

AN ABSTRACT OF THE THESIS OF

Angela K. Johnson for the degree of Master of Science in Nutrition presented on March 20, 2013

Title: Very High Physical Activity Predicts Higher Diet Quality in Healthy Young Adults, as Measured by the Healthy Eating Index 2005

Abstract approved:

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Mary M. Cluskey

Physical inactivity and unhealthful diet are major risk factors for noncommunicable diseases, and strategies worldwide now focus on improving diet and encouraging physical activity (PA). Participation in PA lowers the risk for numerous chronic diseases, while a healthful diet also offers resistance to disease. However, practicing both behaviors offers greater protection than practicing either behavior alone. Research evaluating the relationship of diet and PA has focused primarily on nutrients or food groups. Little research exists on PA and overall diet quality, and no research has used the Healthy Eating Index 2005 (HEI-2005) to assess diet quality in healthy young adults, the objective of the current study. To this end, a convenience sample of 70 healthy, young adults was recruited from a university community in 2005-2006. Dietary intake was measured with 7-d weighed food records and HEI-2005 scores were computed to assess diet quality. PA was obtained from 7-d activity records accounting for all minutes of each day. Linear regression models were used to assess the association of HEI-2005

scores to participation in moderate- and vigorous-intensity PA. In this sample, HEI-2005 scores increased as weekly minutes of PA increased ( $p=0.006$ ,  $B=0.007$ ). When PA was examined categorically, only the VeryHighPA ( $\geq 841$  min/week) group had diet quality scores significantly higher than the LowPA ( $\leq 420$  min/week) group, independent of age, BMI, and gender ( $p=0.033$ ,  $B=7.987$ ). Further studies are warranted to clarify the relationship of these health behaviors, an especially important topic as prevalence of obesity and chronic disease continues to rise.

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Very High Physical Activity Predicts Higher Diet Quality in Healthy Young Adults, as  
Measured by the Healthy Eating Index 2005

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I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

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Angela K. Johnson, Author

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## DEDICATION

*To Todd Cross,*

my loving and loyal husband, for your enduring understanding of the time commitment required of this project, for taking on more parenting and home duties with such grace and enthusiasm, for never making me feel like this was taking too long, and for letting me carve the path to the end, albeit filled with detours through employment, pregnancy, dietetic internship, employment, childbirth and “maternity leave,” more employment, and on and on until here we are, finally at the destination. I could not have done it without you.

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I will love you both, always.

## **Very High Physical Activity Predicts Higher Diet Quality in Healthy Young Adults, as Measured by the Healthy Eating Index 2005**

### **INTRODUCTION**

Physical inactivity and unhealthful diet are major risk factors for noncommunicable diseases, which now account for 60% of deaths worldwide.<sup>1</sup> The World Health Organization has created a Global Strategy to promote physical activity (PA) and healthful diet,<sup>1</sup> and in the United States (US), the Dietary Guidelines for Americans (DGA) and the more recently created Physical Activity Guidelines for Americans (PAG) advise healthful eating<sup>2</sup> and regular PA.<sup>3</sup> By itself, PA lowers the risk of all-cause mortality, early death, cardiovascular disease, some cancers, type-2 diabetes, metabolic syndrome, obesity, depression, and other diseases and risk factors.<sup>3-5</sup> A review of cross-sectional data indicates a strong positive association between PA and health-related quality of life.<sup>6</sup> Similarly, a healthful diet reduces the risk of cardiovascular disease, hypertension, diabetes, osteoporosis, and numerous forms of cancer.<sup>2</sup> Good nutrition and PA as coexisting behaviors appear to have a synergistic effect, offering greater reduction of risk factors and chronic disease when practiced together rather than independently.<sup>7-12</sup>

Research has connected greater participation in PA with greater intake of some beneficial nutrients or food groups or lower intake of detrimental nutrients or food groups, suggesting that one behavior may lead to a greater likelihood of practicing the other behavior,<sup>13-22</sup> but due to the widely variable approach in obtaining and measuring diet and activity, a better understanding of how diet and PA behaviors coexist is needed. Few studies<sup>23-25</sup> have sought to compare a more comprehensive description of diet to PA, by looking at overall diet quality rather than separate nutrients or food groups. The Healthy Eating Index 2005 (HEI-2005) is one composite measurement method to assess diet quality and is designed to reflect adherence to

the 2005 DGA.<sup>26</sup> To our knowledge, only one published study<sup>24</sup> has used the HEI-2005 to examine the relationship of PA and diet quality, in female participants diagnosed with breast cancer. Other research has used the HEI-2005 to study the diet quality of various adolescent populations, female-only adults,<sup>24,27,28</sup> and adults with specific diseases<sup>24,27</sup> disability,<sup>29</sup> or who were older in age,<sup>27,29-31</sup> but no research has used the HEI-2005 with healthy, young adults. The aim of the present work is to evaluate diet quality as measured by HEI-2005 scores and its relationship with quantity of PA performed in a group of healthy, young adult men and women.

## **METHODS**

### **Study Design and Subjects**

Subjects were originally recruited for a study described elsewhere.<sup>32</sup> Recruitment was done in a Pacific Northwest university town during 2005-2006 through flyers posted on campus and through email sent to local athletic clubs. Telephone screening identified potential participants, who had to either 1) participate in >7 hours per week of moderate- and high-intensity PA or 2) participate in <7 hours per week for at least 5 years, based on the Institute of Medicine's recommendation that all adults perform at least an hour of moderate-intensity PA per day to maintain cardiovascular health.<sup>33</sup> Other eligibility criteria included: age of 19 to 35 years; non-smoking in the past year; no history or current status of menstrual dysfunction or disordered eating (assessed by questionnaire); not currently injured; BMI  $\leq 28$  kg/m<sup>2</sup>; lack of chronic disease diagnosis; and not taking medications that effect plasma homocysteine.<sup>32</sup> Other criteria were also chosen to control for effects on plasma homocysteine. Eighty volunteers were invited to participate. From those recruited, 10 participants were excluded for failure to return records (one participant), or for underreporting (nine participants). Underreporting was determined if total energy intake was 200 kcal/day less than that calculated by estimated resting metabolic rate multiplied by Goldberg et al.'s<sup>34</sup> factor of 1.3. Among the remaining 70 healthy,

young men and women who participated in the study, 47% male were male and the average age was 26.2 years. Based on standard BMI categories, 1.4% of participants were underweight, 69.2% were normal weight, and 29.4% were overweight. Mean HEI-2005 score was 63.1, with scores ranging from 40.9 to 84.9.

Anthropometrics were obtained during an on-site visit. Height in meters was measured with no shoes using a stadiometer, a digital scale was used to weigh the subjects wearing only swimsuits, and BMI ( $\text{kg}/\text{m}^2$ ) was calculated. All participants were instructed by the same trained interviewer on how to accurately complete 7-day diet and activity records, and examples of completed records were provided to reduce reporting error. Researchers chose 7-day weighed food records based on the relative precision of this method for estimating average usual intake.<sup>35,36</sup> Calibrated scales were issued to participants to weigh food to be eaten. On activity records, participants accounted for all minutes of the day (1440 minutes) for all 7 days. Records were kept on 7 consecutive days, during which no special events (i.e., weddings, holidays) were scheduled. Participants were encouraged to contact researchers if they had questions during their recording period. This study was approved as exempt by the Institutional Review Board of Oregon State University.

### **Diet Quality**

Diet quality was assessed using the HEI-2005. The HEI-2005 is comprised of 12 components whose individual scores sum to a maximum score of 100 points.<sup>26</sup> There are nine "adequacy" components (higher scores if you meet recommended levels) and three "moderation" components (higher scores if you eat less).<sup>26</sup> The adequacy components (and their respective possible points) are: total fruit (5), whole fruit (5), total vegetables (5), dark green and orange vegetables and legumes (5), total grains (5), whole grains (5), milk (10), meat and beans (10), and oils (10).<sup>26</sup> The moderation components (and points) are: saturated fat (10), sodium (10), and calories from solid fats, alcohol, and added sugars (20).<sup>26</sup> For each category, the more closely one's diet adheres to the DGA, the more likely all possible points for that component will be

attained. To obtain HEI-2005 scores, daily energy, sodium, and saturated fat intake were calculated from the 7-d food records using Food Processor (ESHA version 10.7; Salem, OR). These values were entered into an Excel program, along with the most appropriate HEI-2005 food code<sup>37</sup> for each food or drink consumed each day and the weight of that food or drink. In this way, daily component scores and daily total scores were calculated for each subject, and an average daily HEI-2005 score obtained for analysis from the 7 daily scores.

### **Physical Activity**

Each participant recorded the time spent in resting, sitting, standing, moderate- and high-intensity activities over 7 consecutive 24-hour periods. Intensity of activity was described to each participant based on descriptive physical activities<sup>38</sup> as follows: resting (laying down, sleeping), very light (all sitting activities: studying, driving, computer work), light (all standing activities: standing around, teaching, housework, walking below 4 mph) moderate (i.e., fast walk >4 mph pace, jogging, swimming, biking), and heavy (competitive sport event, jogging or running >5 mph). Researchers totaled weekly minutes for each intensity category. Total weekly minutes of activity from the moderate- and heavy-intensity categories were used to assign PA groups: LowPA for those doing 420 minutes/week of PA or less (based on the IOM's recommendation that all adults average an hour of PA per day<sup>33</sup>), HighPA, which included those doing 421-840 minutes/week of PA, and VeryHighPA, which included participants who performed 840 minutes/week or more of PA.

### **Statistical Analysis**

Version 19.0 of IBM SPSS (2010, IBM Corp., Armonk, NY) was used for analysis.  $P < 0.05$  was considered statistically significant. The association between HEI-2005 score and PA was evaluated using univariate and multivariate linear regression models. HEI-2005 scores were treated as continuous data and were tested against total minutes of PA as continuous data. BMI, age, and gender were covariates for analyses in the multivariate linear regressions to determine whether they

contributed to the relationship of minutes of PA and HEI-2005 scores. The association between average HEI-2005 scores and three levels of PA (LowPA, HighPA, VeryHighPA) was also examined, and linear regression analyses were repeated with and without covariates above.

## RESULTS AND DISCUSSION

Analysis revealed a positive association between HEI-2005 score and total weekly minutes of PA ( $p=0.006$ ,  $B=0.007$ ), and the association remained significant after adjusting for BMI, age, and gender ( $p=0.012$ ,  $B=0.007$ ). This beta-coefficient means that for every minute of PA, HEI-2005 scores improved 0.007, so an additional 60 minutes more PA in a week might raise an individual's HEI-2005 score 0.42. When PA was examined categorically rather than as continuous minutes, the VeryHighPA group had significantly higher HEI-2005 scores than the LowPA group ( $p=0.035$ ,  $B=7.952$ ). Adjusting for BMI, age and gender retained significance ( $p=0.033$ ,  $B=7.987$ ). Mean HEI-2005 scores increased from the LowPA group to the HighPA group ( $p=0.394$ ,  $B=2.125$ ) in the unadjusted model, which, while not statistically significant, does simulate the US Department of Agriculture's Strategic Plan goal of a "two-point increase among the general public."<sup>39</sup> All assumptions of linear regression models were met, and the p-value for trend between these categories was significant at  $p=0.029$ . Power to detect differences between the VeryHighPA group ( $n=9$ ) and the LowPA group ( $n=28$ ) was 71%.

Several researchers have noted that participation in PA coincided with higher intake of micronutrients,<sup>15-17,20</sup> higher intake of more healthful foods<sup>14-19,21,22</sup> (for example, fruits, vegetables, low-fat dairy, fish, whole grains), or a lower intake of foods that are recommended in moderation (e.g., saturated fat).<sup>15-17,20,22</sup> When looking at the Stages of Change Model in relation to PA and healthful eating, Blakely et al<sup>13</sup> reported that select measures of a healthful diet were higher for those in the maintenance phase of participation in moderate PA and that eating fruits,

vegetables, and whole grain products improved linearly as groups' readiness to perform PA increased from precontemplation to contemplation to preparation.

**Healthy Eating Index 2005 (HEI-2005) Scores and Demographic Characteristics by Level of Physical Activity (PA) Participation**

<b>Variables</b>	<b>LowPA (n=28)</b>	<b>HighPA (n=33)</b>	<b>VeryHighPA (n=9)</b>
HEI-2005 Score	61.11 (10.4)	63.24 (9.45)	69.07 (7.4)*
PA min/week	252 (121)	588 (127)	1324 (690)
Male	35.7%	63.6%	22.2%
Age (years)	27.5 (5.0)	25.1 (4.5)	25.8 (4.5)
BMI (kg/m <sup>2</sup> )	23.6 (2.9)	23.0 (2.9)	23.3 (2.9)

Values are presented as means (SD), except gender, which is by % male.

\* $P < 0.05$  statistical significance when compared to LowPA group.

PA categories are weekly minutes of physical activity in moderate to high intensity: LowPA $\leq$ 420 minutes; HighPA=421-840 minutes; VeryHighPA $\geq$ 841 minutes.

While these studies focused on nutrients, foods, and food groups, a few studies, like the current study, have looked at overall diet quality in relation to PA participation. In Spanish university students, those with a higher diet quality as measured by the Global Dietary Quality Score were more apt to report being physically active.<sup>25</sup> Thiele and colleagues found that higher diet quality was positively associated with "sport activity."<sup>23</sup> Little other research uses the HEI-2005 to compare diet quality to PA, but as with the current study, George et al<sup>24</sup> found that women with breast cancer who had higher HEI-2005 scores were also more apt to engage in recreational PA, both before and after diagnosis. Higher HEI-2005 scores have also been linked to better physical performance in adults 60 years and older, as measured by average gait speed and knee extensor strength.<sup>30</sup>

Few studies reexamine their active participants to look at what quantity of PA is associated with higher diet quality. In the present work, only those who averaged two hours or more of PA per day were shown to eat significantly higher quality diets than participants who performed an hour or less of PA per day. Contrary to our

findings, Matthews and colleagues<sup>17</sup> examined adults with hyperlipidemia and found that among active participants, categorized by at least 30 minutes of leisure time PA (LTPA) each week, “individuals reporting only 30 to 60 min of LTPA each week consumed consistently the lowest fat and most micronutrient dense diet of any LTPA group.” Similarly, when comparing diet quality to hours of PA in Spanish university students, Moreno-Gomez did not find increased diet quality with more hours of PA per week.<sup>25</sup>

Compared to other research looking at relationship of diet and PA, measurement methods of the current study add to its strength. Our rigorous measurement of total weekly minutes of PA from prospective activity records is to our knowledge a unique contribution to the collection methods used in other literature on this topic. Use of the HEI-2005 is an asset in that it validly measures adherence to key recommendations of the 2005 DGA,<sup>40</sup> and that it controls for energy intake, meaning that eating more will not equate to higher scores.<sup>26</sup> In addition, most research using the HEI-2005 has calculated these scores from a single 24-hr recall,<sup>29,30,41</sup> food frequency questionnaires,<sup>24,31</sup> or a combination of a 24-hr recall and 2 days of food records.<sup>28</sup> Only one other known study<sup>27</sup> has used 7 days of weighed food records to obtain an average HEI-2005 score. Weighed food records are a more objective and precise measure of intake that self-report alone.<sup>35</sup> Specifically, 7 days of weighed food records have “often been considered appropriate for estimating the average usual nutrient intakes of individuals,”<sup>35</sup> and including all 7 days of the week is beneficial to account for differences between intake on different days of the week.<sup>36</sup> Use of a convenience sample of healthy young adults may limit generalization to a broader population.

## **CONCLUSION**

To our knowledge, this is the first study to use the HEI-2005 to examine the relationship of PA participation and diet quality in healthy, young adults. Analyses of

PA as both continuous and categorical variables revealed that diet quality increases with higher amounts of PA performed. This substantiates other research noting higher intake of healthful foods to be associated with PA participation.<sup>13-22</sup> When PA was treated categorically, only the VeryHighPA group had HEI-2005 scores that were statistically higher than the LowPA group, which contrasts other research that did not find higher diet quality to be associated with more PA.<sup>17,25</sup> Though the results of the current study both corroborate and contradict previous work examining the relationship between PA and diet behaviors, it is difficult to elicit meaningful comparisons due to wide variability in measurements and lack of a standardized definition for active PA participation. This is a limitation of the breadth of research on this topic, and further research is warranted to continue to clarify the relationship of diet and PA behaviors.

The cross-sectional nature of this and other research precludes inference of causality between PA and diet, yet it is still valuable to examine whether PA and healthful eating behaviors are influential or reinforcing of each other. In attempting to answer this question, Joseph et al<sup>42</sup> surmised that routinely practicing PA strengthens executive functions of the brain's prefrontal cortex, which are required to help individuals to make goal-oriented choices like eating healthful foods and engaging in additional PA. Since Sweet and colleagues<sup>12</sup> found that interventions focused on either PA or eating behavior were "more effective at increasing the targeted behaviours" than interventions focused on changing multiple behaviors simultaneously, encouraging PA may be a successful long-term strategy in fostering healthful eating. Well-designed longitudinal studies will help clarify whether strengthening either PA or diet quality will serve to positively influence the other behavior. This would be a crucial contribution to global strategies focused on improving health and preventing disease.

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