

THE WHAM REPORT

Societal Impact of Research Funding for Women's Health

IN ALZHEIMER'S DISEASE AND ALZHEIMER'S DISEASE- RELATED DEMENTIAS

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Women's
Health
Access
Matters®

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WHAM, whamnow.org, is a 501c3 dedicated to funding women's health research to transform women's lives.

This report was conceived by WHAM in response to the considerable funding gap, historical exclusion, and under representation of women in health research.

As businesswomen, we believed that a focused study showing the impact of accelerating sex and gender-based health research on women, their families and the economy by quantifying costs and economic benefits will be an invaluable accountability index. In other words, if more investment is made in women's health research the plausible assumption is that women would benefit from sex-specific prevention strategies, diagnoses and treatments that reduce their burden of disease and thus improve their wellbeing and hence the wellbeing of society.

WHAM commissioned the RAND Corporation to conduct a data-driven study of the economic impact to society of increasing the investment in women's health research. This first research project comprises three disease modules: Alzheimer's Dementia, Rheumatoid Arthritis as representative

of Autoimmune Disease, and Coronary Artery Disease. In the future, we plan to include Lung Cancer and also study different socioeconomic groups to the extent that the data are available and detail the global data which expands this research.

To the best of WHAM's and RAND's knowledge, this is the first analysis of its kind to create and calibrate a microsimulation model of investments in health R&D that examines differences for women's health research investment, and should become a seminal part of the arsenal in advocating for increased investment in women's health research. The research methodology and the microsimulation models have been vetted by a diverse panel of experts convened by RAND.

We are so thankful for the dedicated, invested partnership of the research team at the RAND Corporation who conducted the analysis presented here and brought their findings to life. We encourage other leaders, including advocates, economists, scientists, business leaders, public health experts and policy makers to draw from and act upon the results of this report. Together, we can drive meaningful change.

Carolee Lee

Founder and CEO, WHAM

www.whamnow.org | www.thewhamreport.org

Please find additional infographics and social media toolkits on www.thewhamreport.org.

The technical specifications for the models are publicly available. Please visit www.thewhamreport.org to learn more about using these data and citing this report.

WHAM's LEAD COLLABORATORS

WHAM's leadership of this research project was encouraged through the generous support and collaboration from the following organizations:

American Heart Association

The American Heart Association is a relentless force for a world of longer, healthier lives dedicated to ensuring equitable health for all—in the United States and around the world. The American Heart Association's signature women's initiative, Go Red for Women® (GRFW), has been the trusted, passionate, relevant force for change to end heart disease and stroke in women all over the world for nearly two decades. Go Red for Women and WHAM will collaborate to directly address the lack of societal-level evidence on the economic cost, benefits, and social impact due to the underrepresentation of women in cardiovascular research.

BrightFocus Foundation

BrightFocus Foundation is a leading source of private research funding to defeat Alzheimer's, macular degeneration and glaucoma. Supporting scientists early in their careers to kick-start promising ideas, BrightFocus addresses a full and diverse range of approaches from better understanding the root causes of the diseases and improving early detection and diagnosis, to developing new drugs and treatments. The nonprofit has a longstanding commitment to funding pioneering, sex-based research in Alzheimer's and related dementias. BrightFocus currently manages a global portfolio of over 275 scientific projects, a \$60 million investment, and shares the latest research findings and best practices to empower families impacted by these diseases of mind and sight.

The Connors Center for Women's Health and Gender Biology at Brigham and Women's Hospital/Harvard Medical School

is a leading local and national force in advancing the health of women, with a rich history and strong foundation of women's health and sex-differences discovery, clinical care, and advocacy for equity in the health of women and is the Premier Partner and the Lead Scientific Research Partner of the WHAM Collaborative for Women's Health Research. The Connors Center shares the bold vision of improving the health of women and a commitment to joining forces to advance scientific discovery for the benefit of all women.

La Jolla Institute for Immunology

La Jolla Institute (LJI) is one of the top five research institutes in the world focused on the study of the immune system. LJI is home to three research centers that harness the efforts of collaborative groups of researchers on defined areas of inquiry, to accelerate progress toward the development of new treatments and vaccines to prevent and cure autoimmune conditions, cancer and infectious disease. Together, LJI and WHAM will create a framework for researchers to re-analyze existing data with sex as a biological variable, to work together to spark new projects, to hire new faculty to build key research areas, to communicate via the WHAM Report, and to establish an ignition point for new leadership in the scientific field.

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WHAM convenes thought leaders, researchers and
scientists to work together to identify problems and
devise solutions. Our members include:

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RAND convened an advisory panel to help guide
the work and elicit insights on the target case
study areas of Autoimmune/Immune Disease,
Cardiovascular Disease, and Alzheimer's Disease.
Central to RAND's work was the creation of health
economic models in each case study area. RAND
is committed to creating final products with
immediate relevance for use by funders, advocacy
organizations, researchers, and other stakeholders.

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Executive Summary

The impact of limited knowledge about women’s health relative to men’s is far-reaching. Without information on the potential return on investment for women’s health research, research funders, policymakers, and business leaders lack a basis for altering research investments to improve knowledge of women’s health.

Using microsimulation analyses, we examined the societal cost impact of increasing research funding in Alzheimer’s disease and Alzheimer’s disease–related dementias (AD/ADRD). We quantified the potential impact of increasing funding for women’s health on health outcomes and the ultimate societal costs in the United States, including health care expenditures, the labor productivity of informal caregivers, and quality-adjusted life years (QALYs). We calculated impacts across 30 years of doubling the current 12 percent of the National Institutes of Health extramural AD/ADRD portfolio devoted to women’s health.

Key Takeaways

Investing in women’s health research on AD/ADRD yields benefits beyond investing in general research. Compared with investments in research with equal impact on women’s and men’s health, investing in women’s health research can yield higher overall returns on investment.

Large returns result from very small health improvements. Assuming 0.01 percent improvement in health from small reductions in age incidence and AD/ADRD disease severity,



- more than 6,000 years with AD/ADRD can be saved across 30 years, with substantial gains in health-related quality of life
- nursing home costs could drop by more than \$360 million
- the return on investment is 224 percent for doubling investment in women's health research.

The results establish the potential for investment in women's health research on AD/ADRD to realize gains beyond additional general research investment and point the way to a concrete, actionable research and funding agenda. Large societal gains may be possible by increasing investment in women's health research on AD/ADRD. The potential to recognize societal gains is greater for research devoted to women's health relative to general research, according to the assumptions used here.

Policy Opportunities

Increase research funding directed at women's health within AD/ADRD. Given the limitations in knowledge about women and AD/ADRD relative to men, the potential gains from women-focused research are substantial.

Pursue research on the biological and cultural dimensions of AD/ADRD and women. Clinically actionable knowledge is likely from both spheres. Biologically focused research could address the effect of hormonal status on AD/ADRD risk and the progression and impact of pregnancy factors on AD/ADRD risk. Cultural research could address marital effects and the impact of physical activity and education on AD/ADRD risk and disease course.

Expand research agendas to address relationships between AD/ADRD and other health conditions in women. For example, existing research in cardiovascular health and metabolic disease could be mined to identify promising signals that are relevant to AD/ADRD in women.

By raising awareness of the current state of funding directed toward women's health in AD/ADRD and the potential for such funding to yield a variety of societal benefits, researchers and other communities can pursue information relevant for improving funding allocation decisions. Specific ways to connect other communities to the relevant issues include the following:

- ***Raise awareness of the potential value of investment in women's health research on AD/ADRD.*** The ways in which women's health research is disadvantaged relative to general research require further study, but investing not just in the research agenda but also in the careers of those who can pursue that agenda is critical. Identify such obstacles as career interruption from caregiving burden for women and develop strategies to overcome these and systemic factors, such as implicit and explicit bias against women in health research.
- ***Raise awareness among the business community of the potential return on investment for women's health research.*** The viability of women's health research agendas and funding depends on an understanding of the value on the part of the market for such research. Within the pharmaceutical and biotechnology industry, decisions made by leaders about research investments should be informed by the potential for societal return on investment. Leaders across multiple other business sectors need to understand the consequences of underinvestment for workforce productivity and the health care burden associated with AD/ADRD. These communities are key to informing future research investment strategies.



Introduction

Because women have been underrepresented in health research, what we know about women’s health is limited. Even today, the value of research investment on women’s health is not widely accepted. The impact of this oversight is far-reaching.

Also unknown is the potential impact of accelerating and increasing funding for women’s health research. What difference would doing so make in the health and well-being of everyone? Understanding this impact would provide vital information to funders, researchers, and policymakers to help them plan investments that can yield the greatest public health benefits (Johnson et al., 2014).

As part of an initiative of the Women’s Health Access Matters (WHAM) nonprofit foundation, RAND Corporation researchers examined the impact of increasing funding for women’s health, beginning with a focus on AD/ADRD.

WHAM has four pillar areas of focus: brain health, oncology, heart health, and autoimmune diseases. We reviewed disorders to use as case examples within each of these areas, comparing them in terms of overall prevalence; prevalence by gender; societal impact in terms of morbidity, mortality, and overall cost burden; and feasibility of obtaining data for constructing models. Within brain health, AD/ADRD was chosen as an important case study and one that could meaningfully inform funding policy.

We invited an expert advisory group to two meetings, in late summer and early fall 2020, about the project to provide input into model structure and assumptions. Members included health economists, health researchers and funders (including women’s health experts), patient advocates, and representatives from health insurers and the elder care business community. The advisers’ input enabled the finalizing of key assumptions and the model structure.



Why Focus on AD/ADRD?

AD/ADRD results in substantial illness burden, health care costs, caregiving burden, and mortality (Johnson et al., 2014). Recognizing the societal costs, the federal government established the first Professional Judgment Budget for AD/ADRD in 2017. The only other areas that have received this type of federal investment are cancer and the human immunodeficiency virus (HIV; Consortium of Social Science Associations, 2015; National Institutes of Health [NIH], 2019).

Quantifying the impact of research funding investment is a relatively new area of inquiry (Adam et al., 2018). Microsimulation modeling can help address the gap in knowledge about investment in women's health research (see, for example, Grant and Buxton, 2018). *Women's health research* as used in this report refers both to analyses that address sex and/or gender within general sample or population studies and to research focusing on women specifically.¹

¹ We follow terminology guidance from the NIH, which states the following:

- “Sex” refers to biological factors and processes (e.g., sex chromosomes, endogenous hormonal profiles) related to differentiation between males (who generally have XY chromosomes) and females (who generally have XX chromosomes). “Gender” refers to culturally- and socially-defined roles for people, sometimes but not always along the lines of a gender binary (girls and women, boys and men).
- “Gender” incorporates individuals’ self-perceptions (gender identity); the perceptions, attitudes, and expectations of others (gender norms); and social interactions (gender relations) (NIH, 2020b). For the purposes of these analyses, we refer to sex and/or gender research generally; assumptions are about sex and/or gender research focused on women.

We present the results of microsimulation models used to explore the potential for enhanced investment in women’s health research, in terms of the economic well-being of women and for the U.S. population. Models allow funding impacts to be quantified in economic terms. Models also provide a way to quantify the impact of the disease and its treatment on health-related quality of life (Grant and Buxton, 2018). These models include disease burden and societal productivity costs and benefits. Productivity costs are important in AD/ADRD, given the impact of the disease not just on the individuals with it but also on their informal caregivers (AARP and National Alliance for Caregiving, 2020). As with many diseases, women are more likely than men to be informal caregivers for someone with AD/ADRD. Women bear substantially more of the cost of that informal caregiving than men (Yang and Levey, 2015).

Determining the Research Investment

The models assume that increased research funding reduces the incidence of disease, reduces the severity of disease for those who are diagnosed, and improves health-related quality of life.

We used current levels of funding from the NIH as the base case, with comparisons to doubling the level of research funding invested in women-focused research. Certainly, the universe of funding for AD/ADRD research extends beyond NIH and includes advocacy organizations, the biopharmaceutical industry, and philanthropic organizations (Cummings, Reiber, and Kumar, 2018). The NIH’s share of AD/ADRD research investment is large, however, and provides a starting point for understanding investments in health research generally and women’s health research in particular. The results using NIH funding levels can be considered a lower bound on the possibilities for research investment.

The goal of the analyses is to serve as a foundation for developing a concrete, actionable research and funding agenda. The analyses are intended to demonstrate the potential impacts of increased funding for research on women’s health and thereby inform the prioritization of research funding allocations for funders, legislators, and the business community.



Methods

We used microsimulation models to address the impact of funding for women’s health research on AD/ADRD. The models followed a cohort representing the U.S. population of individuals who have or could develop AD/ADRD beginning at age 65 and older, along with the working-age informal caregivers age 35 and older. The model assumed 100 percent mortality at age 99.

The model simulated the progression of each person’s health in the sample over a 30-year time horizon. After generating a base case to establish baseline health care costs, we generated a model with the assumption that increased investment improves health outcomes and thus lowers costs (see Figure 1).²

AD/ADRD Model

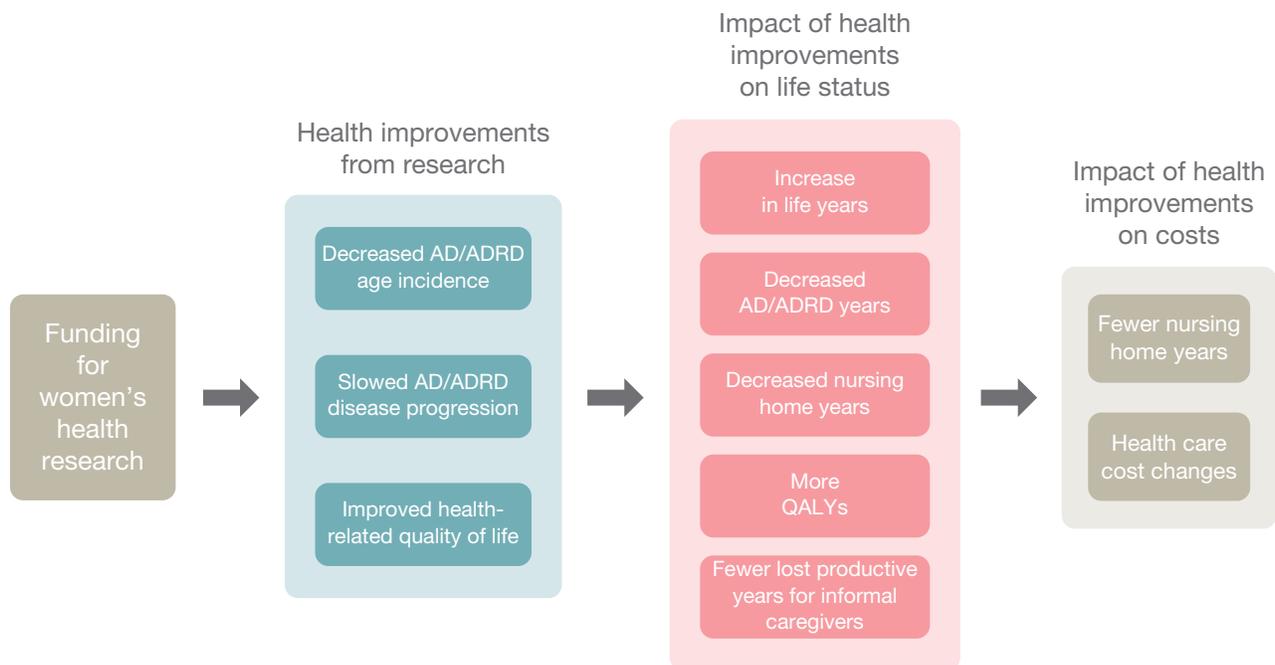
By tying different funding scenarios to societal burden, the microsimulation model quantifies how funding amounts affect the societal burden of AD/ADRD in terms of health expenditures, caregiver time loss, and lost life years. The impact on QALYs (and not just on absolute lost life years) is important to quantify for AD/ADRD, given the ways in which the disease affects individuals. The QALY is one way in which monetary value can be assigned to disease impact, and has been used as a metric for disease impact and impact of health innovation, incorporating length of life with the quality of life (Grant and Buxton, 2018).

The severity of the disease in the model cohort was one of the following: normal cognitive status or mild cognitive impairment, mild AD, moderate AD, severe AD, non-AD cognitive impairment, or death.

² For a detailed technical appendix describing the specifics of the microsimulation model, please visit www.rand.org/t/RR708-1.

FIGURE 1

Model of Research Funding Impacts for AD/ADRD



Expenditures were estimated as a function of age, gender, care status, and disease severity. For example, severe AD/ADRD is associated with higher nursing home costs for memory units. The model accounts for informal caregiving costs (for example, the cost of a spouse or a child helping the individual with AD/ADRD).

We used prior research on funding investment return as a basis for assumptions on the return on research investment: that is, the impact of funding levels on health outcomes (Grant and Buxton, 2018). The return on research investment calculation was a function of the following specific health outcomes: age incidence of disease, improved detection rates and earlier detection in the disease course, severity with assumption of reduced severity and reduced time in more-severe stages of disease, and reduced mortality due to disease. Following analyses in which the return on research investment was permitted to vary, we constrained the model to determine inputs that would yield an expected return on investment of 15 percent, in line with findings from several therapeutic areas (Committee on Family Caregiving for Older Adults, 2016).

Taken together, these components enabled us to simulate the effects of increasing funding for health research on women in terms of economic outcomes. These economic outcomes included the monetary value of workers being able to stay in the labor force longer as a result of decreased caregiving burden.

Addressing Future Earnings Equality

In the United States, earnings for white males exceed those of Black and Latino males and exceed those for all women. Rather than use race and ethnicity and gender to adjust earnings for the hypothetical cohort, we chose to base earnings calculations for everyone on the earnings of non-Hispanic white males. This avoids the gender- and race-based labor market discrimination that is inherent in the different (and lower) earnings for women and non-Hispanic white males.

Time Horizon

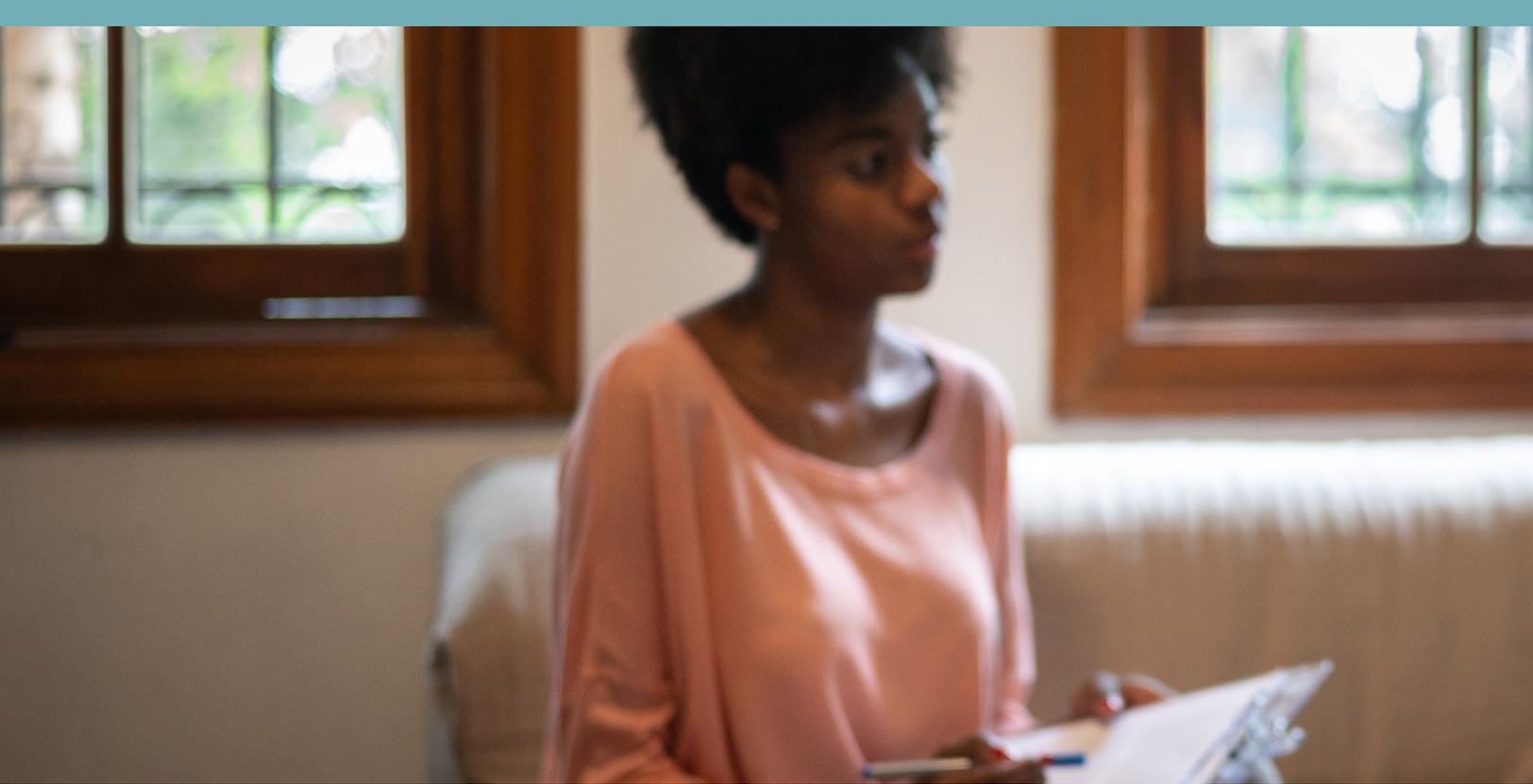
The representative cohort of around 1 million lives was moved through a 30-year time horizon, with the impact of investment expected ten years from initiation. The cohort was created as a representative sample of the United States, following age and gender distributions for individuals age 35 and older and using existing disease rates by age and gender.

We chose a ten-year investment impact using existing research on the time from investment to health care impacts (Cruz Rivera et al., 2017; Hansen et al., 2013; Scott et al., 2014). The 30-year model time horizon permits accrual of impacts for the 20 subsequent years, within the life span of the majority of the cohort.

Investment Impacts on Health Improvements

The model provides the return on investment (ROI) for each of the following health improvement impacts, first separately and then assuming that all three impacts occur together:

1. decreased age incidence of disease (probability of onset at a given age)
2. delay in progression to more-severe levels of disease, with the assumption that innovations will reduce severity and slow progression
3. improvements in health-related quality of life, with the assumption that reduction in symptoms and more functional independence would account for more QALYs.



How Much Health Improvement?

Given the uncertainty regarding overall health improvements that investment in research can produce, we examined three levels of improvement: 0.01 percent, 0.02 percent, and 1 percent improvement. That is, we estimated the reduced disease incidence, reduced severity, and improved quality of life together to sum to an overall health improvement at these three levels. Results for the lowest level, 0.01 percent, are presented here.

Who Benefits?

The main model assumption was that health improvements for women were three times that of men for a targeted investment in women's AD/ADRD research. Investment in women's health research can be expected to benefit women, but some of the innovation will benefit everyone.

For comparison purposes, we examined results assuming equal health innovation impacts on men and women: i.e., assuming research investments in general research rather than research on women's health specifically. Given the relative lack of attention to women even within gender-neutral research, this assumption likely overestimates the impact on women's health.

Thus, when considering an average health improvement of 1 percent, the equal impact assumes that both women and men realize a 1 percent improvement, whereas the three-times model assumes that

Investment in women's health research can be expected to benefit women, but some of the innovation will benefit everyone.



women realize a 1.5 percent improvement and men realize a 0.5 percent improvement.

Baseline Investment in Women’s Health Research

To estimate the baseline level of research funding for women’s health in AD/ADRD, we retrieved all titles and abstracts in this research portfolio using NIH RePORTER, the publicly available interface of funded extramural NIH projects (NIH, 2020c). The terms used to search the retrieved titles and abstracts to determine the total number of women-focused projects were “women,” “sex,” “gender,” and “female.” Projects without these terms in the title or abstract were excluded from the women-focused research set examined ($N = 56,612$).

The total AD/ADRD project funding level was calculated using the NIH Research, Condition, and Disease Categorization (RCDC) codes (NIH, 2020a). The total funding level in 2019 for AD/ADRD was \$2.398 billion dollars, and 12 percent of that amount was invested in women-focused projects in 2019, according to the method described in this section (NIH, 2020a; Sekar, 2020). Models examined a doubling of the 12 percent. All costs are presented in 2017 U.S. dollars.



Results

We present the health and economic improvements and resulting impact on costs for the primary specification: a 0.01 percent average health improvement, with three times the impact for women as for men. Finally, we present the resulting returns on investment and probability of success necessary to have an expected return on investment of about 15 percent. Complete results are provided in the technical report (Baird et al., 2021).

Impact of Increased Funding of Women’s Health Research on Health and Economic Outcomes

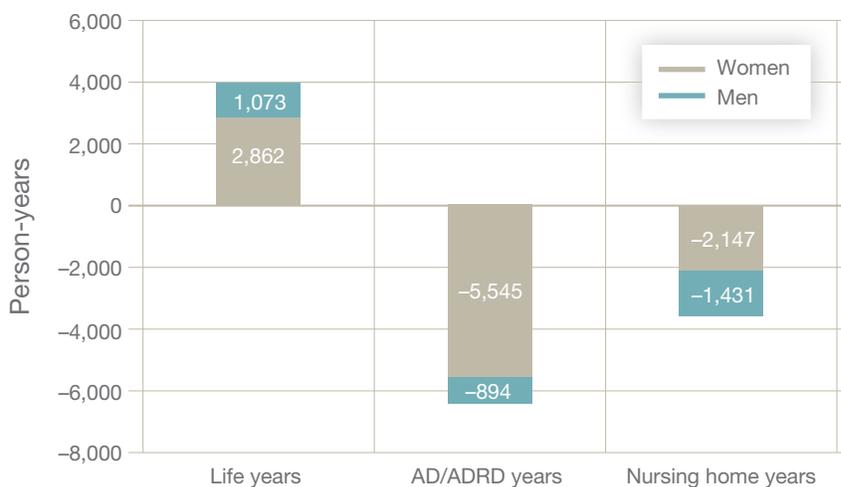
Figure 2 presents results in terms of health and economic outcomes and the resulting impact on costs, using the model cohort and then scaled up to the U.S. population, age 35 and older. This represents approximately 179 million people, of which about 7 million people had AD/ADRD at the beginning of the model time frame.

Increased Life Expectancy

A 0.01 percent health improvement results in nearly 4,000 additional life years, more than 6,000 fewer years with AD/ADRD, and nearly 4,000 fewer nursing home years. Women realize more than 2,800 additional life years from innovations, and men realize more than 1,000 additional life years from innovations.

FIGURE 2

Health and Economic Improvements for U.S. Population Age 35-Plus: Disease Years and Institutionalization



NOTE: Figure represents the U.S. population age 35 and older of about 179 million, of which about 7 million had AD/ADRD.

A 0.01 percent health improvement results in more than 5,500 fewer life years with AD/ADRD for women and nearly 900 fewer life years with AD/ADRD for men.

Decreased Disease Burden

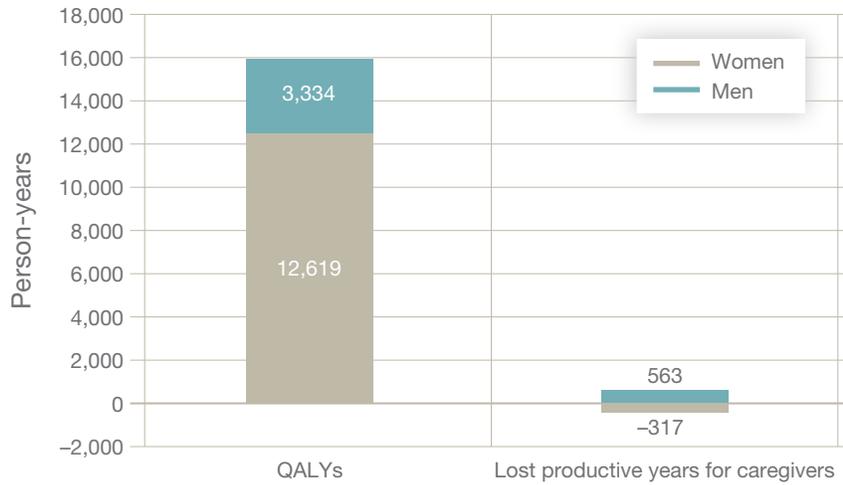
The burden of AD/ADRD disease is reduced with innovations, a function of both a reduction in age incidence—fewer people getting the disease—and a shorter disease duration for those with AD/ADRD because of slowed progression. A 0.01 percent health improvement results in more than 5,500 fewer life years with AD/ADRD for women and nearly 900 fewer life years with AD/ADRD for men.

Reduced Institutionalization

Women have more than 2,100 fewer life years in nursing homes, and men have more than 1,400 fewer life years in nursing homes. Assuming a year of nursing home care costs \$100,000, these 3,500 fewer years represent a cost savings of \$350 million, far exceeding the magnitude of the doubled investment in women’s health research funding (see Figure 3).

FIGURE 3

Health and Economic Improvements for U.S. Population Age 35-Plus: Quality-Adjusted Life Years and Productivity



NOTE: Figure represents the U.S. population age 35 and older of about 179 million, of which about 7 million had AD/ADRD.

Increased Quality of Life

The 0.01 percent health improvement is associated with a large improvement in quality of life, approximately 16,000 additional full life-year equivalents. Unlike the other results, the impact on quality of life results from all three of the health improvements modeled: reduced age incidence, delayed progression, and increased quality of life. That is, delayed disease onset reduces the years of AD/ADRD burden, which increases quality of life (measured in QALYs). Slowed progression of the diseases also improves quality of life because people spend more years in less severe states. Finally, we directly decreased the reduction in quality of life for AD/ADRD patients because of the health improvements, which represent potential innovations that, while not changing the onset or severity of the disease, decrease the burden of the disease for a given severity.

Caregiver Productivity

Lost productive years for those providing informal care shows the impact of reduced institutionalization caused by slowed progression to severe stages, along with the impact of reduced disease age incidence. Of note is that there are approximately 300 fewer lost years of productivity given in care for women as a result of the health improve-

ments, resulting in an overall gain in work productivity for informal caregivers because of the impact of health innovation on women.

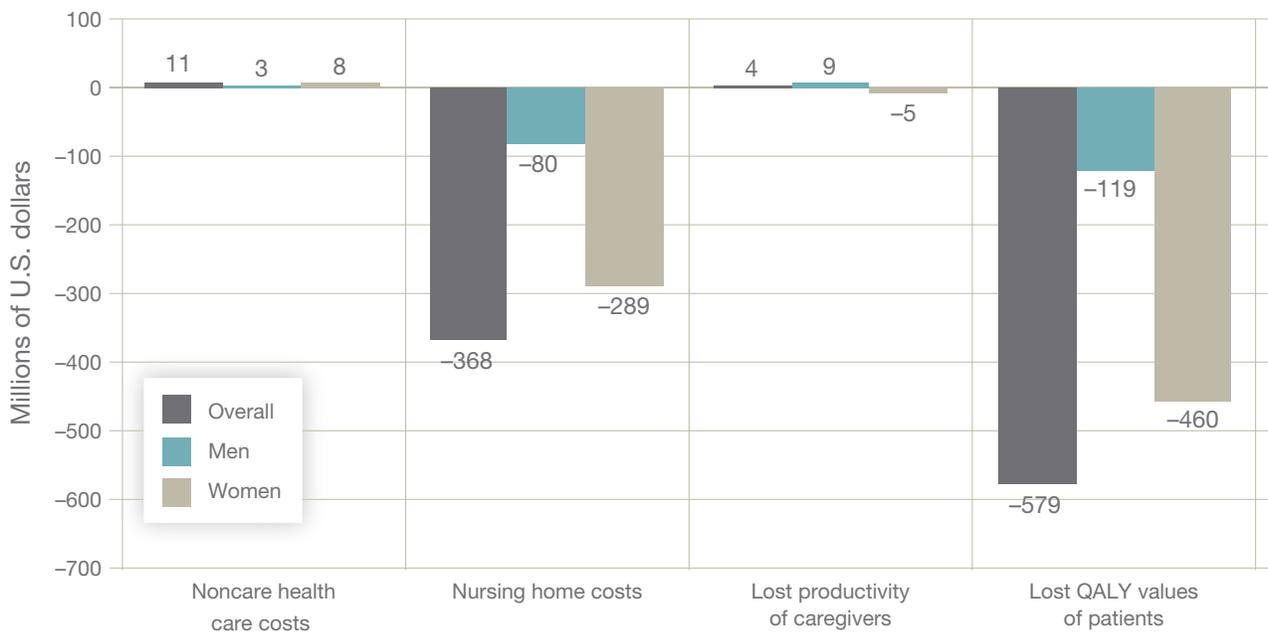
In contrast, informal caregivers lose additional productivity (about 500 years) because of informal care given to men. Assuming that formal health care support for the less severe levels of impairment remains limited, the informal caregivers make up the care shortfall. Because some men are kept out of nursing homes, which would have shifted care to formal caregivers, informal caregivers pick up the increased care need instead. Countering this effect is the smaller number of individuals with the disease, which ultimately reduces overall productivity loss for the informal caregivers.

Impact on Cost Outcomes

Costs associated with the 0.01 percent health improvement vary by sector examined (see Figure 4). This level of research investment in women’s health would yield an overall reduction in costs of about \$930 million over 30 years, in 2017 dollars. Approximately 40 percent of that cost reduction is a result of fewer nursing home stays. Noncare health care costs demonstrate a very small increase as a result of fewer years of formal institutional care. The costs of lost productivity of informal caregivers are also exceedingly small.

FIGURE 4

Change in Costs for 0.01 Percent Health Improvement





What Is the Return on Investment for Funding Women’s Health Research?

According to the model assumptions (doubling the investment in women’s health research within the AD/ADRD portfolio and assuming the small 0.01 percent health improvement), the return on investment is 224 percent. The result suggests that, in the face of large potential gains, an increase in investment may pay off over several decades.



Discussion

Large societal gains may be possible by increasing investment in women’s health research on AD/ABRD. The potential to recognize societal gains is greater for research devoted to women’s health relative to general research, according to the specifications used here. Overall magnitude of impact is in line with similar research on impact of research investment (Luce et al., 2006).

The lack of societal-level evidence on the economic costs, benefits, and social impacts of attention to sex and gender in health research is a major obstacle to moving from policies of passive inclusion to an active focus on the medical gender gap. Research on AD/ABRD to date has yielded some benefits, but lagging attention to women leaves a knowledge gap.

All models involve assumptions. The assumptions used in these models were generally chosen to provide a lower-bound or conservative estimate. For example, the size of the investment increments examined in these models is relatively small, representing an addition to overall research funding of less than 15 percent. The very small health improvements examined here make the direction of impacts robust to smaller overall investments.

These results assumed that dollars invested in women’s health research would yield greater benefits for women than for men but that all people would recognize health benefits from the investment. We made comparisons between an “equal” impact on women and men and a differential impact on women. The status quo investment stance for general research disadvantages women, given the historical use of men as research standards and women as special cases. That is, gender-neutral or gender-inclusive research yields results that are less applicable to women than to men. Assuming that women benefit from women-focused research investment at a rate of three to one compared with men may underestimate the actual benefit to women.

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Estimates for the time from investment to a discernible impact of investment for health research are about 13 to 25 years (Cruz Rivera et al., 2017; Hansen et al., 2013; Scott et al., 2014). Future research may accelerate that timeline. The speed with which treatments and vaccines are being developed to address the coronavirus disease 2019 (COVID-19) pandemic may be a bellwether for research time horizons, demonstrating the potential for shorter timelines for peer review and publication of research results. Finally, these models assume a single cohort without replacement. Although impacts were scaled up to the U.S. population, cumulative impacts of health improvements may be greater longitudinally than presented here, given the movement of individuals over 30 years.

The differential impacts on informal caregiving by gender, in addition to results that vary by size of health improvements, suggest that policies that address the transitions between formal long-term care and informal caregiving deserve close attention when planning for future public health impacts of research investment. Home health reimbursement and workforce readiness may be critical to address if innovations increase the informal care burden by extending time in nonsevere but highly functionally impaired stages. The longer average life span for women may exacerbate the informal caregiving need.

One key consideration when modeling using labor force participation and earnings is the selection of earnings profiles. We chose to apply the earnings of non-Hispanic white males for all races and ethnicities and genders in the informal caregiving population. This has the advantage of avoiding assumed ongoing bias but represents a departure from the strict matching of other economic modeling studies.

Health research investments affect society through many pathways. The models examined here focused on a small but important subset of potential impacts on population health using investment in women's health research. Although a cure and/or preventive intervention may be possible for AD/ADRD over the coming decades, these analyses assume relatively small health impacts from research investment. More-optimistic scenarios are not unreasonable.

Limitations

All microsimulation models involve uncertainty associated with model assumptions. We kept our assumptions as realistic as possible, given the current understanding of disease mechanisms and the near-term outlook for treatments. Disease modification that yields a different severity profile—for example, longer time in moderate-to-severe

stages with reduced mortality—could yield more-negative impacts than those presented here. A preventive intervention or cure is certainly possible as well and could yield more-positive impacts than presented here.

Policy Implications

The results of these analyses suggest several policy actions to inform decisionmaking about research funding allocations:

- ***Direct additional research funds toward women’s health within AD/ADRD.*** The potential for improved return on investment for research directed at women’s health relative to general health research makes such an investment more valuable from a societal perspective. Information about women and AD/ADRD is limited relative to information about men and AD/ADRD. Among the potentially fruitful women-focused research areas that could yield important clinically actionable knowledge are biologically and culturally focused research. Biologically focused research that is likely to uncover new advances includes the impact of hormonal status on AD/ADRD risk and progression, impact of pregnancy factors (parity, hypertensive pregnancy disorders) to AD/ADRD risk, differing profile of cardiometabolic risks, and relationship of mood disorders with higher prevalence in women to AD/ADRD risk (Lin et al., 2014). Among the cultural areas for research that could positively impact AD/ADRD are marital effects and the impact of physical activity and education (Hood, 2017).
- ***Establish research agendas that expand beyond existing work to permit the identification of unstudied and understudied relationships between AD/ADRD in women and other health conditions, such as cardiovascular disease*** (Lin et al., 2014). Women’s health researchers have identified promising “signals” of the relevant effects of health conditions on later life cognition. We recommend focused mining of existing research to inform the agenda for future AD/ADRD research that is likely to yield high-impact results for women.

Broader actions that could improve decisionmaking about research funding involve increasing awareness of the current state of funding directed toward women’s health in AD/ADRD and the potential for such funding to yield a variety of societal benefits. Specifically, we recommend the following:

- ***Increase outreach to multiple research disciplines to raise awareness of the current limitations of knowledge about***



women and AD/ADRD and of the potential for research to yield benefits for women and for society. This step requires an evaluation of the culture of science and the ways in which women's health research is disadvantaged relative to other health research. A key focus of this evaluation must be on the ways in which women's research careers are disadvantaged relative to men's because of family factors, such as a differential caregiving burden for women, and because of systemic factors, such as an implicit and explicit bias against women in health research.

- ***Increase outreach to the business community to raise awareness of the potential return on investment for women's health research.*** It is crucial to address and remedy discriminatory practices in terms of research funding allocations and women's health researcher careers. This alone is not sufficient, however. Raising awareness among business leaders is critical to ensuring a market pull for research, which is necessary for the viability of women's health research agendas and funding. Within the pharmaceutical and biotechnology industry, decisions made by leaders about research investments should be informed by the potential for societal return on investment. Leaders across multiple other business sectors should understand the potential for improving workforce productivity and reducing health care burden associated with AD/ADRD because of research investment in order to inform investment and advocacy for research funding.

Conclusion

Understanding the full range of societal impacts from health research investment requires the consideration of multiple factors and, given the uncertainty of the future, requires assumptions. Differences in etiology, detection, care access, and treatment by sex and gender are well-documented in AD/ADRD and can provide specifics to inform an agenda for research on women's health (Nebel et al., 2018). In conjunction with detailing the research agenda, the financial investment needed to realize the goals of that agenda requires planning. Investing more in research on women's health is likely to deliver net positive societal impacts. A clear understanding of the potential for investment can improve decisions about where and how to invest in order to recognize positive impacts for women and for society as a whole.

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omen's health has suffered from insufficient research addressing women. The research community has not widely embraced the value of this research, and the impact of limited knowledge about women's health relative to men's is far-reaching. Without information on the potential return on investment for women's health research, research funders, policymakers, and business leaders lack a basis for altering research investments to improve knowledge of women's health. As part of an initiative of the Women's Health Access Matters (WHAM) nonprofit foundation, RAND Corporation researchers examined the impact of increasing funding for women's health, beginning with a focus on Alzheimer's disease and Alzheimer's disease-related dementias (AD/ADRD), which result in substantial illness burden, health care costs, caregiving burden, and mortality. In this report, the authors present the results of microsimulation models used to explore the potential for enhanced investment in women's health research, in terms of the economic well-being of women and for the U.S. population.

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