiggins, Melissa Ghim, Katrina Serrano, Ching-yi Shieh, Denise Stredrick, and Paris Watson.

ORWH received 145 responses to the RFI. ORWH reviewed and analyzed the input received from the RFI and used it to develop the five goals for the strategic plan.

Following the approval of the ORWH strategic planning process by NIH leadership, the ORWH Director presented an outline of the process to the NIH Council of Councils for review and feedback.

A process to develop the objectives that would operationalize each goal included intense NIH engagement. ORWH conducted two strategic planning think tank sessions involving representatives from ICs across NIH to develop objectives under each of the five strategic goals. These meetings were used as brainstorming sessions to identify priority objectives relevant to the areas of research across NIH.

ORWH established an ACRWH Strategic Plan Working Group (ACRWH WG) including external stakeholders from ACRWH and a Trans-NIH Women's Health Strategic Planning Team for each of the five goals in the strategic plan. The Trans-NIH Women's Health Strategic Planning Teams (Appendix D) comprised NIH staff members from the think tank sessions and those designated by their respective IC and OD Office leadership. The two groups provided guidance and input throughout the remainder of the strategic planning process. ORWH worked with both groups to refine the goals of the strategic plan, develop objectives for the goals, and provide input on the guiding principles for the plan. Additionally, the ORWH Director communicated with each IC Director and key OD Directors to procure input on the strategic goals for the trans-NIH plan.

The final draft plan underwent review by external and NIH internal stakeholders. The plan was distributed to all NIH IC representatives on CCRWH, members of the strategic plan teams, and ORWH staff members. The strategic plan was presented at the 46th meeting of the ACRWH and subsequently approved by NIH senior leadership.

Appendix B: NIH-Wide Partnerships Supporting the Health of Women and Women in Biomedical Careers

Building Interdisciplinary Research Careers in Women's Health (BIRCWH)

BIRCWH is an ORWH signature initiative cosponsored with multiple NIH ICs. The BIRCWH K–12 program aims to increase the number and skills of investigators who conduct research on sex and gender influences on health and disease. BIRCWH provides for mentored research training and career development that prepares investigators for independent scientific careers in interdisciplinary science. The program supports scholars by providing them with protected time to receive career development, to conduct their research, and to achieve research independence. The interdisciplinary team approach is applied to the study of women's health across the life course, bridging basic and clinical science and incorporating new models of collaboration and institutional support. Mentors from collaborating departments provide needed expertise and resources to BIRCWH scholars' projects on research relevant to women's health, including research on sex and gender influences, as well as research on factors that contribute to disparities in health status or health outcomes for different populations of women.

Specialized Centers of Research Excellence (SCORE) on Sex Differences

The SCORE program is a signature ORWH program, supported by a U54 grant mechanism, and is the successor to the ORWH SCOR P50 program that began in 2002. Since its inception, the program has been sponsored through partnership with several NIH ICs. SCORE's objective is to expedite the development and application of new knowledge to human diseases that affect women, to learn more about the etiology of these diseases, and to foster improved approaches to treatment and/or prevention. SCORE represents an innovative interdisciplinary research program focusing on sex differences and major medical conditions affecting women in the United States and supports established scientists at Centers across the country that conduct groundbreaking research that integrates basic, clinical, and behavioral research approaches to incorporate sex differences. ORWH's SCORE is the only NIH Center program supporting disease-agnostic research on sex differences.

ORWH R56 Program

The Trans-NIH High-Priority, Short-Term Awards (R56) for Women's Health Research are sponsored by the NIH Office of the Director, DPCPSI. The Trans-NIH R56 initiative allows ORWH to partner with NIH ICs to fund or co-fund innovative, potentially high-impact research that falls outside of NIH IC pay lines, but which—if implemented successfully—could significantly advance knowledge of women's health and/or sex and gender influences on human health and disease. This award allows the investigators to improve their research proposal significantly so that the submission/resubmission application can succeed in the highly competitive peer review and fiscal environment. Additionally, the use of the R56 mechanism can potentially enhance research in targeted areas, such as the influence of sex and gender on health and disease, by allowing the principal investigator to incorporate new content into the revised application to address topics relevant to the health of women.

Administrative Supplements

An administrative supplement is a noncompeting award that provides additional funding to a currently funded grant to meet increased costs that are within the scope of the approved project.

Research on Sex and Gender Differences

ORWH provides one year of support to ongoing NIH-funded grants to catalyze exploratory research on sex and gender differences. The program bolsters the research of NIH IC grantees to encourage sex and/or gender comparisons in preclinical and clinical studies and encourages researchers to study females and males as a catalyst for considering sex as a fundamental biological variable in research. The supplement supports three types of research approaches:

(i) add the opposite sex and/or gender (the addition of animal or human subjects, tissues, or cells of the sex opposite to those used in the parent grant to allow sex and/or gender-based comparisons);

(ii) increase sample size (the addition of more animal or human subjects, tissues, or cells to a sample that already includes both males and females to increase the power of a study to analyze for a sex and/or gender difference); and

(iii) analyze existing data (comparative analyses of existing samples/datasets/databases and/or data mining to investigate the role of sex and/or gender).

Research on the Health of Women of Understudied, Underrepresented, and Underreported (U3) Populations

ORWH supports administrative supplements for interdisciplinary research focused on the effect of sex and gender at the intersection of social determinants of health and disease, including but not limited to race and ethnicity, SES, education, health literacy, gender identity, and urban/rural residence. These administrative supplements are available for one year to active NIH grants supporting preclinical, clinical, or behavioral studies. The purpose of the supplement is to address health disparities among populations of women in the United States who are understudied, underrepresented, and underreported in biomedical research. Projects must include a focus on one or more NIH-designated health disparity populations, which includes African Americans or Blacks, Hispanics or Latinos, American Indians or Alaska Natives, Asian Americans, Native Hawaiians and Other Pacific Islanders, socioeconomically disadvantaged populations, underserved rural populations, and sexual and gender minorities. Combining two or more populations is encouraged.

Promote the Reentry into Biomedical and Behavioral Research Careers

ORWH, participating NIH ICs, and the Office of Dietary Supplements support administrative supplements to research grants to support individuals with high potential to reenter an active research career after taking time off for family responsibilities or other qualifying circumstances. The aim of these supplements is to encourage such individuals to reenter research careers within the missions of all NIH program areas. This program will provide administrative supplements to existing NIH research grants to support full-time or part-time research by these individuals to update their existing research skills and knowledge. An NIH evaluation of the program showed that, at an average time of five years post-award, more than 80 percent of reentry awardees remained in academia and in scientific research.

Appendix C: NIH Advisory Committee on Research on Women's Health Members, Fiscal Years 2017 and 2018

*Bairey Merz, Noel C., M.D., FACC, FAHA (2016-2019)**, Director, Barbra Streisand Women's Heart Center, Cedars-Sinai Medical Center

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Chen, Wei-Jung A., Ph.D. (2016-2019), Professor and Associate Dean for Faculty Affairs, Department of Neuroscience and Experimental Therapeutics, College of Medicine, Texas A&M Health Science Center

Clayton, Janine A., M.D., Chairperson, Director, Office of Research on Women's Health, National Institutes of Health

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***Green, Carmen R., M.D. (2015-2018)**, Associate Vice President and Associate Dean, Office for Health Equity and Inclusion, University of Michigan Health System

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Woodruff, Teresa, Ph.D. (2014-2017), Vice Chair for Research, Thomas J. Watkins Professor of Ob-Gyn, Women's Health Research Institute, Feinberg School of Medicine, Northwestern University

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Hayward, Mark, Ph.D., Professor of Sociology, Faculty Research Associate, Population Research Center, University of Texas at Austin

Langer, Ana, M.D., Professor of the Practice of Public Health, T.H. Chan School of Public Health, Harvard University

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Appendix D: *Trans-NIH Strategic Plan for Women's Health Research* Team Members

Goal 1: Research

Co-chairs: Rebecca DelCarmen-Wiggens (ORWH) and Somdat Mahabir (National Cancer Institute)

Rajeev Agarwal (ORWH), Tanya Agurs-Collins (National Cancer Institute), Christina Annunziata (National Cancer Institute), Donna Baird (National Institute of Environmental Health Sciences), Lisa Begg (ORWH), Inna Belfer (National Center for Complementary and Integrative Health), Abee Boyles (National Institute of Environmental Health Sciences), Gina Brown (OD Office of AIDS Research), LaVerne Brown (Office of Dietary Supplements), Natasha Brown-Knight (National Cancer Institute), Gretchen Buckler (ORWH), Nicholas Bushar (National Institute of Allergy and Infectious Diseases), Kelly Chandler (National Institute of Environmental Health Sciences), Kelly Filipski (National Cancer Institute), Elena Gorodetsky (ORWH), Ivana Grakalic (National Institute on Alcohol Abuse and Alcoholism), Eleanor Hoff (National Institute of Diabetes and Digestive and Kidney Diseases), Bede Jean Francois (National Institute on Minority Health and Health Disparities), Jim Koenig (National Institute of Neurological Disorders and Stroke), Tram Lam (National Cancer Institute), Aaron Laposky (National Heart, Lung, and Blood Institute), Tamara Lewis Johnson (National Institute of Mental Health), Christine Maric-Bilkan (National Heart, Lung, and Blood Institute), Lisa Neuhold (National Eye Institute), Karen Parker (OD Office of Sexual & Gender Minority Health Research), Sonia Rosenfield (National Cancer Institute), Neeraja Sathyamoorthy (National Cancer Institute), Thad Schug (National Institute of Environmental Health Sciences), Abigail Soyombo (National Cancer Institute), Rita Valentino (National Institute on Drug Abuse), Cora Lee Wetherington (National Institute on Drug Abuse), Steve Zullo (National Institute of Biomedical Imaging and Bioengineering)

Goal 2: Methods

Co-chairs: Katrina Serrano (ORWH) and Sung Sug (Sarah) Yoon (National Institute of Nursing Research)

Rao Divi (National Cancer Institute), Dena Fischer (National Institute of Dental and Craniofacial Research), Lisa Neuhold (National Eye Institute), Diane Palmieri (National Cancer Institute), Barbara Sorkin (Office of Dietary Supplements), Steve Zullo (National Institute of Biomedical Imaging and Bioengineering)

Goal 3: Dissemination and Implementation

Co-chairs: Margaret Bevans (ORWH) and Margaret Farrell (National Cancer Institute)

Laura Bartlett (National Library of Medicine), Gretchen Buckler (ORWH), Juliane Caviston (National Institute of Allergy and Infectious Diseases), Jessica Ceruto (National Cancer Institute), Dave Clark (National Center for Complementary and Integrative Health), Courtney Coombes (National Heart, Lung, and Blood Institute), Dena Fisher (National Institute of Dental and Craniofacial Research), Tianna Hicklin (OD Office of Communications and Public Liaison), Lenora Johnson (National Heart, Lung, and Blood Institute), Elizabeth Neilson (Office of Disease Prevention), Christen Sandoval (OD Office of Communications and Public Liaison), Lamont Williams (ORWH)

Goal 4: Training and Careers

Co-chairs: Melissa Ghim (ORWH), Kay Lund (OD Office of Extramural Research), and Xenia Tigno (National Heart, Lung, and Blood Institute)

D. Lee Alekel (National Institute of Arthritis and Musculoskeletal and Skin Diseases), Whitney Barfield (National Heart, Lung, and Blood Institute), Ann Berger (NIH Clinical Center), Rosalina Bray (OD Office of Extramural Programs), Laura Brockway-Lunardi (National Cancer Institute), Kelly Chandler (National Institute of Environmental Health Sciences), Tammy Collins (National Institute of Environmental Health Sciences), Myra Derbyshire (National Library of Medicine), Nicole McNeil Ford (National Cancer Institute), Lisa Gallicchio (National Cancer Institute), Lindsay Garvin (National Heart, Lung, and Blood Institute), Cheryl Kitt (OD Office of Extramural Research), David Landsman (National Library of Medicine), Amanda Melillo (National Institute of General Medical Sciences), Meghan Mott (National Institute of Neurological Disorders and Stroke), Khara Ramos (National Institute of Neurological Disorders and Stroke), Anu Sharman (National Cancer Institute), Jennifer Troyer (National Human Genome Research Institute)

Goal 5: Evaluation

Co-chairs: Kathryn Morris (OD Office of Behavioral and Social Sciences Research), Lisa Halvorson (Eunice Kennedy Shriver National Institute of Child Health and Human Development), and Anne Leong (Eunice Kennedy Shriver National Institute of Child Health and Human Development/ORWH)

Gillian Acca (OD Office of Behavioral and Social Sciences Research), Brenda Boersma (National Cancer Institute), Stephanie Courchesne-Schlink (OD Office of Strategic Coordination), Deborah Duran (National Institute on Minority Health and Health Disparities), Paige Green (National Cancer Institute), Rebecca Henry (National Institute of Nursing Research), Grace Liou (National Cancer Institute), Kate Nagy (National Institute on Aging), Kristianna Pettibone (National Institute of Environmental Health Sciences), Denise Stredrick (ORWH), Michelle Turner (National Cancer Institute)

Appendix E: References

Abad-Díez, J. M., Calderón-Larrañaga, A., Poncel-Falcó, A., Poblador-Plou, B., Calderón-Meza, J. M., Sicras-Mainar, A., Clerencia-Sierra, M., Prados-Torres, A. (2014). Age and gender differences in the prevalence and patterns of multimorbidity in the older population. *BMC Geriatrics*, *14*:75.

Bartley, E. J., Fillingim, R. B. (2013). Sex differences in pain: a brief review of clinical and experimental findings. *British Journal of Anaesthesia*, *111*(1): 52-58.

Bird, C. E., Conrad, P., Fremont, A. M., Timmermans, S. (Eds). (2010). *Handbook of Medical Sociology*, 6th Edition. Nashville, TN: Vanderbilt University Press.

Buttorff, C., Ruder, T., Bauman, M. (2017). *Multiple Chronic Conditions in the United States*. Santa Monica, CA: RAND Corporation.

Clayton, J. A. (2016). Studying both sexes: a guiding principle for biomedicine. *The FASEB Journal*, *30*(2): 519-524.

Clayton, J. A., Tannenbaum, C. (2016). Reporting sex, gender, or both in clinical research? *Journal of the American Medical Association*, *316*(18): 1863-1864.

Early, J. (2016). Health is more than healthcare: It's time for a social ecological approach. *Journal of Nursing and Health Studies*, *1*(1): 2.

Freedman, V. A., Wolf, D. A., Spillman, B. C. (2016). Disability-free life expectancy over 30 years: a growing female disadvantage in the US population. *American Journal of Public Health*, *106*(6): 1079-1085.

GBD 2015 Maternal Mortality Collaborators. (2016). Global, regional, and national levels of maternal mortality, 1990-2015: a systematic analysis for the Global Burden of Disease Study 2015. *The Lancet*, *388*(10053): 1775-1812.

Hales, C. M., Fryar, C. D., Carroll, M. D., Freedman, D. S., Ogden, C. L. (2018). Trends in obesity and severe obesity prevalence in U.S. youth and adults by sex and age, 2007-2008 to 2015-2016. *Journal of the American Medical Association*, *319*(16): 1723-1725.

Ho, J. Y., Hendi, A. S. (2018). Recent trends in life expectancy across high-income countries: retrospective observational study. *The BMJ*, *362*: 562.

Kelly, T., Yang, W., Chen, C.-S., Reynolds, K., He, J. (2008). Global burden of obesity in 2005 and projections to 2030. *International Journal of Obesity (London)*, *32*(9): 1431-1437.

Montez, J. K., Zajacova, A., Hayward, M. D. (2016). Explaining inequalities in women's mortality between U.S. States. *SSM-Population Health*, *2*: 561-571.

Murtagh, K. N., Hubert, H. B. (2004). Gender differences in physical disability among an elderly cohort. *American Journal of Public Health*, *94*(8): 1406-1411.

National Academies of Sciences, Engineering, and Medicine. (2005). *Facilitating Interdisciplinary Research*. Washington, DC: The National Academies Press.

National Academies of Sciences, Engineering, and Medicine. (2016). *Improving the Health of Women in the United States: Workshop Summary*. Washington, DC: The National Academies Press.

National Cancer Institute. (2018). *Team Science Toolkit*. National Cancer Institute. [Online] [Cited: July 27, 2018]. Retrieved from https://www.teamsciencetoolkit.cancer.gov/Public/WhatIsTS.aspx.

Nelson, D. B., Moniz, M. H., Davis, M. M. (2018). Population-level factors associated with maternal mortality in the United States, 1997-2012. *BMC Public Health*, *18*(1).

Nielsen, M. W., Alegria, S., Börjeson, L., Etzkowitz, H., Falk-Krzesinski, H. J., Joshi, A., Leahey, E., Smith-Doerr, L., Woolley, A. W., Schiebinger, L. (2017). Gender diversity leads to better science. *Proceedings of the National Academy of Sciences of the United States of America*, *114*(8): 1740-1742.

Pinn, V. W. (2018). Perspectives from a pathologist: my journey on the path to women's health research, sex and gender policy, and practice implications. *Annual Review of Pathology: Mechanisms of Disease*, *13*: 1-25.

Rovner, G. S., Sunnerhagen, K. S., Björkdahl, A., Gerdle, B., Börsbo, B., Johansson, F., Gillanders, D. (2017). Chronic pain and sex-differences; women accept and move, while men feel blue. *PLoS One*, *12*(4): e0175737.

Schweinhart, A., Clayton, J. A. (2018). Reversing the trends toward shorter lives and poorer health for U.S. women: a call for innovative interdisciplinary research. *International Journal of Environmental Research and Public Health*, August 21;15(9). pii: E1796. doi: 10.3390/ijerph15091796.

Singh, G. K., Daus, G. P., Allender, M., Ramey, C. T., Martin, E. K., Perry, C., De Los Reyes, A. A., Vedamuthu, I. P. (2017). Social determinants of health in the United States: addressing major health inequality trends for the Nation, 1935-2016. *International Journal of Maternal and Child Health and AIDS*, *6*(2): 139-164.

Spong, C. Y., Bianchi, D. W. (2018). Improving public health requires inclusion of underrepresented populations in research. Journal of the *American Medical Association*, *319*(4): 337-338.

Stokols, D., Hall, K. L., Taylor, B. K., Moser, R.P. (2008). The science of team science: overview of the field and introduction to the supplement. *American Journal of Preventive Medicine*, *35(2)*: S77-S89.

Tingen, C., Nagel, J. D., Clayton, J. A. (2013). Monitoring the implementation of the National Institutes of Health strategic plan for women's health and sex/gender differences research: strategies and successes. *Global Advances in Health and Medicine*, *2*(5): 44-49.

U.S. Department of Health and Human Services. (2013). *Report on activities related to "improving women's health" as required by the Affordable Care Act*. Office on Women's Health, Office of the Assistant Secretary for Health. Washington, DC: U.S. Department of Health and Human Services.

Wang, H., Schumacher, A. E., Levitz, C. E., Mokdad, A. H., Murray, C. J. (2013). Left behind: widening disparities for males and females in U.S. county life expectancy, 1985-2010. *Population Health Metrics*, *11*(1).

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