1a. Full Title: Individual and contextual socioeconomic profile and physical function in late life: the Atherosclerosis Risk in Communities (ARIC) Study

b. Abbreviated Title (Length 26 characters): SEP and physical function

2. Writing Group:
   Writing group members: Priya Palta, B. Gwen Windham, Michael Griswold, Anna Kucharska-Newton, Mehul Patel, Michelle Snyder, Benjamin Capistrant, Gerardo Heiss, others welcome

I, the first author, confirm that all the coauthors have given their approval for this manuscript proposal. X (please confirm with your initials electronically or in writing)

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ARIC author to be contacted if there are questions about the manuscript and the first author does not respond or cannot be located (this must be an ARIC investigator).

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3. Timeline: 1-2 years from proposal approval.

4. Rationale:
   Successful aging implies living longer while maintaining high physical and cognitive function and engagement in social activities. Individual and neighborhood factors can influence a person’s ability to age successfully. Mobility-disability includes impairments in the lower extremities and often impacts an individual’s ability to perform activities of daily living (e.g. bathing and dressing) resulting in dependence on others for basic self-care needs. The prevalence of mobility-disability among U.S. adults 65 years and older is estimated at 45.3% and 56.5% for males and females, respectively. Disability in older age is important since individuals with disabilities are subject to expenditures associated with nursing home admission or community care, hospital visits and physician visits. Our proposed study will examine individual and
neighborhood measures of socioeconomic position (SEP) and the impact of these factors on physical function outcomes in late life.

Previous research on SEP as a predictor of physical function is mainly limited to studies examining individual-level measures of SEP (e.g. education and income) and SEP measures assessed at one point in time. Independent of objective measures of health; individuals with low educational attainment and low income self-report high level of disabilities\(^3\)\(^{11}\) and demonstrate poor objectively measured physical function.\(^6\)\(^{12}\)\(^{13}\) Fewer studies have examined the association of neighborhood-level factors (e.g. area-based median income and neighborhood disadvantage) with physical function. There has also been limited use of multi-level models to account for both individual and neighborhood factors concurrently. The few studies that have examined the association of neighborhood-level SEP with physical function outcomes suggest that individuals from more disadvantaged neighborhoods have more self-reported and objectively measured disability, as compared to those from neighborhoods with higher levels of SEP.\(^{14}\)\(^{19}\) Of these studies, five used longitudinal data on functional outcomes\(^{14}\)\(^{16}\)\(^{18}\)\(^{19}\) and only one used objectively measured physical function.\(^{14}\)

Neighborhood environmental characteristics, such as walkability of sidewalks and access to parks, have been found to be associated with chronic disease risk,\(^{20}\) and are likely important to understanding early declines in physical function and as barriers to aging successfully free of impairment. These contextual factors describe a person’s environmental setting and provide information on the economic and social context of a neighborhood. These factors also influence how an individual interacts with their environment and the ease with which their basic needs for access to healthy food,\(^{21}\)\(^{22}\) care,\(^{23}\) and social support can be met.\(^{24}\) There is data to show that neighborhood environmental characteristics are an important contributor to health status. One recent study showed that residing in an attractive community, defined by sidewalk cafes and presence of trees was associated with a lower body mass index.\(^{25}\)

We hypothesize that individual SEP and the neighborhood environmental setting may be similarly associated with healthy life expectancy, and with the postponement of mobility-disability, which has been identified as an important contributor to healthy aging. To evaluate this, our research aims are to estimate the beneficial and adverse roles of individual- and neighborhood-level SEP on a key element of successful aging, namely self-perceived and objectively measured physical function.

5. **Main Hypothesis/Study Questions:**

**Aim 1:** Estimate the association of individual- and neighborhood-level SEP at visit 3 with trajectories of self-reported functional status from 1993-2007.

*Hypothesis Set 1a:* Residing in a socioeconomically disadvantaged neighborhood is associated with greater declines in self-reported functional status compared to residing in a socioeconomically advantaged neighborhood from 1993-2007, independent of individual SEP.

*Hypothesis Set 1b:* Low family income (e.g. below poverty line) and low educational attainment (e.g. < high school education) are associated with greater declines in self-reported functional status from 1993-2007, independent of neighborhood SEP.
Aim 2: Estimate the cross-sectional association of individual- and neighborhood-level SEP with objectively measured physical function at visit 5.

Hypothesis Set 2a: Residing in a socioeconomically disadvantaged neighborhood is inversely associated with objectively measured physical function at visit 5, independent of individual SEP.

Hypothesis Set 2b: Low family income (e.g. below poverty line) and low educational attainment (e.g. < high school education) are inversely associated with objectively measured physical function at visit 5, independent of neighborhood SEP.

6. Design and analysis (study design, inclusion/exclusion, outcome and other variables of interest with specific reference to the time of their collection, summary of data analysis, and any anticipated methodologic limitations or challenges if present).

Study design: Prospective analysis of individual- and neighborhood-SEP at visit 3 and trajectories of self-reported functional status from 1993-2007. Cross-sectional analysis of individual- and neighborhood-SEP and objectively measured physical function at visit 5.

Exclusions: Not White or Black, Blacks in Washington County and Minneapolis

Exposure: Individual- and neighborhood-level socioeconomic position (Table 1)

Individual-level SEP factors that will be assessed in this study include family income, educational attainment and occupation. Neighborhood SEP will be constructed from census-tract information and a neighborhood summary score will be derived based on aggregate measures of wealth/income, education, and occupation previously done in ARIC. Contextual area-based measures (e.g. neighborhood walkability, access to parks and neighborhood safety) will be excerpted from resources extant at the national level for each of the neighborhoods/census tracts included in the four ARIC study areas at visits 3, 4 and 5.

<p>| Table 1. Socioeconomic measures in ARIC |</p>
<table>
<thead>
<tr>
<th>Level</th>
<th>Examples</th>
<th>Visits measured</th>
<th>Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual</td>
<td>Educational attainment</td>
<td>1, 3, 4, 5</td>
<td>ELEVEL01</td>
</tr>
<tr>
<td></td>
<td>Annual household income</td>
<td>1, 3, 4, 5</td>
<td>PHXA60,</td>
</tr>
<tr>
<td></td>
<td>Occupation</td>
<td>1, 3, 4, 5</td>
<td>PHXA54</td>
</tr>
<tr>
<td></td>
<td>Financial and social standing</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Neighborhood*</td>
<td>Neighborhood summary score based on:</td>
<td>LCSES (2001-2002): geocoded data at visits 3 and 4 and 5 (data acquisition proposed in M.D. Patel ancillary proposal # 2014.03)</td>
<td>V3INCMDH V3INCOTH</td>
</tr>
<tr>
<td></td>
<td>a. Wealth income (Log of the median household income; log of the median value of owner occupied housing units; proportion of households receiving interest, dividend or net rental income</td>
<td></td>
<td>V3EDHS V3EDCOL</td>
</tr>
<tr>
<td></td>
<td>b. Education (proportion of adults &gt; 25 years of age with a high school diploma; proportion of adults &gt; 25 years of age with completed college education)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>c. Occupation (proportion of people employed in executive, managerial, or professional specialty occupations)</td>
<td></td>
<td>V3PROFE</td>
</tr>
</tbody>
</table>
Outcome:

(1) Trajectories of annual self-reported functional status from 1993-2007

Functional status was measured annually from 1993-2007 (AFU forms D-K). Participants were asked to self-report their ability (yes or no) to do the following physical activities without help. These questions are based on the Rosow and Breslau questionnaire that was developed to determine an individual’s difficulty with performing tasks of daily living.24

a. Are you able to do heavy work around the house, like shoveling snow or washing windows, walls or floors without help?
b. Are you able to walk up and down stairs without help?
c. Are you able to walk half a mile without help? That’s about 8 ordinary blocks.
d. Are you able to go to work?
e. During the past 4 weeks, have you missed work for at least half a day because of your health?
f. Are you able to do your usual activities, such as work around the house or recreation?
g. During the past 4 weeks, have you had to cut down on your usual activities (such as work around the house or recreation) for half a day or more because of your health?

We propose to sum the four questions most relevant to performance on daily functional tasks, listed in Table 2 below, to provide us with a functional status score ranging from 0-4 with 0 indicating poor functional status and 4 indicating optimal functional status. We will examine trajectories in this functional status score from 1993-2007. Before analyzing the data, we will perform a factor analysis of these four questions to determine whether it is justifiable to combine into one metric. As a subsidiary analysis, we will examine one question (i.e. Are you able to walk half a mile without help? That’s about 8 ordinary blocks) that most likely defines an individual’s ability to perform daily functional tasks to represent their overall functional status.

Table 2. Measurement of functional status (FS) at annual follow-up

<table>
<thead>
<tr>
<th>Question</th>
<th>Scoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1: Are you able to do heavy work around the house, like shoveling snow or washing windows, walls or</td>
<td>0= no 1= yes</td>
</tr>
<tr>
<td>floors without help?</td>
<td></td>
</tr>
<tr>
<td>Q2: Are you able to walk up and down stairs without help?</td>
<td>0= no 1= yes</td>
</tr>
<tr>
<td>Q3: Are you able to walk half a mile without help? That’s about 8 ordinary blocks.</td>
<td>0= no 1= yes</td>
</tr>
<tr>
<td>Q4: Are you able to do your usual activities, such as work around the house or recreation?</td>
<td>0= no 1= yes</td>
</tr>
<tr>
<td>Total Score: 0-4</td>
<td>0= poor FS 4=optimal FS</td>
</tr>
</tbody>
</table>
(2) Objectively measured physical function at visit 5
Objectively measured lower extremity physical function was captured at visit 5 (2011-2013) of ARIC using the Short Physical Performance Battery (SPPB), which measures the following:

1. Gait speed (i.e. 4 meter walk)
2. Chair stands (i.e. single chair stands and repeated chair stands)
3. Balance (i.e. semi tandem stand, side-by-side stand, tandem stand)

As shown in the literature, conventional ordinal categorizations of the raw physical function data will be performed. A performance score from 0-4 will be given for each of the three measures above. Zero indicates that the participant was unable to complete the task (i.e. tried but were unable to complete or interviewer/subject felt it was unsafe). A score of 1-4 will be assigned to participants who complete the exercise. The score is constructed on timed quartiles of performance based on data from previous studies. As applicable, we will look at the continuous scales of the timed SPPB measures independently. The SPPB summary score (derived variable at visit 5) is calculated by summing the scores (0-4 for each measure) from the three exercises, yielding a possible maximum score of 12 indicating the highest degree of functioning. The SPPB score will be examined continuously (0-12) and as a 4-level categorical variable:
- SPPB ≥ 10 : Ideal
- SPPB ≥ 6 and SPPB < 10 : Intermediate
- SPPB ≤ 5 : Poor
- SPPB = 0 : Dead or Unable to Complete

Objectively measured physical function was also assessed by grip strength using a dynamometer at visit 5 and will be analyzed continuously.

Covariates: Age, sex, race/center, self-reported health, pulmonary function, body mass index, comorbid conditions (CHD, stroke, HF), physical activity, smoking status, marital status.

Analysis:

Aim 1: We propose to use multilevel mixed models to estimate changes over time (i.e. trajectories) of functional status from 1993-2007 with the individual and neighborhood-level SEP measures from visits 3-5. We will examine, at a minimum, subject-specific intercept and slope models for functional status. As an additional analysis, the subject-specific trajectory components (e.g. empirical Bayes-estimated random intercepts and slopes) from these models will be connected with the objectively measured physical function outcomes at visit 5 using simple generalized linear models (GLM) and non-linear mixed models (as proposed in Windham and colleagues in MS#2254).

Aim 2: We propose to use GLM with the individual and neighborhood-level SEP measures from visits 3-5 to estimate and compare cross-temporal relationships with visit 5 objectively measured physical function. Several GLM formulations will be explored for the continuous (e.g. log-link, negative binomial distributions) and categorical (e.g. log/ “logistic”-link, multinomial distributions) SPPB outcomes and continuous grip strength. Effects of individual-level and neighborhood-level SEP will be partitioned out separately in the models.
For both aims, we will perform sensitivity analyses using inverse probability weighting and/or shared parameter model methods to account for dropout/missingness. In an effort to explain gender-specific differences in the prevalence of physical disability, these associations will be examined separately in men and women. We will also examine hypothesized effect modification by prevalent disease statuses at visit 3 (e.g. CHD, stroke, HF) that are related to functional outcomes.

**Methodological limitations:** Objectively measured physical function was assessed only at visit 5. In the setting of the ARIC study, most of the Black participants are from the Jackson site. Therefore, race/center, in this work, may be more of a reflection of geographic region and place of residence. Further, we expect less variation in neighborhood SEP among Blacks than Whites. Given these issues, we plan to do sensitivity analyses stratifying by race/center.

7.a. Will the data be used for non-CVD analysis in this manuscript?  ____ Yes  __X__ No

b. If Yes, is the author aware that the file ICTDER03 must be used to exclude persons with a value RES_OTH = “CVD Research” for non-DNA analysis, and for DNA analysis RES_DNA = “CVD Research” would be used?  ____ Yes  ____ No
(This file ICTDER03 has been distributed to ARIC PIs, and contains the responses to consent updates related to stored sample use for research.)

8.a. Will the DNA data be used in this manuscript?  ____ Yes  __X__ No

8.b. If yes, is the author aware that either DNA data distributed by the Coordinating Center must be used, or the file ICTDER03 must be used to exclude those with value RES_DNA = “No use/storage DNA”?  ____ Yes  ____ No

8.c. If yes, is the author aware that the participants with RES_DNA = ‘not for profit’ restriction must be excluded if the data are used by a for profit group?
   ____Yes  ____No

9. The lead author of this manuscript proposal has reviewed the list of existing ARIC Study manuscript proposals and has found no overlap between this proposal and previously approved manuscript proposals either published or still in active status. ARIC Investigators have access to the publications lists under the Study Members Area of the web site at: [http://www.cscu.unc.edu/ARIC/search.php](http://www.cscu.unc.edu/ARIC/search.php)  ____X__  Yes  _______ No

10. What are the most related manuscript proposals in ARIC (authors are encouraged to contact lead authors of these proposals for comments on the new proposal or collaboration)?

MS #830 (Lead: Denise Houston)- Association between body composition and functional and self-rated health in a bi-ethnic cohort: the Atherosclerosis Risk in Communities Study
MS#1602 (Lead: Roland Thorpe)- Race, Socioeconomic Status, and Mobility: the ARIC Study
MS#1603 (Lead: Roland Thorpe)- Race, Lung Function, and Mobility: the ARIC Study
MS#2254 (Lead: Gwen Windham)- Relationship of Adiposity Trajectories to Later Life Physical Function and Strength

11. a. Is this manuscript proposal associated with any ARIC ancillary studies or use any ancillary study data?  
   X Yes  No

11. b. If yes, is the proposal
   X A. primarily the result of an ancillary study (list number* 1998.02-Life course SES, social context, and CVD (SESCVD)
   B. primarily based on ARIC data with ancillary data playing a minor role (usually control variables; list number(s)*

*ancillary studies are listed by number at [http://www.cscc.unc.edu/aric/forms/](http://www.cscc.unc.edu/aric/forms/)

12a. Manuscript preparation is expected to be completed in one to three years. If a manuscript is not submitted for ARIC review at the end of the 3-years from the date of the approval, the manuscript proposal will expire. Agreed

12b. The NIH instituted a Public Access Policy in April, 2008 which ensures that the public has access to the published results of NIH funded research. It is your responsibility to upload manuscripts to PUBMED Central whenever the journal does not and be in compliance with this policy. Four files about the public access policy from [http://publicaccess.nih.gov/](http://publicaccess.nih.gov/) are posted in [http://www.cscc.unc.edu/aric/index.php](http://www.cscc.unc.edu/aric/index.php), under Publications, Policies & Forms.

[http://publicaccess.nih.gov/submit_process_journals.htm](http://publicaccess.nih.gov/submit_process_journals.htm) shows you which journals automatically upload articles to Pubmed central.
References


