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Diet Quality of Adolescent Females in Relation to Disease Risk

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By

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University of Nebraska, 2016

Abstract

Background: Many people are living longer with chronic diseases costing billions in healthcare costs every year. Many things influence the risk of chronic diseases but one easily modified risk factor is diet. Alternate Healthy Eating Index (AHEI) and Alternate Healthy Eating Index-2010 (AHEI-2010) diet quality indexes have been associated with chronic disease risk but has not been studied in disease risk in adolescents.

Purpose: The purpose of this study is to look at adolescent girls' diet quality scores compared with known adult values associated with chronic diseases and risk of mortality.

Methods: This is a secondary analysis of a previous 12-month randomized control trial that included 273 adolescent girls aged 13-14 years who were above the median BMI for their age. AHEI and AHEI-2010 scores were calculated from dietary intake assessed by 3-day food records provided at baseline, 3, 6, 9 and 12 months. The distributions of scores were compared to scores that have been associated with breast cancer, COPD, CVD, stroke and diabetes.

Results: The total average energy intake was 1695.48 $\pm$ 354 kcals/day. The mean AHEI score of the participants was 25.99 $\pm$ 6.13 and 26.59 $\pm$ 7.86 for AHEI-2010. Based on the AHEI scores, only 8% of the participants had scores that were protective against breast cancer. Of the AHEI-2010 scores, only 1 participant had a score that was protective against COPD and stroke; 6% of

the participants had scores that were protective against CVD and major chronic disease; and 48% had scores that were protective against CHD and diabetes.

Conclusion: There is growing evidence that diet during specific times of growth and development can alter the risk for chronic diseases. The overall diet quality of our participants was poor with very few having scores that are preventive of chronic diseases.

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List of Abbreviations

AAP	American Academy of Pediatrics
AHEI	Alternate Healthy Eating Index
AHEI-2010	Alternate Healthy Eating Index-2010
aMED	alternate Mediterranean diet
BMI	body mass index
CDC	Centers for Disease Control and Prevention
CHD	Coronary heart disease
CI	95% Confidence Interval
COPD	chronic obstructive pulmonary disease
CVD	Cardiovascular disease
DASH	Dietary Approaches to Stop Hypertension
DHA	docosahexaenoic acid
DXA	dual-energy X-ray absorptiometry
EPA	eicosapentaenoic acid
ER+	Estrogen receptor-positive
ER-	Estrogen receptor-negative
GUTS	Growing Up Today Study
HDL	high-density lipoproteins
HEI	Healthy Eating Index 2005
HEI-2010	Healthy Eating Index-2010
HR	Hazards ratio
KIDMED	Mediterranean Diet Quality Index for children and adolescents
LDL	low-density lipoproteins
MVI	multivitamin

NHANES	National Health and Nutrition Examination Survey
OR	Odds Ratio
RFS	Recommend Foods Score
RR	Relative Risk
WHI	Women's Health Initiative
YHEI	Youth Healthy Eating Index

Introduction

Over the years, the average life expectancy for people in developed countries has increased from 69.7 years in 1960 to 78.7 years in 2011[1]. With longer life expectancies, there has been a rise in the number of people living with chronic diseases like heart disease, stroke, cancer, diabetes, obesity and arthritis. According to the Centers for Disease Control and Prevention (CDC), about half of the United States population had one or more chronic diseases as of 2012[1]. Seven of the top ten causes of death are chronic diseases including cardiovascular disease (CVD), cancer, chronic lower respiratory disease, stroke, Alzheimer's disease, diabetes and nephritis/nephrosis[2]. A common risk factor for many chronic diseases is obesity. According to the CDC, approximately 17% of children aged 2-19 years are obese; this trend continues on into adulthood with 34.9% of US adults being categorized as obese[3].

In addition to the number of deaths caused by chronic diseases, billions of healthcare dollars are spent every year on the treatment of chronic diseases. In 2010, 86% of healthcare dollars were spent on people with one or more chronic diseases[1]. During that year, $193.4 billion were spent in direct medical cost for heart disease and stroke[1]. In addition to the direct medical costs, there are billions of dollars spent on indirect costs like time off from work, disability, and transportation to and from medical appointments[1].

There are a number of factors that contribute to the risk of chronic diseases including lifestyle choices, environmental influences, age and genetics[4]. While not all of these factors can be controlled, there are many steps that can be taken to decrease the risk of developing many chronic diseases. One such step is a well-balanced diet. The focus has switched more recently from looking at individual nutrients to the overall dietary quality of the American population. It is not only individual nutrients that contribute to overall health and prevention of diseases, but also how all of the nutrients interact within the body[5, 6]. Nutrients are not consumed in isolation but in combination with each other and interact with each other. By looking at the overall diet quality, it

avoids focusing on single foods and/or nutrients that can be correlated with or interact with each other. Also, single nutrients may have effects that are too small to be identified or isolated from each other[6].

Adolescence is a time of rapid growth and cell proliferation. With all the growth and develop taking place during this stage in life, it is reasonable to think that diet during this stage could influence the risk of chronic diseases later in life; this idea led to a few studies examining adolescent diet and the risk for breast cancer and heart disease risk factors[7-11]. There is growing evidence that diet during key times of growth and development can influence the risk for chronic diseases.

A couple of studies have examined the association between red meat consumption and breast cancer risk[7, 8]. The Farvid study showed a 23% reduction in risk for premenopausal breast cancer and 15% reduction in overall cancer risk when one serving per day of red meat was replaced by a serving of poultry, fish, nuts and legumes[7]. Likewise, another study showed a decreased risk for benign breast disease (a risk factor for breast cancer) with a daily serving of peanut better, peanuts, nuts, beans and corn[9].

Other studies have shown a decreased risk for CVD with dairy consumption and an increased risk for CVD with diets higher in added sugar[10, 11]. In addition to the role diet has on the risk for cancers, it also plays a role in the risk for heart disease and diabetes[12].

Adolescence is a very formative stage where children are developing not only physically but also mentally and forming habits. Many things influence adolescents' actions and dietary habits including social influences from media, peers, family and teachers[13]. Not only do they form many of their own dietary habits, there is also a lot of physical development that occurs during this time. Examining and improving diet quality during this time of growth and development, may help prevent future adult chronic diseases.

Many studies have looked at adult diets and their associated risk for chronic diseases, but little research exist that applies diet quality scores to adolescent diets and the potential of their

diets for contributing to adult chronic disease risk. The purpose of this study is to look at adolescent girls' diet quality scores compared with known adult values associated with chronic diseases and risk of mortality.

Literature Review

Diet Quality during Adolescence and Chronic Disease

There have been studies that support diet during adolescence may influence the risk for some diseases like cancer and heart disease. Adolescence is a time of rapid growth and cell proliferation and therefore has the potential to contribute to disease risk. The studies during this stage of life completed to date examine individual food groups or nutrients and their influence of disease risk.

One such study looked at the influence red meat consumption during adolescence and the risk of breast cancer[7]. They prospectively followed over 44,000 women in the Nurses' Healthy Study ll cohort who completed a detailed questionnaire about diet during adolescence. The study showed that higher intakes of red meat were statistically significantly associated with premenopausal breast cancer (RR 1.43; CI: 1.05-1.94; P_{trend}=0.007); they did not find a significant association with postmenopausal breast cancer. When one serving of red meat was replaced with a combination of a serving of poultry, fish, legumes and nuts, the risk of premenopausal breast cancer was associated with a 23% reduction of risk (RR 0.77; CI: 0.64-0.92) and a 15% reduction of risk for overall cancer (RR 0.85; CI: 0.74-0.96)[7]. Linos et al. were the first to conduct a similar analysis using the same cohort and looking at the risk of breast cancer associated with red meat consumption[8]. They found similar results in that lower red meat consumption in high school was associated with lower risks of breast cancer (RR 1.34; CI: 0.94-1.89)[8]. The Farvid study examined more sources of protein in comparison of just red meat intake[7,8].

Similarly another study examined the association of higher vegetable fat and protein intake and the risk of benign breast disease, which is a risk factor for breast cancer[9]. They looked at the Growing Up Today Study (GUTS) cohort that included over 9,039 girls from all 50 states. At 14 years of age, a daily serving of peanut butter, peanuts, nuts, beans or corn was associated with a decreased risk of benign breast disease (OR 0.34; CI: 0.16-0.75; p=0.02)[9].

In a study looking at diet during preschool and the risk of breast cancer, they found a 27% increased risk (OR 1.27; CI: 1.12-1.44) for one additional serving of French fries per week consumed during preschool, while there was a slight reduction in risk seen with consumption of whole milk (OR 0.90; CI: 0.82-0.99)[14]. Diet information was obtained from the mothers of the nurses in the Nurses Healthy Study and the Nurses Health Study ll using a 30-item food frequency questionnaire. During the exposure time for this cohort, the median used to fry the French fries changed from solid shortening to hydrogenated oils, so the findings may be different based on the median used to fry today and may not be applicable today[14].

In addition to studies looking at breast cancer risk, there have been studies that looked at dietary influences on heart disease risk factors including systolic blood pressure, sum of 4 skin-fold thicknesses (bicipital, tricipital, subscapular and suprailiac), serum triglyceride concentrations, total cholesterol to high density lipoprotein (HDL)-cholesterol ratio and cardio-respiratory fitness. The Healthy Lifestyle in Europe by Nutrition in Adolescents (HELENA) study looked at dietary influences during adolescence on those cardiovascular disease risk factors. It was a cross-sectional study covering 10 cities in Europe (Athens, Greece; Dortmund, Germany; Ghent Belgium; Heraklion, Greece; Pecs, Hungary; Lille, France; Rome, Italy; Stockholm, Sweden; Vienna, Austria and Zaragoza, Spain) that included 3528 participants. Dairy consumption was statistically significantly associated with the CVD risk factors. There was an inverse relationship observed between waist circumference, the sum of skin-fold tests, systolic blood pressure, triglycerides, and total cholesterol to HDL-cholesterol ratio with dairy consumption ($p<0.05$) and was positively correlated with cardio-respiratory fitness[10].

A common risk factor for cardiovascular disease is dyslipidemia. Dyslipidemia in childhood is a strong indicator of dyslipidemia in adulthood and has a strong association with early-onset atherosclerosis. One thing that has been significantly correlated with HDL cholesterol, low density lipoprotein (LDL) cholesterol and triglycerides is added sugar[11]. The *2010 Dietary Guidelines for Americans*, recommends less than 10% of calories per day come

from added sugars[15]. A recent study used dietary recalls of 4,047 participants aged 12-19 years collected through the 2005-2010 National Health and Nutrition Examination Study (NHANES) to calculate the percentage of calories from added sugars. Of the participants, 88% of them consumed ≥10% of calories from added sugars (5.5% consumed ≥25% of calories from added sugar.) The study showed an inverse association with percentage of calories from added sugars and HDL cholesterol; there was a positive association between the percentage of calories from added sugars and LDL and triglycerides. The OR for the risk of dyslipidemia of those in the highest versus the lowest quintiles for percentage of calories from added sugars was 1.41 (CI: 1.01-1.95; p=0.005)[11].

Another study compared the Healthy Eating Index 2005 (HEI) and the Youth Healthy Eating Index (YHEI) in low-income, African American adolescents. They calculated scores from food frequency questionnaires collected from the Challenge cohort and the Three Generation Project cohort. There was variation between the scoring indexes and between the scores of the cohorts. Overall, they found higher scores with the HEI index, especially in females (64.47 ± 11.70 points; $p<0.05$) and higher HEI scores were associated with low percent body and abdominal fat (-0.17 and -0.19 respectively; $p<0.05$); YHEI scores were not associated with percent body and abdominal fat. Higher percent body fat and abdominal fat are associated with increased risk for chronic diseases, so the HEI index may be better able to predict disease risk in the adolescent population[16].

Creation of Dietary Quality Scoring Indices

With the recent change in focus from individual nutrients to overall dietary pattern, several different scoring indices have been developed and revised over the years to measure diet quality. These various diet quality indices have examined the association between higher quality diets and the risk of chronic diseases and mortality in adult populations. Few of the studies have applied or modified the indices to adolescent populations and none have looked at the association

of diet quality in adolescence and the risk of developing chronic diseases later in life. Most of the indices created or modified for adolescent populations measure diet quality along with other factors including activity level and behavior, and they do not examine chronic disease risk[13,17]. The specific indices used for analysis in this study are the Alternate Healthy Eating Index (AHEI) and the Alternate Healthy Eating Index-2010 (AHEI-2010).

The AHEI was based off the HEI. The HEI was originally developed by researchers at the US Department of Agriculture to measure adherence to the Dietary Guidelines for Americans and the food guide pyramid[5,6]. The guidelines and pyramid were recommendations created to help prevent chronic diseases. The HEI originally had 10 components that measured intake of five major food groups, four nutrients to be consumed in moderation and a component measuring variety[5]. The components included grains, vegetables, fruits, milk, meat, total fat, saturated fat, cholesterol, sodium and variety[5].

In 2002, McCullough and colleagues developed the AHEI by modifying the HEI to reflect intake of foods and macronutrients that are predictive of chronic disease risk[5, 6]. The AHEI has nine components including vegetables, fruit, nuts and soy, ratio of white to red meat, cereal fiber, trans fat, ratio of polyunsaturated fats to saturated fats, multivitamin (MVI) use, and alcohol consumption[5, 6].

The other diet quality index used in this study was the AHEI-2010, which was developed by Chuive and colleagues[18]. The new score was based off several things including the AHEI, new scientific evidence on diet and health, and the 2010 Guidelines for Americans[18]. The AHEI-2010 included 11 components including vegetables, fruit, nuts and legumes, whole grains, red and processed meats, sugar sweetened beverages and fruit juice, trans fat score, long-chain fats, polyunsaturated fatty acids, sodium and alcohol intake[18, 19].

Other Diet Quality Scoring Indices

In addition to the indices used in this study, several other diet quality scoring indices have been created including the alternate Mediterranean diet score (aMED), the YHEI, Mediterranean Diet Quality Index for children and adolescents (KIDMED), Recommended Food Score (RFS), and Dietary Approach to Stop Hypertension (DASH). They have been created for various reasons and based on different research and recommendations.

The Mediterranean diet has a substantial amount of research supporting its beneficial effects[20-24]. There have been various Mediterranean scores created but they all include common components including high consumption of fruits, vegetables, whole grains, increased protein intake from plant sources like nuts and legumes, high intake of mono-unsaturated fats and poly-unsaturated fats, and moderate fish and alcohol intake[20, 24]. Some of variation is reflective of how the geographical location influences the diet[22]. The version of aMED considered for use in this study was the one created by Fung et al. since it does not penalize dairy intake[24]. It is scored by giving one point each for intake greater than the median intake for vegetables, fruits, nuts, legumes, fish and monounsaturated fats to saturated fats ratio and one point for intake less than or equal to the median intake of red or processed meats. Total amount of points possible is 8[24].

The KIDMED was developed based on the aMED to assess the diet of children and adolescents in Spain[22]. The KIDMED index was developed based on the principle components of the aMED but also took into account things that undermine the Mediterranean dietary pattern. Possible points range from 0 to 12 points with one point given if the subject consumed a fruit or fruit juice every day, another point if they had a second fruit, had a vegetable regularly once a day, another point for more than one serving of vegetable per day, consumed fish at least 2-3 times per week, eats pulses more than once per week, consumed pasta or rice at least 5 times per week, had cereal or grains for breakfast, consumed nuts at least 2-3 times per week, used olive oil at home, had a dairy product for breakfast and consumed 2 yogurt or cheese (40g) daily. One point is subtracted if they went to a fast food restaurant more than once a week, consumed

commercially baked goods or pastries for breakfast, and if they consumed candy several times per day[22].

The YHEI was based on the Healthy Eating Index-2010 (HEI-2010) but focuses more on dietary issues of older children and adolescents. It focuses more on total fat, saturated fats, trans fat, sodium, added sugars and fiber along with some behavioral components like eating certain meals and eating dinner with family[17]. The YHEI score ranges from 0 to 100 points and includes 13 components. The components include whole grains, vegetables, fruits, dairy, meat ratio, snack foods, soda and sweetened beverages, multivitamin use, margarine and butter intake, fried foods outside the home, visible animal fat intake, if they eat breakfast, and if they eat dinner with family[17].

The RFS score was developed in 2000 by Kant et al. and was based on items included in a 62-item food frequency questionnaire[25]. They used 23 items from that questionnaire to create the RFS based on foods emphasized by current dietary guidelines. Those foods included fruits, vegetables, whole grains, lean meats or meat alternatives, and low fat dairy products. Each food item reportedly consumed at least once per week was given 1 point for a total of 23 points possible. The other items on the food frequency questionnaire did not meet the criteria to be included in the score[25].

Like the aMED, there are various versions of the DASH diet score, but the one most frequently used in literature is the one established by Fung et al in 2008[6, 26]. It is based on a substantial amount of research that showed an association between diets consistent with a DASH dietary pattern and a significantly lower blood pressure. The score consists of eight components including vegetables, fruits, nuts and legumes, low-fat dairy products, whole grains, sodium, sweetened beverages and red and processed meats[6, 26]. Total points range from 8 to 40 points[26].

Disease Risk and Diet Quality Scores

There have been a number of studies that have looked at the association between diet quality score and the risk of various chronic diseases and overall chronic disease risk.

McCullough et al. looked at the AHEI and RFS compared to the HEI to determine which predicted chronic disease risk best. They found that the AHEI is almost twice as predictive of CVD than the HEI with reducing the risk of CVD by 28% in women (RR 0.72; CI: 0.60-0.86)[5]. The McCullough study did not find a significant association between higher AHEI scores and cancer risk, but higher AHEI scores have been associated with a reduced risk of specific cancers including the risk of estrogen receptor-negative breast cancer[24]. The RFS was not predictive of major disease risk or CVD risk in women[5].

Another study looked at HEI, AHEI-2010, RFS and aMED scores and the association with beast cancer. They looked at the subjects in the Nurses' Health Study who completed food frequency questionnaires starting in 1986. There was no association between the diet quality scores and overall postmenopausal breast cancer risk. However, when examined based on estrogen receptor positive (ER+) and estrogen receptor negative (ER-) breast cancer, there was an inverse association between AHEI-2010 (RR 0.78, CI: 0.59-1.04, p=0.001), RFS (RR 0.79, CI: 0.51-0.94, p=0.003), and aMED (RR 0.79, CI: 0.60-1.03, p=0.03) scores and ER- cases of breast cancer; there was no association between any diet quality score and ER+[24].

One study looked at AHEI-2010 scores and the association with chronic obstructive pulmonary disease (COPD)[27]. They included women from the Nurses' Health Study and men from the Health Professionals Follow-up Study for a total of 73,228 females and 47,026 males. They used food frequency questionnaires to calculate AHEI-2010 scores. Those with higher quality diets (higher AHEI-2010 scores) were 33% less likely to develop COPD than those that ate the least healthy diets (HR 0.67, CI: 0.53-0.85). There was no association between AHEI-2010 scores and incidence of asthma[27].

A recent meta-analysis showed the an association of the highest diet quality scores of the HEI, AHEI and DASH are significantly associated with a reduced risk of all-cause mortality by 22% (RR 0.78, CI: 0.76-0.80, $p<0.005$), CVD by 22% (RR 0.78, CI: 0.75-0.81, $p<0.005$), cancer by 15% (RR 0.85, CI: 0.82-0.88, $p<0.005$), and risk of type 2 diabetes by 22% (RR 0.78, CI: 0.72-0.85, $p<0.005$); no significant association was observed with Parkinson's disease[6].

Higher AHEI-2010 scores were inversely associated with the risk of COPD, CVD, coronary heart disease (CHD), diabetes, total cancer risk and risk of mortality from chronic disease in women[18, 21, 27]. Chiuve et al. looked at the HEI and the AHEI-2010 to examine which was more strongly associated with disease risk. The AHEI-2010 was more strongly associated with risk for CHD and diabetes than HEI ($p_{difference}=0.002$ and <0.001 respectively). Higher AHEI-2010 scores were associated with a 19% reduction in risk for chronic disease ($p_{trend}<0.001$), a 31% reduction of risk for CHD ($p_{trend}<0.001$), and a 33% reduction in risk of diabetes ($p_{trend}<0.001$)[18].

Harmon et al also examined AHEI-2010 scores along with HEI-2010, aMED and DASH diet scores in a multiethnic US population. They looked at the association between higher diet quality scores and mortality from CVD and cancer. They found an association between higher scores and a decreased risk of mortality from all causes, CVD and cancer in adult women. The AHEI-2010 and aMED showed the largest reduction in risk for all-cause mortality (HR 0.78, CI: 0.74-0.82) and CVD (HR 0.84, CI: 0.68-0.83) for women; the aMED showed the largest reduction in risk for cancer (HR 0.84, CI: 0.76-0.92)[19].

Both diet quality indices (AHEI and AHEI-2010) are highly correlated with each other as they share many of the same or similar components including vegetables, fruits, nuts and soy/legumes trans fat, and polyunsaturated fats[6, 18, 28]. Similarly, there have been multiple studies looking at multiple scoring indices and how well they correlate. Reedy et al. looked at the HEI-2010, AHEI-2010, aMED and DASH diet scores and how well they predicted all-cause mortality, CVD and cancer mortality. They found that higher index scores were associated with a 12-28%

decreased risk (HEI-2010 HR: 0.77, CI: 0.74-0.80; AHEI-2010 HR: 0.76, CI: 0.74-0.79; aMED HR: 0.76, CI: 0.73-0.79; DASH HR: 0.78, CI 0.73-0.79)[29]. Overall, diet quality scores have been associated with many different chronic diseases, and eating higher quality diets, have been associated with a reduction in risk for various chronic diseases including CVD/CHD, cancer, COPD and diabetes.

In addition to chronic diseases, a study looked at diet quality and bone health. This study looked women in the Women's Health Initiative (WHI) observational study and compared their HEI-2010, aMED and DASH scores to the risk of fracture. The study found no significant association between the HEI-2010 and DASH diet scores with risk of bone fraction (HR 0.87, CI: 0.75-1.02 and HR 0.89, CI: 0.75-1.06 respectively). There was an association between higher aMED scores and risk for hip fracture but there was not an association between higher aMED scores and overall risk for bone fracture (HR 0.80, CI: 0.66-0.97 and HR 1.01, CI: 0.95-1.07 respectively)[30].

There have been some studies looking at diet quality indices and their reliability and validity for measuring diet quality in adults and adolescents[13, 21, 31]. One study looked specifically at the validity and reliability of the HEI-2010 by comparing it to 4 menus established to represent very high-quality diets (scores ranged 87.8 to 100 points out of 100 possible points), comparing it to NHANES analyses (average HEI-2010 score 49.9 $\pm$ 0.5) and internal consistency was measured by Cronbach's coefficient α (0.68)[31].

Methods

Overview

This is a secondary analysis of a previous 12-month randomized control trial at the Creighton Osteoporosis Center. The original study was designed to assess the impact of dairy foods on weight gain. It included 274 adolescent girls aged 13 and 14 years old who were at least 1.5 years past menarche. The inclusion criteria included: 13-14 years old; habitual dietary calcium intake of less than or equal to 600 mg/d; willingness to increase dietary calcium intake (low fat milk or yogurt) for one year; and body mass index (BMI) greater than the 50th percentile and less than the 98th percentile for age and sex on the CDC Growth curves. The exclusion criteria included: menarche before 10 years old; history of lactose intolerance or milk allergy; dieting behavior with weight loss great than 10 pounds in the last 3 months; weight over 300 pounds; metal in the skeleton (i.e. pins, rods) due to dual-energy X-ray absorptiometry (DXA) limitations; current pregnancy; chronic disease or disorders like diabetes, polycystic ovarian syndrome, thyroid disease, eating disorders, seizures or cancer; and use of steroids, contraceptives, anti-depressants, Accutane or high dose vitamin A or weight reducing or seizure medications. The participants were recruited from the community with an extensive effort to recruit girls from all racial and ethnic groups in the community.

Assessment of Dietary Intake

Dietary intake was determined by three multiple pass dietary recalls provided from participants at baseline, 3, 6, 9 and 12 months. The multiple pass method involves the participants providing a quick list of the foods they have eaten in the last 24 hours and then probing for food they may have forgotten. They are then asked more probing questions about timing, brand and amount of foods. Lastly, at the end of the interview, the information is repeated back to the participants and they are given a change to fix any mistakes or provide any thing else they may have forgotten. This is the same method used in collecting dietary intake for NHANES[32]. The

recalls were obtained on one weekend day and two week days. The participants were taught how to estimate portions sizes by food models prior to the first recall. The nutrient information was recorded for each food record for each participant and was then analyzed using the Nutrition Data System for Research, which is support and updated by the Nutrition Coordinating Center at the University of Minnesota.

Calculation of AHEI

Daily average nutrient consumption was then calculated for each of the components of the AHEI and AHEI-2010 for each participant by averaging the intakes from each food record collected. The categories used to calculate the AHEI score include vegetables, fruits, nuts and soy, cereal fiber, white meat to red meat ratio, polyunsaturated fat to saturated fat ratio and trans fat score. Categories of the AHEI not used to calculate the scores in this study include alcohol and daily MVI use due to the ages of participants and available data. With the elimination of these categories, possible scores ranged from 0 to 70 points with higher scores representing higher quality diets. Each component could contribute a maximum of 10 points; intermediate intakes were scored proportionately (Table 1). How foods from the food frequency questionnaire were classified can be found in Table 2.

Table 1: Calculation of the AHEI Score

AHEI component:	**Criteria for minimum score of 0 points**	**1***	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Criteria for maximum score of 10 points**
Vegetable, servings per day	0 servings/day	0.10 - 0.55	0.56 - 1.11	1.12 - 1.67	1.68 - 2.20	2.21 - 2.76	2.77 - 3.32	3.33 - 3.88	3.89 - 4.44	4.45 - 4.99	≥5 servings/day
Fruits, servings per day	0	0.01 - 0.44	0.45 - 0.90	0.91 - 1.35	1.36 - 1.80	1.81 - 2.25	2.26 - 2.70	2.71 - 3.15	3.16 - 3.58	3.59 - 3.99	≥4
Nuts and soy, servings per day	0	0.01 - 0.10	0.11 - 0.21	0.22 - 0.32	0.33 - 0.43	0.44 - 0.54	0.55 - 0.65	0.66 - 0.76	0.77 - 0.87	0.88 - 0.99	≥1
Cereal fiber, grams per day	0	0.01 - 1.66	1.67 - 3.33	3.34 - 5.0	5.10 - 6.73	6.74 - 8.40	8.41 - 10.0	10.10 - 11.76	11.77 - 13.43	13.44 - 14.99	≥15
White to red meat ratio	0	0.01 - 0.44	0.45 - 0.90	0.91 - 1.35	1.36 - 1.80	1.81 - 2.25	2.26 - 2.70	2.71 - 3.15	3.16 - 3.58	3.59 - 3.99	White:red meat ratio of ≥4
Polyunsat to saturated fat ratio score	≤0.1	0.11 - 0.19	0.20 - 0.29	0.30 - 0.39	0.40 - 0.49	0.50 - 0.59	0.60 - 0.69	0.70 - 0.79	0.80 - 0.89	0.90 - 0.99	≥1
Trans fat score (% of energy)	≥4	3.99 - 3.60	3.59 - 3.21	3.20 - 2.81	2.80 - 2.41	2.40 - 2.01	2.0 - 1.61	1.60 - 1.21	1.20 - 0.85	0.85 - 0.51	≤0.5
Total score (range)		0-70**									

*Intermediate intakes are scored proportionally between 0 and 10.
**Excludes alcohol intake and MVI use so there are 70 maximum points possible.

Table 2: Food classifications

Component	CUORC database foods included	Scoring index
Vegetables, servings per day	Dark-green vegetables Deep-yellow vegetables Tomato Vegetable juice Other vegetables	AHEI AHEI-2010
Fruits, servings per day	Citrus fruit Fruit excluding citrus fruits	AHEI AHEI-2010
Nuts, soy and legumes, servings per day	Nuts and seeds Nut and seed butters Meat alternatives Cooked dried beans	AHEI AHEI-2010
Cereal fiber, grams per day	Grains, Flour and Dry Mixes - Some Whole Grain Grains, Flour and Dry Mixes - Refined Grain Loaf-type Bread and Plain Rolls - Some Whole Grain Loaf-type Bread and Plain Rolls - Refined Grain Other Breads (quick breads, corn muffins, tortillas) - Some Whole Grain Other Breads (quick breads, corn muffins, tortillas) - Refined Grain Crackers - Some Whole Grain Crackers - Refined Grain Pasta - Some Whole Grain Pasta - Refined Grain Ready-to-eat Cereal (not presweetened) - Some Whole Grain Ready-to-eat Cereal (not presweetened) - Refined Grain Ready-to-eat Cereal (presweetened) - Some Whole Grain Ready-to-eat Cereal (presweetened) - Refined Grain Cakes, Cookies, Pies, Pastries, Danish, Doughnuts and Cobblers - Some Whole Grain Cakes, Cookies, Pies, Pastries, Danish, Doughnuts and Cobblers - Refined Grain Snack Bars - Some Whole Grain Snack Bars - Refined Grain Snack Chips - Some Whole Grain Snack Chips - Refined Grain Baby Food Grain Mixtures Non-grain Flour and Similar Grains, Flour and Dry Mixes - Whole Grain Loaf-type Bread and Plain Rolls - Whole Grain Other Breads (quick breads, corn muffins, tortillas) - Whole Grain Crackers - Whole Grain Pasta - Whole Grain Ready-to-eat Cereal (not presweetened) - Whole Grain Ready-to-eat Cereal (presweetened) - Whole Grain Cakes, Cookies, Pies, Pastries, Danish, Doughnuts and Cobblers - Whole Grain Snack Bars - Whole Grain Snack Chips - Whole Grain Popcorn Flavored Popcorn	AHEI
White to red meat ratio	White meat: Game Poultry Lean poultry Fried chicken Red meat: Beef Lean Beef Veal	AHEI

	Lean veal Lamb Lean lamb Fresh pork Lean fresh pork Cured pork Lean cured pork Cold Cuts and Sausage Lean Cold Cuts and Sausage Organ meats Baby Food Meat Mixtures Meat-based Savory Snack	
Polyunsaturated fat to saturated fat ratio score	Total saturated fat Total polyunsaturated fats Polyunsaturated to Saturated Fat Ratio	AHEI
Trans fat score	Total Trans-Fatty Acids (TRANS) (g)	AHEI AHEI-2010
Whole grains, grams per day	Grains, Flour and Dry Mixes - Whole Grain Loaf-type Bread and Plain Rolls - Whole Grain Other Breads (quick breads, corn muffins, tortillas) - Whole Grain Crackers - Whole Grain Pasta - Whole Grain Ready-to-eat Cereal (not presweetened) - Whole Grain Ready-to-eat Cereal (presweetened) - Whole Grain Cakes, Cookies, Pies, Pastries, Danish, Doughnuts and Cobblers - Whole Grain Snack Bars - Whole Grain Snack Chips - Whole Grain Popcorn Flavored Popcorn	AHEI-2010
Red and processed meats, servings per day	Beef Lean beef Veal Lean veal Lamb Lean lamb Fresh pork Lean fresh pork Cured pork Lean cured pork Cold Cuts and Sausage Lean Cold Cuts and Sausage Organ meats Baby Food Meat Mixtures Meat-based Savory Snack	AHEI-2010
Sugar and sweetened beverages and juice, servings per day	Sweetened soft drinks Sweetened fruit drinks Sweetened tea Sweetened coffee Sweetened coffee substitutes Sweetened water Nondairy-based Sweetened Meal Replacement/Supplement	AHEI-2010
Long chain fats, miligrams per day	PUFA 20:5 (eicosapentaenoic acid [EPA]) (g) PUFA 22:6 (docosahexaenoic acid [DHA]) (g)	AHEI-2010
Polyunsaturated fatty acids (PUFA), % of energy	Total polyunsaturated fats	AHEI-2010
Sodium, grams per day	Sodium (g)	AHEI-2010

Calculation of AHEI-2010

The categories used to calculate the AHEI-2010 included: vegetables, fruits, nuts and legumes, whole grains, red and processed meats, sugar sweetened beverages and fruit juices, trans fats, long-chain fats (EPA and DHA), polyunsaturated fats and sodium. The alcohol category was excluded due to the ages of the participants. With the elimination of the alcohol category, total possible scores ranged from 0 to 100 points with higher scores representing higher quality diets. Each component could contribute a maximum of 10 points; intermediate intakes were scored proportionately (Table 3).

Table 3: Calculation of the AHEI – 2010 Score

AHEI – 2010 components	**Criteria for minimum score of 0 points**	**1***	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Criteria for maximum score of 10 points**
Vegetables, servings per day	0 servings/day	0.01 - 0.55	0.56 - 1.11	1.12 - 1.67	1.68 - 2.20	2.21 - 2.76	2.77 - 3.32	3.33 - 3.88	3.89 - 4.44	4.45 - 4.99	≥5 servings/day
Fruits, servings per day	0	0.01 - 0.44	0.45 - 0.90	0.91 - 1.35	1.36 - 1.80	1.81 - 2.25	2.26 - 2.70	2.71 - 3.15	3.16 - 3.58	3.59 - 3.99	≥4
Nuts and legumes servings per day	0	0.01 - 0.11	0.12 - 0.22	0.23 - 0.33	0.34 - 0.44	0.45 - 0.55	0.56 - 0.66	0.67 - 0.77	0.78 - 0.88	0.89 - 0.99	≥1
Whole grains, grams per day Women	0	0.01 - 8.35	8.36 - 16.68	16.69 - 25.01	25.02 - 33.34	33.35 - 41.67	41.68 - 50.00	50.01 - 58.33	58.34 - 66.66	66.67 - 74.99	75
Red/processed meat, servings per day	≥1	0.99 - 0.89	0.88 - 0.78	0.77 - 0.67	0.66 - 0.56	0.55 - 0.45	0.44 - 0.34	0.33 - 0.23	0.22 - 0.12	0.11 - 0.01	0
Sugar Sweetened beverages and fruit juices, servings per day	≥1	0.99 - 0.89	0.88 - 0.78	0.77 - 0.67	0.66 - 0.56	0.55 - 0.45	0.44 - 0.34	0.33 - 0.23	0.22 - 0.12	0.11 - 0.01	0
Trans fat score, % of energy	≥4	3.99 - 3.60	3.59 - 3.21	3.20 - 2.81	2.80 - 2.41	2.40 - 2.01	2.00 - 1.61	1.60 - 1.21	1.20 - 0.85	0.85 - 0.51	≤0.5
Long-chain (n-3) fats (EPA=DHA), mg per day	0	0.01 - 27.75	27.76 - 55.53	55.54 - 83.31	83.32 - 111.09	111.1 - 138.87	138.88 - 166.65	166.66 - 194.43	194.44 - 222.21	222.22 - 249.99	250
PUFA, % of energy	≤2	2.01 - 2.87	2.88 - 3.76	3.77 - 4.65	4.66 - 5.54	5.55 - 6.43	6.44 - 7.32	7.33 - 8.21	8.22 - 9.10	9.11 - 9.99	≥10
Sodium, mg per day	≥3337	3336.99 - 3089.78	3089.77- 2842.56	2842.55- 2595.34	2595.33- 2348.12	2348.11- 2100.9	2100.89- 1853.68	1853.67- 1606.46	1606.45- 1359.24	1359.23- 1112.01	≤1112
Total score (range)	0-100**										

*Intermediate intakes are scored proportionally between 0 and 10.
**Excludes alcohol intake so 100 maximum points possible.

Components of AHEI and AHEI-2010

The different categories were included in both AHEI and AHEI-2010 due to previous research showing an association of reduced risk for various chronic diseases; therefore, these categories contributed more points to the overall score for higher intake. Vegetable, fruit, whole grain, nuts and legumes, fish, and greater polyunsaturated fat intake over saturated fat intake has been associated with a reduction in risk for CVD. Some categories have been associated with a reduction in the risk for cancers including vegetable, fruit, and whole grain intake. Vegetable, especially green leafy vegetables, and whole grain intake has been associated with lower risks of developing diabetes. Fatty fish intake of at least one serving per week has been shown to be protective against fatal cardiac arrhythmias and sudden cardiac events; associations with other risk reduction for chronic disease are not as strong[5, 18, 19, 23].

Other categories showed an association for increased risk with higher intakes; therefore, these categories contributed more points towards the overall score with limited or lower intake. Intake of sugar-sweetened beverages, red and processed meats, trans fats, and high sodium have all been associated with an increased risk for CVD and all but high sodium intake have been associated with an increased risk for diabetes. Sugar sweetened beverages and fruit juices have been associated with an increased risk of weight gain and obesity. Red and processed meats and high sodium intake have been associated with increased risk of some cancers[5, 18, 19, 23].

Some foods that would typically be classified in the categories were excluded from those categories for various reasons. Potatoes were excluded from the vegetable category as they have not been associated with any risk reduction and higher intakes are associated with increased risk for diabetes. Fruit juice was excluded from the fruit category as it has not been associated with a decreased risk of CVD or cancer and may actually increase the risk of diabetes. Also, limited juice intake is recommended for this age group by the American Academy of Pediatrics (AAP) to help prevent dental carries and excessive calorie intake. Avocadoes were also excluded from the fruit group due to the natural high amount of saturated fat[18, 33].

Quintile Scores

The distribution of scores for AHEI was then compared to scores that have been associated with breast cancer risk[23]. Similarly, the distribution of scores for AHEI-2010 was compared to scores that have been associated with COPD, stroke, CVD, CHD, and diabetes[18, 27]. In the Fung study, it showed for adults who scored between 35.85-70.0 points to be protective against ER- breast cancer[23]. Likewise, AHEI-2010 scores between 52.8-100.0 points were protective against COPD and stroke[18, 27]. Similarly, those who scored between 40.2-100.0 points, as assessed by the AHEI-2010, were protective against CVD and major chronic disease[18]. Lastly, those that scored between 27.6-100.0 on the AHEI-2010 were protective against CHD and diabetes[18].

Statistical Analysis

Descriptive statistics were used to describe the number of food records, daily consumption and scores of the participants. Means and standard deviations were used to describe continuous data. Frequency and percentages were used to describe the categorical data. Statistical analysis was preformed using SPSS.

Results

Baseline Demographics

The number of participants included in this study was 273; all participants were females aged 13-14 years old. The mean number of food records was 14.51 ±1.72 with 17 being the maximum number of food records recorded. The total average energy intake was 1695.48 ± 354 kcals/day. There was no difference in the distribution of scores between the control group and the dairy intervention group for both AHEI and AHEI-2010.

Alternate Healthy Eating Index Scores

The average daily consumption of the various components of the AHEI is presented in Table 4. The mean AHEI score of the participants was 25.99 ± 6.13. Intake of fruits, vegetables and white to dark meat ratio contributed the least amount of points to the total score (2.18, 1.71, and 1.89 points respectively) while the total dietary fiber and the ratio of polyunsaturated fats to saturated fats contributed the most amount of points to the total score (7.12 and 6.15 points respectively).

Table 4: Mean daily consumption and scores of AHEI components

Component:	Mean	Standard deviation	Minimum	Maximum	Mean Score
Vegetable (servings/day)	0.93	± 0.48	0.00	3.36	2.18 ± 0.91
Fruit (servings/day)	0.55	± 0.53	0.00	3.65	1.71 ± 1.24
Nuts and soy (servings/day)	0.32	± 0.48	0.00	5.29	3.14 ± 2.82
Total dietary fiber (grams/day)	11.23	± 3.00	5.16	22.87	7.12 ± 1.60
Ratio of white to dark meat	0.64	± 0.86	0.00	9.41	1.89 ± 1.61
Polyunsaturated to saturated fat ratio	0.66	± 0.19	0.21	1.54	6.15 ± 1.81
Total trans fatty acids (grams/day)	2.74	± 1.08	0.37	7.26	3.80 ± 2.33
Total energy intake (kcals/day)	1695.48	± 354.00	805.52	2740.04	25.99 ± 6.13

Alternate Healthy Eating Index-2010 Scores

The average daily consumption of the various components of AHEI-2010 is presented in Table 5. The mean AHEI-2010 score of the participants was 26.59 ± 7.86. Intake of polyunsaturated fat and trans fat contributed the most amount of points to the total score (5.56 and 3.80 points respectively). High intake of red and processed meats and low fiber intake contributed the least amount of points to the total score (0.61 and 1.23 points respectively).

Table 5: Mean daily consumption and scores of AHEI-2010 components

Component	Mean	Standard deviation	Minimum	Maximum	Mean Scores
Vegetables (servings/day)	0.93	± 0.48	0.00	3.36	2.18 ± 0.91
Fruit (servings/day)	0.55	± 0.53	0.00	3.65	1.17 ± 1.24
Nuts and legumes (servings/day)	0.32	± 0.48	0.00	5.29	3.14 ± 2.82
Whole grains (grams/day)	0.41	± 0.43	0.00	3.48	1.23 ± 0.86
Red and processed meats (servings/day)	1.79	± 0.88	0.00	6.94	0.61 ± 1.71
Sugar sweetened beverages and fruit juice (servings/day)	0.89	± 0.69	0.00	3.29	3.45 ± 3.45
Trans fat score (% energy)	2.74	± 1.08	0.37	7.26	3.80 ± 2.33
Long-chain fats (mgday)	6.52	± 1.67	3.16	12.24	1.86 ± 1.59
Polyunsaturated fatty acids (% energy)	12.73	± 4.11	3.42	29.71	5.56 ± 1.81
Sodium (grams/day)	2.76	± 0.60	1.23	4.64	3.04 ± 2.07
Total energy intake (kcals/day)	1695.48	± 354.00	805.52	2740.04	26.59 ± 7.86

Quintile Scores

When comparing the AHEI scores to the quintile scores associated with chronic diseases in adult populations, only 8% of the participants had scores that were protective against breast cancer (Table 6). Of the AHEI-2010 scores, only 1 participant (0.4% of the participants) had a score that was protective against COPD and stroke; 6% of the participants had scores that were protective against CVD and major chronic disease. Lastly, 48% of the participants had AHEI-2010 scores that were protective against CHD and diabetes (Table 7).

Table 6: AHEI quintiles

AHEI Component	Quintile Score Range									
	Q1		Q2		Q3		Q4		Q5	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Vegetables	255	93.41	17	6.23	0	0	1	0.37	0	0
Fruits	254	93.04	10	3.66	5	1.83	3	1.10	1	0.37
Nuts and soy	38	13.92	68	24.91	40	14.65	51	18.68	76	27.84
Cereal fiber	0	0	0	0	0	0	11	4.03	262	95.97
White to red meat ratio	140	51.28	80	29.30	39	14.29	7	2.56	7	2.56
Polyunsat to sat fat ratio	12	4.40	41	15.02	55	20.15	165	60.44	0	0
Trans fat score	202	73.99	44	16.12	15	5.49	0	0	12	4.40
Total	89	32.60	99	36.26	63	23.08	22	8.06	0	0

Table 7: AHEI-2010 quintiles

AHEI-2010 Component	Quintile Score Range									
	Q1		Q2		Q3		Q4		Q5	
	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage
Vegetables	267	97.8	5	1.83	0	0	1	0.37	0	0
Fruits	218	79.85	36	13.19	10	3.66	5	1.83	4	1.47
Nuts and legumes	106	38.83	40	14.65	30	10.99	21	7.69	76	27.84
Whole grains	199	72.89	0	0	54	19.78	16	5.86	4	1.47
Red and processed meats	240	87.91	12	4.40	12	4.40	2	0.73	7	2.56
Sugar and sweetened bevs and fruit juice	102	37.36	16	5.86	30	10.99	71	26.01	54	19.78
Trans fat score	246	90.11	0	0	15	5.49	7	2.56	5	1.83
Long chain fats	253	92.67	11	4.03	4	1.47	2	0.73	3	1.10
PUFA	34	12.45	43	15.75	60	21.98	100	36.63	36	13.19
Sodium	123	45.05	75	27.47	64	23.44	10	3.66	1	0.37
Total	142	52.01	115	42.12	15	5.49	1	0.37	0	0

Discussion

The research is showing more evidence that diet during specific periods of development can alter the risk for various chronic diseases. The results from our study show a very large area for improvement in the quality of diet adolescent girls in the mid-west are consuming. Based on the diet quality indexes used in this study, only between 0.4 to 6% of participants were consuming diets that are associated with lower risks of chronic diseases like cancer, COPD, CVD and stroke. These results are consistent with the results seen in a couple other studies using diet quality scores to assess adolescent and children's' diets[13, 16]. A study in Turkey of 1,104 adolescents that used the HEI score found that no participant scored high enough to classify as having a "good diet;" (>80 points was considered a "good diet")[13]. The average score was 51.5 $\pm$ 9.07 and the average score for females was 51.8 $\pm$ 8.92 out of a possible 100 points; this is similar to our results in that the majority of our participants also had scores that reflected poor diet quality[13].

Similar results and scores were seen between the two scoring indexes as they share many similar components including vegetables, fruits, nuts and soy, red meat consumption, examining saturated and unsaturated fats, and trans fat score[6, 18, 28]. Variation between the scores are related to the difference in components included, which for the AHEI and AHEI-2010 include cereal fiber versus whole grains, added sugars from sweetened beverages and fruit juice, and sodium intake. The differences in components used in calculating each score reflect difference seen in healthy dietary patterns and updates in recommendations over the years from new research.

Both of the diet quality indexes designed to assess adolescent diets (YHEI and KIDMED) not only gave points for foods recommended but also deducted points for foods to be limited in this age group like sweetened beverages and snacks high in sodium and fat[16, 17, 22]. While these indices may be able to assess diet quality, they may or may not reflect a decreased risk for chronic diseases as seen in the Hurley et al. study[16]. This is an area for further research to

compare not only the indices designed to assess adolescent diets but also applying other indices to adolescents to assess the risk of chronic diseases.

Obesity and Federal Programs

In addition to diet quality, those with higher diet quality scores were less likely to be smokers, more physically active, lower BMI, have higher levels of education and more likely to use postmenopausal hormones in the studies conducted by Fung, et al., Chiuve et al. and Haring et al.[18, 24, 30]. Not all of these are applicable to our population (e.g. level education and postmenopausal hormone use). In addition, one of the inclusion criteria for the dairy intervention study was their BMIs be greater then the median for their age group. This alone is a risk factor for chronic disease and in addition our subjects had over poor diet quality (another risk factor). By improving their diet quality, they are more likely to also decrease their weight; therefore decreasing their risk for chronic diseases later in life.

The Dietary Guidelines for Americans was developed to help reduce the risk for chronic diseases. The guidelines influence various federal policies and programs. The most recent guidelines are the Dietary Guidelines for Americans 2015 and they focus on the shift from looking at individual nutrients and foods to overall diet pattern. The new recommendations include 5 overall recommendations including 1) following a healthy eating pattern across the lifespan; 2) focus on variety, nutrient density and amount; 3) limit calories from added sugars and saturated fats and reduce sodium intake; 4) shift to healthier food and beverage choices; and 5) support healthy eating patterns for all[15]. Many of these things were examined and assess through the AHEI and AHEI-2010. As our results show, the participants did not meet the guidelines as they did not following a healthy eating pattern with the mean scores (AHEI: 25.99 and AHEI-2010: 26.59) reflecting poor diet quality. They also consumed diets high in sodium exceeding the recommend amount of 2300 mg/day (they averaged 2760 mg/day).

There have been a couple of studies completed using dietary data gathered through the NHANES survey to help assess how successful the Dietary Guidelines have been[34, 35]. One looked at the vegetable and fruit consumption of children aged 2-19 years during the years 2009-2010[34]. They found that 77.1% consumed a fruit on any given day and 92% consumed a vegetable on any given day. When looking at the breakdown of what types of vegetable were consumed, 11% consumed green leafy vegetables, 75.1% consumed a red/orange vegetable, 53% consumed a starchy vegetable and 60.1% consumed other vegetables. Just looking at adolescents (12-19 years), 90% consumed a vegetable and 66.3% consumed a fruit on any given day[34].

The other study using NHANES data looked at the changes in beverage consumption trends in children aged 2-19 years over the years 2001-2010[35]. From 2001 to 2010, there was a decrease both in overall beverage consumption and beverage consumption in relation to energy intake. The percent of energy intake of total calorie intake decreased from 24.4% in 2001 to 21.1% in 2010 ($p<0.001$); total fluid intake (excluding water) also decrease from 32.0 oz to 27.9 oz ($p<0.001$)[35]. The total milk consumption did not change over the study period but there was a decrease in whole milk consumption (2.7% to 1.6% energy; $p<0.001$). Other decreases were seen in sugar-sweetened sodas (13.5% to 10.2% energy; $p<0.05$), fruit juices with added sugar (2.3% to 2.1% energy; $p<0.05$), and fruit flavored drinks (1.6% to 0.8% energy; $p<0.05$). While there was a decrease in some sweetened beverages, there was also an increase in other including sweetened coffees/teas, energy drinks, sports drinks, and unsweetened juices (total energy intake remained <1% though). There was an increase in low and no-calorie drinks as well from 0.2 oz to 1.3 oz per day[35].

These changes in beverage consumption trends and the prevalence of fruit and vegetable intake, may reflect of the recent focus on childhood obesity. The bigger focus on childhood obesity has resulted in some changes in some federal programs including the National School Lunch program. The changes have put an emphasis on increasing whole grains, fruits, vegetables and reducing sodium and empty calories, especially through added sugars as seen in the dietary

intake data from NHANES[34, 35]. The next step to take would be to look at how these changes have affected overall diet quality and the risk for chronic diseases.

Diet Quality Indexes Not Used

As discussed earlier, there are several diet quality scoring indices that have been developed and studied. Some of them were not feasible to use for this study, like the RFS, which is essentially a food frequency questionnaire or the YHEI and KIDMED that incorporated behaviors into the scores[17, 22, 25]. Some examples of behaviors included in these scores are frequency of fast/fried foods outside the home, skipping breakfast and eating dinner with family[17, 22]. These behaviors were not gathered as part of the dairy interventions study so we were unable to calculate these scores. The DASH diet score was not used due to various versions in the research and no standardized version[6].

Similarly, the aMED has several versions used in research. The original version of the score included a dairy group with 1 point given for intake less then the median and no points for intake equal to or greater then the median intake[36]. As our population was part of a dairy intervention study, the original aMED score created by Trichopoulou et al. was no appropriate so we use the modified version created by Fung et al. in 2005 to attempt to calculate the scores[23]. The aMED score was not used in this study due to various issues that we encountered while trying to calculate the scores for each participant. One challenge encountered when trying to calculate the score was it is based on less than and greater than or equal to median values; we did not have mean intake values for this age group to compare them to and comparing it to our own data would introduce bias into the scores. In addition, some of the median intakes were 0 servings per day whereas the means were greater than 0 servings per day. The aMED score could be useful in the future to look at and apply to adolescents' diets to assess disease risk, as the aMED has been strongly associated with heart disease[19-21, 23, 29].

The various diet quality indices may not be able to assess disease risk in adolescents yet, but they are effective tools to determine overall diet quality[13, 17]. There is a big opportunity and need for further research in this area for using the diet quality indices to assess chronic disease risk, especially with the high rates of childhood and adult obesity[3].

Limitations

There are several limitations with this study, first of all it is a secondary analysis of diary intervention study; however, there was no difference in scores between the control and diary intervention group. Therefore, the data had already been collected and did not include all the information needed to include each component of the indexes used (e.g. MVI use). They also did not have all the information that would have been needed to calculate other diet quality scores like the KIDMED and YHEI. We also did not have access to all the demographic information. The study also consisted of all girls from the mid-west and the result may not be reflective of all adolescents in the United States. As with most diet recalls and records, there is a chance of underreporting.

In addition to the limitations of it being a secondary analysis, the only available comparison for the scores of the adolescent girls are scores that have been associated with disease risk in adult populations. Since they were designed for adult populations, they included components not applicable to this age of population (e.g. alcohol consumption). The scores associated with disease risk from previous research can only show correlation between diet and chronic disease risk; causation is still unknown.

Strengths

A strength of this study includes the large sample size of 273 girls. Also, there was an extensive database of dietary intake that was collected using the multiple pass dietary record method, which reduces the chance for recall bias and is the same method used in the dietary

survey part of NHANES. A strength of diet quality scores is they account for the multidimensional characteristics of food and not just the individual nutrients contained in foods. Foods are not consumed in isolation and they interact with and can enhance each other. People are not typically deficient in just one nutrient; a deficiency of one nutrient is reflective of an overall poor diet[6, 15].

Conclusion

A majority of the participants in this study did not have diet quality scores that have been associated with a decreased risk for chronic diseases in adult populations. The overall diet quality in the participants was poor, which is similar to other results in research. In addition to poor diet quality, all the participants had BMI's greater than the median for their age putting them at even greater risk for chronic diseases in adulthood if they continue to be heavier. More research is showing that variations in diet during specific periods of growth and development can alter the risk for various chronic diseases. There is a great need to help improve the quality of adolescent girls diets'. Also, more research needs to be conducted before diet quality indexes can be used to help assess disease risk in adolescents.

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