NE_TEMP2439: Improving the health span of aging adults through diet and physical activity.

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Statement of Issues and Justification

Aging adults face numerous barriers to achieving optimal health and wellness, including chronic diseases, nutritional risk, food insecurity and functional impairments[1, 2, 3]. The United States (U.S.) population is experiencing a shift in demographics. Adults aged 65 years and older have become the largest growing age group. In 2020, about 1 in 6 Americans classified as an older adult, with about 16.8% (55.8 million) aged 65 years and older[4]. There is also a steady increase in older adults identifying as persons of color. The number of persons of color aged 65 years and older increased by 8.2% from 2010 to 2020, making up 23.4% of the population aged 65 and over[4]. The population age 65 and older is projected to be 21.6% of the population by 2040[5].

As the aging adult population continues to grow, a better understanding of effective strategies aimed toward improving the health span is needed. Aging is a multifaceted area of study that is continually exploring how to promote health and well-being throughout the lifespan. An integrative, interdisciplinary approach toward healthy aging from the metabolic level to translational science is imperative as aging is influenced by our genetics, metabolic processes, environment, and lifestyle practices. In doing so, we will likely improve the health span (part of a person's life during which they are generally in good health) of aging adults.

Based on the demographics described above, nutrition, physical activity, and biomarker research for aging adults must include a diverse sample of the US population. A multistate approach is one strategy in which to achieve this.

Factors affecting aging, as indicated by stakeholders

Socioeconomic status. Poverty affects many older adults. In 2020, 8.9% of older adults were living below the poverty level, which increased to 10.3% in 2021 per the Official Poverty Measure [6]. Of this proportion of older adults living below the poverty line, people of color had higher percentages of poverty. Among Black, Asian, and Hispanic populations, the poverty rates were roughly 18%, 9.3%, 17.1% compared to 6.8% among White, not Hispanic[6]. Compared to men, older women are also more likely to be classified as living in a state of poverty in almost all racial/ethnic groups with 10.3% vs. 7.7% in White, 19.1% vs. 16% in Black, 14.9% vs. 11.2% in Asian, 19.8% vs. 17.3% in Hispanic[7]. Limited income adversely affects the nutrition intake of older adults[8].

Food and nutrition insecurity. Food insecurity and hunger can have profound impacts on nutritional status and health-related quality of life (QOL). Although food insecurity and hunger are often used interchangeably, the two are different degrees of the same indicators. Food insecurity is characterized by having inconsistent access and uncertainty in obtaining food, putting individuals at higher risk for malnutrition, chronic disease, and low QOL 24. The threat of food insecurity and hunger among older adults is rapidly increasing with about 15.8%[9] being food insecure and 14.7% facing the threat of hunger [10]. Older adults at greatest risk include those with a low income, those under the age of 70 years, being a person of color, and residing in the southern states [10]. Food insecurity is correlated with lower energy and nutrient intakes, poor health outcomes, increased risk of early mortality and increased health care expenditures [11, 12, 10]. Food insecurity and hunger affect more aging women than aging men [10]. In addition, food insecurity is associated with higher likelihood of having limitations performing activities of daily living (ADLs) [13]. Older adults who were facing the threat of hunger are 30% more likely to report at least one ADL limitation[10]. In turn, due to food-related physical functional limitations such as food purchase and food preparation, the risk of food insecurity is increased. While food security is about economic and physical access to a certain quantity of food, nutrition security considers food quality. This concept is currently being developed.

The USDA NE-1939 Multistate Project "Changing the Health Trajectory for Older Adults through Effective Diet and Activity Modifications" team has conducted various studies to examine the determinants and outcomes of food security. In addition, the USDA Food Security tool was enhanced by developing, testing and validating a physical function food security tool to assess the full extent of food security among older adults attributed not only to economic causes but to physical function limitations as well. Further work is ongoing to examine the quality of the diet of individuals who are food insecure due to economic and physical functional limitations.

Nutritional Risk. Nutritional risk increases with age. This is due to a variety of factors such as decreased appetite, chewing and swallowing difficulties, physical limitations, limited income, reduced social interaction, and chronic diseases. Nutritional risk encompasses both ends of the health spectrum, undernutrition and overnutrition, each with equally detrimental health consequences. The prevalence of malnutrition among older adults is problematic. A nutrient-poor diet is related to morbidity and mortality, physical impairments, functional disability and a greater frequency of admittance to hospitals and other long-term care facilities [14]. The USDA NE-1939 Multistate Project "Changing the Health Trajectory for Older Adults through Effective Diet and Activity Modifications" team has conducted various studies examining the dietary practices of older adults. A three-state study revealed that 80.1% of older adults electing to take part in community nutrition programs were classified as "at nutritional risk" or "at possible nutritional risk" [15]. Poor diets can have a profound effect on cell physiology altering inflammatory markers and oxidative stress, which contribute to telomere erosion and cellular senescence. Our work demonstrates the need for better understanding of the bidirectional relationships between the nutritional status of aging and the impact of nutritional status on health outcomes. An interdisciplinary approach would enable researchers to examine these issues at the cellular, individual and societal levels.

Dietary Intakes. A primary factor affecting the nutritional status of older adults is inadequate food and nutrient intakes. MyPlate recommendations suggest adults over age 50 years consume 1½ to 2 cups of fruits, 2 to 2½ cups of vegetables, 5 to 6 ounce-equivalents of grains, 5 to 5½ ounce-equivalents of protein and 3 cups of dairy daily [16]. However, based on the Healthy Eating Index, only 18% of adults age 60+ years meet grain recommendations, 32% meet recommendations for vegetables, 34% meet total fat recommendations and between 23-27% consume the recommended amount of meat, dairy and fruit [17]. Inadequate food intakes and aging can affect micronutrient status. For example, it is estimated that selenium status in 10% of Americans aged 40 or older is sub-optimal. These levels of marginal deficiency increase the susceptibility to age-related degeneration later in life. High dietary selenium intake has also been reported to increase muscle protein levels by 10-14% in adult pigs[18]. Inversely, whether or not a high protein diet affects body selenium status among aging adults is unknown.

As people age, blood levels of the cardioprotective fatty acid, linoleate (18:2n6) decreases. The decrease in blood levels of linoleic status parallels the loss of skeletal and cardiac muscle function and lean mass[19]. In addition, diminished linoleate status in older individuals coincides with diminished mitochondrial function in skeletal muscle that accompanies aging [20, 21]. Exercise and a balanced diet may prevent muscle atrophy by targeting mitochondria [22].

A dietary intake frequency assessment conducted by the NE-1939 multistate team revealed that the majority of community-residing older adults surveyed were consuming low intake frequencies of protein-rich foods, produce and whole grains [39]. In addition to examining whole food consumption among aging adults, the NE-1939 team is exploring specific nutrients including selenium and fatty acids.

Physical Activity. Physical activity is a key modifiable behavior that can attenuate chronic disease risk and improve physical functioning in older adults [23]. It also builds "physical reserves" so that if physical function declines resulting from illness or injury, individuals with greater physical reserves would be less likely to fall below the threshold for disability [24]. Thus, physical activity is a key component of healthy aging. Unfortunately, the vast majority of older adults are not engaging in the recommended levels of physical activity [23].

Muscular Skeletal Health & Body Composition. Adults can experience a 3 to 8% decline in muscle mass per decade beginning in their 40s and 50s; [25]muscle mass traditionally declines 30% to 50% between the ages of 40 and 80 years [26]. For this project, we use the definition of the Foundation for the National Institutes of Health Sarcopenia Project (FNIH-SP) that uses lean mass (absolute or relative to body mass) and physical function cut points to define sarcopenia [27]. The cut points have been shown to be independent predictors of incident mobility impairment in men and women [28]. Sarcopenia-related health care costs are substantial, with estimates ranging from $11.8 to $26.2 billion 32. A 10% reduction in sarcopenia prevalence could save upward of $1.1 billion annually in the U.S. [29]. Nearly half (46.6%) of these savings would occur if 10% of those with severe sarcopenia were able to improve to a moderate level of sarcopenia while the remaining 56.4% would occur if 10% of those classified with "moderate sarcopenia" moved to "normal" [29]. If sarcopenia were to be eradicated, about 26% of disability cases would be eliminated [29].

Lifestyle practices of older adults, in particular physical inactivity and poor nutritional intake, and weight status (obesity) increase sarcopenia risk [30]. This provides a unique challenge when designing community-based exercise and nutrition programs. An effective sarcopenia prevention/treatment program must increase physical activity and promote healthy eating while preventing an energy deficit that promotes weight loss, which can adversely affect sarcopenia [30]. Establishing successful interventions that preserve and/or improve lean mass and physical function is crucial. There has been a significant effort to determine the most effective and efficacious interventions for treating sarcopenia and its associated symptoms [31]; however, many efforts are not easily transferable to the community setting.

A study conducted as part of the NE-1939 project demonstrated that a 12-week periodized resistance training intervention strategy was effective in retaining appendicular lean muscle mass and improving muscle strength in women ages 65-84 years [32]. The renewal project will further develop this work into a larger-scale, multistate intervention.

Importance of Work

Through our collaborative efforts, we identified community supports for increasing produce consumption among older adults [33] and decreasing nutritional deficiencies that place aging adults at increased sarcopenia risk and nutritional risk in general [15]. For example, we found that dietary selenium insufficiency induces age-related diabetes-like symptoms in association with accelerated telomere shortening [33, 34]. Other dietary interventions, such as fortifying diets with high-quality oils rich in linoleic acid appear to impact skeletal muscle mass [35]. Additionally, we identified exercise modalities that offer promise in lowering sarcopenia risk and severity [32] and that nutritional risk is associated with shorter telomeres, a biological marker of aging [36].

Building on our previous effort, a project renewal will provide the opportunity to expand on the work completed thus far by the members of the USDA NE-1939 Multistate Project “Changing the Health Trajectory for Older Adults through Effective Diet and Activity Modifications” from 2014 to the present. Further work can build on these findings to ascertain if shortened telomeres and the corresponding increase in cellular senescence contribute to sarcopenia.

The renewal project will focus on **three objectives**: (1) to identify biomarkers and molecular mechanisms contributing to healthspan, (2) to conduct multidimensional assessments of food security, nutritional status, physical activity and related factors affecting the aging population, and (3) to develop, implement and evaluate interventions that improve health in aging populations. Given the diversity of the current team, which includes experts from metabolic nutrition to Extension and Outreach researchers, our team is well-positioned to address the health and well-being of community-residing older adults from the laboratory to community. This provides a unique opportunity to work from the metabolic level to translational science.

We will also expand our reach to include those 40 years and older. This expansion of age inclusion is based on our present work that has illustrated the need to start interventions earlier than age 60 when applicable [37, 38, 32.]

The technical feasibility of the research.

Our team has a long-standing interest and a strong research record in the areas of lifestyle risk factors, dietary patterns, nutritional status, exercise/physical activity, physiology and health promotion. Each has extensive experience in one of five areas: metabolic nutrition, epidemiology, nutrition and/or physical activity interventions, qualitative research, nutritional science, and cell physiology. The proposed research is strengthened by our interdisciplinary approach that embodies translational research, taking it from the lab to the community. The project team has a successful work history, including project development, data collection, evaluation, and dissemination.

The advantages for doing the work as a multistate effort.

This multistate aspect will provide the opportunity for team members to reach a diverse group of aging adults from around the United States. The multistate and institutional aspect allows us to collect data from a range of socioeconomic and ethnically diverse populations across rural, suburban and urban geographical areas. This multistate group currently covers the northeast, mid-Atlantic, Southern, and upper Midwest regions of the country. Second, the multistate nature of the project, which entails the utilization of standardized assessment tools used by all researchers, lends itself to establishing a large data set from which additional analyses can be conducted. Additionally, the collaborative nature of the proposed work will allow a better utilization of research funding on larger-scale, multi-purpose, comprehensive projects that embody translational research (lab to community).

Anticipated Impacts

The proposed multistate research team **will train undergraduate and graduate students** in qualitative research (e.g., conducting focus groups, analyzing focus group transcripts), quantitative research (e.g., data collection, data analysis), professional and scientific writing, laboratory skills, anthropometric measures, nutritional status assessment, dietary intake assessment, and physical function. The team will **submit collaborative grant applications** to external funding organizations and **publish research findings** in joint publications. The work conducted through our independent and collaborative efforts will (1) **provide a better understanding of the dietary and physical activity needs** of at-risk aging adults, (2) **develop and implement effective strategies** to address these needs, and (3) **identify biomarkers** related to the health of aging adults. Overall, these combined efforts will improve understanding of dietary intakes, physical function, quality of life (QOL), and food and nutrition security, lower sarcopenia risk, and reduce age-related diseases such as type 2 diabetes.

Related, Current and Previous Work

Related multistate projects. A recent Current Research Information System (CRIS) search of multistate research projects was conducted using the key words: human, aging, nutrition, exercise, physical activity, obesity, and sarcopenia. This search revealed that this proposed renewal project is unique. Other multistate initiatives address some aspects of nutrition, physical activity, exercise, obesity and sarcopenia, but the focus on aging and older adults is not replicated with other multistate projects. Furthermore, there are no known groups working at the intersection of these important topics, with members who represent such a diverse range of disciplines and skills. Continued support of these efforts is perhaps more important than ever before as the population of the US continues to age.

Accomplishments under current project. A strength of the NE-1939: Changing the Health Trajectory for Older Adults through Effective Diet and Activity Modifications multistate project is that the current team is comprised of molecular biologists, nutritional scientists, sociologists, anthropologists, registered dietitian nutritionists, exercise physiologists, and Extension researchers. Having a broad interdisciplinary team provides an opportunity for innovative collaborative translational work. Translational research is key to fundable, comprehensive nutritional research.

Our work since October 2014 has focused on three research areas including molecular and mechanistic understanding of age-related diseases, environmental assessment, and lifestyle needs assessments and interventions. Collectively, we have secured more than $17,119,964 in funding, published 122 peer-reviewed manuscripts (6 joint publications), trained 118 undergraduate students, 118 graduate students, and 27 post-doctoral research associates, and developed various Extension resources, including a four-module Extension healthy aging curriculum (For more information, https://www.nimss.org/meetings/project/18618).

Given the diversity of the work being completed, the resulting projects have been a blend of individual state projects and collaborative multistate efforts. For example, Dr. Belden adapted a PCR-based telomere length assay (a marker for cellular aging) similar to the one used in the NHANES national survey [40]. This initial project involved only Rutgers University (Rutgers) students and faculty. Following this assay adaption, Dr. Ventura-Marra (West Virginia University [WVU]) collaborated with Dr. Belden to perform a telomere assessment as a biological marker of cellular aging as part of a diet and cardiovascular risk assessment study. This collaborative effort provided Dr. Ventura-Marra with the opportunity to report objective data on cellular aging to support the efficacy of a lifestyle intervention and allowed Dr. Belden to use the developed assay in a real-world application [37]. The proposed renewal project is anticipated to expand on this type of collaboration. In addition to their individual foundation experiments, the molecular biologists and nutritional scientists will be involved with select intervention studies to help assess programming impacts by performing comprehensive dietary analyses. Another example is the needs assessment project that was led by Dr. Francis (Iowa State University [ISU]). Dr. Francis worked with NE1939 team members (KUMC, SDSU, UMD, URI, WVU) to 1) assess the nutrition and wellness needs and preferences for adults ages 40 years and older from Iowa, Illinois, South Dakota, Washington DC, West Virginia, Maryland, and Rhode Island; 2) assess

the nutrition and physical activity training needs and preferences for health care professionals ages 18 years and older from across the U.S. Additionally, a NIFA, USDA grant application has been submitted with Dr. Weidauer (PD) as the leading institution worked with seven research teams in Arkansas, Iowa, New York, Rhode Island, South Dakota, Washington DC and West Virginia. The project titled "PARTNERSHIP StrengthenHer: Empowering Women through a Community-Based Virtual Sarcopenia Prevention Program" is an effort to develop and implement a community-based, online sarcopenia prevention program over a five-year period across multiple states. There are also several collaborative projects underway, such as Brain Health (lead by Dr. Elgloria Harrison) and Technology and Digital Option for older adults (lead by Dr. Dara LoBuono). These multistate collaborations resulted in ascertaining the priorities for healthy eating in older adults in diverse communities [33] and used the resulting survey tool to determine the perceived environmental supports for produce consumption among older adults [41]. As a result, our team has a better understanding of the produce access issues facing older adults. We learned how to use technology to conduct qualitative research across state lines and now have a tool that can be used by other team members. Further, the inclusion of sociologists and anthropologists on our team in recent years has enabled our environmental and intervention work to look more holistically at the health and well-being of older adults. We anticipate expanding on this work by including more quality-of-life assessment tools during our studies.

Multistate research projects offer many benefits, including working across state lines to evaluate the efficacy and impact of lifestyle interventions among diverse audiences. However, a challenge is that in order for an intervention to be effective it must be focused on the needs and preferences of the target audience. This means the approach utilized by each state may need to differ. To be more collaborative while respecting the unique needs of residents from each state, we began using common assessment tools across studies. This has allowed for the merging of data to perform cross-sectional studies. For example, many states were implementing various community-based nutrition education programs designed to meet the needs of our stakeholders. Although we were not evaluating the same intervention across states, each state had asked the same sociodemographic questions and used the same nutritional risk assessment tool. Team members from three states, New Hampshire (no longer with the project), Rhode Island and Iowa, created a multistate database with sociodemographic data and the nutritional risk assessment data to identify the nutritional risk factors of community-residing older adults. This study revealed most community-residing older adults were at nutritional risk and that their intake frequencies of protein-rich foods was low [15]. Given the success of this project, this approach will be expanded for this proposed renewal project with all states choosing from the same assessment measures as appropriate for their studies.

Furthermore, three current team members are Extension state specialists (ISU, Mississippi State University [MSU], and UICU). Having Extension Specialists on the NE-1939 team, has allowed for the development of community-based materials and interventions based on the formative work completed through the NE-1439 project. For example, the Stay Independent—a healthy aging series (https://www.extension.iastate.edu/humansciences/stay-independent) was developed based on the nutritional risk assessments by MacNab and others [15]. It is now a statewide program in Iowa. For the proposed renewal project, we aim to pilot test community-

based interventions through Extension as well as develop Extension publications and products that are informed through our collaborative research efforts. Doing so, increases the likelihood of this multistate project having national implications, as Extension is available in all states.

The work accomplished over the past few years through the NE-1939 multistate project has identified sarcopenia as a focus of our future interdisciplinary work. Helping adults age in place is a critical public health and economic issue as the number of adults turning age 65+ grows rapidly. Long-term care spending reached $210.9 billion in 2011 in the United States (US) [42] and can comprise a major expense for older adults. Sarcopenia is a major threat to the ability to age in place. It is an often undiagnosed, chronic disease affecting older adults, and has dire consequences both financially and physically [29]. The renewal project provides the opportunity for team members to focus on sarcopenia prevention, applying a translational approach that is inclusive of molecular, community and environmental areas. This is innovative in the area of sarcopenia research. While sarcopenia will be a disease endpoint of focus, we will also continue to emphasize the way in which the work we do will have applications for the general aging process and for other health conditions.

Objectives

1. To identify biomarkers and molecular mechanisms contributing to healthspan.
2. To conduct multidimensional assessments of nutrition, physical activity and related factors affecting the aging population.
3. To develop, implement and evaluate interventions that improve health in aging population.

Methods

Team members are expected to participate in at least one of the three overarching research objectives. The interdisciplinary composition of our team necessitates individual-level research as well as integrative, collaborative projects. The proposed activities will contribute toward the long-term goal of promoting the independence and well-being of community-residing aging adults (ages 40 years and older) while enabling researchers to maintain autonomy over their research experiments. For example, many of the laboratory-based projects will take place at the one of three universities (MSU, Ohio State University [OSU], and Rutgers); however, the formative work being completed in the areas of lipidomics (OSU), selenium (MSU) and telomere length (Rutgers, MSU) will inform our intervention strategies. It is also anticipated that some of our lifestyle intervention researchers will work with our molecular biologists and nutritional scientists to conduct specialized laboratory tests in addition to the traditional blood tests when examining the impact of dietary and physical activity programming. Finally, establishing one standardized set of inclusion criteria for human subjects conducted as part of this project is not feasible given the anticipated blend of individual-level and collaborative research as well as target behaviors. Therefore, the recruitment strategies utilized may vary by study (Appendix A). The following are some ongoing and proposed new research activities by objective.

Objective 1: To identify biomarkers and molecular mechanisms contributing to healthspan.

Studies in this area involve performing molecular assessments on aging adults as a means to better inform participants' activities and diet choices. Diet and exercise ultimately affect physiology on the molecular and cellular level and specific biomarkers are often the best predictors of whether certain diet and exercise modifications are beneficial. To accomplish Area 1, routine assessments of telomere length (Leukocyte Telomere Length [LTL] assay) will be coupled with assays that monitor markers of inflammation (CRP, Fibrinogen, IL-6, and TNFg). The purpose of these assays will help predict the best diet and activity interventions for the participants and educate them on best practices to increase health span and independent living. In particular, Wu and others [34], have reported dietary selenium deficiency shortens telomere length in the highly proliferative colonocytes and accelerates incidence of such age-related symptoms of telomere-humanized mice. This provides an opportunity to assess whether telomere length is associated with blood selenium status in aging adults. Muscle mass will be estimated using bioelectrical impedance or skinfold and circumference measurements. Muscle function will be measured using grip strength, a criterion of the FNIH definition of sarcopenia [27] will be used to assess muscle function [43, 44]. Peripheral blood lymphocytes collected at the same time as plasma for markers of inflammation and telomere length (above) will be analyzed for mitochondrial enzyme activity (e.g., citrate synthase activity)[45]. Targeted lipidomics of mitochondrial fractions from peripheral blood lymphocytes will identify mitochondrial phospholipids that are modified by dietary lipids[46].

Objective 2: To conduct multidimensional assessments of nutrition, diet, physical activity and related factors affecting the aging population. These multidimensional assessments will be at the community and individual levels and the findings will be used to inform studies conducted under Objective 3

includes conducting needs assessments on the preferences on the preferences, opinions, beliefs, and attitudes of aging populations' for community environmental supports for secure, culturally appropriate environments for healthy lifestyle. Improving the general health, functionality and the quality of life (QOL) of aging populations is a Healthy People 2030 goal [47, 48]. In order to achieve this, social determinants of health (circumstances in the environment in which people are born, live, learn, work, worship and age) must be considered. The purpose of these studies is to identify the most important and modifiable enablers of healthy eating behaviors among aging adults. To accomplish this, mixed methodology approaches will be used, including both qualitative and quantitative methods such as individual interviews, focus groups and consumer surveys. Qualitative methodology is an effective way to engage groups of people in a conversation about topics in which there are gaps in the literature and results can be useful as formative data to create surveys. Open-ended questions will be used, and questions will be developed to answer gaps in the literature. All individual interviews and focus group discussions will be transcribed verbatim and will be analyzed using standard protocols. Themes will then be identified from the most prevalent codes found amongst the transcriptions. Additional consumer surveys will be developed using literature reviews, formative data from focus group discussions, or from community service providers and/or members in the

participating states. These surveys will highlight the most important and modifiable community settings to improve food access and dietary behaviors in older adults. Unvalidated surveys will be pretested for clarity and reliability and then administered to consumers and other community centers serving aging populations in participating states. Surveys will identify aging populations' use of community supports for healthy lifestyle behaviors and provide recommendations for improvement to foster these healthy behaviors. Additionally, analysis will be conducted to examine dietary patterns and coping strategies of food-insecure individuals due to limited social resources and physical functionality using the validated USDA Household Food Security Scale and the Food Security-Physical Function limitations.

Objective 3: To develop, implement, and evaluate interventions that improve health in aging populations. This objective will involve developing theory-based, consumer-informed nutrition and physical activity interventions which can be translated and adopted at the community level to better help aging population improve their overall health and prolong independence. These interventions may focus on a variety of health areas affecting aging adults such as chronic disease prevention, weight management, sarcopenia, arthritis reduction, and food security. For example, expanding on the work completed as part of the NE-1939 project we will further develop a sarcopenia prevention program. The key outcome measures include anthropometric, biochemical, clinical, dietary, physical activity, socioeconomic, and environmental factors. The growth of the current team (13 states) has resulted in a more diverse make-up of states. This diversity includes population density (urban versus rural). Of the 11 states focused on community-based research, four (36.4%) have rural state populations of 20% and higher [49]. Rural-residing older adults have worse physical health, decreased socialization, and a lower health-related quality of life than their urban-residing counterparts do [50, 51]. The proposed renewal project will begin to examine programs' relevance toward both rural and urban environments. The proposed renewal project will also begin to consider clustered important factors linked to evidence-based intervention sustainability including local policy, health care systems and environments, and examine strategies that could better address those factors in an effort to enhance the identified needs from Objective 2. All of those approaches are attempted to examine and disseminate effective strategies results from varied interventions into practice at varied community settings.

It is the development and testing of a theory-based, community-implemented, exercise and nutrition program (StrengthenHer [Empowering Women through a Multi-State Virtual Sarcopenia Prevention] Program) capable of reducing the risk of and/or severity of sarcopenia among women ages 40-75 years across different racial/ethnic groups. The long-term goal of the StrengthenHer Program is to promote the independence and well-being of community-residing aging and older women through an integrative, community-based exercise and nutrition intervention. The StrengthenHer program utilizes an interdisciplinary approach, applies sustainable lifestyle intervention approaches, and is designed for community-delivery through Extension. The StrengthenHer Program will include creating an exercise DVD that emphasizes resistance training (based on work completed by URI as part of the NE-1439 project) and a nutrition curriculum that promotes protein intake through whole foods (based on MacNab study [15]). The key indicators may include physical function (grip strength, four-meter gait speed test, chair stand tests, isometric leg extensor strength), body composition (multi-frequency

bioelectrical impedance analysis (MFBIA), height and weight), nutrition and food measures (multiple 24-hour recalls, nutritional risk and dietary intake frequencies, complete blood counts, serum selenium levels), and markers of inflammation. The intervention will be pilot-tested in a variety of community settings. Data analysis will be undertaken using general linear models methods, focused on testing for differences between Control and Treatment groups and controlling for relevant demographic and structural covariates. The StrengthenHer program will be implemented across six states (Arkansas, Iowa, New York, Rhode Island, South Dakota, and West Virginia) and one district (Washington DC) in both urban and rural areas.

Survey Tool Descriptions (*note: common instruments used across different sites thus we don't have to list all the tool used)

Sociodemographic Attributes

We will use the demographic questions collected as part of the Performance Outcome Measurement Project (POMP) [52]. The demographics modules include 10 questions related to gender, race, age, marital status. These questions utilize standard wording used with national surveys, which will allow for better comparison to national findings.

Nutritional Risk and Dietary Intake Frequency Assessment:

The Dietary Screening Tool (DST) is a validated tool to assess nutritional risk in middle-aged and older adults based on frequency of intakes of fruits, vegetables, dietary fiber, lean protein, added fat, sugars and sweets, dairy, and processed meats. The DST has 25 food and behavior specific questions, which can be completed by individuals in less than 10 minutes and scored by clinicians in less than 5 minutes [53, 54]. The maximum score of 100 points is divided into 7 diet component categories (added fats, sugar, and sweets; whole fruit and juice; vegetables; total and whole grains; lean protein; dairy; and processed meat). A higher score is desirable as it indicates lower nutritional risk ("nutritional risk" [75 points]) [53]. As part of the NE-1439 project, Dr. Ventura-Marra validated the DST for use among middle-age adults (45 to 64 year olds) [55]; thus expanding its use among all aging adults.

Food Security

Food insecurity is associated with poverty, lower nutrient intakes, increased likelihood of poor or fair health, being a person of color, activities of daily living (ADLs) limitations, and poor chronic disease management [56-62]. Per the USDA Economic Research Service, nearly all the states in the renewal project where community-based research will occur (10 out of 11) has a food insecurity rate of 10% and higher [49]. The renewal project intends to collect food security data. To lower participant burden, researchers will be encouraged to use either the "Six-Item Short Form" [63] or the two-question option [64]. The "Six-Item Short Form" quickly assesses food insecurity among older adults [63]. A two-question subset from this short form has a sensitivity of 96% and higher and a specificity of 79% and higher [64].

Quality of Life (QOL)

We will assess QOL using one of the following tools: Satisfaction with Life Scale (SWLS) [65], food satisfaction will be measured using the Satisfaction with Food-Related Life (SWFL) scale [66], or the deJong Gieveld 6-item loneliness scale [67]. The validated SWLS is a measure of subjective well-being. It is a 5-item 7-point Likert scale questionnaire used as a measure of global cognitive judgments of satisfaction with one's life [65]. The SWFL scale is comprised of five questions on a 6-point Likert scale centered on food and meals [66]. The loneliness scale consists of six questions and assesses emotional loneliness and social loneliness [67].

Physical Activity

The validated Yale Physical Activity Survey (YPAS) estimates caloric expenditure of habitual physical activity, including exercise activities, chores, and leisure activities in older adults [68, 69.] It is valid and reliable when used with adults aged 60-86 years. Since there are no questions regarding specific exercises such as resistance training, we will ask a few additional questions regarding recent engagement in resistance training or other exercises including recent frequency, duration, and intensity.

Physical Function

Physical function will be assessed using at least one of the following tests: static handgrip strength [70-73] the Short Physical Performance Battery Protocol (SPPB) [74, 75] and a 400-meter walk test [76, 77].

Static handgrip strength is a simple, safe, reliable and valid predictor of total body strength, physical functioning, and future disability and will be done using a hand-grip dynamometer (Jaymar Hydraulic Dynamometer, J.A. Preston, Corp., Jackson, MS) [70-73]. Participants will perform the grip strength test in a seated position using their dominant arm with the elbow flexed at a 90-degree angle. They will be instructed using standardized oral encouragement to squeeze the dynamometer with as much force as possible and the highest force attained will be recorded. Three trials separated by a 1-minute rest period will be done and the highest force will be used.

The SPPB includes three balance tests, a gait speed test and a chair stand test [74, 75]. Walking speed will be measured by requesting the participant to walk at their normal pace over a 4m distance. Time in seconds to complete the full course will be recorded. Two attempts will be done, and the faster of the two times will be used. A 46-cm high straight-back chair will be used to complete the repeated chair stand test, and participants will be instructed to stand up from the chair once without using their arms for assistance. If a participant is able to complete one chair stand, he/she will be asked to stand up and sit back down five times as quickly as possible, and the time to complete one series of five chair stands will be recorded. Participants will be instructed to sustain balance in three different positions distinguished by sequential narrowing of the base of support. Position one will begin with feet together (i.e. side by side); position two will consist of the heel of one foot next to the big toe of the other foot (i.e. semi-tandem); the last position will have the heel of one foot in front of and touching the toes of the other foot (i.e. tandem). For all three positions, participants will be timed for a maximum of 10 seconds, and scores will be summed for the measure of balance for a range of 0 to 30 seconds.

Scores from 0 (inability to complete the test) to 4 (highest possible score) will be assigned to each of the three performance measures based on standard cut-points. A summary score ranging from 0 (lowest) to 12 (highest) will be calculated by adding walking speed, chair stands, and balance scores.

We will also use the 400-m walk test [76,77]. This test is a predictor of subsequent mortality in older adults. On a track (or measured corridor) each participant will be instructed to walk the track in a continuous loop as quickly as possible at a pace that can be maintained. Standardized oral encouragement will be given, as well as feedback regarding the number of laps remaining.

Measurement of Progress and Results

Outputs

- • Development of a Manual of Operations that includes all common validated tools that will be used for multistate research efforts. This manual will help ensure common research protocols are followed by all states.
- A comprehensive database of needs assessment and intervention data will be developed to allow for multistate cross-sectional data analysis and comprehensive assessment of lifestyle inventions for community-residing aging adults.
- Results from these studies will be used to provide recommendations to appropriate agencies regarding implementation of methods to improve availability and accessibility of healthful foods and physical activity for older adults.
- Continued statistical exploration of the associations among the following age-related health factors: dietary and physical activity behaviors, quality of life, socioeconomic status, race, etc.
- Molecular data of telomere length and markers of inflammation correlated with specific dietary and activity interventions.
- Using cross-sectional and longitudinal approaches, we will measure the association of dietary fat quality with changes of muscle function, mass and mitochondrial capacity. Results will be used to design intervention studies to test dietary oils (doses and types) to attend the loss of muscle mass and function in older people.

Outcomes or Projected Impacts

- Improved understanding of the nutrition and physical activity practices of community-residing adults ages 40 years and older influencing their chronic disease status.
- Reduced chronic disease incidence and/or severity as indicated through self-report, validated survey outcomes related to the targeted chronic disease and/or blood values.
- Reduced nutritional risk and improved dietary intake frequencies as measured by the DST among those participating in nutrition-focused interventions
- Increased physical activity participation among aging adults and increased physical function among those attending exercise, physical activity and/or sarcopenia interventions.

- Reduced food insecurity among those with limited incomes
- Enhanced healthspan as assessed by reduced chronic disease risk factors, increased QOL, and/or physical function.
- Study participants will gain knowledge regarding recommended nutrition and physical activity behaviors.
- Optimized healthspan through nutrition and physical activities that are cost-effective and achievable for aging or older adults.
- Study participants will implement dietary and other lifestyle goals that will attenuate muscle loss.

Milestones

1. Develop operations manual for common survey tools. o Develop SPSS-base codebooks for each of the common research tools. o Prepare manuscripts and grant submissions for studies.

2. Create lifeSPAN curriculum and prepare related grant applications. o Optimize laboratory procedures for blood collection and preparation of peripheral blood lymphocytes at multiple sites. o Prepare manuscripts and grant submissions for studies.

3. Pilot-test lifeSPAN program. o Collect survey data from across states. o Examine telomere length and markers of inflammation for selected studies. o Quantify association of dietary fat intake with mitochondrial capacity and muscle health. o Prepare manuscripts and grant submissions for studies.

4. Conduct cross-sectional data analysis using multistate dataset. o Examine telomere length and markers of inflammation for selected studies. o Prepare manuscripts and grant submissions for studies.

Projected Participation

View Appendix E: Participation

Outreach Plan

We plan to disseminate the work accomplished through this multistate project at multiple levels. We will create and distribute education materials and programs for community-level implementation, ideally through Extension but may also include Area Agencies on Aging and public health departments. Joint publications related to our research findings will be prepared and submitted to peer-reviewed journals. We will continue to do oral and poster presentations at local, regional and national professional meetings such as Experimental Biology, American College of Sports Medicine, the American Society for Nutrition annual meeting, Food and

Nutrition Conference and Expo, the Society of Nutrition Education and Behavior annual meeting, and the annual National Health Outreach Conference (Extension).

Organization/Governance

Currently an Executive Committee (chair, chair-elect, past-chair, secretary, and member-at-large) and a Regional Administrative Advisor has the administrative oversight and organization for the multistate group. All positions are elected to three-year terms by team members during the annual meeting. The term begins October 1 of each respective year. The Chair is responsible for setting the meetings, developing and posting agendas, and facilitating the meetings. The Chair also oversees the completion of the annual reports and project-related revisions. The chair-elect completes the duties in the absence of the chair. The secretary maintains the minutes and sends to the Chair to post on the multistate website. The member-at-large attends the executive committee meetings and performs other duties as assigned by the Chair. The multi-state members meet on a regular basis (every other month) via online meetings and annually face-to-fact at a date and place that is selected by the entire group.

The NE-1939 Multistate group is in the process of developing and adopting a policy and procedures manual that will guide the functioning of the group. The maximum size of the multistate group will be 25 members. Members will be expected to actively participate in, collaborate, and contribute to the multistate research and administrative activities. Members who choose not to actively participate will be asked to resign from the group. Active participation is defined as participating in at least 50% of online meetings and contributing to the collaborative research and administrative activities. Consideration for termination of group membership due to inactive status will be presented on agenda and discussed by full group membership followed by a vote by the full membership at the next group meeting (face-to-face or online). A protocol will be established for accepting new members. It is anticipated that new members will be voted upon by the current members and should have applicable expertise that strengthens the group research, at least one chapter of dissertation published, and able to obtain independent funding for participation. The best time to join the group will be during the renewal process. Candidates must submit CV and documentation of how their skills meet the group research needs to the Chair. The group will review and vote upon the respective candidates.

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