

ARIC Manuscript Proposal # 3059

PC Reviewed: 11/14/2017

Status: _____

Priority: 2

SC Reviewed: _____

Status: _____

Priority: _____

1.a. Full Title: The association between sport participation by type and incident cardiovascular disease morbidity and mortality: The Atherosclerosis Risk in Communities Studies (ARIC)

b. Abbreviated Title (Length 26 characters): Sport and CVD

2. Writing Group:

Writing group members: Anna Porter, Kelly Evenson, Aaron Folsom, Katie Holliday, Priya Palta, others welcome

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

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3. Timeline: Analyses to start upon approval of proposal. Submit for publication within 6 months from proposal approval.

4. Rationale:

Physical activity is an essential health behavior that has been associated with numerous health benefits.¹ Physical activity is performed at differing levels of intensity, generally categorized as light, moderate, and vigorous. In addition to intensity, physical activity can be subdivided into 4

general domains: leisure, transport, occupational, and domestic. Within the domain of leisure, there are myriad sport disciplines that can be pursued, such as running, cycling, and racquet sports. These differing sport activities require use of various muscle groups and movements, and have distinct energy costs and levels of intensity.² Data from the 2011 BRFSS indicates that, for sport and exercise participation within the past month, U.S. adults most commonly report walking. However, sport activities such as running/jogging, conditioning exercises, bicycling, and dancing/aerobics are also regularly reported.³

Currently, the Physical Activity Guidelines for Americans recommend that adults engage in at least 150 minutes of moderate-intensity physical activity per week, at least 75 minutes of vigorous-intensity physical activity per week, or a combination of the two.⁴ It is further recommended that adults perform muscle strengthening activities of moderate or vigorous intensity and involve all major muscle groups on 2 or more days per week.⁴ Data from the 2016 National Health Interview Survey indicate that only 22% of adults meet these guidelines for both aerobic and muscle-strengthening activity.⁵

Although there is general evidence of the benefits of physical activity, research on the impact of specific sport participation on health outcomes is lacking.⁶ The majority of studies that have examined the health impact of various sport types have been cross-sectional.⁶ The few that have examined the impact of sports via intervention studies have limited scope, mainly examining running and soccer.⁵ Prospective cohort studies have examined a bit more breadth of sport, such as running, cycling, and swimming, but the results have been mixed. When considering cardiovascular disease (CVD) incidence and mortality, running has been shown to be protective against CVD, but other studies have found no association.⁶ Studies on swimming and cycling have generally found no association with CVD incidence,⁶ but a recent study found that there was an association between swimming and CVD mortality.⁷ Further study on these and other sports in diverse populations is needed.

A systematic review by Oja and colleagues called on the research community to examine the impacts of different sports on health outcomes.⁶ Sports are a feasible way to address the gap between what is the recommended amount of physical activity for health, and the current state of inactivity in the population.⁸ Further, it is important to consider what types of sport activities can provide the biggest impact on population health, noting that a day is limited to 24 hours, and within that only a small proportion can be committed to leisure time physical activity. Therefore, this study aims to examine different sports activities and their association with cardiovascular disease morbidity and mortality in the ARIC cohort.

5. Main Hypothesis/Study Questions:

Main Hypothesis: Types of sport participation will be differentially associated with incident cardiovascular disease morbidity and mortality.

Aims:

(1) Examine the independent associations between participation in the most reported types of leisure-time sports and exercise and incident cardiovascular disease morbidity and mortality

(2) Examine the time-displacement (i.e. isotemporal substitution of one sport for another) of the most reported types of leisure-time sports and exercise and incident cardiovascular disease morbidity and mortality

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 cohort design of physical activity measured at Visit 1 and incident CVD morbidity and mortality

Exclusion: Not Caucasian or African-American, CVD at baseline

Exposure: Participation in exercise/sport activities (such as walking, bicycling, swimming, etc.), and frequency using data from the Baecke Questionnaire at ARIC visit 1 – type, hours a week, months a year, metabolic equivalent.⁹

Note: the Baecke Questionnaire derived leisure index score will not be used.

For each sport type, participation will be operationalized as:

- Dichotomous (yes/no)
- Average min/week, continuous and in quartiles
- MET min/week, continuous and in quartiles

Table 1. Prevalence of most commonly reported exercise/sport activities at Visit 1 in the Atherosclerosis Risk in Communities Study (ARIC)

Reported Sports	Frequency (n)*
Walking (walking to work, walking for pleasures, walking for transport)	6,241
Bicycling (< 10 mph, ≥ 10 mph, stationary)	1,847
Aerobics (aerobic exercise, aqua aerobics, dancing low to moderate, dancing high, gymnastics beam, gymnastics floor, mini trampoline, pilates, health club class or exercise not otherwise specified)	874
Swimming (recreational, with implements, backstroke ≤ 35 yards/min, backstroke > 35 yards/min, breaststroke ≤ 40 yards/min, breaststroke > 40 yards/min, butterfly, crawl, backstroke, sidestroke, synchronized)	822
Golf (walking and carrying clubs)	725
Floor exercises	716
Racquet sports (tennis, squash, badminton, racquetball)	581
Calisthenics	500

Running (jogging less than 6 mph, jogging greater than 6 mph, running greater than 6 mph, cross country)	498
Baseball/softball	300
Weight lifting	253
Basketball (game or non-game)	233
Volleyball	159

* all have power >0.8 to detect event probability of 0.37¹⁰

Outcomes: Incident CVD morbidity and mortality will be identified using methods previously described.¹⁰ CVD includes coronary heart disease, ischemic stroke, and heart failure.

Covariates (measured at baseline):

Model 1 (confounders) - Age, sex, site-race, mobility limitations (PHEA01, RPAA25), alcohol consumption, smoking status, education, income, marital status, Total MET min/week from all reported physical activity (minus the sport activity under study for certain models, to identify the impact of specific sport participation on incident CVD)

Model 2 (further confounders/potential mediators) - body mass index, hypertension, dyslipidemia, diabetes mellitus

Analysis:

The distribution of all variables under study will be examined – frequency for categorical variables, and mean, median, standard deviation, range for continuous variables. Normality will be assessed for continuous variables, and box-cox transformations will be considered for those variables not normally distributed.

Cox proportional hazard models will be used to examine the independent associations between participation in the most reported types of leisure-time sports and exercise and incident cardiovascular disease morbidity and mortality (aim 1). Log-minus-log plots will be used to examine proportional hazard assumptions.

Isotemporal substitution models (ISM) for proportional hazards,^{11,12} will be used to examine the time-displacement of the most reported types of leisure-time sports and exercise and incident cardiovascular disease morbidity and mortality (aim 2). According to Mekary and colleagues,¹¹ ISMs “estimate the effect of replacing on physical activity type with another physical activity type for the same amount of time”. In this study, an ISM may be expressed as follows:

$$h(t) = h_0(t) \exp[(b_1)\text{walking} + (b_2)\text{bicycling} + (b_3)\text{aerobics} + (b_4)\text{swimming} + (b_5)\text{golf} + (b_6)\text{floor exercises} + (b_7)\text{racquet sports} + (b_8)\text{calisthenics} + (b_9)\text{running} + (b_{10})\text{baseball/softball} + (b_{11})\text{weight lifting} + (b_{12})\text{basketball} + (b_{13})\text{volleyball} + (b_{14})\text{total physical activity} + (b_{15})\text{covariates}]$$

If we eliminate one sport/exercise from the model (e.g. walking),

$h(t) = h_0(t) \exp[(b_1)\text{walking} + (b_2)\text{bicycling} + (b_3)\text{aerobics} + (b_4)\text{swimming} + (b_5)\text{golf} + (b_6)\text{floor exercises} + (b_7)\text{racquet sports} + (b_8)\text{calisthenics} + (b_9)\text{running} + (b_{10})\text{baseball/softball} + (b_{11})\text{weight lifting} + (b_{12})\text{basketball} + (b_{13})\text{volleyball} + (b_{14})\text{total physical activity} + (b_{15})\text{covariates}]$

the other beta values represent the effect of substituting walking with their respective sports¹² (e.g. b_2 would represent the effect of substituting walking with bicycling).

Univariate and multivariate models will be used for all analyses, adjusted for covariates in two ways: model 1 will consider confounders; model 2 will include those in model 1 as well as further confounders/potential mediators with the expectation that, despite being potential mediators, they will not explain the entire association between sport and CVD and will further clarify these associations. Cox proportional hazard models will control for total physical activity, minus the activity of the sport being examined (i.e. the reference group will be all individuals who did not report participating in the specific activity under study, controlling for other reported sport activity).

The following sensitivity analyses will be conducted. First, participants with CVD morbidity/mortality within the first 24 months of follow-up will be excluded to clarify the temporal association between the exposure and outcome.⁷ Additionally, the dose response relationship between distribution-based quartiles of physical activity by sport and incident CVD morbidity/mortality will be considered using Cox models.

7.a. Will the data be used for non-CVD analysis in this manuscript? ___ Yes ___ 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 ICTDER 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 ___ 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

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.csc.unc.edu/ARIC/search.php>

___ 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#332 (Evenson, K): Physical activity and ischemic stroke risk: the Atherosclerosis Risk in Communities Study

MS#1715 (Bell, EJ): Physical activity and incidence of cardiovascular disease in African Americans

MS#2631 (Florio, R): Physical activity, family history of premature coronary heart disease (CHD), and incident CHD in the Atherosclerosis Risk in Communities (ARIC) study

MS#2711(Kubota, Y): Physical Activity and Lifetime Risk of Incident Cardiovascular Disease, and Cancer: the ARIC Study.

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

11.b. If yes, is the proposal

___ **A. primarily the result of an ancillary study (list number* _____)**

___ **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.csc.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.

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/> are posted in <http://www.csc.unc.edu/aric/index.php>, under Publications, Policies & Forms. http://publicaccess.nih.gov/submit_process_journals.htm shows you which journals automatically upload articles to PubMed central.

13. Per Data Use Agreement Addendum, approved manuscripts using CMS data shall be submitted by the Coordinating Center to CMS for informational purposes prior to publication. Approved manuscripts should be sent to Pingping Wu at CC, at pingping_wu@unc.edu. I will be using CMS data in my manuscript ____ Yes ___x___ No.

References

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10. Kubota Y, Evenson KR, Macle hose RF, Roetker NS, Joshu CE, Folsom AR. Physical activity and lifetime risk of cardiovascular disease and cancer. *Med Sci Sports Exerc.* 2017;49(8):1599-1605.
11. Mekary RA, Willett WC, Hu FB, Ding EL. Isotemporal substitution paradigm for physical activity epidemiology and weight change. *Am J Epidemiol.* 2009;170(4):519-527.
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