

Women’s Health Initiative (WHI) Extension Study Protocol 2020-2028
May 24, 2021

1. Summary of WHI Extension Study

The Women’s Health Initiative (WHI) Extension Study follows all consenting participants from each of the original WHI study components (randomized clinical trials of a dietary modification, hormone therapy, and calcium and vitamin D supplementation as well as the observational study) for health outcomes. The purpose of extended follow-up is to expand the range of scientific questions that can be reliably addressed in the WHI, to provide an infrastructure able to support additional investigations requiring some of the unique features of a very large longitudinal study of aging in postmenopausal women, and to continue to describe the longer term effects of the original interventions. The Extension Study activities, funded through the National Heart Lung and Blood Institute (NHLBI), were funded for 3 five year periods 2005-2020, and have been extended to continue through January 31, 2026, and potentially beyond, as funding permits. Some streamlining of the program was incorporated in 2010 with operations consolidated primarily into a small number of Regional Centers (RCs) and their satellites along with the Clinical Coordinating Center (CCC). The WHI Extension Study will continue to provide an infrastructure to facilitate the use of data and specimens by WHI investigators throughout the Extension period, by outside investigators through collaboration.

2. Background

The WHI was one of the largest studies on the health of postmenopausal women done to date. Between 1993 and 1998, more than 161,000 women between 50 and 79 years of age joined the WHI which consisted of an Observational Study (OS) involving 93,676 women and a partial factorial Clinical Trial (CT) consisting of three components: a Dietary Modification Trial (DM) with 48,835 participants; a Hormone Replacement Trial (HT) with 27,347 participants, which included an Estrogen plus Progestin (E+P) arm (16,608 participants) and an Estrogen-alone (E-alone) arm (10,739 participants); and a Calcium and Vitamin D Supplement Trial (CaD) with 36,282 participants.

The original protocol indicated that study close-out was to occur between October 2004 and March 2005. Participants in the DM and CaD trials remained on intervention until their last clinic visits during this interval. The E+P intervention was terminated in July 2002 at the recommendation of the WHI Data and Safety Monitoring Board (DSMB), following the findings that risks outweighed the benefits for combined hormone use (The Writing Group for the Women’s Health Initiative, 2002). The E-alone intervention was stopped in March 2004 at the direction of the NHLBI based on an increased risk of stroke and the unlikelihood of being able to establish either CHD benefit or an adverse effect on breast cancer (The Women’s Health Initiative Steering Committee, 2004). Participants in both hormone trials continued to be followed, including annual mammography, through the scheduled close-out visits. Participants in the OS were followed annually by mail until the final cycle of mailings that began in spring of 2004. Details on the design of the WHI, WHI participants, and major study findings for the DM and CaD are described elsewhere (The Women’s Health Initiative Study Group, 1998; Anderson et al, 2003, Prentice et al, 2006a, Beresford et al, 2006, Jackson et al, 2006, Wactawski-Wende et al, 2006; Howard et al, 2006).

Beginning in October 2004, participants were consented for the WHI Extension Study (ES). Overall, 82% of CT participants (52,176) and 73% of OS participants (63,230) agreed to further follow-up (115,406 total). The ES follow-up entailed an annual mailing to obtain self-reported outcomes, hormone use among HT trial participants, and quality of life. Other data collection included a one-time collection of historical diagnoses of Parkinson’s disease and diabetes (ES Year 1), and medication and supplement use during (ES Year 5). Throughout the initial extension period, participants previously randomized to the intervention arm of the DM trial received a quarterly newsletter to promote maintenance of the dietary behaviors taught by the intervention. To assess

dietary intake during this period, random samples of DM participants completed a 24-hour dietary recall in ES Years 1 and 5.

2.1 Considerations for Follow-up of WHI Participants

Continuing high quality clinical outcome ascertainment will increase the range of scientific issues that can be examined. In particular additional follow-up will allow the WHI to address questions related to rarer health conditions and areas important in the research of older women, such as cognition, eye disease, and more. Extended follow-up of the entire WHI cohort contributes to the data investigators are already using to: establish stable estimates of the magnitude of risk factor impact on health in postmenopausal women; identify new risk factors; explore risk factors of uncertain status or factors which have yet to be identified; help elucidate the mechanisms underlying the excess risk of mortality at low levels of weight, cholesterol, and blood pressure; and to examine subgroups of women to determine whether or not the same risk factors operate to the same degree across such subgroups. Most CVD events and deaths occur in older women, women over the age of eighty. This is the most rapidly growing demographic in the US, and WHI has one of the largest cohorts of older women, with over 30% of the 115,000 enrolled in the Extension study having reaching their ninth decade by 2009.

As envisioned, continued follow-up will also provide the basic infrastructure on which additional, high quality investigations can be supported in a cost-efficient manner. Maintaining contact with these long-standing participants and obtaining information on their health status through an efficient nationwide mechanism will create opportunities to explore related topics (e.g., biological mechanisms of disease, predictors of healthy aging) in more depth or to evaluate emerging interventions that may prevent morbidity and mortality in this increasingly important age-group at lower cost.

Additional follow-up will also allow a reliable study of the longer term health benefits and risks of the CT interventions including those that may be affected by study treatments only many years after the initiation of intervention (e.g., mortality), particularly for the hormone therapy trials.

2.2 Considerations for Additional Data Collection from HT Participants

In the first report from post-intervention follow-up for the E+P trial, no statistically significant increased cardiovascular risks were observed in the women assigned to CEE plus MPA as compared to women assigned to placebo, although point estimates suggested the possibility of some continuing adverse effects for stroke and venous thromboembolic disease (Heiss et al, 2008). The protective effect of E+P on fractures had also diminished (Heiss et al, 2008). Evidence of some dilution of E+P effects on breast cancer incidence was observed (Chlebowski et al, 2009) but a greater risk of fatal and nonfatal malignancies occurred after the intervention in the CEE plus MPA group and the global risk index remained significantly elevated in women randomly assigned to the combined hormone group (Heiss et al, 2008). While these reports on the early post-intervention period found few statistically significant effects, longer follow-up is needed to track the trajectory of these effects and determine whether there is persistent harm for stroke, VT, breast cancer and other cancer incidence and mortality as well as to examine any longer term effects of this 5-year intervention on women in their eighth and ninth decade.

Post-intervention follow-up of the E-alone trial has not yet been reported. The profile of E-alone effects observed during the intervention period (The Women's Health Initiative Steering Committee, 2004) was quite different from those observed for E+P (The Writing Group for the Women's Health Initiative, 2002) and there is strong interest in determining whether these differences persist. In particular, the initial E-alone results suggested some reduction in breast cancer risk (Stefanick et al, 2006) which was unanticipated and has led to concern that any such early reduction may be transient and perhaps be followed by elevated risk.

2.3 Considerations for Additional Data Collection from Women of Latina Ethnicity and Black Race

In 2007, NHLBI initiated the SNP Health Association Resource (SHARe) program to create a widely shared resource of genome-wide SNP typing and multiple phenotypes for gene discovery. Beginning in 2008, WHI participated in this program, contributing specimens and data from approximately 9,000 African Americans and 4,000 Hispanic participants to this unique database for the discovery of gene associations with common discrete clinical phenotypes. Because of the large numbers of racial/ethnic minority women participating, WHI will complement substantially the heart failure research in ARIC and Framingham, and the GWAS efforts in other NHLBI cohorts. Continued follow-up of these participants and collection of high quality clinical outcomes data will increase the value of this resource and support the overall mission of SHARe.

Additionally, providing an infrastructure to exploring predictors of health outcomes for women in these groups is of critical importance.

3. Study Objectives

The primary objectives of the continuing WHI Extension Study are:

Objective 1: To study factors leading to an increased risk of CVD in older women of diverse race and ethnicity, including CHD, stroke, heart failure, atrial fibrillation, PAD, and VTE, and conversely to examine the factors that determine absence of CVD as part of successful aging.

Objective 2: To serve as a platform, at low incremental cost, for a new generation of prevention trials of lifestyle interventions or supplements affecting the overall health of older women.

Objective 3: To serve as a platform, at low incremental cost, for studies of the health of post-menopausal women as they age. One study of this sort is the Life and Longevity After Cancer study, an infrastructure study to facilitate future study of cancer survival and survivorship as well as molecular epidemiology of cancer.

To achieve these objectives full outcomes ascertainment and documentation will occur annually in two important sub-cohorts of women—those in the hormone trials, plus African-American and Hispanic women--totaling 22,000 of whom half are over age 80, and 9,000 are racial/ethnic minorities. In addition, self-reported outcomes for the full range of health conditions will be collected annually from the entire cohort to support the same high quality documentation of their outcomes as funding permits. Administrative data from the Center for Medicare and Medicaid Services (CMS) and the National Death Index (NDI) will continue to augment our data repository, allowing for efficient collection of data regarding endpoints of interest that are missed by existing mechanisms. We are additionally working with NAACCR to determine whether the NCI project to provide a national-level platform for efficient cross-registry data provision of data will be a viable option for both the WHI and other large national cohorts.

4. Study Design

4.1 Overview

The original WHI design was composed of two primary study components, a partial factorial randomized clinical trial and an observational study. Women participating in the CT accepted randomization into the DM or HT trials (or both). After one year of CT participation, they were offered randomization into the CaD trial. Women not eligible or interested in the CT were offered enrollment into the OS. For the continuation of the WHI Extension Study, participating women will continue to be associated with the same study component(s) to which they were originally enrolled.

4.2 Study Population

In the original WHI, eligibility and exclusion criteria were as broad as possible to increase the generalizability of the results to the population of postmenopausal women. The original study inclusion criteria were identical for all components and consisted of:

- Age 50-79 years at initial screening
- Postmenopausal
- Expected to live in the same geographic area for 3 years
- Willing to provide written informed consent

Exclusion criteria were specific to each of the components and were related to safety, adherence and retention issues, and competing risks.

The WHI Extension Study includes all participants from the WHI who provide written informed consent indicating their willingness to be followed in the future.

4.3 Outcomes of Interest

To support the broader scientific objectives of the WHI Extension Study, some that are uniquely feasible in a very large study of older women, information on a broad range of health events and conditions will be ascertained through both active and passive follow-up mechanisms. With the increased emphasis on heart disease and aging, several new study outcomes are now included. In most cases, outcomes will be ascertained initially through self-report (or proxy report in the case of death or incapacity).

Medical Records Cohort (MRC): Full outcomes ascertainment and documentation will be conducted in two important sub-cohorts of women: those in the hormone trials plus all African American and Hispanic participants.

Self-Reported Outcomes Cohort (SRC): The remaining WHI Extension Study participants will be followed with outcomes ascertainment limited to self (or proxy) report or passive follow-up sources of information unless or until funding is obtained to collect their medical records.

CMS data: As written into the data use agreement (DUA) between WHI and CMS: “Objective 1: To use Medicare data to enhance and supplement data collected from the WHI (Including WHI Extension Studies) on health outcomes that have already been collected, as well as those not currently collected by WHI” To enhance and supplement our data collected, we can identify potential endpoints using validated algorithms, and then retrieve medical records to confirm these endpoints, as funding is available.

Table 1
Outcomes by Study Component and Level of Information Required for this Renewal
A—Adjudicated medical records; S—Self/Proxy Report/Passive follow-up only;
L—Limited documents reviewed for other events/ICD9/10 coding; M-Medicare-based outcomes

Outcome	Medical Records Cohort	Self-Reported Outcomes Cohort	Trial Outcomes
CARDIOVASCULAR:			
Coronary heart disease	A	S	A/M
Angina	S	S	S
Coronary Artery Bypass Surgery (inpatient)	A	S	A/M
PTCA	A	S	A/M
Heart valve problem/repair*	A	S	S
Abdominal aortic aneurysm*	A	S	S
Stroke	A	A*	A/M
Transient ischemic attacks	S	S	S
Carotid artery revascularization (inpatient)	A	S	S
Heart Failure	A	S	A/M
Venous thromboembolic disease	A	S	S
Peripheral vascular disease	A	S	S
CANCER:			
All sites except non-melanoma skin cancer	A*	A*	A
FRACTURES:			
Hip	A	S	A/M
Other fractures	S	S	S/M
OTHER AGE-RELATED DISEASES			
Chronic obstructive pulmonary disease (COPD)	S	S	S
Diabetes mellitus requiring therapy (insulin, pills, diet)	S	S	S
Hypertension requiring therapy	S	S	S
Intestinal or colon polyps or adenomas	S	S	S
Macular degeneration	S	S	S
Osteoarthritis or arthritis associated with aging	S	S	S
Parkinson's disease	S	S	S
Systemic lupus erythematosus	S	S	S
SOCIAL/PSYCHOLOGICAL CONDITIONS			
Moderate/severe memory problems (dementia/Alzheimer's)	S	S	S
Depression requiring treatment	S	S	S
Anxiety requiring treatment	S	S	S
OTHER			
Selected Hospitalizations for 2+ nights L	S		L/M
Falls	S	S	S
Hysterectomy	S	S	S
Death from any cause	A	S	S

* Funding for cancer adjudications in the SRC comes from NCI as an option to the WHI contract, funding for SRC stroke adjudications comes from NINDS as an option and will be a subset

4.4 Sample Size

The original sample sizes for each study component and each arm of the partial factorial design are shown in *Figure 1*. In 2004-2005, all living WHI participants who permitted study contact were invited to participate in the WHI ES. Over 115,000 participants consented (77% of eligible participants, 71% of original enrollees), resulting in the distribution by study component shown in Figure 1. For the continuation of the Extension Study, all living participants under active surveillance in 2010 were invited to participate in ongoing follow-up. Approximately 86% of those consented to continuing follow-up.

Figure 1
Original and Extension Study Enrollment by Study Component

	CT	OS	Total
Original WHI enrollment	68,132	93,676	161,808
Extension Study enrollment	52,176	63,230	115,406
Extension II Study enrollment	41,499	52,068	93,567

WHI CT Partial Factorial Design

Number of women enrolled in the original trial WHI components (# in parentheses represent CaD trial)

		HT (CaD)					
		Intact Uterus				Not Randomized	
		Yes		No			
		E+P	Placebo	E-alone	Placebo		
		8,506	8,102	5,310	5,429	40,785 (20,193)	
DM (CaD)	Intervention	19,541 (9,645)	972 (596)	925 (577)	615 (371)	670 (430)	16,359 (7,671)
	Control	29,294 (15,565)	1,457 (917)	1,304 (838)	1,039 (639)	1,068 (649)	24,426 (12,522)
	Not Randomized	19,297 (11,072)	6,077 (3,530)	5,873 (3,455)	3,656 (2,064)	3,691 (2,023)	
Total		68,132 (36,282)					

Women consenting to the Extension Study by WHI trial components (CaD enrollment)

		HT (CaD)					
		Intact Uterus				Not Randomized	
		Yes		No			
		E+P	Placebo	E-alone	Placebo		
		6,545	6,243	3,778	3,867	31,743 (16,946)	
DM (CaD)	Intervention	14,769 (7,920)	741 (493)	712 (466)	448 (286)	499 (337)	12,369 (6,338)
	Control	23,089 (13,090)	1,140 (756)	1,028 (714)	753 (494)	794 (518)	19,374 (10,608)
	Not Randomized	14,318 (8,852)	4,664 (2,887)	4,503 (2,817)	2,577 (1,598)	2,574 (1,550)	
Total		52,176 (29,862)					

Power calculations pertinent to the combined CT and OS as a cohort study for a range of sample sizes that may represent either the entire cohort or key component specific or racial/ethnic subgroups are included in Appendix B.

5. Study Plan

5.1 General

All WHI CT/OS participants who re-consented to the Extension Study in 2010 who are still in active follow-up will continue participation in the WHI-ES. Participants will complete annual data collection forms primarily by mail with follow-up for additional details, if needed, typically by phone. Retention efforts will be employed throughout the WHI-ES to maintain contact with participants and encourage continued participation.

5.2 Re-consent

All WHI Extension Study Participants who had not declined further contact were eligible to continue in the WHI-ES. The re-consent process occurred in 2010. In April 2010, the CCC sent the annual study newsletter to participants introducing the continuation of the program, the planned re-organization, and letting them know to expect the consent mailing.

The CCC sent consent packets containing a letter asking her to consider continuing in the study, two copies of the informed consent document, a Personal Information Update form, a Release of Information form, and a self-addressed, postage-prepaid envelope. Consent materials were provided in large print in English or Spanish. A copy of the consent is included in Appendix A. Participants were asked to return one copy of the consent form, the Personal Information Update and the Release of Information to the CCC in the enclosed pre-addressed envelope. Women who did not respond to this mailing within 4 weeks were sent a second consent mailing. A toll-free number was provided for women to call if they have questions.

Women who did not respond to either consent mailing were contacted by telephone by staff from the WHI Field Center responsible for their follow-up. Typically, at least 3 attempts to contact each participant were made by September 30, 2010. If the participant no longer had the consent documents, the Field Center staff arranged for the CCC to mail another packet.

Women who were followed only by phone were contacted first by the responsible WHI Field Center to ascertain interest and willingness to continue. If the woman indicated continuing interest, the Field Center arranged for the CCC to send a consent mailing to her.

This consenting process resulted in consent and continued participation by 93,567 women, which was 86.9% of the 107,706 continuing eligible women who were approached for consent. As of April 2016, when the WHI CCC was funded for the next period of the Extension Study (2015-2020), more than 82,600 participants were continuing their participation in the Extension Study.

5.3 Follow-up

Continuing Extension Study participants are followed annually, primarily by mailed questionnaires from the CCC, to collect data primarily on self-reported health events and related conditions, using a modification of the procedures employed previously. To spread the work evenly throughout the year, approximately one-twelfth of the participants will receive the mailing each month. The contents of the mailing will vary by year, as indicated in Table 2 but will always include Form 33 Medical History Update and a postage-paid envelope.

Follow-up packets returned by the US Postal Service to the CCC with a change of address notification will be sent a personal contact information update form and follow-up packet by first class mail.

Participants with undeliverable packets will be flagged in the Extension Study database for RC follow-up.

Participants will be asked to complete and return their forms to the CCC for scanning. Non-respondents will receive up to one additional mailing from the CCC. Once a sufficient interval after the last mailing has passed with no response, Regional Center (RC) or Outcomes Collection Satellite (OCS) staff will attempt to contact those participants by telephone to collect this information. In addition, RC/OCS staff will also telephone participants who have requested telephone follow-up. RC/OCS staff will be asked to review personal contact information on each such contact.

Because of the nature of the medications and inventory forms, participants will be given an option of completing these by phone or identifying a proxy to complete forms on their behalf. As previously implemented, a toll-free number will be provided with the mailed questionnaire.

Medical Records Cohort Specific Outcomes Collection Activities:

Data from the scanned Form 33 will be made available electronically to Regional Centers for use in their subsequent outcomes documentation efforts. RC/OCS staff will review Form 33 of Medical Records Cohort members for completeness and for potential health events requiring retrieval of medical records. RC/OCS staff will telephone the participant, as needed, to clarify or complete responses on these questionnaires. If the participant has signed the Release of Information located on the back of Form 33, RC/OCS staff will use this form to obtain medical records for the designated events for participants in the Medical Records Cohort. If needed, RC/OCS staff will obtain an institution-specific release of information from the participant. RC/OCS staff will collect outcomes documentation and then assemble them into packets. They will label each document with the participant’s study ID, electronically scan the entire outcomes packet, remove all confidential identifiers, and forward the scanned documents to the CCC for review and subsequent adjudication according to existing procedures for adjudicating cases.

Self-reported Outcomes Cohort Specific Outcomes Collection Activities:

Data from the scanned Form 33 will be stored at the CCC for use as self-reported events. If funding becomes available, documentation and adjudication as described for the Medical Records Cohort may be implemented for selected outcomes or selected participants. Contract options fund all cancer adjudications in this group, and a subset of roughly 75-80% of stroke adjudications in this group

Medicare data-based Outcomes Collection Activities:

Various outcomes of interest can be characterized with moderate sensitivity and specificity using algorithms that incorporate combinations of codes from the Medicare data. If funding becomes available, documentation and adjudication as described for the Medical Records Cohort may be implemented for selected outcomes or selected participants, to validate outcomes detected through the use of algorithms applied to the Medicare data.

Passive Follow-up: At regular intervals, the CCC will obtain information on vital and health status for the entire cohort, as applicable, through accessing national databases such as the National Death Index (NDI), the Center for Medicare and Medicaid Services (CMS), cancer registries, and large health maintenance organizations such as Kaiser Permanente.

Table 2: Data collection schedule⁸

Form#	Data collection	2020-2021	2021-2022	2022-2023	2023-2024	2024-2025
33	Medical History Update	X	X	X	X	X

151A	Activities of Daily Life +		X		X	
151B	Activities of Daily Life +	X		X		X
COVID	COVID follow-up			X		
301	Long Life Study 2		L	L		

X = Extension participants; L = Long Life Study 2 participants

5.5 Retention

Retention of study participants is an important focus after the participant is enrolled in the Extension Study. During the Extension, several retention activities used during WHI will continue, including an update of contact and proxy information at the time of reconsent, annual participant newsletters, updates of the participant's address provided by the US Post Office, regular review of contact information on all phone contacts.

Participant newsletter

The CCC will send all participants an annual WHI newsletter. The newsletter will present WHI news and lay versions of results, and will support retention through promotion of participant identification with WHI and address maintenance. To help maintain contact, the newsletter will be mailed by the CCC approximately 6 months before/after the annual data collection packet.

Maintaining current contact information

All CCC mailings to participants will be imprinted with the CCC's return address and include a line requesting address corrections. The US Post Office will notify the CCC if the participant is deceased, if the packet is undeliverable to that address, or with information on a new address. For address corrections, CCC staff will update the participant's address in the database and mail a new packet to the participant, along with a Personal Information Update. Participants will be asked to review and update their contact information and to return it to the CCC. If the current address is undeliverable or the participant is deceased, this information will be noted in the database for use by RC/OCS staff. RC/OCS will use those methods developed in WHI to trace participants with undeliverable addresses to obtain new contact information. No additional mailings will be sent to a participant until the undeliverable address is corrected.

At each telephone contact with participants, RC/OCS staff will review and update the participant's address, phone number(s) and other contact information in the Extension Study database.

Data collection by proxy

Because of a participant's illness, disability, or death, follow-up contacts may need to be conducted by proxy. RC/OCS staff will be responsible for assessing the need to use a proxy respondent and noting this in the Extension Study database. Based on these database flags, the CCC will send the participant forms packet to the proxy contacts previously identified by the participant.

Participant webinars

In the current extension, we have initiated webinars recounting the data collection and analysis of WHI data to engage participants in the impact of their participation in the study. These will initially be monthly, but attendance and feedback will determine the frequency henceforth.

6. Study Operations

6.1 Data Management

For usual data management and communication purposes, each Regional Center and Outcomes Collection Satellites will provide their own personal computers with Windows 7, Internet Explorer 10, and office applications, and reliable and continuous access to the Internet. A small network printer and scan guns are also recommended at each site.

The CCC will provide each Regional Center and their Outcomes Collection Satellites a complete scanning system for electronically scanning outcomes documentation. This system will include a PC,

scanning software and a scanner which will be shipped first to the CCC for configuration and then to the RCs. This system will need to reside on the parent institution network with reliable and continuous access to the Internet.

The CCC will maintain a central repository of all WHI and Extension Study data. For the Extension Study, a central Oracle database will be made accessible by RC/OCS staff over the World Wide Web. Each RC/OCS will be granted access to confidential data only from participants for whom they are responsible for tracking and reporting.

All routine data will be collected and entered using standardized data collection forms. Optical scan formatted forms (e.g., *Form 33—Medical History Update*, *Form 151—Activities of Daily Living Form*) returned to the CCC will be scanned and imaged at the CCC and the data and images will be provided in electronic format to the RC/OCS as needed for their use in subsequent steps of outcomes documentation. Forms 153 and 154 will be data entered at the CCC. Forms used directly by staff (e.g., *Form 7—Participation Status*), will be key entered by staff into a central database using data entry screens developed and provided by the CCC.

For putative heart failure events, the CCC will provide electronic copies of the assembled medical records to the central record abstraction site at University of North Carolina at Chapel Hill. Trained medical records abstractors will review these records and complete the data collection tool with on-entry editing, using ongoing training, re-certification and quality control protocols. Once medical record abstraction is complete, electronically generated summaries of abstracted medical record information, together with scanned portions of the pertinent medical record will be provided to the CCC for distribution to event adjudicators.

Adjudication forms will be completed by adjudicators and preferably entered directly through a web-based application or hard copy will be returned to the CCC for key-entry.

6.2 Quality Assurance

The quality of study-wide operations, data, and products will be assured by clear and complete documentation, central and local training and certification, routine reports, and task specific quality assurance measures (e.g., chart audits, duplicate data entry) as deemed appropriate by the CCC, the Steering Committee (SC) and its subcommittees and the NHLBI Project Office. The training and certification required for each study task is described in Extension Study Manual. In addition the CCC will perform cross-sectional and longitudinal edits of the central database. Data queries resulting from these edits, and from reporting and analysis activities, will be submitted to the RC/OCS for resolution, and a systematic means of updating the central database based on their responses will be established. Standards for performance will be proposed by the Performance Monitoring Committee (PMC), approved by the Steering Committee, documented in Extension Study Manual, and monitored by the PMC. Regional Centers or Outcomes Collection Satellites determined to be operating below acceptable performance levels will be required to submit plans for remedial action to the PMC for approval and will be subject to more frequent monitoring and other actions determined by the PMC and/or the NHLBI to be needed to assure adequate data collection.

6.3 Outcomes Adjudication

For purposes of attaining high quality outcome data consistent with the previous study period, outcomes ascertainment, documentation, and adjudication will follow the procedures developed for the WHI (Curb et al, 2003) and modified for the Extension Study in 2005. Each documented case of cardiovascular disease, hip fractures or death in the Medical Records Cohort will be assigned to an experienced WHI adjudicator for review and coding. For all cancers in the Medical Records Cohort, the outcomes packet will be submitted to the CCC for coding of detailed tumor characteristics by a qualified SEER coder. Strokes will be adjudicated by established central adjudicators at NIH. A standardized training in WHI adjudication will be required whenever a new adjudicator is added.

Heart failure cases will be forwarded to the Heart Failure coding center for abstraction prior to adjudication. The specifics for each scheme of adjudication within the cardiovascular, cancer, and fracture outcomes are detailed in the Extension Study Manual. If additional funding becomes available to document outcomes in the Self-reported Outcomes Cohort, the same adjudication procedures will be used.

7. Study Monitoring and Data Analysis

7.1 General

Progress in the Extension Study will be monitored in several ways: reports on consent, response to annual mailings and phone follow-up contacts, completeness and timeliness of data collection, and accrual of key study outcomes. The CCC will provide regular reports to the Steering Committee and the RC/OCS, as well as to the Data and Safety Monitoring Board (DSMB) and the NHLBI. Reports on event rates by randomization group in the CT will be provided annually to the DSMB. These reports will provide the basis for considerations of remedial actions or protocol changes and for considerations of directed publications and notifications to participants.

7.3 Adherence to Follow-up Procedures

Completeness of data collection will be routinely reported by follow-up year and data collection form. Submission of Form 33 will serve as the primary indicator of participant retention and adherence to follow-up.

A well-defined reporting system has been developed to document the completeness and timeliness of outcomes processing in the WHI. RC/OCS performance reports will reflect the timeliness and completeness of the process initiated at the time that the *Form 33—Medical History Update* form is entered into the Extension Study database and becomes available for RC/OCS processing. Timeliness and completeness of outcomes packet formation and submission to the CCC will be the primary areas of review. Timeliness of cancer coding and adjudication of other outcomes will also be monitored. The PMC will review outcomes performance reports prepared by the CCC and the overall timeliness of outcomes processing and monitoring.

7.4 Analyses of the WHI cohort

The original purpose of the WHI Observational Study was to establish a resource in which risk factors for the major causes of death and disability in postmenopausal women could be examined. With the termination and unblinding of the Clinical Trial interventions, the entire cohort of WHI participants can be used for this same purpose, expanding the sample size available for many studies. These joint analyses are facilitated by the fact that these study populations were recruited and followed in parallel by the same investigators and institutions using primarily the same data collection protocols and instruments.

The ability to estimate relative risks reliably for the outcomes of interest in the WHI as a function of baseline characteristics (exposures, behaviors or biologic measurements), or as a function of changes in such characteristics between baseline and one or three years is dependent on the accurate measurement of the characteristics (and outcomes) under study, and the accurate ascertainment and proper accommodation of all pertinent confounding factors. Even measurement error that is nondifferential in the sense that it is unrelated to disease risk given the 'true' characteristic values, can severely attenuate or otherwise distort relative risk estimates. Since many of the characteristics ascertained (e.g., blood analytes, nutrient intakes, blood cholesterol) are subject to noteworthy measurement error, a stratified 1% random subsample of the OS women had repeat baseline information and specimens obtained at between one and three months following their OS enrollment, and again at between one and three months following their three year clinic visit. This reliability subsample provides information of the reproducibility of the measurements taken (Langer et al, 2003), and can be used, under classical

measurement error assumptions, to correct relative risk estimates for non-differential error in predictor and confounding variables. The 1% reliability sample was stratified on age, racial/ethnic group, and socioeconomic group. The size of the WHI study population, and the comprehensive set of measurements obtained allow a particularly thorough accommodation of confounding, by means of individual matching, stratification or regression modeling. Since, the measurement properties of some exposures of interest (e.g. self-reported nutrient consumption; self-reported physical activity patterns) involve more measurement error properties that are more complex than those acknowledged by the classical measurement model, including important systematic biases, WHI investigators have carried out nutrition and physical activity biomarker studies in subsets of WHI cohorts. These biomarker sub-studies have potential to yield calibrated exposures throughout WHI cohorts for some nutrients and for activity-related energy expenditure. A substantial number of reports have been published in recent years using this calibration approach (e.g. Neuhouser et al, 2008; Prentice et al, 2009) and several other applications are underway. The WHI is in a unique position to lead a new cycle of more reliable association studies in the important diet, physical activity, and energy balance areas of epidemiology, during upcoming years.

Relative risk regression methods (e.g., Cox, 1972) will continue to provide the primary data analytic tool for the observational analyses. These methods, which can be thought of as an extension of classical person-year methods that avoids the assumption of constant disease risk for a study subject across the follow-up period, allow flexible modeling of the risks associated with the characteristics under study, as well as flexible accommodation of potential confounding factors, by means of stratification, matching, or regression modeling. Though less well developed they can also accommodate the types of reliability sample alluded to above (e.g., Prentice, 1982.; Pepe et al, 1989; Espeland et al, 1989; Liu and Liang, 1992), in order to produce 'deattenuated' relative risk estimates. Finally, relative risk regression methods are also readily adapted to accommodate nested case-control (Liddell et al, 1977; Prentice and Breslow, 1978) and case-cohort (Prentice, 1986) sampling schemes.

Nested case-control sampling typically proceeds by selecting for each 'case' of a study outcome one or more 'control' women who have not developed the disease in question by the follow-up time at which the corresponding case was ascertained. Additional matching criteria may include baseline age, clinic, and date of enrollment and study arm(s), and depending on the analysis may also include racial/ethnic or socioeconomic group, history of study disease, or other factors. Nested case-control or case-cohort sampling provides the principal practical approach to reducing the number of women whose blood specimens need be analyzed and processed, if the measurements of interest cannot be assumed to be stable over time. For example, certain of the antioxidant concentrations to be measured in blood specimens are known to substantially degrade over the course of a few months or years of storage, in which case the follow-up-time-matched aspect of the nested case-control approach is essential to valid relative risk estimation. For measurements that are stable over time, however, case-cohort sampling could provide an alternative that has some decided advantages. Case-cohort sampling involves the selection of a random, or a stratified random, sample of the cohort to serve as a comparison (control) group for the cases of all the outcomes under study.

Analyses that relate change in risk factors to disease risk have particular potential for gaining insight into disease mechanisms. For example, the OS provides a valuable forum for addressing the issue of whether or not the association between low blood cholesterol (e.g., <160 mg/dl) and excess non-cardiovascular mortality derives primarily from persons who have experienced major reductions in blood cholesterol over the preceding three years. In fact the OS is large enough that such an analysis could be restricted to women with relatively low baseline blood cholesterol (e.g., lowest two quintiles) in order to avoid a complicated interpretation if the effect of interest happened to 'interact' with baseline cholesterol measurement. Furthermore the OS, by virtue of ascertaining a range of non-specific markers of debility or disease (e.g., serum albumin, hemoglobin; cancer biomarkers; baseline and follow-up disease prevalence by questionnaire and physical exam) may be able to examine whether the excess mortality associated with reduced blood cholesterol can be explained by the presence of recognized or latent disease. The careful accommodation of measurement error in

predictor and confounding variables is particularly important in such risk-factor-change analyses. In recent years WHI cohorts have been extensively genotyped, and the WHI resource has contributed to many new findings of genotype associations with disease risk. Because these associations mostly involve very small hazard ratios, much of this work has taken place in a collaborative mode with other major US and international cohorts.

Appendix 3 of the original WHI protocol provides power calculations for OS analyses as a function of disease rate, exposure frequency, relative risk, follow-up duration and, importantly, as a function of subsample sizes corresponding to racial/ethnic, age, and other important OS subgroups, many of which can be applied to subgroups of the larger WHI cohort.

7.5 Analyses of the Clinical Trials

Further analyses of intervention effects on the defined primary and secondary endpoints of each trial using post-intervention data will include both cumulative effects examining the entire interval since randomization and analyses limited to the post-intervention period. The primary analysis strategies will be informed by those of the original protocol, under the intention-to-treat framework and will employ either the unweighted or weighted (2-sided) log rank statistic as originally described (The Women's Health Initiative Study Group, 1998). Such a statistic can be written

$$T = \sum w_i (O_i - E_i)$$

where w_i is the value of the weight function evaluated at the i^{th} largest time from randomization to clinical outcome event among women in both groups, O_i is one or zero depending on whether the outcome occurred in a woman in the treated group or not, and E_i is the conditional expected value of O_i , under the null hypothesis of no treatment effect. If V_i represents the conditional variance of O_i , then it follows from the uncorrelatedness of the elements of this summation that the variance (2) of T is estimated by $2 = \sum w_i^2 V_i$ and the test for differences between groups is then made by referring $T/2$ to the 95th percentile of a chi-square distribution on one degree of freedom.

The weighting was intended to enhance test power under the expectation that intervention versus control disease incidence ratios increase in absolute value approximately linearly as a function of time since randomization. The weights w_i were chosen to equal time from randomization up to a disease-specific maximum (three years for cardiovascular disease and fracture occurrence, 10 years for cancer occurrence and total mortality) and to be constant thereafter. Because this assumption was supported in some instances in the hormone trials and not in others, both weighted and unweighted statistics will be used, with unweighted statistics as the default test statistics unless a prior evidence had suggested otherwise (e.g., for effects on cancer incidence). In analyses of post-intervention effects, unweighted time to event analyses will be conducted, typically using date of the close-out visit (or date of official notification of study closure for the HT trials) as the "time zero" for these analyses.

Analyses of intervention effects will typically be stratified on baseline age (50-54, 55-59, 60-69, 70-79), and self-reported prevalent disease (if applicable) for that outcome, and the categories of the other interventions. The primary HT comparisons will be examined separately based on baseline WHI hysterectomy status.

To assess potential selection bias among Extension Study participants relative to the initial trial cohort, comparisons of demographics, health history, adherence to intervention and key outcome event rates will be made between Extension Study enrollees and non-enrollees using data from the initial WHI database. If an assumption of no selection bias is supported, women who did not consent to the Extension Study will be censored at their last follow-up contact during the original WHI study, except for total mortality analyses where vital status information will be obtained from the NDI. Methods to account for non-representative enrollment using inverse sampling probability weighted tests may be employed if there is evidence of noteworthy selection in Extension Study enrollment.

All analyses of clinical trial results will be reported as two-sided tests with acknowledgement of multiple testing issues, either by appropriate adjustment of p-values and confidence intervals or by an acknowledgement of the number of tests performed.

More detailed explanatory analyses will include tests for group differences with concomitant adjustment for covariates, as well as explanatory analyses that examine the extent to which an intervention benefit can be explained by changes in intermediate variables and outcomes (e.g., nutritional and biochemical measurements). These analyses will be conducted using relative risk regression methods, with appropriate account of measurement error in the intermediate variable measurements as necessary, using data obtained in the aforementioned reliability sub-study. Nested case-control and case-cohort sampling procedures (see next subsection) will be used in most such analyses since stored materials used to determine intermediate variable values will not be routinely analyzed for the entire CT cohort.

7.6 Statistical Considerations for High Dimensional Data

The analysis of high-dimensional data, especially as generated by genetic and proteomic (nested case-control) studies, requires particular care. Typically laboratory assays used to generate these types of data have high run-to-run variability, and appropriate use of normalization techniques is critical. This is true both for “gene-chips” used for genome-wide association studies, large scale genome-wide studies used to study smaller number of variants, and sequencing and proteomic technologies, although the actual type of normalization differs between different technologies.

Several of these technologies use “labeling approaches”, where two samples are assayed simultaneously and the resulting data are compared between the two samples. For such assays it is critical that either the labeling is randomized, or that it is balanced between cases and controls. For some technologies the amount of missing data can be substantial and assuming the design is balanced is not sufficient in the analysis. Instead, labeling should be properly accounted for in the analysis.

Genetic data has by design a substantial amount of built-in quality control that can be exploited in the analysis. Genetic examples include Hardy-Weinberg equilibrium, especially for control subjects of a single race/ethnicity, and comparisons of minor allele frequencies between the study subjects and publicly available databases, such as HapMap. For many technologies the amount of missing data over the all measurements, e.g. genes, is a good indicator of the reliability of the non-missing measurements on the same subject, and minimum completion quality standards are critical to data quality.

Most proteomic ‘discovery’ data generated in WHI derive from mass spectrometry-based technologies. Valuable standardization can be achieved by isotopic labeling (e.g with heavy or light acrylamide, which binds to cysteine residues in proteins/peptides) of the samples to be compared (e.g. cases of a given disease versus corresponding matched controls), thereby focusing on relative rather than absolute protein abundance estimation. Since the number of differences (out of a few hundred proteins quantified) is typically expected to be small in such comparative studies, which may involve the use of pooled plasma or serum for reasons of throughput, useful normalization can be achieved by shifting the log-concentration ratios in a given experiment to have a median of zero. Additional important quality control can be achieved by imposing stringent standards for peptide and protein identification, and by allowing for any differential labeling effects through random assignment of labels to case and control specimens, and through formally allowing for label effects in regression analyses.

For high-dimensional technologies typically many tests are carried out simultaneously. It is critical that in these situations there is appropriate control for multiple comparisons. Such a control can be done using a Bonferroni correction, by computing appropriate False Discovery Rates (FDR), or sometimes using permutation tests. An additional approach may be to tests groups of genes or proteins in the form of pathway analysis. WHI-related statisticians are actively engaged in the

development of efficient methods for gene/protein set analytic methods that are suited to application in genomic and proteomic studies.

Replication of these results in independent datasets is one of the most important methods for assuring validity of these findings. These studies may be conducted with WHI, where feasible, or often may involve collaboration with other studies. WHI data may also be used to validate the results arising from other such studies.

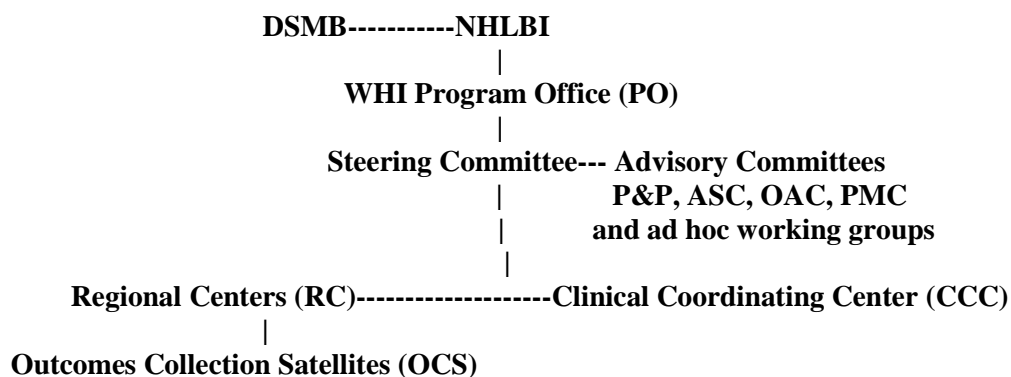
8. Ancillary Studies

Ancillary studies entail the collection of data or specimens from study participants, or the conduct of additional analyses of existing materials or samples, that are outside the specific scientific objectives of the parent study. Ancillary studies must not interfere with the basic objectives of the Extension Study. Proposed ancillary studies will have a separate protocol which will be reviewed in regard to impact on ongoing elements of the program, and for scientific merit, initially by the Ancillary Study Committee (ASC), and following a favorable recommendation, approved by the Steering Committee (SC) and the NHLBI Project Office. All such efforts must undergo separate review by the institutional review boards of the institutions participating operationally in the study, other than expanded medical records collection activities at the Regional Centers which operate under the review of the Fred Hutchinson Cancer Research Center as the IRB or Record for these activities. A separate informed consent may be required. If separate consents are required, the consent forms must be approved by the ASC and submitted to the CCC. Approved ancillary studies requiring separate informed consents will be submitted to the DSMB for notification or review according to existing NHLBI policies. External funding will typically be required.

9. Study Organization

The study organization includes the Program Office at the National Heart Lung and Blood Institute (NHLBI), a small number of Regional Centers (RCs) and their associated Outcomes Collection Satellites (OCS), and the Clinical Coordinating Center (CCC). To promote continued involvement of a broad range of investigators, WHI Committees will draw their membership and leadership from the former WHI Field Centers as well as participating investigators and staff within continuing institutions. A streamlined governing structure will include a Steering Committee (SC), an Ancillary Study Committee (ASC), a Publications and Presentations Committee (P&P), an Outcomes Adjudication Committee (OAC), and a Performance Monitoring Committee (PMC). An external committee, the Data and Safety Monitoring Board (DSMB), reports directly to the NHLBI. Aspects of the study organization are shown in *Figure 2*. Details of the governance plan will be documented separately.

Figure 2
Organization of the WHI Extension Study



9.1 Program Office

The WHI Extension Study is being conducted out of the Epidemiology Branch in the Division of Cardiovascular Sciences, NHLBI. The NHLBI Project Office oversees technical aspects of the program, and the Contracts Office oversees fiscal aspects.

9.2 Clinical Coordinating Center (CCC)

The Clinical Coordinating Center will develop an initial and final Protocol; develop a procedures manual, data collection forms and other study materials in collaboration with other study units; re-consent participants into the Extension Study; provide training and other resources to Regional Center staff for outcomes collection processes; conduct centralized mailings and data collection for extended follow-up; document outcomes for participants assigned to be followed by the CCC, coordinate medical records abstraction, outcomes adjudication and coding; redevelop and deploy modified information technologies consistent with the ongoing study needs; provide regular reports on study progress; provide statistical support for the analyses of study results; lead and support scientific initiatives using the WHI resource; participate in study governance.

9.3 Regional Centers (RC)

Because the outcomes documentation process will now be limited to participants in the Medical Record Cohort, reducing the overall effort, the operations of the 40 former Field Center operations will be consolidated into a small number of Regional Centers and the Coordinating Center. The Regional Centers will be responsible for documenting outcomes and for advancing science--including mentoring new investigators. To facilitate efficient collection of outcomes documentation, Regional Centers may contract with former Field Centers to conduct data collection for a defined subset of participants. For purposes of data collection these Outcomes Collection Satellites will assume the responsibilities of the Regional Center for the assigned participants.

Regional Centers and Outcomes Collection Satellites will ascertain clinical outcomes; accumulate and maintain participant files in a secure fashion; use the CCC-developed study database to enter and manage all participant data collected locally; and perform study procedures according to protocol. In addition Regional Center investigators will participate in reporting on all phases and activities of the program, lead and support scientific initiatives using the WHI resource and participate in study governance.

9.4 Steering Committee (SC)

The Steering Committee serves as the primary decision making body and communication link for study investigators. The SC oversees and coordinates the activities of the other committees and working groups. Membership is composed of four Regional Center PIs, four other regional representatives, four chairs of other standing committees, one representative from the NHLBI Project Office, and two from the CCC.

9.5 Ancillary Study Committee (ASC)

The Ancillary Study Committee will advise on policies and procedures with respect to ancillary study activities and will review all WHI proposals for ancillary studies, and will provide expertise on study design and analysis, as needed. The ASC will ensure that proposals seeking access to specimens have adequate scientific merit, make efficient and appropriate use of biospecimens, and are consistent with the mission of WHI.

9.6 Publications and Presentations Committee (P&P)

The Publications and Presentations Committee advises on policies and procedures related to publications and presentations from the main study and ancillary studies, encouraging the

development of manuscripts and presentations, review investigator-initiated manuscript proposals and abstracts, facilitate fairness in determination of authorship, review and approve final manuscripts for publication, and track and report on the progress of manuscript development. The P&P will also advise on what data if any, can be released to non-WHI investigators prior to their publication.

9.7 Outcomes Adjudication Committee (OAC)

The Central Adjudication Committee will oversee adjudication of clinical outcomes, advise on outcomes associated data collection and clinical outcome coding, advise on new findings in the literature, and provide input to the Performance Monitoring Committee.

9.8 Performance Monitoring Committee (PMC)

The Performance Monitoring Committee will be responsible for monitoring study performance in outcomes collection processes including timeliness and completeness of Form33 follow-up and timeliness of outcomes documentation.

9.9 Other Leadership and Committee Activities

The Steering Committee will establish working groups or task forces to address specific needs as they arise. Membership will be drawn from the Extension Study investigators, supplemented by outside researchers as needed to supply relevant expertise. These groups will exist on a time limited basis for the performance of the charge established by the SC.

9.10 Scientific Interest Groups (SIGs)

The purpose of WHI Scientific Interest Groups is to optimize the use of the WHI resource by stimulating scientific exchange and encouraging collaboration. These groups may be formed around different types of foci, including disease entities, scientific disciplines, exposures or interventions. Formation of a Scientific Interest Group for a new topic area requires approval of the Steering Committee. Participation in Scientific Interest Groups is voluntary and is not required for proposing or conducting manuscripts or ancillary studies related to those topics.

9.11 Data and Safety Monitoring Board (DSMB)

As a change from the previous Extension Study, the DSMB will replace the functions of the former Observational Study Monitoring Board, and will review study activities and data to provide guidance as to the ethical conduct of the WHI. The DSMB, which also serves in this capacity for the WHISH physical activity trial, meets semi-annually to annually, either in person or by conference call and reports to the NHLBI.

10. Timetable

Follow-up data collection	Annual
Close-out	Dependent on future funding
Data Analysis	Ongoing

REFERENCES

- Anderson GL, Manson J, Wallace R, et al. Implementation of the Women's Health Initiative study design. *Ann Epidemiol* 2003;13:S5-S17.
- Beresford SA, Johnson KC, Ritenbaugh C, et al. Low-fat dietary pattern and risk of colorectal cancer: The Women's Health Initiative Randomized Controlled Dietary Modification Trial. *JAMA* 2006;295(6):643-54.
- Chlebowski RT, Kuller LH, Prentice RL, et al. Breast cancer after use of estrogen plus progestin in postmenopausal women. *N Engl J Med* 2009;360(6):573-587.
- Cox DR. Regression models and life-tables (with discussion). *J R Stat Soc B* 1972;34:187-220.
- Curb D, McTiernan A, Heckbert SR, et al. Outcomes ascertainment and adjudication methods in the Women's Health Initiative. *Ann Epidemiol* 2003;13:S122-S128.
- Espeland MA, Platt OS, Gallagher D. Joint estimation of incidence and diagnostic error rates from irregular longitudinal data. *J Amer Statist Assoc* 1989;84:972-79.
- Heiss G, Wallace R, Anderson GL, et al. Health risks and benefits 3 years after stopping randomized treatment with estrogen and progestin. *JAMA* 2008;299(9):1036-45.
- Howard BV, Van Horn L, Hsia J, et al. Low-fat dietary pattern and risk of cardiovascular disease: The Women's Health Initiative Randomized Controlled Dietary Modification Trial. *JAMA* 2006;295(6):655-66.
- Jackson RD, LaCroix AZ, Gass M, et al. Calcium plus vitamin D supplementation and the risk of fractures. *N Engl J Med* 2006;354(7):669-83.
- Langer RD, White E, Lewis CE, et al. The Women's Health Initiative Observational Study: Baseline characteristics of participants and reliability of baseline measures. *Ann Epidemiol* 2003;13(9S):S107-S121.
- Liddell FDK, McDonald JC, Thomas DC. Methods for cohort analysis: appraisal by application to asbestos mining data [with discussion]. *J R Roy Stat Soc A* 1977;140:469-90.
- Liu X, Liang KY. Efficacy of repeated measures in regression models with measurement error. *Biometrics* 1992;48:645-54.
- Neuhouser ML, Tinker L, Shaw PA, et al. Use of recovery biomarkers to calibrate nutrient consumption self-reports in the Women's Health Initiative. *Am J Epidemiol* 2008;167(10):1247-59.
- Pepe MS, Self SG, Prentice RL. Further results on covariate measurement errors in cohort studies with time to response data. *Statist in Med* 1989;8:1167-78.
- Prentice RL. Covariate measurement errors and parameter estimation in Cox's failure time regression model. *Biometrika* 1982;69:331-342.
- Prentice RL. A case-cohort design for epidemiologic cohort studies and disease prevention trials. *Biometrika* 1986;73:1-11.
- Prentice RL, Breslow NE. Retrospective studies and failure time models. *Biometrika* 1978;65:153-158.
- Prentice RL, Langer R, Stefanick ML, et al. Combined postmenopausal hormone therapy and cardiovascular disease: Toward resolving the discrepancy between observational studies and the Women's Health Initiative clinical trial. *Am J Epidemiol* 2005;162(5):404-14.

Prentice RL, Caan B, Chlebowski RT, et al. Low-fat dietary pattern and risk of invasive breast cancer: The Women's Health Initiative Randomized Controlled Dietary Modification Trial. *JAMA* 2006;295(6):629-42.

Prentice RL, Langer RD, Stefanick ML, et al. Combined analysis of Women's Health Initiative observational and clinical trial data on postmenopausal hormone treatment and cardiovascular disease. *Am J Epidemiol* 2006;163(7):589-99.

Prentice RL, Chlebowski RT, Stefanick ML, et al. Conjugated equine estrogens and breast cancer risk in the Women's Health Initiative clinical trial and observational study. *Am J Epidemiol* 2008;167(12):1407-15.

Prentice RL, Chlebowski RT, Stefanick ML, et al. Estrogen plus progestin therapy and breast cancer in recently postmenopausal women. *Am J Epidemiol* 2008;167(10):1207-16.

Prentice RL, Pettinger M, Beresford SA, et al. *Cancer Epidemiol Biomarkers Prev* 2009;18(5):1531-7.

Prentice RL, Shaw PA, Bingham SA, et al. Biomarker-calibrated energy and protein consumption and increased cancer risk among postmenopausal women. *Am J Epidemiol* 2009;169:977-89.

Stefanick ML, Anderson GL, Margolis KL, et al. Effects of conjugated equine estrogens on breast cancer and mammography screening in postmenopausal women with hysterectomy. *JAMA* 2006;295(14):1647-57.

Wactawski-Wende J, Kotchen JM, Anderson GL, et al. Calcium plus vitamin D supplementation and the risk of colorectal cancer. *N Engl J Med* 2006;354(7):684-96.

The Women's Health Initiative Steering Committee. Effects of conjugated equine estrogen in postmenopausal women with hysterectomy. The Women's Health Initiative randomized controlled trial. *JAMA* 2004;291(14):1701-12.

The Women's Health Initiative Study Group. Design of the Women's health Initiative clinical trial and observational study. *Control Clin Trials* 1998;19:61-109.

The Writing Group for the Women's Health Initiative. Risks and benefits of estrogen plus progestin in healthy postmenopausal women. Principal results of the Women's Health Initiative randomized controlled trial. *JAMA* 2002;288(3):321-33.