LITERACY CONTRIBUTES TO NUTRIENT INTAKES AMONG THE
HEALTHY AGING IN NEIGHBORHOODS OF DIVERSITY ACROSS
THE LIFE SPAN (HANDLS) STUDY PARTICIPANTS

by

Loran Marie Pryor

A thesis submitted to the Faculty of the University of Delaware in partial fulfillment of
the requirements for the degree of Master of Science in Human Nutrition

Spring 2012

Copyright 2012 Loran M. Pryor
All Rights Reserved
LITERACY CONTRIBUTES TO NUTRIENT INTAKES AMONG THE
HEALTHY AGING IN NEIGHBORHOODS OF DIVERSITY ACROSS
THE LIFE SPAN (HANDLS) STUDY PARTICIPANTS

by
Loran Marie Pryor

Approved:
Marie Fanelli Kuczmarski, Ph.D.
Professor in charge of thesis on behalf of the Advisory Committee

Approved:
P. Michael Peterson, Ed.D.
Chair of the Department of Behavioral Health and Nutrition

Approved:
Kathleen S. Matt, Ph.D.
Dean of the College of Health Sciences

Approved:
Charles G. Riordan, Ph.D.
Vice Provost for Graduate and Professional Education
ACKNOWLEDGEMENTS

First and foremost, I would like to thank my advisor, Dr. Marie Fanelli Kuczmarski, for her support and guidance throughout this process. Her knowledge and input has helped me immensely, not only with this research project, but also with developing many academic and professional skills. I would also like to thank my other committee members: Dr. Lawrence Hotchkiss for his help with the statistical analysis and interpretation, Dr. Nancy Cotugna for her insight and expertise, and Dr. Melissa Kitner-Triolo for her help with the literacy analysis and interpretation. They were all tremendous assets to this project, and I could not have done it without them. I would also like to extend many thanks to the Healthy Aging in Neighborhoods of Diversity across the Life Span (HANDLS) Study for allowing me to use their data for this analysis, and also for funding my graduate education. I thoroughly enjoyed working on the HANDLS study throughout my graduate studies and have learned a great deal about epidemiological research that I will carry through my future endeavors. Lastly, I would like to thank my close friends and family, who served as my support system and filled me with positivity throughout this process. My work is dedicated to them.
# TABLE OF CONTENTS

LIST OF TABLES............................................................................................vi
ABSTRACT........................................................................................................vii

Chapter

1 INTRODUCTION..........................................................................................1
   Operational Definitions.............................................................................3
   References.................................................................................................4

2 LITERATURE REVIEW...............................................................................6
   Diet Quality and Race .............................................................................7
   Diet Quality and Income ........................................................................9
   Diet Quality and Education ...................................................................10
   Literacy and Diet Outcomes ..................................................................11
   Summary................................................................................................15
   References.................................................................................................17

3 JOURNAL MANUSCRIPT..........................................................................19
   Abstract ..................................................................................................21
   Introduction ............................................................................................23
   Methods..................................................................................................24
      Participants..........................................................................................24
      Dietary Intake Assessment ................................................................25
      Diet Quality Variables ....................................................................25
      Literacy Variable ..............................................................................26
      Independent Variables .....................................................................27
      Statistical Analysis ..........................................................................27
   Results....................................................................................................28
      Sample Characteristics .....................................................................28
      Literacy ..............................................................................................28
      Diet Quality .......................................................................................28
Regression Analyses ......................................................... 29
Discussion ................................................................. 29
References ............................................................... 39

BIBLIOGRAPHY .................................................................. 41

Appendix

A  AUTHOR GUIDELINES .................................................. 44
B  DIETARY REFERENCE INTAKES FOR NUTRIENT ADEQUACY RATIO (NAR) NUTRIENTS ....................................................... 59
C  VARIABLE DEFINITIONS .............................................. 61
D  UNCAPPED REGRESSION ............................................... 62
E  INFORMED CONSENT ................................................... 65
F  REFERENCES (APPENDICES) ............................................ 73
LIST OF TABLES

Table 1. Demographics and reading levels of the HANDLS Study Sample.............33

Table 2. Mean ± Standard Error of the Mean (SEM) Intake of Energy and Macronutrients by Sex.................................................................34

Table 3. Mean ± Standard Error of the Mean (SEM) Percent of Macronutrients as a Percent of Energy by Sex...........................................................35

Table 4. Mean ± Standard Error of the Mean (SEM) of Nutrients, Nutrient Adequacy Ratio (NAR) by Nutrient, and Mean Adequacy Ratio by Sex.................36

Table 5. Percent of Individuals with Low Nutrient Intakes by Nutrient...............37

Table 6. Regression Analysis for Mean Adequacy Ratio for Total Sample..........38

Table 7. Recommended Dietary Allowances (RDA) used for NAR Calculations by Nutrient..............................................................................59

Table 8. Percentage of Participants Exceeding NAR Standard of 100 Per Nutrient.....62

Table 9. Regression Analysis for Capped MAR versus Uncapped MAR versus Log (Uncapped MAR).................................................................62

Table 10. Regression Analysis for Uncapped MAR a versus Log (Uncapped MAR) Including Energy Intake..............................................................63
ABSTRACT

*Background:* Low literacy is a common problem in the United States and can be a barrier to following dietary recommendations. Nutrient-based diet quality has been associated with race and education but no prior identified research has evaluated its association with literacy.

*Purpose:* To determine if literacy is a stronger predictor of diet quality than race or education.

*Methods:* The sample consists of 2,067 African American and white, socioeconomically diverse urban adults, aged 30-64 years who participated in the baseline phase of the Healthy Aging in Neighborhoods of Diversity across the Life Span (HANDLS) Study. Dietary intake data were obtained from two 24-hour recalls using USDA’s Automated Multiple Pass Method. Diet quality was calculated using a micronutrient composite index of nutrient adequacy ratios (NAR) and a mean adequacy ratio (MAR). Literacy was measured using the Wide Range Achievement Test 3rd edition (WRAT-3) Reading subtest. To assess the relationship of literacy, race and education with diet quality, linear regression analysis was performed using total NAR, MAR and WRAT-3 scores.
Results: The mean (±SEM) literacy score for women was 43.3 ±0.4 and for men, 42.9 ±0.5. Mean (±SEM) MAR scores were 77.3 ±0.8 and 82.4 ±0.8, for women and men, respectively. The results of linear regression analyses revealed that both education and literacy, along with sex, predicted diet quality ($R^2 = 0.13$). Race, age and poverty status were found to be nonsignificant.

Conclusion: Since both education and literacy are significant, it seems that education may contribute something besides literacy to choosing a healthy diet.
Chapter 1

INTRODUCTION

Literacy, and its influence on many health and nutrition-related topics, is becoming increasingly popular in today’s literature. Healthy People 2020 even named one of its objectives to “improve the health literacy of the population,” and the American Dietetic Association identified health literacy as one of its seven priority public health areas.\textsuperscript{1,2} Low literacy levels have also been linked to several negative health outcomes.\textsuperscript{3-6}

United States literacy levels are poor, with an estimated 43% (approximately 93 million) of adults having no more than the necessary skills to perform simple and everyday literacy activities.\textsuperscript{7} This poses a concern in relation to the quality of the diet. Nutrition information sources, such as food labels, require literacy skills in order to make appropriate dietary decisions. Literacy has been shown to impact various dietary outcomes, such as food label comprehension, portion size estimation skills, and acquiring of and trust in nutrition information sources.\textsuperscript{8-10} Furthermore, literacy has proven to be the strongest factor influencing these dietary outcomes over many of the factors that predict diet quality, such as race, income, and education, which suggests that literacy may have a strong effect on diet quality.\textsuperscript{8-10} To our knowledge, only one study has directly examined literacy’s effect on diet quality. Using a nutrition literacy assessment, Zoellner
et al\textsuperscript{11} found that literacy significantly predicted food-based diet quality among 373 Lower Mississippi Delta adults.

The Healthy Aging in Neighborhoods of Diversity across the Life Span (HANDLS) Study is a prospective longitudinal study designed by the National Institute on Aging to explore persistent health disparities among a fixed cohort of 3,721 adults, living in Baltimore, Maryland.\textsuperscript{12} Previous HANDLS findings have shown links between race and diet quality, and education and diet quality.\textsuperscript{13} Additionally, another study showed that literacy proved to be a stronger predictor of cognitive functioning than education\textsuperscript{14}; therefore among this population, literacy may be a strong predictor of diet quality.

Lack of literature regarding the relationship between literacy and diet quality, specifically among a large population such as the HANDLS Study, presents a unique opportunity to explore the relationship more in depth. Therefore, the aim of this study is to evaluate the relationship of literacy to diet quality among the participants of the HANDLS study, and to determine if literacy is a stronger predictor of diet quality compared to race, income and education.
**Operational Definitions**

Self-reported whites will henceforth be referred to as whites.

Self-reported African Americans will henceforth be referred to as African Americans.

Poverty Income Ratio (PIR) – refers to a ratio of household income and the poverty threshold defined for the 2004 US census bureau for a person or family. In this analysis, PIR was categorized as either less than 125% or greater than or equal to 125% of the Federal poverty level.\(^\text{12}\)

Dietary Reference Intakes (DRI) – the nutrient intake values established as goals for individuals or groups for good nutrition and health.\(^\text{15}\)

Recommended Dietary Allowance (RDA) – the average daily intake of a nutrient that is thought to meet the nutrient requirements of about 97% of healthy individuals.\(^\text{15}\)

Diet quality indexes – referred to as either food-based, which measures the frequency of consumption among food groups with respect to nutrition recommendations and guidelines, or nutrient-based, which analyzes key nutrients that represent overall nutritional adequacy of the diet.

Nutrient Adequacy Ratio (NAR) – a nutrient-based diet quality index
\[
\text{NAR} = \frac{\text{The subject’s daily intake of nutrient}}{\text{RDA of nutrient}}
\]

Mean Adequacy Ratio (MAR) – a nutrient-based diet quality index
\[
\text{MAR} = \frac{\text{The sum of all 15 nutrient NARs}}{15}
\]

Literacy – using printed and written information to function in society, to achieve one’s goals, and to develop one’s knowledge and potential.\(^\text{1}\)
References


12. Evans MK, Lepkowski JM, Powe NR, LaViest T, Kuczmasrki MF, Zonderman AB. Healthy aging in neighborhoods of diversity across the life span (HANDLS): overcoming barriers to implementing a longitudinal epidemiologic, urban study of
Chapter 2

LITERATURE REVIEW

Food choices affect diet quality and are influenced by a variety of factors. Demographic variables, such as sex and race, have been shown to predict diet quality.\(^1\text{-}\text{4}\) Additionally, it is known that socioeconomic factors, namely income and education, are predictors of diet quality.\(^1\text{,}\text{4}\text{-}\text{10}\) Literacy is associated with these socioeconomic factors, however it is not known if literacy is associated with diet quality to the same degree as socioeconomic factors.\(^1\text{1}\) Literacy has been shown to impact various dietary outcomes, such as food label comprehension, portion size estimation skills, and acquiring and trust in nutrition information sources.\(^1\text{2}\text{-}\text{14}\) To our knowledge, only one study has directly looked at nutrition literacy’s effect on diet quality.\(^1\text{5}\)

The complexity of the influence of each individual factor, and its impact on other factors, determine overall diet quality. Using the example of education, it has been shown that sex, race, and income level all influence years of education. Conversely, years of education and quality of education have been shown to influence literacy.\(^1\text{1}\) Furthermore, all of these demographic and socioeconomic variables have been shown to have an effect on diet quality.\(^1\text{-}\text{10}\) While these variables interact with each other and collectively influence diet quality, it is not known if literacy influences diet quality to the same degree.
Diet Quality and Race

The quality of the diet can be described and measured two ways. The first is through food-based diet quality, which measures the frequency of consumption among food groups with respect to nutrition recommendations and guidelines. The second is through nutrient-based diet quality, which analyzes key nutrients that represent overall nutritional adequacy of a diet. Nutrients are strong predictors of health outcomes, and high diet qualities are associated with decreased negative health outcomes, which is what makes this an important measurement of diet quality.

Race is an important factor influencing diet quality. National nutrition survey data have shown whites to have better diet qualities compared to African-American populations, after controlling for income. These differences can be attributed to things such as cultures, taste preferences, and preparation methods. Data from the second National Health and Nutrition Examination Survey (NHANES II), a nationwide probability sample of 11,658 men and women, documented better diet qualities among whites compared to African-Americans. Variety and quality of the diet was determined using Food Group Scores and Serving Scores, calculated from 24-hour dietary recalls. Food Group Scores measured how many of the five food groups were represented in the daily diet, with a score of 5 meaning the average daily diet included food from all five food groups. Over 40% of blacks and 25% of whites had scores of 3 or less. Serving Scores analyzed the presence of a desired number of servings from all five food groups, with a score of 20 indicating that proper amounts from all five food groups were eaten.
Among whites, the largest group (40%) scored between 13 and 16, whereas among blacks the largest group (34%) scored between 9 and 12.

After controlling for income, African-Americans surveyed in the Continuing Survey of Food Intake by Individuals 1994-96, 1998, displayed lower Healthy Eating Index (HEI) scores than other race/ethnicity groups. The HEI, a tool used to measure adherence to the Dietary Guidelines for Americans, was used to measure diet quality.

McCabe-Sellers et al also showed a relationship between diet quality and race when they assessed the diet quality of Lower Mississippi Delta adults to determine variances among the population subgroups. This cross-sectional study obtained 24-hour dietary intakes using the USDA’s Automated Multiple Pass Method (AMPM) for 1,699 adults via telephone survey. Diet quality was assessed using the HEI. Analysis revealed that African American adults had significantly lower total HEI scores as well as lower vegetable, dairy and variety scores than did white adults. Furthermore, a higher percentage of white Americans met the recommendations for vegetable and dairy groups than did African Americans. Therefore, these results show how diet quality can be affected by cultural and racial differences.

Differences in diet quality between African-Americans and whites were found in an analysis of 1,990 individuals living in Baltimore, Maryland and participating in the Healthy Aging in Neighborhoods of Diversity across the Life Span (HANDLS) Study. These individuals represented a subset of the baseline sample population. This analysis, conducted by Raffensperger et al, measured diet quality by using a micronutrient composite index of nutrient adequacy ratios and a mean adequacy ratio. These scores
were based on a dietary intake obtained by two 24-hour recalls using the USDA’s AMPM. Whites had significantly higher nutrient adequacy ratio scores for thiamin, riboflavin, folate, magnesium, copper, zinc, calcium and vitamins A, B₁₂, and E, while African-Americans had higher vitamin C scores. Thus, among a socioeconomically diverse, urban population, differences exist in diet quality between races.¹

**Diet Quality and Income**

Diet quality has also been linked to income and poverty income ratio (PIR). An analysis of NHANES 1999-2002, conducted by Bowman⁵, used PIR to group individuals into low, medium, and high-income groups. Findings revealed that a lower proportion of low-income adults ate at or above the Adequate Intake or Estimated Average Intake levels for many micronutrients. Furthermore, they ate less fruit, vegetables, meat, fish, and dairy than those with higher income. After controlling for age and sex, Bowman⁵ also found higher energy intake with each increasing PIR level.

Kant and Graubard⁶ examined the association of PIR with diet among the NHANES I (1971-1975), II (1976-1980), II (1988-1994), and 1999-2002. Similar to the Bowman’s findings, a positive association between PIR with the amount of foods and intakes of energy and potassium over three decades (p < 0.001) was found. PIR also increased the likelihood of reporting foods consumed from all five food groups.⁶

In addition to a link between diet quality and race among 1,699 Lower Mississippi Delta adults, McCabe-Sellers⁴ and colleagues found a link between diet quality and household income. Higher household income was associated with eating a diet high in variety, with incomes of $30,000 displaying a significantly higher mean variety score
than those with incomes <$15,000. High-income households also displayed higher vegetables scores than the medium- and low-income households.\textsuperscript{4}

**Diet Quality and Education**

Diet quality has also been consistently linked to education. This relationship has been shown among several national samples and dates back to the Atherosclerosis Risk in Communities (ARIC) Study, which was conducted in 1986 to study the etiology and history of atherosclerotic diseases in middle-aged adults.\textsuperscript{7-9} An analysis of 15,381 African-American and white ARIC Study participants, conducted by Shimakawa et al\textsuperscript{7}, found that higher educational attainment was generally associated with lower intakes of saturated fatty acid and cholesterol and higher intakes of dietary fiber, vitamins A, C, E, B\textsubscript{6}, calcium, potassium, iron, and folate. These results were similar across sexes and races. Similar results were seen in an analysis conducted by Kant et al\textsuperscript{8} of NHANES data, which was collected from 1971-2002. Higher education predicted higher intakes of potassium, calcium and vegetables among both African-American and white individuals. Therefore, findings from these studies clearly demonstrate that regardless of race and sex, higher educational attainment is associated with better diet quality assessed by nutrient intake.\textsuperscript{7,8}

Popkin et al\textsuperscript{9} also found that education had a stronger relationship with diet quality than other variables. Their analysis used data from the 1965 Nationwide Food Consumption Survey and the 1994-1996 Continuing Survey of Food Intake by Individuals and measured diet quality with a nutrient and food-based instrument, the Revised Diet Quality Index (DQI-R). Results displayed that between 1965 and 1996,
improvements were seen in both overall DQI-R and its components across all education levels. Conversely, improvements linked with income were inconsistent.  

Two additional studies that revealed differences in diet quality among education levels were two of the same studies that found diet quality differences between races. The first, which examined diet quality among 1,699 Lower Mississippi Delta adults, found that those with a college education had a significantly higher HEI, vegetable, fruit, and variety scores than did those with less education. The second, which analyzed a subset of the baseline sample from the HANDLS Study sample, found that education was a significant predictor of diet quality among both African-American and white individuals.

Among overweight and obese postmenopausal women, education appears to be the strongest predictor of diet quality. Diet intake was assessed using a 3-month food frequency questionnaire, and diet quality was assessed using the HEI as well as the DQI. Women with a high school education had a lower-diet quality than those with at least some college ($p<0.02$), which was consistent across both indexes. In addition, there were no differences in diet qualities across income levels.

**Literacy and Diet Outcomes**

Literacy is defined as using printed and written information to function in society, to achieve one’s goals, and to develop one’s knowledge and potential. A most widely used tool to assess academic achievement is the Wide Range Achievement Test-3rd Edition (WRAT-3), which includes three subtests: reading, spelling, and arithmetic. The subtests may be used alone, or in combination with each other, depending on what is
being analyzed. However, when assessing literacy alone, the reading subtest is most commonly used assessment of adult literacy.

When assessing literacy’s role in various diet and nutrition-related outcomes, the more specific term of health literacy is sometimes used, which is defined as the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions. The most commonly used tools used to assess health literacy are the Rapid Estimate of Adult Literacy in Medicine (REALM) and the Test of Functional Health Literacy in Adults (TOFHLA). Another tool, the Newest Vital Sign (NVS), tests patients’ comprehension of nutrition information labels and has been validated against the TOFHLA. The NVS serves as an assessment of nutrition literacy, which refers to the degree to which individuals have the capacity to obtain, process, and understand basic nutrition information.

The role of literacy and numeracy in patient comprehension of food labels has been studied by Rothman et al. This cross-sectional study was performed on 200 primary care patients and used the REALM to assess literacy, the WRAT-3 to assess numeracy, and the Nutrition Label Survey (NLS) to assess their understanding of current nutrition labels. Overall, patients correctly answered 69% (standard deviation, 21%) of the NLS questions, however patients with less than 9th-grade literacy skills performed worse on the NLS than patients with higher literacy skills (51% versus 75% correct responses, p<0.0001). Similarly, patients with less than 9th-grade numeracy skills performed worse than those with higher numeracy skills (61% versus 84%, p<0.0001).
In multivariate regression analysis, lower literacy and numeracy skills remained significantly (p<0.001) associated with poorer performance on the NLS, even after adjusting for age, gender, race/ethnicity, income, education, and other factors. These results suggest that addressing literacy and numeracy may help to improve food label comprehension, given that poor label comprehension was highly correlated with low-level literacy and numeracy skills.12

Another study, by Huizinga et al13, aimed to assess 164 primary care patients’ ability to estimate portion size and to evaluate the relationship between portion-size estimation skills and literacy and numeracy skills. Literacy and numeracy were again assessed with the REALM and WRAT-3 respectively, and for three solid-food items and one liquid item, patients were asked to serve both a single serving and a specified weight or volume amount representing a single serving. If the portion fell within +/-25% of a single standard serving, then it was deemed accurate. Unadjusted analyses revealed that patients who overestimated were more likely to have lower literacy or numeracy skills than those who estimated accurately (55% versus 17%, p<0.001; 95% versus 65%, p=0.008). In multivariate analyses, higher literacy was associated with 2.5-fold higher odds of accuracy compared to inaccuracy when participants were asked to serve a single serving (OR=2.54; 95% CI=1.11, 5.81; p=0.027). Thus, lower literacy skills were associated with less accuracy when participants were asked to serve a single serving, which suggests that addressing literacy may help to improve portion-size estimation.13

Zoellner et al14 analyzed the nutrition literacy status of 177 adults in the Lower Mississippi Delta, while also taking into account the influence of media use on
participants’ nutrition literacy status. The NVS, which is the validated questionnaire that asks subjects to answer 6 questions on how they would interpret and act on the information contained on a nutrition information label, was used to measure nutrition literacy. They also developed their own questionnaire, which included 4 questions to understand subjects’ awareness of and exposure to the Dietary Guidelines and MyPyramid, as well as adaptations of 43 questions from the Health Communication section of the National Cancer Institute Health Information National Trends Survey 2 (HINTS-2), which analyzed subjects’ use of different communication channels to obtain health and nutrition information. Nutrition literacy was significantly correlated with media use for general purposes ($F = 2.79$, $P = .005$), media use for nutrition information ($F = 2.30$, $P = .04$), and level of trust from nutrition sources ($F = 2.29$, $P = .005$).

Furthermore, only 12% of participants correctly identified the 2005 MyPyramid graphic. These findings suggest that nutrition literacy has implications for how people seek nutrition information and whether they trust it. The results also further suggest the need to address nutrition literacy.\textsuperscript{14}

To our knowledge, the only study that linked nutrition literacy to diet quality was an analysis of 373 Lower Mississippi Delta adults also conducted by Zoellner et al.\textsuperscript{15} Nutrition literacy was assessed using the NVS, dietary intake was assessed using a 158-item food frequency questionnaire, and diet quality was assessed using the Healthy Eating Index 2005 (HEI-2005), which measures compliance with the 2005 Dietary Guidelines for Americans. In addition to HEI-2005 scores, sugar sweetened beverage (SSB) consumption was also examined. Nutrition literacy significantly predicted HEI
scores \( (F = 18.8; P < 0.01) \), such that every 1-point increase in nutrition literacy was associated with a 1.21 increase in HEI scores, while controlling for all other variables (i.e. sex, race, education, income, and participation in Supplemental Nutrition Assistance Program). Furthermore, nutrition literacy also significantly predicted SSB consumption \( (R^2 = 0.15; F = 6.3; P < 0.01) \), while accounting for demographic variables, with every 1-point increase in nutrition literacy scores accounting for 34 kilocalories less per day from SSB. These results show a relationship between nutrition literacy and diet quality, therefore suggesting the importance of investigating this relationship further in order to understand the causes and consequences of limited literacy in promoting diet and nutrition information.\(^\text{15}\)

**Summary**

Many factors have been shown to effect food- and nutrient-based diet quality. One of these factors is race, with whites consistently displaying better diet quality over African-American populations.\(^\text{1-4}\) Income and education are two other factors that influence diet quality, with diet quality increasing with both income\(^\text{4-6}\) and education levels\(^\text{1,4-10}\). Among the factors influencing diet quality, education appears to be the strongest.

Literacy has been linked to various dietary outcomes, such as food label comprehension, portion size estimation skills, and acquiring of and trust in nutrition information.\(^\text{12-14}\) Furthermore, literacy has proven to be the strongest factor influencing these dietary outcomes over many of the factors that predict diet quality (i.e. race, income, and education), which suggests that literacy may have a strong effect on diet
quality. To our knowledge, only one study has examined the effect of literacy on diet quality, and they found that literacy significantly predicted food-based diet quality.\textsuperscript{15}

This review suggests the need to further explore the relationship between literacy and diet quality, specifically using a nutrient-based diet quality index, which to our knowledge has yet to be analyzed. The strength of this relationship should also be tested in order to determine if literacy is a stronger predictor of diet quality over race, income, and education, and additionally if literacy could be used in place of race, income, and education as a predictor of diet quality.
REFERENCES


15. Zoellner J, Connell C, Smith-Ray RL, Allen K, Tucker KL, Davy BM, Estabrooks P. Health literacy is associated with healthy eating index scores and sugar-


EFFECTS OF LITERACY ON DIET QUALITY OF SOCIOECONOMICALLY DIVERSE URBAN POPULATION

Running Title: Contributing Factors to Nutrient-Based Diet Quality

Loran M Pryor, MS¹
Marie Fanelli Kuczmarski, PhD, RD, LDN, corresponding author
010 Carpenter Sports Building
Newark, DE 19716
302-831-8765
fax: 302-831-4261
mfk@udel.edu

Lawrence Hotchkiss, PhD¹
Nancy Cotugna, DrPH, RD¹
Melissa H Kitner-Triolo, PhD²

1) Department of Behavioral Health and Nutrition,
026 Carpenter Sports Building, Newark, DE 19716
2) Cognitive Testing Group Laboratory of Behavioral Neuroscience, National Institute on Aging, NIH, 251 Bayview Boulevard, Suite 100, Baltimore, Maryland 21224-6825

Keywords: literacy, diet quality, nutrient intake, education

Word count: 2464
Number of Tables: 6

Conflict of Interest: None. No financial disclosures were reported by the authors of this paper.
ABSTRACT

**Background:** Low literacy is a common problem in the United States and can be a barrier to following dietary recommendations. Nutrient-based diet quality has been associated with race and education but no prior identified research has evaluated its association with literacy.

**Purpose:** To determine if literacy is a stronger predictor of diet quality than race or education.

**Methods:** The sample consisted of 2,067 African American and white, socioeconomically diverse, urban adults, aged 30-64 years who participated in the baseline phase of the Healthy Aging in Neighborhoods of Diversity across the Life Span (HANDLS) Study, which was conducted from August 2004 to March 2009. Dietary intake data were obtained from two 24-hour recalls using USDA’s Automated Multiple Pass Method. Diet quality was calculated using a micronutrient composite index of nutrient adequacy ratios (NAR) and a mean adequacy ratio (MAR). Literacy was measured using the Wide Range Achievement Test 3rd edition (WRAT-3) Reading subtest. To assess the relationship of literacy, race and education with diet quality, linear regression analysis was performed using total NAR, MAR and WRAT-3 scores.

**Results:** The mean (±SEM) literacy score for women was 43.3 ±0.4 and for men, 42.9 ±0.5. Mean (±SEM) MAR scores were 77.3 ±0.8 and 82.4 ±0.8, for women and men, respectively. The results of linear regression analyses revealed that both education and literacy, along with sex, predicted diet quality ($R^2 = 0.13$). Race, age and poverty status were found to be nonsignificant.
**Conclusion:** Since both education and literacy are significant, it seems that education may contribute something besides literacy to choosing a healthful diet.
**Introduction**

Literacy, and its influence on many health and nutrition-related topics, is becoming an increasingly popular topic in today’s literature. Healthy People 2020 has even named one of its objectives to “improve the health literacy of the population”, and the American Dietetic Association, now known as the Academy of Nutrition and Dietetics, identified health literacy as one of its seven priority public health areas.\(^1\,^2\) Low literacy levels have also been linked to several negative health outcomes.\(^3\,^6\)

United States literacy levels are poor, with an estimated 43% (approximately 93 million) of adults having no more than the necessary skills to perform simple and everyday literacy activities.\(^7\) These low levels pose a concern in relation to the quality of the diet. Literacy has been shown to impact various dietary outcomes, such as food label comprehension, portion size estimation skills, and acquiring of and trust in nutrition information sources.\(^8\,^9\,^10\) Furthermore, literacy has proven to be the strongest factor influencing these dietary outcomes over many of the factors that predict diet quality, such as race, income, and education, suggesting literacy may also have a strong effect on diet quality. To our knowledge, only one study has directly examined the effect of literacy on diet quality. Using a nutrition literacy assessment, Zoellner et al\(^11\) found that literacy significantly predicted food-based diet quality among 373 Lower Mississippi Delta adults.

The Healthy Aging in Neighborhoods of Diversity across the Life Span (HANDLS) Study is a prospective longitudinal study designed by the National Institute on Aging to explore persistent health disparities among a fixed cohort of 3,721 adults,
living in the city of Baltimore, Maryland. Previous HANDLS findings have shown links between race and diet quality, and education and diet quality. Additionally, another study showed that literacy proved to be a stronger predictor of cognitive functioning than education, therefore among this population; literacy may be a strong predictor of diet quality.

The HANDLS Study provides a unique opportunity to explore in depth the relationship between literacy and diet quality in a relatively large, racially diverse population. The aim of this study was to evaluate the relationship of literacy and diet quality among the participants of the HANDLS study, and to determine if literacy is a stronger predictor of diet quality than race, income and education.

**Methods**

**Participants**

The study population came from a baseline representative sample of African American and white adults, aged 30-64, participating in the HANDLS study. A fixed cohort of approximately 3,721 participants was recruited from 13 predetermined neighborhoods in Baltimore City. Baseline data collection for the HANDLS study began in August 2004 and ended in March 2009. All participants provided written informed consent and were excluded if they had AIDS, had undergone cancer treatment within six months of recruitment, or were pregnant. Inclusion criteria for the study were: age 30-64; ability to give written informed consent and valid photo identification; and ability to
perform at least 5 of the following evaluations: medical history, physical performance, cognitive testing, dietary recall, audio questionnaire, body composition, carotid Doppler, or pulse-wave velocity assessment. In addition, this analysis only included the participants who had complete 2 days of dietary intake, literacy, and independent variable data, which yielded an analytic sample of 2,067 total participants. Human subjects review boards at both the Medstar Research Institute and the University of Delaware approved the HANDLS study protocol, which has been described in depth in a report by Evans et al.12

**Dietary Intake Assessment**

Dietary intake data were collected via two 24-hour dietary recalls, usually 4-10 days apart. The recall was administered by trained interviewers in the home and at mobile research vehicles, using the United States Department of Agriculture’s (USDA) Automated Multiple Pass Method (AMPM) versions 2.3 to 2.5. This collection method was validated for food intakes of protein, carbohydrate, fat and energy use in obese and nonobese men and women.15,16 Food and beverage intakes were then coded and analyzed using USDA Survey Net system and the Food and Nutrient Database for Dietary Studies 3.0.17

**Diet Quality Variables**

Nutrient-based diet quality was determined by comparing the proportion of nutrients consumed to the Recommended Dietary Allowance (RDA). Based on models published by Raffensperger et al13, Murphy et al18 and Foote et al19, dietary intakes of calcium, magnesium, phosphorus, vitamin A, vitamin C, vitamin E, vitamins B6 and B12,
folate, iron, thiamin, riboflavin, niacin, copper, and zinc were used as the basis for diet quality. RDAs of these 15 vitamins and minerals were used to determine each one’s nutrient adequacy ratio (NAR), using the following formula:

\[
\text{NAR} = \frac{\text{The subject’s daily intake of nutrient}}{\text{RDA of nutrient}}
\]

The NAR of each nutrient was then converted to a percent, and percents greater than 100 were truncated to 100.\textsuperscript{18} If the mean 2-day intake was below 67\% of the RDA, then it was considered low due to the fact that an intake above 67\% of the RDA most likely represents nutrient adequacy.\textsuperscript{19}

The total quality of the diet was then calculated from the NARs to form a mean adequacy ratio (MAR) using the following formula:

\[
\text{MAR} = \frac{\text{The sum of all 15 nutrient NARs}}{15}
\]

Since MAR is based on micronutrient intake, mean (±SEM) macronutrient intakes were determined to provide further description of the diet. Total fat, saturated fat, polyunsaturated fat, carbohydrate, protein, and sugar as percent of energy; and means for total energy, cholesterol, and dietary fiber were also calculated.\textsuperscript{18,19}

**Literacy Variable**

Literacy was assessed by trained examiners at the mobile research vehicles, using the reading subtest of the Wide Range Achievement Test- 3rd Edition (WRAT-3), a widely validated and used measurement of literacy.\textsuperscript{20,21} The WRAT-3 Reading subtest measures participants’ ability to recognize and name letters and words. The total WRAT-3 Reading score (total correctly pronounced letters + total correctly pronounced words)
served as the literacy measurement. The total WRAT-3 Reading score was also converted to grade level equivalents for descriptive purposes.\textsuperscript{20}

**Independent Variables**

Several demographic and socioeconomic variables previously shown to have a possible effect on diet quality were included as independent variables in the regression. Trained interviewers collected demographic information, such as age, sex, race, and education, during an in-home interview using survey questionnaires. Age was recorded as the age at the baseline recruitment screen. Sex was categorized as male or female. Race was reported as either African American or white. Educational attainment was reported as the highest grade of school completed.\textsuperscript{12} Income levels were collected by an audio questionnaire. Poverty income ratio (PIR), a ratio of household income and the poverty threshold defined for the 2004 US census bureau for a person or family, was categorized as either $< 125\%$ or $\geq 125\%$ of the Federal poverty level.\textsuperscript{12}

**Statistical Analysis**

To assess whether literacy is associated with diet quality, linear regression analyses were performed using the NAR and MAR diet quality variables and the WRAT-3 Reading scores. The dependent variables were NAR and MAR and the independent variables were WRAT-3 word reading score, sex, race, age, education, and PIR. Descriptive statistics were run in regards to sex, race, age, education, PIR and WRAT-3 Reading scores. All statistical analyses were carried out using the SAS statistical analysis computer package (version 9.2, Copyright © 2002-2008, SAS Institute, Inc, Cary, NC, USA. Licensed to University of Delaware – T&R, Site 0070003968), and data were
weighted using sample weights for the baseline HANDLS study. The analyses were run using SAS survey software procedures, surveymeans and surveyreg. The HANDLS neighborhood variable was specified as the cluster variable, and the variables age, sex, race and PIR were specified as strata variables.

Results

Sample Characteristics

Of the 2,067 baseline HANDLS participants included in the analyses, 1,171 were women and 896 were men. Mean (±SEM) age was 45.9 ±0.8 years and 46.5 ±0.8 years for women and men, respectively. Both sexes averaged 13.2 ±0.2 years of education, and 16.4% of men and 22.5% of women fell below the poverty income ratio.

Literacy

Mean WRAT-3 total scores were 43.3 ±0.4 for women and 42.9 ±0.5 for men. Among the female population, 16.4% had fifth grade or lower reading levels compared to 22.5% of the male population. Both sexes had 14.5% of their population score in the sixth to eighth grade reading level range, and 62.9% of the male and 69.1% of the female population had high school or post high school reading levels (Table 1).

Diet Quality

Overall, men had significantly higher energy intakes than women (2,483 ±70.2 versus 1,797.2 ±44.4 kilocalories). Furthermore, analysis of macronutrient intake
revealed that men had higher intakes than women across all categories (Table 2). Results were similar between sexes in regards to macronutrients as percent of energy (Table 3).

Overall nutrient intake was significantly higher among men than women; with mean MAR scores of 82.4 ±0.8 and 77.3 ±0.8 respectively. NARs that displayed the greatest differences between men and women were iron (97.6 ±0.3 versus 76.2 ±1.8), calcium (73.9 ±1.4 versus 60.6 ±1.4), and folate (79.7 ±1.3 versus 71.0 ±1.3) (Table 4).

The percentage of men having <67% RDA ranged from 2.1% to 75.4% for iron and vitamin E respectively. Women having <67% RDA ranged from 7.2% for phosphorus and magnesium to 85.0% for vitamin E. Over half of the sample had <67% RDA for vitamin A, vitamin E, and magnesium (Table 5).

**Regression Analyses**

Sex (p<0.0001), education (p<0.0001), and literacy (p<0.0001) were all statistically significant predictors of nutrient-based diet quality. Furthermore, when literacy was removed from the model, education remained statistically significant, and when education was removed from the model, literacy remained statistically significant. The remaining independent variables: race, age, and poverty status were nonsignificant.

**Discussion**

To our knowledge, this is the first study to examine the link between literacy and nutrient-based diet quality. Analyses of the HANDLS population revealed that aside from sex, education was the strongest predictor of nutrient intake, closely followed by
literacy. Additionally, both education and literacy remained significant when the other was eliminated from the regression, with education still appearing slightly stronger than literacy. This finding suggests both education and literacy contribute independently to diet quality.

Education has been a significant predictor of nutrient-based diet quality consistently in literature, thus it is not surprising that it was the strongest predictor in this analysis. Analyses of two studies with national samples, the Atherosclerosis Risk in Communities (ARIC) Study and the National Health and Nutrition Examination Survey (NHANES), both displayed that regardless of race and sex, high educational attainment was associated with better diet quality assessed by nutrient intake.22,23 Our results are also consistent with another HANDLS analysis that found education to be the most significant predictor of diet quality, however that analysis did not include literacy.13

While education was the strongest predictor of diet quality, literacy also was associated with a strong and statistically significant effect. Even though education and literacy levels are highly related, several studies have pointed out discrepancies between the effects of the two. On one hand, it is hypothesized that literacy is a better predictor of cognitive performance than years of education because it is a better measure of quality of education.14,24 On the other hand, it is also hypothesized that education provides skills such as vocabulary, numeracy, associative learning, and working memory, that literacy does not capture.25 Additionally, there are studies that hypothesize that literacy mediates the effect of education on health outcomes.26,27 Due to this, it is important to examine both education and literacy when examining either one’s effect, as their effects could
differ depending on what is being analyzed. Among the HANDLS population, it is evident that education provides something to nutrient intake that literacy does not.

This study is not without limitations. First, the dietary intake information represents intake from foods only and not total nutrient intake due to the fact that dietary supplement information collection began with Wave Two of the HANDLS study, and not at baseline. Thus, it would be beneficial to further analyze the quality of the diet after Wave Two to determine if supplement intake impacts nutrient-based diet quality among this population. Second, though two dietary recall interviews were administered, there is still a potential for biased data due to underreporting. Third, though the WRAT-3 word reading subtest is one of the most widely validated and used assessments of literacy, it does not account for numeracy or health literacy skills, which may display a strong link to nutrient-based diet quality. Two assessments of health literacy, the Test of Functional Health Literacy in Adults (TOFHLA) and the Rapid Estimate of Adult Literacy in Medicine (REALM), as well as a numeracy assessment are currently being administered in Wave Three of the HANDLS study. Therefore, it would be of interest to test these assessments’ contribution to nutrient-based diet quality after Wave Three is completed. Lastly, the HANDLS sample contains primarily low socioeconomic status, urban adults; thus the results of this study, and other HANDLS analyses, can only be applied to similar populations.

In conclusion, both education and literacy were found to significantly predict diet quality among the HANDLS study participants, with education being the stronger predictor. This finding suggests that education may provide something to nutrient-based
diet quality that literacy does not. Additionally, this study illustrates the need to consider both education and literacy when educating the public about nutrition, specifically in urban areas of low socioeconomic status.
Table 1. Selected Demographics and WRAT-3<sup>a</sup> reading levels of HANDLS<sup>b</sup> Study Participants

<table>
<thead>
<tr>
<th>Demographics</th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n = 896)</td>
<td>(n = 1171)</td>
</tr>
<tr>
<td>Age, x ±SEM</td>
<td>46.5 ±0.8</td>
<td>45.9 ±0.8</td>
</tr>
<tr>
<td>Education, years, x ±SEM</td>
<td>13.2 ±0.2</td>
<td>13.2 ±0.2</td>
</tr>
<tr>
<td>WRAT-3 Reading score, x ±SEM</td>
<td>42.9 ±0.5</td>
<td>43.3 ±0.4</td>
</tr>
<tr>
<td>WRAT-3 reading grade equivalent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5&lt;sup&gt;th&lt;/sup&gt; grade or lower, n (%)</td>
<td>227 (22.5)</td>
<td>232 (16.4)</td>
</tr>
<tr>
<td>6&lt;sup&gt;th&lt;/sup&gt;-8&lt;sup&gt;th&lt;/sup&gt; grade, n (%)</td>
<td>120 (14.5)</td>
<td>202 (14.5)</td>
</tr>
<tr>
<td>High school or post-high school, n (%)</td>
<td>549 (62.9)</td>
<td>737 (69.1)</td>
</tr>
<tr>
<td>&lt;125% poverty income ratio, n (%)</td>
<td>351 (16.4)</td>
<td>534 (22.5)</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
</tr>
<tr>
<td>African American</td>
<td>577 (64.4)</td>
<td>760 (64.9)</td>
</tr>
<tr>
<td>White</td>
<td>319 (35.6)</td>
<td>411 (35.1)</td>
</tr>
</tbody>
</table>

<sup>a</sup>WRAT-3, Wide Range Achievement Test – 3<sup>rd</sup> Edition
<sup>b</sup>HANDLS, Healthy Aging in Neighborhoods of Diversity across the Life Span
<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Males (n = 896)</th>
<th>Females (n = 1171)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy, kcal</td>
<td>2483 ±70</td>
<td>1797 ±44</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Total Fat, gm</td>
<td>98.1 ±3.2</td>
<td>70.2 ±1.9</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Saturated Fat, gm</td>
<td>32.2 ±1.1</td>
<td>22.5 ±0.7</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Polyunsaturated Fat, gm</td>
<td>20.7 ±0.9</td>
<td>15.8 ±0.5</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Protein, gm</td>
<td>96.6 ±2.5</td>
<td>69.3 ±1.8</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Carbohydrate, gm</td>
<td>286.2 ±8.0</td>
<td>217.0 ±6.4</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Total Sugar, gm</td>
<td>136.3 ±4.8</td>
<td>107.6 ±4.4</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Dietary Fiber, gm</td>
<td>14.6 ±0.6</td>
<td>11.7 ±0.4</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Cholesterol, mg</td>
<td>416.5 ±17.3</td>
<td>277.1 ±10.4</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>

*SEM, Standard Error of the Mean*
Table 3. Mean ±SEM\textsuperscript{a} of Macronutrients expressed as a Percent of Energy by Sex

<table>
<thead>
<tr>
<th>Macronutrient, % (energy)</th>
<th>Males (n = 896)</th>
<th>Females (n = 1171)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Fat, % (energy)</td>
<td>35.0 ±0.4</td>
<td>34.6 ±0.4</td>
</tr>
<tr>
<td>Saturated Fat, % (energy)</td>
<td>11.4 ±0.1</td>
<td>11.1 ±0.2</td>
</tr>
<tr>
<td>Polyunsaturated Fat, % (energy)</td>
<td>7.4 ±0.2</td>
<td>7.8 ±0.2</td>
</tr>
<tr>
<td>Protein, % (energy)</td>
<td>16.1 ±0.2</td>
<td>15.8 ±0.2</td>
</tr>
<tr>
<td>Carbohydrate, % (energy)</td>
<td>46.6 ±0.6</td>
<td>48.5 ±0.5</td>
</tr>
<tr>
<td>Total Sugar, % (energy)</td>
<td>22.3 ±0.6</td>
<td>23.9 ±0.5</td>
</tr>
</tbody>
</table>

\textsuperscript{a}SEM, Standard Error of the Mean
Table 4. Mean ±SEM\(^a\) of NAR\(^b\) by Nutrient and MAR\(^c\) by Sex

<table>
<thead>
<tr>
<th>Nutrient Quality Score</th>
<th>Males (n = 896)</th>
<th>Females (n = 1171)</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAR</td>
<td>82.4 ±0.8</td>
<td>77.3 ±0.8</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>NAR Thiamin</td>
<td>91.3 ±0.9</td>
<td>86.3 ±1.0</td>
<td>0.0002</td>
</tr>
<tr>
<td>NAR Riboflavin</td>
<td>95.7 ±0.6</td>
<td>93.7 ±0.6</td>
<td>0.0161</td>
</tr>
<tr>
<td>NAR Niacin</td>
<td>96.5 ±0.4</td>
<td>93.3 ±0.7</td>
<td>0.0002</td>
</tr>
<tr>
<td>NAR Vitamin B6</td>
<td>91.8 ±0.8</td>
<td>84.8 ±1.0</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>NAR Folate</td>
<td>79.7 ±1.3</td>
<td>71.0 ±1.3</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>NAR Vitamin B12</td>
<td>94.5 ±0.7</td>
<td>88.3 ±0.9</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>NAR Vitamin C</td>
<td>63.4 ±1.8</td>
<td>63.7 ±1.6</td>
<td>0.9107</td>
</tr>
<tr>
<td>NAR Vitamin A</td>
<td>60.0 ±1.7</td>
<td>63.4 ±1.4</td>
<td>0.1102</td>
</tr>
<tr>
<td>NAR Vitamin E</td>
<td>48.9 ±1.5</td>
<td>41.1 ±1.4</td>
<td>0.0002</td>
</tr>
<tr>
<td>NAR Phosphorus</td>
<td>97.6 ±0.3</td>
<td>94.3 ±0.6</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>NAR Magnesium</td>
<td>64.6 ±1.5</td>
<td>66.9 ±1.0</td>
<td>0.1982</td>
</tr>
<tr>
<td>NAR Iron</td>
<td>97.6 ±0.3</td>
<td>76.2 ±1.8</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>NAR Zinc</td>
<td>86.3 ±1.0</td>
<td>85.8 ±1.1</td>
<td>0.7608</td>
</tr>
<tr>
<td>NAR Copper</td>
<td>94.3 ±0.6</td>
<td>89.4 ±0.9</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>NAR Calcium</td>
<td>73.9 ±1.4</td>
<td>60.6 ±1.4</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>

\(^a\)SEM, Standard Error of the Mean
\(^b\)NAR, Nutrient Adequacy Ratio
\(^c\)MAR, Mean Adequacy Ratio
Table 5. Percent of Individuals with Low Nutrient Intakes by Nutrient and Sex

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Percent of Men with Low Intake$^a$</th>
<th>Percent of Women with Low Intake</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thiamin</td>
<td>11.0</td>
<td>18.5</td>
</tr>
<tr>
<td>Riboflavin</td>
<td>5.5</td>
<td>7.2</td>
</tr>
<tr>
<td>Niacin</td>
<td>4.0</td>
<td>7.7</td>
</tr>
<tr>
<td>Vitamin B$_6$</td>
<td>10.5</td>
<td>20.9</td>
</tr>
<tr>
<td>Folate</td>
<td>30.1</td>
<td>43.7</td>
</tr>
<tr>
<td>Vitamin B$_{12}$</td>
<td>7.2</td>
<td>17.7</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>49.2</td>
<td>48.8</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>59.4</td>
<td>54.2</td>
</tr>
<tr>
<td>Vitamin E</td>
<td>75.4</td>
<td>85.0</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>2.3</td>
<td>7.2</td>
</tr>
<tr>
<td>Magnesium</td>
<td>55.1</td>
<td>55.9</td>
</tr>
<tr>
<td>Iron</td>
<td>2.1</td>
<td>37.4</td>
</tr>
<tr>
<td>Zinc</td>
<td>18.1</td>
<td>21.3</td>
</tr>
<tr>
<td>Copper</td>
<td>7.5</td>
<td>12.4</td>
</tr>
<tr>
<td>Calcium</td>
<td>39.4</td>
<td>58.6</td>
</tr>
</tbody>
</table>

$^a$ Criteria for low intake is Nutrient Adequacy Ratio of $\leq 67\%$
Table 6. Regression Analysis for Mean Adequacy Ratio for HANDLS<sup>a</sup> Study Participants (n = 2,067)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
<th>Std Error&lt;sup&gt;b&lt;/sup&gt;</th>
<th>t value</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>57.8690</td>
<td>3.9150</td>
<td>14.78</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Age</td>
<td>-0.0894</td>
<td>0.0486</td>
<td>-1.84</td>
<td>0.0664</td>
</tr>
<tr>
<td>Sex</td>
<td>5.4020</td>
<td>0.9737</td>
<td>5.55</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Race</td>
<td>-1.4280</td>
<td>0.9425</td>
<td>-1.53</td>
<td>0.1278</td>
</tr>
<tr>
<td>Poverty Status</td>
<td>0.7592</td>
<td>1.1062</td>
<td>0.69</td>
<td>0.4929</td>
</tr>
<tr>
<td>Education</td>
<td>0.8111</td>
<td>0.1559</td>
<td>5.20</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>WRAT-3&lt;sup&gt;c&lt;/sup&gt; total score</td>
<td>0.3129</td>
<td>0.0719</td>
<td>4.35</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>

R<sup>2</sup> = 0.13

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
<th>Std Error&lt;sup&gt;b&lt;/sup&gt;</th>
<th>t value</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>68.9570</td>
<td>3.3064</td>
<td>20.86</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Age</td>
<td>-0.1087</td>
<td>0.0487</td>
<td>-2.23</td>
<td>0.0262</td>
</tr>
<tr>
<td>Sex</td>
<td>5.2788</td>
<td>0.9894</td>
<td>5.34</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Race</td>
<td>-2.7649</td>
<td>0.9463</td>
<td>-2.92</td>
<td>0.0037</td>
</tr>
<tr>
<td>Poverty Status</td>
<td>0.3015</td>
<td>1.0800</td>
<td>0.28</td>
<td>0.7802</td>
</tr>
<tr>
<td>Education</td>
<td>1.1372</td>
<td>0.1328</td>
<td>8.56</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>

R<sup>2</sup> = 0.11

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
<th>Std Error&lt;sup&gt;b&lt;/sup&gt;</th>
<th>t value</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>61.3643</td>
<td>4.0884</td>
<td>15.01</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Age</td>
<td>-0.0823</td>
<td>0.0507</td>
<td>-1.62</td>
<td>0.1050</td>
</tr>
<tr>
<td>Sex</td>
<td>5.3743</td>
<td>0.9947</td>
<td>5.40</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Race</td>
<td>-1.6326</td>
<td>0.9885</td>
<td>-1.65</td>
<td>0.0994</td>
</tr>
<tr>
<td>Poverty Status</td>
<td>-0.0958</td>
<td>1.1207</td>
<td>-0.09</td>
<td>0.9319</td>
</tr>
<tr>
<td>WRAT-3 total score</td>
<td>0.4795</td>
<td>0.0631</td>
<td>7.60</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>

R<sup>2</sup> = 0.11

<sup>a</sup>HANDLS, Healthy Aging in Neighborhoods of Diversity across the Life Span

<sup>b</sup>Std Error, Standard Error

<sup>c</sup>WRAT-3, Wide Range Achievement Test – 3<sup>rd</sup> Edition
References


BIBLIOGRAPHY


Appendix A

AUTHOR GUIDELINES

American Journal of Preventive Medicine Author Guidelines

COMMUNICATING WITH THE EDITORIAL OFFICE

We encourage you to communicate with the AJPM Editorial Office.

Address: AJPM Editorial Office, University of California, San Diego, 9500 Gilman Drive, Dept 0811, La Jolla, CA 92093-0811.

Fax: 858-534-9344

To check on the status of a manuscript, e-mail: eAJPM@ucsd.edu or call 858-534-9340.

For all other business, please e-mail: ajpm@ucsd.edu.

GENERAL INFORMATION

The American Journal of Preventive Medicine [AJPM] is the official journal of the American College of Preventive Medicine and the Association for Prevention Teaching and Research. Started in 1985, AJPM is a fully peer-reviewed international journal that publishes original research articles, reviews, current issues papers, commentary, and correspondence on all aspects of practice, education, policy, and research in preventive medicine and public health.

Manuscripts are accepted for consideration with the understanding that they have been submitted solely to AJPM; that they have not been previously published, either in whole or in part; and that the findings have not been posted online. The editors reserve the right to make editorial changes in all matter published in the Journal and cannot enter into correspondence about manuscripts not accepted for publication. The editors, editorial board, sponsoring organizations, and publishers are not responisible for the statements
expressed by authors in their contributions.

The editors and staff of AJPM adhere to the ethical standards established by the Committee on Publication Ethics (COPE; www.publicationethics.org) and are committed to providing authors with a transparent process in the handling of manuscripts received in the editorial office. Any alleged breach of scientific integrity will be adjudicated by COPE.

In addition, AJPM follows the guidance on editorial independence produced by the World Association of Medical Editors (www.wame.org), and subscribes to the tenets of reporting guidelines established by the EQUATOR network (www.equator-network.org). AJPM supports the policies of the International Committee of Medical Journal Editors (ICMJE), and the following author instructions follow the ICMJE Uniform Requirements for Manuscripts Submitted to Biomedical Journals, available at www.icmje.org/. Manuscript preparation should follow these ICMJE guidelines.

Copyright

Copyright of all material is held by the American Journal of Preventive Medicine. Authors may use their own material in other publications provided that AJPM is acknowledged as the original place of publication and that permission is obtained from Elsevier Science Inc. in advance and in writing. Requests may be completed online via the Elsevier website at www.elsevier.com/permissions.

Article Types

Research Articles and Brief Reports are original empirical articles, such as reports of randomized controlled trials, observational studies, or other basic clinical and public health investigations. These make up the majority of journal pages.

Required elements:
Structured abstract (for research papers): background; purpose; methods (include years of data collection and analysis); results; conclusions
(for interventions): background; purpose; design; setting/participants; intervention; main outcome measures; results; conclusions

Objective or hypothesis
Research methods (including statistical methodologies and IRB approval and informed
consent)
Essential features of interventions
Outcome measures
Results
- discuss in context of published literature
- emphasize what is novel about findings
- emphasize contribution to literature in medicine and public health
Word limits:
Research articles: 3000
Randomized controlled trials: 4000
Brief reports: 1200

**Review Articles:** Systematic reviews and meta-analyses are systematic, critical assessments of the literature and data sources pertaining to clinical topics, emphasizing factors such as cause, diagnosis, prognosis, therapy, and prevention. Data sources should be as current as possible.

Required elements:
Structured abstract: context; evidence acquisition; evidence synthesis; conclusions
Inclusion and exclusion criteria for sources
Description of search and selection process
Type of study or analysis description of population, intervention, exposure, tests/outcomes for each article or data source

Word limit: 4000

Note: Tables longer than two pages will likely be published as an online-only appendix.

**Special Articles** may address virtually any important topic in preventive medicine or public health. Word limit: 4000

**Research and Practice Methods** articles include those detailing the methods used to answer specific research questions. Typical length: 3000 words

**Teaching Preventive Medicine** articles highlight methods used in teaching preventive medicine or evaluating educational methods, either at the undergraduate or graduate level. They cover the spectrum of educational topics in preventive medicine and public health. Typical length: 3000 words
**Current Issues** papers are scholarly but not exhaustive reviews of any area that the author thinks might be of interest to AJPM readers. They should be broadly informative, and bold in prompting new thinking. Example topic areas include preventive medicine, public health, social and behavioral health, health disparities, global health, environmental and ecologic issues, and health-related technologies. No abstract.

**Commentaries** are short, essay-type articles that comment on another article in the same issue; these are generally solicited by the editors.

**Letters to the Editor** offer opinions or interpretations of articles previously published in AJPM. It is customary for the editorial office to send each letter to the author(s) of the original work; the authors' response may be published as a companion to the Letter to the Editor. Tables and figures included only if absolutely necessary. Reference limit: 7. Word limit: 500

**Research Letters** report original research (e.g., the result of a pilot study) and should include: introduction, methods, results, and discussion. All research letters considered for publication undergo external peer review. May include one table or figure. Reference limit: 10. Word range: 500-700.

**Book/Media Reviews** are generally solicited by the editorial office. AJPM publishes a list of books that have been received but not reviewed, in the June and December issues, as a courtesy to AJPM readers.

**Corrections** are published for printed errors relating to data collection or interpretation, or information that is likely to lead the reader to misinterpret the research. PubMed then publishes the correction(s) as part of the online article.

**AJPM'S PUBLICATION PROCESS AND FEATURES**

**Timetable**

The approximate timetable for the various stages leading to publication in AJPM is as follows:

- 4-7 days from initial submission for internal review and to learn whether the manuscript will be rejected or sent out for external peer review.
4-8 weeks until all the reviews are received and the editors make a decision on whether the paper should be accepted, revised, or rejected based on reviews.

4-6 weeks is the average time authors take to submit a revision, but the amount of time is up to the author.

3-4 weeks for final decision of acceptance/rejection for publication (may include a re-review).

12 weeks to publication (print); about 6 weeks for online publication.

**Expedited Review and Publication Online Before Print**

Authors who feel that their paper should receive expedited review and/or rapid publication should request it and explain their rationale in the Comments section of EES (ees.elsevier.com/ajpm/). They should also send a separate explanatory e-mail to the managing editor at eajpm@ucsd.edu. Expedited peer review takes 5-7 days, with the paper edited and online in 4-5 weeks. Authors are reminded that as a monthly journal, AJPM does not operate on the timeframe of a weekly and does not ordinarily publish "news" items.

**Supplemental Online-Only Material**

Material that is considered to be supportive of the published article, but not critical for inclusion in the print issue, may be posted online only as an appendix. Direction to the website (www.ajpmonline.org) will be given within the print copy. This material will not be typeset, and therefore will not be provided with the author proof. Requests for changes to appendixes should be directed to the editorial office.

**Sponsored Articles**

AJPM offers authors the option to sponsor nonsubscriber access to their articles online at www.ajpmonline.org and www.sciencedirect.com. Authors can elect to sponsor their article only after receiving notification that their article has been accepted for publication in AJPM. The charge for article sponsorship is $3000, which is used to offset publishing costs; there are no fees from the editorial office. The fee excludes taxes and other potential author fees such as color charges, which are additional. Authors who have had their article accepted and who wish to sponsor their article to make it available to nonsubscribers should complete and submit the sponsored article order form located at: www.elsevier.com/wps/find/authors.authors/sponsoredarticles.
Online-Only Publication

Each month, some articles will be chosen to be published online only. These decisions are based on the available print pages, and do not reflect the importance of a particular article. All online-only articles are fully published, with a doi (digital object identifier), and are fully citable. As with many medical journals, AJPM has significant online activity.

Audio/Visual

AJPM produces and posts video casts related to the print articles. If an author would like to participate in the production of a video cast, please contact the editorial office. In addition, authors may be interested in submitting other types of visuals to enhance the printed article. The AJPM editors and staff will work with authors who would like to provide animated GIFs, links to database files, or JAVA-applets, for example.

SciVee

Located at www.scivee.tv, SciVee has partnered with AJPM to provide a video pubcast based on a different article each month. View these at www.ajpmonline.org. Authors should contact the AJPM editorial office to participate in this project.

Continuing Medical Education (CME)

Each month, AJPM editors select two articles to participate in the Continuing Medical Education project supported by the American College of Preventive Medicine. Each article is so noted in the print issue, with objectives printed in the front section of each issue. The test for each article is located on the AJPM website at www.ajpmonline.org.

Offprints, Reprints, PDFs

Reprints are available from the publisher. A PDF of the article is provided to corresponding authors of each paper for their internal use.

Press Activity

The AJPM editors and staff work with the Center for Advancing Health and Elsevier to provide press releases for many AJPM articles. If authors want to coordinate press
activity between AJPM and their institutions, please contact the editorial office.

**Embargo Policy**

For the protection of each author's work, AJPM does not allow the unauthorized pre-publication of any materials slated for publication. All materials within AJPM are under embargo until the appropriate release date. AJPM recognizes the authority of the Committee for Publication Ethics in any breach of scientific integrity.

**Plagiarism Prevention**

In the interest of preserving the scientific integrity of all articles published in AJPM, starting in January 2011, the Editorial Office will be running all revised manuscripts through an online plagiarism-prevention program. Following the lead of the Committee on Publication Ethics (COPE), whose policies are in turn supported by the ICMJE, if plagiarism is discovered, the author will be notified before any further action is taken. AJPM adheres to the process established by COPE, whose guidelines and flowcharts for action are available online at publicationethics.org.

**Open-Access Articles**

Each month, two AJPM articles are selected to be available open access to all readers (available online at www.ajpmonline.org). In addition, AJPM adheres to the National Institutes of Health Public Access Policy:

The NIH Public Access Policy ensures that the public has access to the published results of NIH funded research. It requires scientists to submit final peer-reviewed journal manuscripts that arise from NIH funds to the digital archive PubMed Central upon acceptance for publication. To help advance science and improve human health, the Policy requires that these papers are accessible to the public on PubMed Central no later than 12 months after publication.

**MANUSCRIPT PREPARATION**

**Authors whose first language is not English.** AJPM is increasingly read worldwide, and we welcome submissions from scholars around the globe. We encourage authors whose first language is not English to seek assistance in manuscript preparation, including writing and editing, prior to the initial submission.
Manuscript Format

Dimensions: Format as an 8.5" x 11" (215 mm x 280 mm) page with 1" (25 mm) margins on all four sides.
Font: Times New Roman 12-point is recommended for text and tables; use Arial (nonserif) font for figures.
Spacing: Text should be double-spaced, flush left; separate paragraphs with two hard returns, not tabs.
All text should be written in the third person (do not use "we" or "our" unless expressing the opinion of the authors).
Order of sections: title page, abstract, text, acknowledgments, references, list of titles for all figures (on 1 page), tables, and figures.
Page numbering: Number pages consecutively, beginning with the title page. No other automatic formatting is permitted.
Line numbering: Number all lines of text continuously (do not start each page with 1).
Section groupings by file: The sections should be organized into the following MS Word files: (1) cover letter, (2) title page, abstract, text, acknowledgements, references, figure titles, and tables, (3) figures.

Cover Letter

The cover letter must state that the manuscript has been submitted solely to AJPM and that it has not been previously published, either in whole or in part, nor have the findings been posted online. The corresponding author must include a statement confirming full access to all aspects of the research and writing process, and takes final responsibility for the paper.

Title Page

Title: Should be concise but informative; highlight rather than explain; be a label, not a sentence; reflect what you did; have no verbs, have dense nouns for improved searchability; use no symbols or abbreviations
Author names and affiliations: Include the first name, middle initial, last name, and highest academic degree of each author, and the names of their departments and institutions (including city and state), to which the work should be attributed
Corresponding author information: Include the name, address, telephone and fax numbers, and e-mail address of the author responsible for correspondence
Word count: Provide the total word count (text only) and the number of pages, tables, and figures
Conflict of interest statement on title page: Include a statement from each of the
authors disclosing all funding sources that supported their work as well as all institutional and corporate affiliations. Also include a publishable statement disclosing any commercial associations, current and over the past 5 years, that might pose a conflict of interest. These include but are not limited to consultancies, including those for investment companies; stock or other equity ownership; stock options; patent licensing arrangements; and payments for conducting or publicizing the study.

In addition, authors are required to disclose similar associations with companies that make a competing product. If the authors have competing or conflicting interests that cannot be disclosed in publishable statements, authors should list them in the comments section of EES (ees.elsevier.com/ajpm/). When no competing interests are present, this should be indicated in the publishable disclosure statement (e.g., "No financial disclosures were reported by the authors of this paper.").

Example of disclosure statements that should appear on the title page:

(Author 1 name) owns stock in _____ company.
(Author 2 name) has no financial disclosures.
(Author 3 name) has no financial disclosures.
(Author 4 name) has received consulting fees from _____, a company that manufactures a competing product to the one discussed in this paper.

Abstract
Structured format required for:
Research articles: background, purpose, methods, results, conclusions
Intervention studies: background, purpose, design, setting/participants, intervention, main outcome measures, results, conclusions
Review articles: context, evidence acquisition, evidence synthesis, conclusions

Word limit: 250; for interventions: 300.

Other article types: include unstructured abstract. Length limit: 250 words; two paragraphs. Note: Current Issues papers include no abstract. Instead, please identify a pertinent quote to highlight from your paper.
Text

All research manuscripts must include (in both abstract and methods section) the year(s) in which the data were collected and when the study/analysis was conducted. The number of figures and tables should be in proportion to the amount of text. Follow the word-count parameters provided in the AJPM Content section.

Common Abbreviations
Following are abbreviations that do not require definition in the text of manuscripts.
• Abbreviations used commonly in the American Journal of Preventive Medicine

Acknowledgments

List sources of support in the form of grants, equipment, or drugs, and describe the role of the study sponsor(s), if any, in study design. Acknowledge only people who have made substantive contributions to the study. All individuals mentioned in the acknowledgments or in personal communications within the paper must provide consent for their names to be used. Include any necessary disclaimers.

Clinical Trial Registration:

A clinical trial is any research study that prospectively assigns human participants or groups of humans to one or more health-related interventions to evaluate the effects on health outcomes. Health-related interventions include any intervention used to modify a biomedical or health-related outcome; purely observational studies do not require registration. Any study that was started after July 2005 requires registration. If a trial started before July 2005, it should be registered retrospectively, before submission to a journal.

Some trials assign healthcare providers, rather than patients, to intervention and comparison/control groups. If the purpose of the trial is to examine the effect of the provider intervention on the health outcomes of the providers' patients, then investigators should register the trial. If the purpose is to examine the effect only on the providers (for example, provider knowledge or attitudes), then registration is not necessary.

Manuscripts reporting clinical trials must include the following information on the title page: trial registry name and registration number, date of registration, funding source for the trial, and the name and date of approval of an institutional review board.
General information about trial registration can be found at www.icmje.org. Questions about whether a trial requires registration should be directed to: register@clinicaltrials.gov.

Acceptable trial registries include:
• www.clinicaltrials.gov
• www.anzctr.org.au
• www.isrctn.org

Other trial registration sites will be considered on an individual basis.

References
Ensure that references are correct by using the PubMed Citation Matcher www.ncbi.nlm.nih.gov/entrez/query/static/citmatch.html
Automatic reference numbering in Word is not accepted; programs such as EndNote and Reference Manager are acceptable.
References are to follow the Vancouver Style and should be identified by number in the order in which they are mentioned in the text (citation-order system) with a superscript arabic numeral, not a number in parentheses, e.g.,1. If subsequent reference is made to a citation, the original reference number should be used again. All reference numbers must be outside of punctuation.
References that apply only to tables and figures should be numbered in sequence where the text first refers to the table or figure.
Titles of journals must be abbreviated according to Index Medicus style, which can be found at http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?db=journals.

Example References

Journal article


Book

Norman IJ, Redfern SJ, editors. Mental health care for elderly people. New York:
Churchill Livingstone, 1996.

**Book chapter**


**Website** (include in references only those websites that take the reader directly to a document within a website)


**Articles accepted but not yet published**


**Cite the Following in Text Only, Not in the References Section**

Personal communication. Format: first initial, last name, affiliation, "personal communication," date (R. Draco, Syracuse University, personal communication, 1998). Consent must be provided from all individuals named in the text.

Software. Format: name of software, version number. (Stata, version 9).

Websites that refer to the website in general (e.g., a home page). Format: URL in parentheses (www.anaconda.com)

Articles that have been submitted but not accepted. Format: (J Smith, University of Minnesota, unpublished observations, 1999)

Citing an unpublished work by one of the authors. Format: (JWK, unpublished observations, 1999)

**Tables**

Format: submit each on a separate page.

Numbering: identify with arabic numerals (Table 1).
Titles: word limit: 15

Footnotes: use lowercase letters (a,b,c). Exception: footnotes reporting statistical significance should be noted with asterisks (*, **, ***).

Abbreviations: ALL abbreviations used in a table must be defined in an alphabetical list below the table. Example: FDA, Food and Drug Administration; HEI, Healthy Eating Index

*Figures*

Format: submit in a form suitable for reproduction.

Typeface: nonserif (e.g., Arial).

Coloring: use only black on white background, with bold patterns or distinct variations of gray shading. Exception: maps, photos, and graphs that are too confusing in black and white must be submitted in color.

Titles: a list of all figure titles should be typed on one page and placed after the references.

File types: figures can be submitted in TIFF, EPS or PDF formats. MS Office files (Word, Excel and PowerPoint) are also accepted. Figure resolution for pixel-based images should be at least 1,200 dpi for line art (e.g., graphs, flow charts) or 500 dpi for photographs, micrographs, computed tomography scans, and related images. Color images should use CMYK color mode.

Permissions: if the figure is from another publication, provide written permission from the original publisher to reprint it.

*Reporting Guidelines*

In an effort to make the reporting of health research more transparent and to provide guidance and structure to authors, AJPM joins other major medical journals in supporting the following reporting guidelines.

The EQUATOR (Enhancing the Quality and Transparency of Health Research)
network (www.equator-network.org/) is an umbrella network that brings together researchers, medical journal editors, peer reviewers, and the developers of reporting guidelines to provide collaboration and consistency.

CONSORT (Consolidated Standards of Reporting Trials) statement (revised), found at www.consort-statement.org for randomized controlled trials. The flow diagram and checklist must be included in the article. AJPM style for the CONSORT flow diagram: Please note that papers reporting RCTs must include a statement that there was no racial or gender bias in the selection of participants.

TREND (Transparent Reporting of Evaluations with Nonrandomized Designs), found at www.cdc.gov/trendstatement/, provides information on the use of the checklist, a required element in manuscript submissions.

PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses), located at www.prisma-statement.org/, provides information for using both the checklist and the flow diagram. Both of these items should be included in submitted manuscripts.

HOW TO SUBMIT A PAPER

AJPM uses an online submission and peer-review program via the Elsevier Editorial System, located at ees.elsevier.com/ajpm. Follow the onscreen instructions for all submissions. If you have questions during the process, please contact the AJPM Editorial Office at eajpm@ucsd.edu.

CHECKLIST

Review manuscript submission requirements
Include cover letter, detailed as outlined in these author instructions
Provide first and last names and middle initials of all authors; include highest degree and institutional affiliation
On title page, include word count, number of tables and figures, and conflict of interest statements
Provide an abstract that conforms with author instructions for article type
Provide text files in Microsoft Word
Provide text in Times New Roman, 12 pt, and double-spaced
Provide continuously numbered lines (each page does not start at 1)
Check all references for accuracy and completeness, as well as AJPM format
Title each table and figure
Include all sources of financial and material support in the Acknowledgments section, including grant numbers as appropriate
Include in the Methods section any information on institutional review board approval or informed consents.

**Conflict of Interest Statement for Papers Accepted for Publication**

To maintain a transparent process throughout the writing and publishing of a scientific article, when a paper has been accepted for publication, each author will be required to sign a formal conflict of interest statement, which includes author-contribution information. Each author will have to state his/her level of participation in the production of the manuscript.

*Last updated: February 2012*
Table 7. Recommended Dietary Allowances (RDA) used for NAR\textsuperscript{a} Calculations by Nutrient\textsuperscript{1}

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Males</th>
<th></th>
<th></th>
<th></th>
<th>Females</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ages</td>
<td>19-30</td>
<td>31-50</td>
<td>51-70</td>
<td>&gt;70</td>
<td>Ages</td>
<td>19-30</td>
<td>31-50</td>
</tr>
<tr>
<td>Calcium</td>
<td>mg/day</td>
<td>1,000</td>
<td>1,000</td>
<td>1,000</td>
<td>1,200</td>
<td>1,000</td>
<td>1,000</td>
<td>1,200</td>
</tr>
<tr>
<td>Magnesium</td>
<td>mg/day</td>
<td>400</td>
<td>420</td>
<td>420</td>
<td>420</td>
<td>310</td>
<td>320</td>
<td>320</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>mg/day</td>
<td>700</td>
<td>700</td>
<td>700</td>
<td>700</td>
<td>700</td>
<td>700</td>
<td>700</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>mcg/day</td>
<td>900</td>
<td>900</td>
<td>900</td>
<td>900</td>
<td>700</td>
<td>700</td>
<td>700</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>mg/day</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>90</td>
<td>75</td>
<td>75</td>
<td>75</td>
</tr>
<tr>
<td>Vitamin E</td>
<td>mg/day</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Vitamin B\textsubscript{6}</td>
<td>mg/day</td>
<td>1.3</td>
<td>1.3</td>
<td>1.7</td>
<td>1.7</td>
<td>1.3</td>
<td>1.3</td>
<td>1.5</td>
</tr>
<tr>
<td>Vitamin B\textsubscript{12}</td>
<td>mcg/day</td>
<td>2.4</td>
<td>2.4</td>
<td>2.4</td>
<td>2.4</td>
<td>2.4</td>
<td>2.4</td>
<td>2.4</td>
</tr>
<tr>
<td>Folate</td>
<td>mcg/day</td>
<td>400</td>
<td>400</td>
<td>400</td>
<td>400</td>
<td>400</td>
<td>400</td>
<td>400</td>
</tr>
<tr>
<td>Thiamin</td>
<td>mg/day</td>
<td>1.2</td>
<td>1.2</td>
<td>1.2</td>
<td>1.2</td>
<td>1.1</td>
<td>1.1</td>
<td>1.1</td>
</tr>
<tr>
<td>Riboflavin</td>
<td>mg/day</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
<td>1.1</td>
<td>1.1</td>
<td>1.1</td>
</tr>
<tr>
<td>Niacin</td>
<td>mg/day</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>14</td>
<td>14</td>
<td>14</td>
</tr>
<tr>
<td>Zinc</td>
<td>mg/day</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Copper</td>
<td>mg/day</td>
<td>900</td>
<td>900</td>
<td>900</td>
<td>900</td>
<td>900</td>
<td>900</td>
<td>900</td>
</tr>
<tr>
<td>Iron</td>
<td>mg/day</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>18</td>
<td>18</td>
<td>8</td>
</tr>
</tbody>
</table>

\textsuperscript{a}Nutrient Adequacy Ratio (NAR)
Appendix C

VARIABLE DEFINITIONS

HANDLS Variables

Age
AgeScreener – age ate baseline recruitment screen

Education
HseHldEducation – Highest grade school completed

PIR
PovertyScreener – Demog: 125% Poverty status (0=above, 1=below)

Race
RaceScreener – white, black (0=white, 1=black)

Sex
Sex – male, female (0=male, 1=female)

Literacy
NeuPsyWRATword: WRAT words total correct, NeuPsyWRATlett: WRAT letters total correct
Appendix D

UNCAPPED REGRESSION

Part of the nutrient-based diet quality model used in this paper, published by Murphy et al$^2$ and Foote et al$^3$, is to convert each NAR to a percent. Percents that are greater than 100 are then truncated to 100 before calculating the MAR. Since many of the participants take in a large amount of calories, their nutrient intakes are subsequently large as well. Due to this, many of the NARs were above 100 before being capped (Table 8). The resulting uncapped distribution is highly skewed to the right. The skew is the rationale for reporting regressions with the log if MAR as the dependent variable.

Using the uncapped MAR in the regression displayed different results than that of the capped MAR. Table 9 shows incremental increase in the R-squares moving from capped MAR to uncapped MAR to the log of uncapped MAR. The effect of literacy (WRAT-3) is significant in all three regressions. The effect of education shifts from significant to nonsignificant to significant again, however its p-value is lower in the capped regression (<.0001) than in the log of uncapped MAR (0.0016).

Additionally, the results change when adding total energy intake (in kilocalories) to the regressions, as shown in Table 10. This addition not only dramatically increases the R-squares, but it also completely accounts for the effect of sex. Literacy still remains significant in this model, however the p-value is increased. Education also remains
significant, and race, which is nonsignificant without total energy intake in the model, comes out to be significant in the log of uncapped MAR.

Table 8. Percentage of Participants Exceeding NAR\(^a\) Standard of 100 Per Nutrient

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Percent Exceeding NAR Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium</td>
<td>15.45</td>
</tr>
<tr>
<td>Magnesium</td>
<td>11.33</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>65.99</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>16.87</td>
</tr>
<tr>
<td>Folate</td>
<td>24.85</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>26.89</td>
</tr>
<tr>
<td>Vitamin E</td>
<td>4.08</td>
</tr>
<tr>
<td>Vitamin B6</td>
<td>45.18</td>
</tr>
<tr>
<td>Vitamin B12</td>
<td>62.40</td>
</tr>
<tr>
<td>Iron</td>
<td>51.62</td>
</tr>
<tr>
<td>Thiamin</td>
<td>47.65</td>
</tr>
<tr>
<td>Riboflavin</td>
<td>62.90</td>
</tr>
<tr>
<td>Niacin</td>
<td>61.98</td>
</tr>
<tr>
<td>Zinc</td>
<td>43.64</td>
</tr>
<tr>
<td>Copper</td>
<td>51.23</td>
</tr>
</tbody>
</table>

\(^a\)NAR, Nutrient Adequacy Ratio

Table 9. Regression Analysis for Capped MAR\(^a\) versus Uncapped MAR versus Log(Uncapped MAR)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Capped MAR</th>
<th>p value</th>
<th>Uncapped MAR</th>
<th>Coefficient</th>
<th>p value</th>
<th>Log(Uncapped MAR)</th>
<th>Coefficient</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>57.8690</td>
<td>&lt;.0001</td>
<td>43.9104</td>
<td>0.0123</td>
<td></td>
<td>4.0705</td>
<td>&lt;.0001</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>-0.0894</td>
<td>0.0664</td>
<td>-0.5171</td>
<td>0.0264</td>
<td></td>
<td>-0.0033</td>
<td>0.0371</td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td>5.4020</td>
<td>&lt;.0001</td>
<td>38.1752</td>
<td>&lt;.0001</td>
<td></td>
<td>0.2732</td>
<td>&lt;.0001</td>
<td></td>
</tr>
<tr>
<td>Race</td>
<td>-1.4280</td>
<td>0.1278</td>
<td>-5.4045</td>
<td>0.2824</td>
<td></td>
<td>-0.0484</td>
<td>0.1329</td>
<td></td>
</tr>
<tr>
<td>PIR</td>
<td>0.7592</td>
<td>0.4929</td>
<td>17.5766</td>
<td>0.0097</td>
<td></td>
<td>0.0797</td>
<td>0.0400</td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td>0.8111</td>
<td>&lt;.0001</td>
<td>1.9342</td>
<td>0.0323</td>
<td></td>
<td>0.0179</td>
<td>0.0016</td>
<td></td>
</tr>
<tr>
<td>WRAT-3</td>
<td>0.3129</td>
<td>&lt;.0001</td>
<td>1.5382</td>
<td>&lt;.0001</td>
<td></td>
<td>0.0107</td>
<td>&lt;.0001</td>
<td></td>
</tr>
</tbody>
</table>

\(^a\)MAR, Mean Adequacy Ratio
Table 10. Regression Analysis for Uncapped MAR\(^a\) versus Log(Uncapped MAR) Including Energy Intake

<table>
<thead>
<tr>
<th>Variable</th>
<th>Uncapped MAR</th>
<th>p value</th>
<th>Log(Uncapped MAR)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>-39.8197</td>
<td>0.0125</td>
<td>3.4529</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Age</td>
<td>0.1815</td>
<td>0.3332</td>
<td>0.0019</td>
<td>0.1149</td>
</tr>
<tr>
<td>Sex</td>
<td>3.8155</td>
<td>0.3368</td>
<td>0.0198</td>
<td>0.4241</td>
</tr>
<tr>
<td>Race</td>
<td>-10.0846</td>
<td>0.0122</td>
<td>-0.0830</td>
<td>0.0006</td>
</tr>
<tr>
<td>PIR</td>
<td>14.5806</td>
<td>0.0043</td>
<td>0.0576</td>
<td>0.0244</td>
</tr>
<tr>
<td>Education</td>
<td>1.7053</td>
<td>0.0060</td>
<td>0.0162</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>WRAT-3</td>
<td>0.8596</td>
<td>0.0014</td>
<td>0.0057</td>
<td>0.0013</td>
</tr>
<tr>
<td>Energy (kcal(^b))</td>
<td>0.0488</td>
<td>&lt;.0001</td>
<td>0.0004</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>

R\(^2\)=0.42  
R\(^2\)=0.57

\(^a\)MAR, Mean Adequacy Ratio  
\(^b\)kcal, kilocalories
Appendix E

INFORMED CONSENT

Healthy Aging in Neighborhoods of Diversity across the Life Span Informed Consent

Introduction

We must have your written informed consent before we perform research tests or examinations. We follow federal regulations for research with human subjects. These regulations require us to make sure that you understand what examinations we will perform and the risks that are involved, if there are any.

This booklet reviews the tests that we will perform in this research. We perform these tests free of charge. You should understand the purpose of this study before you agree to participate in this research. We welcome any questions that you might have about what to expect in this study. You may participate in any of the tests, but you need not participate in all of the tests. You may stop any time after a test starts. You may ask questions any time during a test.

We want to make sure that you understand the tests in this study. We must witness your signature on the consent form. Please do not sign the consent form until you arrive at the Mobile Medical Research Vehicles.

Purpose of the Study

The purpose of this study is to learn about changes in health over time. We want to study as many people in different communities as we can by using our Mobile Medical Research Vehicles (MRVs).

Our goal is to study the rate of health change as people grow older. We plan to do this by studying the same people over many years. This gives us the information we want about how people’s bodies change over time. We will invite you to participate in our study every three years when we visit your neighborhood with our Mobile Research Vehicles. The study data will be collected in two parts. The first part of the study consists of a household interview. This interview includes questions about your background, educational experience, occupational history, health and health care experiences, physical activities, and a few questions about your neighborhood. For the second part of the study
you will visit our Mobile Medical Research Vehicles (MRV-I and MRV-II). The MRV-I will be used for the medical history and physical examination, body composition, test of the heart’s function, strength testing, bone density, and laboratory samples. MRV-II will be used for consenting, questionnaires, cognitive and memory testing, and the emotions and heart rate test. We plan to administer the same tests every three years for the next 20 years.

We also want to study why some people are healthier as they get older than others. We want to discover if we can predict the causes of good health with aging. If we can find the causes of good health, then we might find the cures for some of the diseases related to aging. We call our study Healthy Aging in Neighborhoods of Diversity across the Life Span.

List of Tests and Statements of Risk

You may participate in some or all of our tests. You may stop any test anytime you want even after you agree to do it. We want you to understand the risks in taking some of these tests. We welcome your questions about the tests and any risks even after the test starts. Risks, if any, are stated and discussed with the description of the test, or in the section on Assessment of Risks in this booklet.

Household Survey

The household survey is designed to take place in your home. You will be asked to answer several questions about your background, household characteristics, educational experience, occupational history, ethnic identity and discrimination experiences, health and health care experiences, physical activities, stress and coping, and a few questions about your neighborhood.

Nutritional Dietary Recall

During this interview we will ask you to remember all the foods and beverages you have consumed during the last 24 hours. We will have some cups and measures to help you remember the amounts. A trained interviewer will record your answers and ask questions designed to help you remember using a method developed by the United States Department of Agriculture (USDA). The risks for the household survey and dietary recall interview are very minimal. The only risk of this part of the study is that you may become tired. All examiners who are involved in asking these questions are experienced in using these procedures and they will minimize any discomfort that you might feel.

Body Composition

We will weigh you and measure various parts of your body. There are no risks from this test.

Bone Density

We will measure the size and thickness of the bones in your arm, lower back, and hipbone. We will also measure how much lean tissue you have and how much fat tissue
you have. These measures will tell us if you are likely to have bone fractures or osteoporosis. We will ask you to lie down on a device called a DEXA scanner. The scanner uses small amounts of X-ray radiation to make measurements as a detector examines your body. The risk to you, if any, is estimated to be slight. The risks are discussed in the section on Assessment of Risks in this booklet.

Muscle Strength Testing
Grip Strength Test
Handgrip strength in both hands will be measured using an adjustable, hand-held, hydraulic grip strength dynamometer. The hydraulic grip strength dynamometer is a device you hold in your hand and squeeze. It measures the strength of your handgrip. You will be asked to sit with the arm to be tested resting on the table. The dynamometer is held in the hand to be tested and is resting on a mouse pad. We will ask you to grip the two bars of the dynamometer in your hand, and to slowly squeeze the bars as hard as you can. The test is repeated on the other hand. Exclusions. You will not be tested on the affected hand if you have had arm or hand surgery like fusion, arthroplasty, tendon repair, synovectomy, or other related surgery in the past 3 months.

Chair Stand
Using a standard armless chair placed securely against a wall, you be asked to rise from the chair without using your arms and return to a seated position. If this is done successfully, you will be asked to repeat that movement 10 times. Exclusions. There are no formal exclusions from attempting the single chair stand; inability to rise from a chair without using arms excludes participants from doing repeated chair stands.

Balance Test
We will ask you to stand with your feet together and with your feet in a heel-to-toe position for 30 seconds each. We will also ask you to try to stand on one leg for 30 seconds. You may stand on whichever leg is more comfortable. The examiner will demonstrate exactly what is expected. We will ask you to try to hold your foot up for thirty seconds. We will ask you to repeat this test 2 times. The information we collect will help us to understand how strength changes as people get older. We want you to know that there are very minimal risks associated with these tests. The only risks are that there is a slight risk of falling and you may feel tired after these tests.

Medical History and Physical Examination
Medical History
We will ask you questions about your medical history. The examiner will add information to the form when you have your physical examination.

Smoking, Drug and Alcohol History
We will ask you about your smoking habits and use of drugs and alcohol. We will also ask about information about your parents’ smoking habits.
Physical Examination
Our physician or nurse practitioner will give you a physical exam in our private exam room. They will check your blood pressure and pulse in both arms. They will listen to your heart and lungs, examine your eyes, joints, and check your reflexes and other parts of your nervous system. The physician or nurse practitioner will also examine your abdomen. Our physician or nurse practitioner will not do a complete physical exam. You should still see your personal physician for regular check-ups.

Tests of your Heart Functions
We will do tests to find out about changes in your heart and blood vessels. We will discuss the results with you after we finish the tests. If we find a heart problem, we will discuss the problem with you and we will send the results to your personal doctor if you want us to.

Resting Electrocardiogram (EKG)
We will place wires called electrodes on your skin to record your heartbeats. By looking at the electrical pulse of your heart we will examine you heart rate and rhythm, and check if you have had a heart attack. There are no risks from this procedure.

Carotid Doppler Ultrasonography
We will ask you to lie down and rest for 10 minutes. We will place a small ultrasonic probe on your neck to take pictures of the artery in your neck and measure the thickness of this blood vessel. There are no risks from this test. There is no radiation in this test. Ultrasound is not the same as an x-ray and does not involve any radiation.

Pulse Wave Velocity
The measurement of the stiffness of your blood vessels is performed entirely non-invasively (no needles or sticking involved). You will be asked to lie flat on your back, and we will place a sensor on your wrist, one over the artery in your neck (carotid artery), and another sensor over the artery in your groin (femoral artery). We will then record the arterial waveform tracings. There are no risks associated with this procedure.

Problem Solving and Memory Testing
We will ask you to do some tasks that exercise your thinking and memory. These tasks ask you to remember words, numbers, and pictures. These tasks also ask you to find similar words or to think of words beginning with certain letters or belonging to certain categories. They will also ask you to imagine how objects look in different positions. The tests for remembering are called the Benton Visual Retention Test, the California Verbal Learning Test, and the Digit Span Test. The tests for words are called the Wide Range Achievement Test and the Category Fluency Test. The test for comparing objects is called the Identical Pictures Test. The test for switching letters and numbers is called the Trailmaking Test. The test for imagining objects in different positions is called the Card Rotations Test. Other tests, called Mental Status Tests, measure several types of memory abilities. These tests are given in a private, quiet room with a tester who will
help you understand how to do the best you can.

We want you to know that some people find these tests tiring. Sometimes, people feel nervous when they do these tests. All examiners who are involved in giving these tests are experienced in using these procedures and they will minimize any discomfort that you might feel. If the tests are disturbing you, then you may stop testing any time you want.

Questionnaires
We will ask you to complete several questionnaires about your social support, racial and cultural identification, family income, your feelings and interests, coping, and mental health. These questionnaires will be filled out on the Mobile Research Vehicles by using a computer and headphones. We will help you do the questionnaires if you want us to. If you have trouble seeing or reading the questions you may ask one of our testers to help you. These tests are given in a private, quiet room.

Emotions and Heart Rate
This interview is to see how recalling emotions and standing up affects heart rate and blood pressure. You will be asked to recall past experiences while we record your heart rate and blood pressure. There are no risks with this test.

Buccal Mucosa Smear
As part of the medical evaluation, a buccal mucosa smear will be collected from you, if you agree, using the Whatman FTA collection system. This system collects buccal cells from inside your mouth using foam tipped applicator which is placed into the mouth and rubbed on the inside of both cheeks for 30 seconds by you. The sample obtained is then transferred to the Indicating FTA cards. The extracted DNA will be used for epigenetic analysis.

Blood, Tissue, and Urine Sampling
If you agree, we will ask you to give us a blood sample and a urine sample. To prepare you for the blood tests we will ask you not to eat or drink anything after midnight the night before your visit to the MRVs. The blood draw will be performed right before you are served breakfast. We will use these samples to measure your health and so that we can measure changes in your health if we test you again. We will measure your white and red blood cells, your cholesterol, salt and sugar, how well your blood carries oxygen through your body, and how fast you heal from minor cuts. We will also measure blood chemistry that may tell us how well your body organs work, such as your heart, liver, and kidneys.

Women between the ages of 30 and 55 years will get a pregnancy test. We will be testing for communicable diseases including Hepatitis B, Hepatitis C, and Syphilis. You will be offered a test for HIV. If you decide to have the test, you will be asked to sign a separate consent form that explains the HIV testing procedures for the HANDLS study.
Doctors often make new discoveries by testing blood and urine. We would like to freeze a portion of your blood and urine samples to save them in our frozen tissue bank. We are not sure what new discoveries will appear in the future. We want to set aside your samples until there are new tests that will help us understand health and aging.

More and more, we are discovering that our genes are important for understanding our health. Your genes are the parts of each cell inherited from your mother and father. Your genes are what make you a unique individual. Genes are made from DNA. We want to use some of your donated blood to freeze your DNA. We are not sure what studies will use your DNA. New studies may look at how your genes affect age-related diseases.

The samples saved in our bank will be stored at very low temperatures. Unlike household freezers, these freezers can preserve samples for many years, perhaps many decades. We will label your samples with code numbers. Only the principal investigators in this study will know your code number. Only researchers in this study will know the results of tests using your genes. We will not reveal your results to anyone who is not associated with this research.

We will ask you if you want the results of the tests that we perform on your blood and urine. We will also ask you if you want us to send your results to your personal physician. We do not plan to report the results of the studies we do on your genes because these tests do not diagnose or predict the development of specific diseases at this time. In the future, we may offer you some of the results if the Food and Drug Administration approve some of the tests.

We will ask you to donate about 62 milliliters of blood (about 4½ tablespoons). For comparison, the Red Cross usually asks for a donation of about 500 milliliters of blood (about two cups).

Compensation
You will be paid $100 for participating in this study. You will receive your payment in the form of an ATM debit card at the end of the MRV visit. If you do not perform all of the tests you will receive a portion of the payment. The ATM card will be activated before you leave the vehicle. You will be able to take the card to an ATM machine in your neighborhood to withdraw your payment. We will provide round-trip transportation from your home to our mobile testing center if you want it. We will serve a box breakfast and box lunch if you are participating in tests during mid-day. We will do our best to meet your dietary needs if you have any.

You are participating in a research study and our physicians and technicians are not your primary health-care providers. We will provide medical feedback to you and, with your permission, to your personal physician about your health based on the tests in which you participate. If you need a referral to a physician, we will provide a list of local
Assessment of Risks
Buccal Mucosa Smear
The possible risks for this procedure include irritation of the inside of the cheek and/or gum line by the foam tipped swab used to collect cells and saliva.

Blood Sampling
We want you to know that there are some risks in donating a blood sample. The trained HANDLS staff member will insert a needle in a vein in your arm. There is a risk of an infection from the needle puncture. There is also a risk of a black and blue mark, and you may feel faint. These risks are very small. Our staff is well trained and has drawn blood many times. It is common to have a small black and blue mark, but it disappears after a day or so. Some people have begun perspiring, or they felt nauseated and their pulse slowed. None of them had any after effects.

Radiation
Each day everyone receives a certain amount of natural radiation from various sources in the environment. The exact amount of radiation is measured in units called millirems. The National Council on Radiation Protection and Measurements measures average radiation exposure. They estimate that people in our country receive 300 millirems of annual exposure.

The radiation you will receive from participating in this study is equivalent to an exposure of less than 1 millirem to your whole body. This whole body dose is called the effective dose. The average annual background radiation in the United States is an effective dose of 300 millirems per year. The amount of radiation in this study is equal to the background radiation in about one day. Using the standard way of describing radiation dose, you will receive 1.5 millirems to the skin over your lower spine and hip area, and .24 millirems to the skin over your forearm. Thus, your body will receive a small dose of radiation. Please be aware that this radiation exposure is necessary for this research study only, and is not essential for your medical care. The NIH Radiation Safety Committee, a group of experts on radiation matters, has reviewed the use of radiation in this research study and has approved this use as being necessary to obtain the research information desired.

The radiation dose you will receive is within the NIH Radiation Safety Guidelines for research subjects, that is, the effective dose is less than 5000 millirems in one year. The potential long-term risk from the radiation in this study is uncertain, but these doses have never been associated with any definite adverse effects. Thus the risk to you, if any, is estimated to be slight. Please advise your doctor if you have participated in research studies at the NIH or other institutions that involved the use of radiation so that it may be determined that the total radiation from all studies is not excessive. Examples of such studies include x-ray studies conducted in radiology departments, cardiac catheterization,
and fluoroscopy as well as nuclear medicine studies, for example technetium and PET scans.

If you are female, you may participate in this study only if you are certain you are not pregnant. If you become pregnant (or suspect pregnancy) before the study is completed, you must inform the investigator.
Appendix F

REFERENCES APPENDICES

