Published in final edited form as:

Matern Child Health J. 2020 October ; 24(10): 1299–1307. doi:10.1007/s10995-020-02987-3.

Dietary Patterns, Physical Activity, and Socioeconomic Associations in a Midwestern Cohort of Healthy Reproductive-Age Women

Bronwyn S. Bedrick*, Ashley M. Eskew*, Jorge E. Chavarro†, Emily S. Jungheim*

*Department of Obstetrics and Gynecology, Division of Reproductive Endocrinology & Infertility, Washington University School of Medicine, St. Louis, MO

†Harvard T.H. Chan School of Public Health, Harvard University, Boston, MA

Abstract

Objective: To characterize dietary patterns and physical activity in a diverse cohort of Midwestern reproductive-age women and to determine associations between these lifestyle factors, socioeconomic factors, and obesity.

Methods: In this cross-sectional study, 185 women completed validated food frequency and physical activity questionnaires. Dietary patterns were identified through principal component analysis. Sociodemographic characteristics associated with dietary pattern adherence and physical activity participation were identified through linear regression. Associations between lifestyle factors and obesity were assessed through logistic regression.

Results: Two dietary patterns were identified: a “Prudent” pattern characterized by consumption of fruits, vegetables, olive oil, and nuts and a “Western” pattern including meat, refined carbohydrates, and high-calorie drinks. African-American women and women without a college degree were more likely to adhere to the Western dietary pattern than other women. Women in areas with higher socioeconomic deprivation had lower levels of physical activity, especially leisure-time exercise. Women who completed college participated in more leisure-time exercise and had less physically demanding occupations. Obesity was associated with increasing adherence to the Western dietary pattern in a dose-dependent fashion (aOR range: 2.68 to 4.33, 95% CI range: 0.69 to 16.61) but was not associated with adherence to the Prudent pattern (aOR range:

Terms of use and reuse: academic research for non-commercial purposes, see here for full terms. <https://www.springer.com/aam-terms-v1>

Corresponding Author: Emily S. Jungheim, MD, MSCI, 676 North St. Clair Street, Suite 2310, Chicago, IL 60611, (312) 926-8244, Emily.jungheim@gmail.com.

Statement of authors' contributions:

BSB, AEM, JEC, and ESJ designed and conducted research. BSB, AEM, and ESJ analyzed data and wrote the paper. ESJ has primary responsibility for the final content. JEC provided essential material. All authors read and approved the final manuscript.

Conflict of Interest:

Bronwyn S. Bedrick: No conflicts of interest

Ashley M. Eskew: No conflicts of interest

Jorge E. Chavarro: No conflicts of interest

Emily S. Jungheim: No conflicts of interest

Publisher's Disclaimer: This Author Accepted Manuscript is a PDF file of an unedited peer-reviewed manuscript that has been accepted for publication but has not been copyedited or corrected. The official version of record that is published in the journal is kept up to date and so may therefore differ from this version.

0.46 to 1.06, 95% CI range: 0.13 to 3.41). Increased physical activity was associated with reduced odds of obesity (aOR range: 0.28 to 0.30, 95% CI range: 0.10 to 0.93).

Conclusions for practice: This study highlights dietary and physical activity patterns associated with obesity in reproductive-age women. Lifestyle interventions focused on minimizing consumption of the Western diet and increasing physical activity may provide an opportunity to reduce obesity among reproductive-age women.

Keywords

Obesity; dietary pattern; physical activity; women of childbearing age; public health

Introduction

Over the past several decades, there has been a dramatic increase in the rate of hypertensive diseases, gestational diabetes, and other diseases of pregnancy in the United States. These diseases contribute to increased obstetrical complications and to adverse long-term outcomes for women and their children (American College of Obstetricians and Gynecologists' Committee on Practice Bulletins, 2015, 2018, 2019).

Evidence demonstrates that diet and exercise habits before pregnancy, irrespective of maternal BMI, influence diseases of pregnancy and newborn health (Bao et al., 2014; Raghavan et al., 2019; Stephenson et al., 2018; Zhang, Schulze, Solomon, & Hu, 2006). For example, diets high in red and processed meats are associated with increased risk of gestational diabetes (Bao et al., 2014; Zhang et al., 2006), whereas diets high in fruits, vegetables, and whole grains are associated with lower risks of hypertensive diseases (Raghavan et al., 2019) and preterm birth (Tan et al., 2015). Additionally, pre-pregnancy and early pregnancy physical activity are associated with decreased risk of gestational diabetes (Starling et al., 2017).

While pregnancy offers opportunity to optimize maternal health, interventions to improve nutrition and exercise during pregnancy have minimal effect on maternal and fetal outcomes (Stephenson et al., 2018; Tan et al., 2015). Therefore, we must identify effective interventions to improve pre-conception lifestyle behaviors (Hanson et al., 2017; Stephenson et al., 2018). Since approximately 45% of pregnancies in the United States are unintended (Finer & Zolna, 2016), an emphasis should be placed on optimizing the health of all reproductive-age women, not just women planning pregnancy.

To develop effective interventions, we need to understand dietary and exercise behaviors of reproductive-age women. Dietary patterns vary by age, gender, and geography (Cusack, Smit, Kile, & Harding, 2017; Hajjar & Kotchen, 2003; Kant & Graubard, 2018; Trivedi et al., 2015). For example, American adults in the Midwest and South have significantly lower levels of folate and iron consumption than adults in the Northeast or West (Kant & Graubard, 2018), and rural adults consume higher quantities of sugar-sweetened beverages and lower quantities of fruit, vegetables, and fiber than urban adults (Trivedi et al., 2015). While there is increasing interest in the relationship between dietary patterns and disease, few studies have examined dietary patterns in healthy, reproductive-age women in the

United States. Furthermore, while regional analysis allows for precise description of local dietary patterns, they obfuscate rural-urban differences and local customs.

In this study, we had three aims. First, we aimed to describe dietary patterns and physical activity levels in healthy, reproductive-age women in a large Midwestern city. Second, we aimed to identify socioeconomic and demographic factors associated with adherence to dietary patterns and physical activity. Finally, we aimed to determine the association between diet, physical activity, and obesity in this population.

Methods

Study Design and Participants:

This study was a cross-sectional study of reproductive-age women in the St. Louis, Missouri metropolitan area. Women were recruited from the local community between May 2014 and May 2018. Women were eligible for the study if they were between 18 and 44 years of age and had regular menstrual cycles. Women were excluded if they were pregnant, had a major chronic disease (e.g., diabetes mellitus, hypertension, autoimmune disease), or had a history of ovarian surgery or infertility. This study was approved by the Institutional Review Board at Washington University School of Medicine (#201405045), and all participants provided written consent at study recruitment.

Measurements

Participants completed three questionnaires: a general demographic questionnaire, a validated food frequency questionnaire (Hu et al., 1999), and the Kaiser Physical Activity Survey (Ainsworth, Haskell, et al., 2000; Ainsworth, Sternfeld, Richardson, & Jackson, 2000). The general demographic questionnaire contained questions on race, ethnicity, educational attainment, and annual income. Participants also provided obstetric history, past and present use of contraceptives, and past and present smoking status. BMI was calculated from the height and weight measured at the woman's office appointment. BMI was categorized according to the WHO classifications: underweight ($<18.5 \text{ kg/m}^2$), normal weight ($18.5\text{--}24.9 \text{ kg/m}^2$), overweight ($25.0\text{--}29.9 \text{ kg/m}^2$), and obese ($\geq 30.0 \text{ kg/m}^2$).

Participants' home addresses were used to identify their Area Deprivation Index (ADI), an index of socioeconomic deprivation experienced by a neighborhood (University of Wisconsin School of Medicine and Public Health, 5/1/2018). This index is composed of several neighborhood-level variables, including percentage of families living under the poverty level, percentage of occupied housing units without complete plumbing, and percentage of households without a motor vehicle. A higher ADI indicates greater socioeconomic deprivation. Each neighborhood is placed within a national percentile, comparing it to all other neighborhoods in the United States. ADIs were divided into quartiles for comparison and analyses.

Dietary Assessment

The Harvard Willett Food Frequency Questionnaire (Hu et al., 1999) was used to capture diet over the previous year. The questionnaire asked participants to report how often, on

average, they consumed a specified amount of 131 foods, beverages, and supplements with nine frequency options ranging from “never or less than once per month” to “six or more times per day.” A commonly used unit or portion size (e.g. one orange, 8 oz glass of milk) was used for quantification. Each frequency category was converted into a daily intake, and nutrient intakes were determined by summing the nutrient contribution from each individual item. The individual food items were combined to form 40 predefined food categories (e.g., low-fat dairy products and sweets). These food categories were chosen for similar nutrient profiles and culinary use as described previously (Hu et al., 1999). Women with caloric intake less than 500 kcal/day or greater than 5000 kcal/day were excluded from analyses. Cutoffs for caloric intake were based on previous studies and examination of the physical activity level and BMI of women in the cohort (Willett, 2012).

Assessment of Physical Activity

A validated questionnaire, the Kaiser Physical Activity Survey (KPAS) (Ainsworth, Sternfeld, et al., 2000), was used to capture participants’ physical activity over the previous year. KPAS, which was designed for use in women, is composed of four indices: household and caregiving; occupational; active-living; and sports/exercise. The total KPAS score is the sum of the four indices’ scores, ranging from 4 (least active) to 20 (most active). The Compendium of Physical Activity was used to assign metabolic equivalent ratings for activities listed in the sports and exercise index (Ainsworth, Haskell, et al., 2000). We used a modified version of the occupational index, which excludes the occupational intensity component, as previously described (Im, Ham, Chee, & Chee, 2015), and individuals who were unemployed were assigned a value of one for the occupational index.

Statistical Analysis

Principal component analysis with varimax rotation was used to categorize food groups into factors, or dietary patterns (Cutillas-Tolin et al., 2015; Hu et al., 1999; Wu et al., 2004). Varimax rotation was used for greater interpretability (Panaretos, Tzavelas, Vamvakari, & Panagiotakos, 2017). The number of dietary patterns retained was determined according to three considerations: eigenvalues >1.0, scree plot, and pattern interpretability. Parallel analysis was conducted to assess retention accuracy (Hayton, Allen, & Scarpello, 2004). For dietary pattern naming, food groups were considered discriminatory if their loading factors were $\geq |0.4|$. Positive loading values indicate a positive association between the food group and dietary pattern, whereas negative loading values indicate a negative association. The dietary pattern score for each woman was determined by summing her daily consumption of each food group multiplied by the standardized coefficients of each food group.

Each participant’s adherence to a dietary pattern was defined by her dietary pattern score. Therefore, women with higher scores for a specific dietary pattern were considered to be more adherent to that dietary pattern.

Trends in consumption of discriminatory food groups and proportions of fat and protein from vegetables, animal, and dairy were assessed with Wilcoxon rank-sum tests. Multivariate linear regression with backwards elimination was used to assess variables associated with adherence to the dietary patterns and physical activity. Variables assessed

were age, race, employment, high vs. low ADI neighborhood, parity greater than zero, annual income greater or less than \$25,000, and completion of college. Daily caloric intake was also included when assessing adherence to dietary patterns. Spearman correlation was used to assess relationships between dietary patterns and total KPAS scores.

To assess associations between obesity and socioeconomic factors, physical activity, and dietary patterns, multivariate logistic regression with backwards elimination was performed, controlling for age, smoking status, education, and income. KPAS and dietary pattern scores were divided into quartiles, with the lowest quartile representing women least adherent to the behavior.

Data were stored on the online database REDCap (Harris et al., 2009). $P < 0.05$ was considered statistically significant. SAS version 9.4 (SAS Institute, Cary, NC, USA) was used for all statistical analyses.

Results

Cohort

A total of 185 women were recruited from the St. Louis metropolitan area. Nine women were excluded because their caloric intake was greater than 5000 kcal/day, and one woman was excluded for not completing the food frequency questionnaire, so 175 women were included in the final analyses. Women in the cohort were between 20 and 44 years old with a mean age of 31 (Table 1). While a higher proportion of the women in our cohort graduated college than women in the St. Louis metropolitan area, the racial and ethnic composition of our cohort was similar to that of the metropolitan area, with 62% non-Hispanic white women and 21% African-American women (U.S. Census Bureau, 2017).

Our cohort was evenly distributed amongst the ADI quartiles, with 20% of women living in neighborhoods in the lowest quartile (least deprivation) and 21% living in the highest quartile (highest deprivation). Women who lived in the highest ADI quartile were more likely to be obese ($P = 0.008$) than women living in lower ADI neighborhoods. Women living in the highest ADI quartile were more likely to be African American ($P < 0.0001$) and to be current smokers ($P = 0.01$) than were women living in the lowest ADI quartile.

Dietary Patterns and Physical Activity

Principal component analysis identified three dietary patterns to explain the variance in the food frequency questionnaire data. The first pattern, which we termed the “Prudent” pattern, explained 11% of the variance and was characterized by consumption of fruits, vegetables, nuts, olive oil, and water (Table 2). The second pattern, which we termed the “Western” pattern, explained an additional 11% of the variance and was characterized by meat, snack foods, potatoes, and high-calorie drinks. The third pattern explained 6% of the variance and was characterized by low-calorie drinks, snack bars, and condiments. This factor was not considered to represent an interpretable or significant dietary pattern contributing to disease, and thus we did not consider it in our analysis. Average monthly consumption of discriminatory food groups for the Prudent and Western dietary patterns are shown in Table

3. Wilcoxon rank-sum test showed a significant trend across adherence quartiles for all discriminatory foods (P -trend <0.0001) except coffee drinks.

As adherence to the Prudent pattern increased, vegetable fat and protein intake increased, and animal fat and protein intake decreased (p -trend <0.0001). Individuals more adherent to the Prudent pattern tended to have greater contribution of monounsaturated fats to their overall fat caloric intake. The opposite trends were seen with increased adherence to the Western pattern. Furthermore, adherence to the Western pattern was associated with increasing contribution of dairy to both fat and protein caloric intake.

KPAS scores were between 5.6 and 17.4, with a median score of 10.2. Of the four indices, sports/exercise was the most variable. The majority of women (56%) stated they participated in sports/exercise weekly, and 46% stated they participated in sports/exercise more than once per week.

Adherence to the Prudent pattern was positively correlated with total KPAS score ($\rho=0.39$, $P<0.0001$), and adherence to the Western pattern was negatively correlated with total KPAS score ($\rho=-0.21$, $P=0.005$).

Relationship between dietary patterns, physical activity, and socioeconomic indices

Women who completed college were more adherent to the Prudent pattern than women without a college degree ($\beta=0.47$, 95% CI 0.19 to 0.75, $p=0.001$, Table 4). African-American women were less adherent to this dietary pattern than non-African-American women ($\beta=-0.36$, 95% CI -0.68 to -0.05 , $p=0.023$). Annual income, employment, parity, age, and ADI were not associated with adherence to the Prudent pattern.

Significant predictors for adherence to the Prudent pattern were the same as for adherence to the Western pattern, but with opposite effects; African-American women were more adherent to the Western pattern ($\beta=0.34$, 95% CI 0.11 to 0.57, $p=0.004$), and college graduates were less adherent to this pattern ($\beta=-0.33$, 95% CI -0.54 to -0.13 , $p=0.002$). Additionally, women were more adherent with the Western pattern with increasing age ($\beta=0.014$, 95% CI 0.0005 to 0.028, $p=0.04$).

Women with children and employed women had significantly higher KPAS scores than women who did not have children or were unemployed ($\beta=1.25$, 95% CI 0.51 to 2.00, $p=0.01$; $\beta=1.65$, 95% CI 0.59 to 2.72, $p=0.03$ respectively). Additionally, living in the highest ADI quartile neighborhoods was associated with lower KPAS scores ($\beta=-0.85$, 95% CI -1.58 to -0.11 , $p=0.03$), and total physical activity decreased with increasing age ($\beta=-0.06$, 95% CI -0.11 to -0.005 , $p=0.03$).

Socioeconomic and demographic characteristics associated with individual KPAS indices varied. Among women who were employed, having a college degree was associated with a significantly lower occupational physical activity ($\beta=-0.33$, 95% CI -0.59 to -0.07 , $p=0.01$). Having a college degree was also a significant predictor of the sports/exercise index ($\beta=0.44$, 95% CI 0.06 to 0.83, $p=0.02$). Living in a neighborhood with the highest ADI was associated with lower sports/exercise score ($\beta=-0.48$, 95% CI -0.90 to -0.06 , $p=0.03$) and lower active-living scores ($\beta=-0.31$, 95% CI -0.60 to -0.02 , $p=0.03$). Women who made >

\$25,000 had higher household physical activity ($\beta = 0.17$, 95% CI 0.004 to 0.34, $p = 0.04$) but lower active-living scores ($\beta = -0.26$, 95% CI -0.51 to -0.003 , $p = 0.047$) than women who made $< \$25,000$. Being employed was associated with less household physical activity ($\beta = -0.53$, 95% CI -0.81 to -0.26 , $p = 0.002$), but having a child was associated with more physical activity at home ($\beta = 0.77$, 95% CI 0.60 to 0.93, $p < 0.0001$).

Association with Obesity

In our cohort, 29% of women were obese. In univariate analysis, adherence to the Western diet was associated with a higher odds of obesity. Adherence to the Prudent diet was associated with a reduced odds of obesity (aOR range 0.24 to 0.58, 95% CI range 0.08 to 1.47), but this association disappeared after controlling for other variables. However, in multivariate analysis, adherence to the Western diet conferred a dose-dependent increase in odds of obesity, with the highest quartile having greater than four times higher odds of obesity than the women in the lowest quartile (aOR 4.33, 95% CI: 1.13 to 16.61, $p = 0.03$). Compared to women in the lowest quartile of physical activity, more physically active women had lower odds of obesity (aOR 0.28, 95% CI: 0.08 to 0.93, $p = 0.04$), but activity had no further dose-dependent association with obesity. African-American women had a threefold higher odds of obesity than women of other races after controlling for education, income, dietary patterns, and physical activity (aOR = 3.11, 95% CI: 1.23 to 7.89, $p = 0.02$).

Conclusions for Practice

In this study of healthy, reproductive-age women, we describe two dominant dietary patterns, a Prudent pattern and a Western pattern. African-American women and women without a college degree were more adherent to the Western pattern and less adherent to the Prudent pattern than white women or women with a college degree. Women who lived in more disadvantaged neighborhoods had lower physical activity levels, especially leisure exercise, than women in more advantaged areas. Adherence to the Western pattern had a dose-dependent association with odds of obesity, but adherence to the Prudent pattern was not associated with obesity after controlling for other variables. Additionally, women who were physically active had a decreased odds of obesity regardless of diet.

Studies of Western dietary patterns frequently describe “Western” and “Prudent” dietary patterns in which the “Western” dietary pattern is defined by high quantities of meat and refined carbohydrates, whereas the “Prudent” diet is defined by high quantities of vegetables, fruits, and whole grains (Hu et al., 1999). The two diets in our study explained 22% of the variability in the data, which falls in range of previous studies (Hu et al., 1999; Kant, 2004) and followed this previously described delineation.

Although the Prudent and Western dietary patterns have been well described in studies of Western nutrition, considerable heterogeneity can exist in the actual makeup of these dietary patterns (Hu et al., 1999; Kant, 2004; Kant & Graubard, 2018; Slimani et al., 2002). This variation exists at national and regional levels (Cusack et al., 2017; Hajjar & Kotchen, 2003; Kant & Graubard, 2018; Slimani et al., 2002; Trivedi et al., 2015). For example, in a study examining regional fish consumption and blood mercury levels, Cusack et al. found that reproductive-age women living in the Midwest consumed less fish than women in other

regions and also had lower blood mercury levels (Cusack et al., 2017). Our study confirms low consumption of fish in this population, as fish did not contribute significantly to either dietary pattern. Given the importance of omega-3 fatty acids in fetal neurodevelopment (Hibbeln et al., 2007), this finding suggests an important role for encouraging dietary supplementation.

In general, higher socioeconomic status is associated with healthier dietary patterns (Kant, 2004) and increased physical activity (Sternfeld, Ainsworth, & Quesenberry, 1999). In our study, women who had at least a college education were more adherent with the Prudent diet and less adherent with the Western diet, but income and neighborhood ADI were not associated with dietary adherence. Even after controlling for other socioeconomic factors, African-American women in our cohort were more adherent with the Western pattern and less adherent with the Prudent pattern. Physical activity was positively associated with adherence to the Prudent pattern and negatively associated with adherence to the Western pattern, suggesting that women who exercise maintain a more health-conscious diet. The stronger correlation between physical activity and the Prudent diet than between physical activity and the Western diet may explain why in multivariate analysis the association between the Prudent diet and obesity disappeared but the association between obesity and the Western diet did not.

National data suggest that African-American women are less active than women of other races (Lee & Im, 2010). Indeed, in a study examining KPAS in a racially diverse cohort, African-American women had lower scores for the sports/exercise and active-living indices than white women (Sternfeld et al., 1999). In our cohort, physical activity levels between African-American women and non-African-American women did not differ significantly. However, women who lived in the most socially disadvantaged areas (highest ADI), who were predominately African-American, had lower total KPAS scores and lower sports/exercise indices than women living in less disadvantaged areas. This finding is consistent with previous research showing that individuals in low socioeconomic areas, who often have little access to free exercise spaces and safe surroundings, have reduced physical activity (Estabrooks, Lee, & Gyurcsik, 2003).

In our cohort, women who were employed and those with children had higher KPAS scores, which is partially explained by the fact that both occupational labor and caring for children contribute to KPAS scoring. Consistent with previous studies (Sternfeld et al., 1999), women with higher levels of education had lower levels of occupational physical activity and higher levels of sports/exercise activity. However, after controlling for other factors, education did not contribute significantly to the overall KPAS score. Therefore, while women with different levels of education may be participating in different types of physical activity (leisure vs work), they are participating in similar levels of physical activity overall. However, given that occupational labor tends to be shorter and less intense than leisure exercise and that it is obligatory and repetitive, it may not have the same health benefits as optional exercise (Chen, Stevinson, Ku, Chang, & Chu, 2012).

Several limitations must be considered. First, our participants all lived in the St. Louis metropolitan area, which limits generalizability to women in other regions. However, given

variability in diets by region, studying regional populations is critical to develop interventions. Second, we only included healthy women. Had we included women with chronic disease, we may have seen higher consumption of food groups linked with diabetes and hypertension. Nevertheless, we identified a dietary pattern defined by food groups associated with chronic disease. Third, our measures of lifestyle, KPAS and the food frequency questionnaire, are subject to recall bias. Fourth, while we controlled for many factors that might influence lifestyle behavior, unmeasured factors may play an important role. Finally, as our study was cross-sectional, we cannot make causal inferences between lifestyle and obesity.

We note several strengths. First, our study was unique in that our cohort included only reproductive-age women without chronic disease who were not planning pregnancy. However, obesity and an unhealthy dietary pattern were prevalent, highlighting an important opportunity for intervention in this population as diet is modifiable. In contrast, most previous studies have focused on associations between diet and disease or have looked at women who are planning or currently pregnancy, and thus may have changed their behavior in preparation. Second, we used principal component analysis, rather than predefined dietary patterns, which allowed us to identify dietary patterns rather than fit the data into pre-defined diets. This methodology is especially important given that dietary patterns vary by gender and geography. Finally, we used KPAS, which more appropriately captures physical activity in women than do many other physical activity questionnaires designed for use in men.

In summary, we found that a diverse cohort of reproductive-age women in St. Louis, Missouri follow two dietary patterns that mirror patterns described in other studies. Adherence to the Western pattern was associated with increased odds of obesity, and physical activity was associated with decreased odds of obesity. African-American women, women with less than a college degree, and older women were more adherent to the Western diet. Women without a college degree and women living in more disadvantaged areas were less physically active. These findings help identify at-risk populations to target for preconception interventions to reduce obstetrical risks and long term maternal and child health.

Acknowledgements:

The authors would like to thank Deborah Frank for her editorial assistance

Sources of support:

Research reported in this publication was supported by the National Center for Advancing Translational Sciences of the National Institutes of Health under Award Numbers and KL2 TR000450 and TL1TR002344. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

References:

- Ainsworth BE, Haskell WL, Whitt MC, Irwin ML, Swartz AM, Strath SJ, ... Leon AS (2000). Compendium of physical activities: an update of activity codes and MET intensities. *Med Sci Sports Exerc*, 32(9 Suppl), S498–504. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/10993420> [PubMed: 10993420]

- Ainsworth BE, Sternfeld B, Richardson MT, & Jackson K (2000). Evaluation of the kaiser physical activity survey in women. *Med Sci Sports Exerc*, 32(7), 1327–1338. Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/10912901> [PubMed: 10912901]
- American College of Obstetricians and Gynecologists' Committee on Practice Bulletins. (2015). ACOG Practice Bulletin No 156: Obesity in Pregnancy. *Obstet Gynecol*, 126(6), e112–126. doi:10.1097/AOG.0000000000001211 [PubMed: 26595582]
- American College of Obstetricians and Gynecologists' Committee on Practice Bulletins. (2018). ACOG Practice Bulletin No. 190: Gestational Diabetes Mellitus. *Obstet Gynecol*, 131(2), e49–e64. doi:10.1097/AOG.0000000000002501 [PubMed: 29370047]
- American College of Obstetricians and Gynecologists' Committee on Practice Bulletins. (2019). ACOG Practice Bulletin No. 202 Summary: Gestational Hypertension and Preeclampsia. *Obstet Gynecol*, 133(1), 211–214. doi:10.1097/AOG.0000000000003019 [PubMed: 30575668]
- Bao W, Bowers K, Tobias DK, Olsen SF, Chavarro J, Vaag A, ... Zhang C. (2014). Prepregnancy low-carbohydrate dietary pattern and risk of gestational diabetes mellitus: a prospective cohort study. *Am J Clin Nutr*, 99(6), 1378–1384. doi:10.3945/ajcn.113.082966 [PubMed: 24717341]
- Chen LJ, Stevinson C, Ku PW, Chang YK, & Chu DC (2012). Relationships of leisure-time and non-leisure-time physical activity with depressive symptoms: a population-based study of Taiwanese older adults. *Int J Behav Nutr Phys Act*, 9, 28. doi:10.1186/1479-5868-9-28 [PubMed: 22413813]
- Cusack LK, Smit E, Kile ML, & Harding AK (2017). Regional and temporal trends in blood mercury concentrations and fish consumption in women of child bearing Age in the united states using NHANES data from 1999–2010. *Environ Health*, 16(1), 10. doi:10.1186/s12940-017-0218-4 [PubMed: 28212649]
- Cutillas-Tolin A, Minguez-Alarcon L, Mendiola J, Lopez-Espin JJ, Jorgensen N, Navarrete-Munoz EM, ... Chavarro JE (2015). Mediterranean and western dietary patterns are related to markers of testicular function among healthy men. *Hum Reprod*, 30(12), 2945–2955. doi:10.1093/humrep/dev236 [PubMed: 26409012]
- Estabrooks PA, Lee RE, & Gyurcsik NC (2003). Resources for physical activity participation: does availability and accessibility differ by neighborhood socioeconomic status? *Ann Behav Med*, 25(2), 100–104. doi:10.1207/S15324796ABM2502_05 [PubMed: 12704011]
- Finer LB, & Zolna MR (2016). Declines in Unintended Pregnancy in the United States, 2008–2011. *N Engl J Med*, 374(9), 843–852. doi:10.1056/NEJMsa1506575 [PubMed: 26962904]
- Hajjar I, & Kotchen T (2003). Regional variations of blood pressure in the United States are associated with regional variations in dietary intakes: the NHANES-III data. *J Nutr*, 133(1), 211–214. doi:10.1093/jn/133.1.211 [PubMed: 12514292]
- Hanson M, Barker M, Dodd JM, Kumanyika S, Norris S, Steegers E, ... Yang H (2017). Interventions to prevent maternal obesity before conception, during pregnancy, and post partum. *Lancet Diabetes Endocrinol*, 5(1), 65–76. doi:10.1016/S2213-8587(16)30108-5 [PubMed: 27743974]
- Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, & Conde JG (2009). Research electronic data capture (REDCap)—a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform*, 42(2), 377–381. doi:10.1016/j.jbi.2008.08.010 [PubMed: 18929686]
- Hayton JC, Allen DG, & Scarpello V (2004). Factor Retention Decisions in Exploratory Factor Analysis: a Tutorial on Parallel Analysis. *Organization Research Methods*, 7(2), 191–205.
- Hibbeln JR, Davis JM, Steer C, Emmett P, Rogers I, Williams C, & Golding J (2007). Maternal seafood consumption in pregnancy and neurodevelopmental outcomes in childhood (ALSPAC study): an observational cohort study. *Lancet*, 369(9561), 578–585. doi:10.1016/S0140-6736(07)60277-3 [PubMed: 17307104]
- Hu FB, Rimm E, Smith-Warner SA, Feskanich D, Stampfer MJ, Ascherio A, ... Willett WC (1999). Reproducibility and validity of dietary patterns assessed with a food-frequency questionnaire. *Am J Clin Nutr*, 69(2), 243–249. doi:10.1093/ajcn/69.2.243 [PubMed: 9989687]
- Im EO, Ham OK, Chee E, & Chee W (2015). Physical activity and depressive symptoms in four ethnic groups of midlife women. *West J Nurs Res*, 37(6), 746–766. doi:10.1177/0193945914537123 [PubMed: 24879749]

- Kant AK (2004). Dietary patterns and health outcomes. *J Am Diet Assoc*, 104(4), 615–635. doi:10.1016/j.jada.2004.01.010 [PubMed: 15054348]
- Kant AK, & Graubard BI (2018). Secular trends in regional differences in nutritional biomarkers and self-reported dietary intakes among American adults: National Health and Nutrition Examination Survey (NHANES) 1988–1994 to 2009–2010. *Public Health Nutr*, 21(5), 927–939. doi:10.1017/S1368980017003743 [PubMed: 29317006]
- Lee SH, & Im EO (2010). Ethnic differences in exercise and leisure time physical activity among midlife women. *J Adv Nurs*, 66(4), 814–827. doi:10.1111/j.1365-2648.2009.05242.x [PubMed: 20423369]
- Panaretos D, Tzavelas G, Vamvakari M, & Panagiotakos D (2017). Repeatability of dietary patterns extracted through multivariate statistical methods: a literature review in methodological issues. *Int J Food Sci Nutr*, 68(4), 385–391. doi:10.1080/09637486.2016.1252317 [PubMed: 27829309]
- Raghavan R, Dreifelbis C, Kingshipp BL, Wong YP, Abrams B, Gernand AD, ... Stoody EE (2019). Dietary patterns before and during pregnancy and maternal outcomes: a systematic review. *Am J Clin Nutr*, 109(Supplement_7), 705S–728S. doi:10.1093/ajcn/nqy216 [PubMed: 30982868]
- Slimani N, Kaaks R, Ferrari P, Casagrande C, Clavel-Chapelon F, Lotze G, ... Riboli E (2002). European Prospective Investigation into Cancer and Nutrition (EPIC) calibration study: rationale, design and population characteristics. *Public Health Nutr*, 5(6B), 1125–1145. doi:10.1079/PHN2002395 [PubMed: 12639223]
- Starling AP, Sauder KA, Kaar JL, Shapiro AL, Siega-Riz AM, & Dabelea D (2017). Maternal Dietary Patterns during Pregnancy Are Associated with Newborn Body Composition. *J Nutr*, 147(7), 1334–1339. doi:10.3945/jn.117.248948 [PubMed: 28539412]
- Stephenson J, Heslehurst N, Hall J, Schoenaker D, Hutchinson J, Cade JE, ... Mishra GD (2018). Before the beginning: nutrition and lifestyle in the preconception period and its importance for future health. *Lancet*, 391(10132), 1830–1841. doi:10.1016/S0140-6736(18)30311-8 [PubMed: 29673873]
- Sternfeld B, Ainsworth BE, & Quesenberry CP (1999). Physical activity patterns in a diverse population of women. *Prev Med*, 28(3), 313–323. doi:10.1006/pmed.1998.0470 [PubMed: 10072751]
- Tan HC, Roberts J, Catov J, Krishnamurthy R, Shypailo R, & Bacha F (2015). Mother's pre-pregnancy BMI is an important determinant of adverse cardiometabolic risk in childhood. *Pediatr Diabetes*, 16(6), 419–426. doi:10.1111/pedi.12273 [PubMed: 25800542]
- Trivedi T, Liu J, Probst J, Merchant A, Jhones S, & Martin AB (2015). Obesity and obesity-related behaviors among rural and urban adults in the USA. *Rural Remote Health*, 15(4), 3267 Retrieved from <https://www.ncbi.nlm.nih.gov/pubmed/26458564> [PubMed: 26458564]
- U.S. Census Bureau. (2017). American Community Survey 1-year estimates. Retrieved from Census Reporter Profile page for St. Louis, MO-IL Metro Area. Retrieved from <https://censusreporter.org/profiles/31000US41180-st-louis-mo-il-metro-area/>
- University of Wisconsin School of Medicine and Public Health. (5/1/2018). Area Deprivation Index. Retrieved from <https://www.neighborhoodatlas.medicine.wisc.edu/>
- Willett WC (2012). Issues in Analysis and Presentation of Dietary Data In Hofman A, Marmot M, Samet J, & Savitz DZ (Eds.), *Nutritional Epidemiology* (3rd ed., Vol. 40). New York, NY: Oxford University Press.
- Wu K, Hu FB, Fuchs C, Rimm EB, Willett WC, & Giovannucci E (2004). Dietary patterns and risk of colon cancer and adenoma in a cohort of men (United States). *Cancer Causes Control*, 15(9), 853–862. doi:10.1007/s10552-004-1809-2 [PubMed: 15577287]
- Zhang C, Schulze MB, Solomon CG, & Hu FB (2006). A prospective study of dietary patterns, meat intake and the risk of gestational diabetes mellitus. *Diabetologia*, 49(11), 2604–2613. doi:10.1007/s00125-006-0422-1 [PubMed: 16957814]

Significance:

Little is known regarding dietary and exercise patterns of non-pregnant reproductive-age women despite the fact that these lifestyle behaviors impact a woman's health and the health of her future children. In a cohort of healthy reproductive-age women, we identified two predominant dietary patterns—a Western pattern and a Prudent pattern. The Western diet and decreased physical activity levels were independently associated with obesity. African-American women, women without a college degree, and women living in areas with high deprivation had higher odds of obesity-prone lifestyle patterns. Obesity interventions for women should incorporate this knowledge.

Table 1:

Demographics of participants in a Midwestern cohort study of reproductive-age women

Characteristic	All participants (N=175)
Age , y (N=173)	30.9 ± 6.6
Race (N=172)	
Non-Hispanic White	107 (62)
African-American	37 (21)
Other	28 (16)
BMI Category (N=175)	
Underweight	7 (4)
Normal Weight	69 (39)
Overweight	49 (28)
Obese	50 (29)
Education (N=173)	
Completed college	122 (71)
Less than college degree	51 (29)
Income (N=173)	
> \$25,000	118 (68)
\$25,000	55 (32)
Employment Status (N=173)	
Employed	157 (91)
Unemployed	16 (9)
ADI (N=175)	
Quartile 1	35 (20)
Quartile 2	60 (34)
Quartile 3	43 (25)
Quartile 4	37 (21)
Parity (N=175)	
1+	114 (65)
0	61 (35)
Smoking Status (N=171)	
Non-smoker	157 (92)
Current Smoker	14 (8)

Values are N (%) or mean ± SD; ADI= Area Deprivation Index

Table 2:

Dietary pattern factor loading in a Midwestern cohort study of reproductive-age women

Food Category	Food Group	Prudent Diet	Western Diet
Meats	Processed meats	−0.21	0.55
	Red meats	−0.21	0.49
	Organ meats	−0.13	0.02
	Poultry	−0.08	0.51
	Fish	0.18	0.31
Dairy and eggs	Eggs	0.27	0.08
	Butter	0.25	0.18
	Margarine	0.02	0.48
	Low fat dairy	0.17	0.21
	High fat dairy	0.23	0.37
Carbohydrates	Cream Soup	0.10	0.32
	Whole grains	0.37	0.09
	Breakfast cereals	0.04	0.23
	Refined grains	0.14	0.60
	Potatoes	0.16	0.44
Fruit and vegetables	Fruit	0.70	−0.10
	Cruciferous vegetables	0.59	−0.21
	Yellow vegetables	0.59	−0.24
	Tomatoes	0.49	0.24
	Green vegetables	0.52	0.00
	Legumes	0.57	−0.03
	Other vegetables	0.68	0.16
Snacks	Snacks Food	0.10	0.42
	Nuts	0.51	−0.20
	Sweets	−0.10	0.38
	Snack bars	0.31	0.02
Other foods	Fries	−0.23	0.45
	Pizza	−0.10	0.48
	Olive oil and vinegar	0.51	0.18
	Mayonnaise	0.02	0.58
	Dairy replacement	0.00	−0.05
	Artificial sweetener	0.17	0.02
	Condiments	0.29	0.29
Drinks	Water	0.41	−0.23
	Coffee drinks	0.18	0.40
	Tea	0.37	0.02
	Fruit juice	0.00	0.47
	High calorie drinks	−0.08	0.51
	Low calorie drinks	0.25	0.04

Food Category	Food Group	Prudent Diet	Western Diet
	Decaffeinated drinks	0.09	−0.10

Values are loading factors; loading factors $|0.4|$ were considered discriminatory and are bolded.

Author Manuscript

Author Manuscript

Author Manuscript

Author Manuscript

Table 3:

Monthly frequency of consumption of discriminatory food groups for Prudent and Western diets in a Midwestern cohort study of reproductive-age women

	Lowest quartile (<i>n</i> = 44)	Highest quartile (<i>n</i> = 44)
Prudent Diet		
Fruit	9.6 (4.8–22.5)	70.8 (42.5–102)
Cruciferous vegetables	4.8 (2.4–9.6)	28.05 (19.5–71.1)
Yellow vegetables	2.4 (0–4.8)	29.1 (16.5–29.1)
Tomatoes	2.4 (0.0–4.8)	16.2 (9.0–25.8)
Green vegetables	4.8 (0.0–8.4)	25.8 (9.6–30.3)
Legumes	2.4 (0.0–6.6)	20.4 (11.7–38.0)
Other vegetables	7.2 (2.4–12.6)	32.4 (22.2–32.4)
Nuts	4.2 (2.4–7.2)	28.50 (9.0–38.9)
Olive oil and vinegar	4.2 (2.4–8.4)	33.3 (15.0–48.0)
Water	30 (2.4–135)	180 (135–180)
Western Diet		
Processed meats	2.4 (0.0–6.6)	17.3 (9.3–30.6)
Red meats	4.8 (0.0–9.6)	21.0 (13.2–31.8)
Chicken	6.6 (0.0–15.3)	22.7 (12.6–38.7)
Margarine	0.0 (0.0–0.0)	2.4 (0.0–12.9)
Refined grains	7.2 (4.2–15.6)	34.8 (21.2–46.2)
Potatoes	0.0 (2.4–4.2)	12.9 (4.2–12.9)
Fries	0.0 (0.0–2.4)	2.4 (2.4–12.9)
Pizza	2.4 (0.0–2.4)	4.2 (2.4–8.55)
Snacks	7.2 (4.8–15.0)	19.5 (11.1–31.5)
Mayonnaise	0.0 (0.0–2.4)	4.8 (2.4–10.7)
Fruit juice	0.0 (0.0–2.4)	14.1 (4.8–30.3)
High calorie drinks	0.0 (0.0–0.0)	12.75 (4.2–30.0)
Coffee drinks	0.0 (0.0–2.4)	2.4 (0.0–4.2)

Monthly frequency of consumption of discriminatory food groups for each dietary pattern by quartile of adherence to either the Prudent or the Western diets. Values are median (inter-quartile range). Wilcoxon rank-sum test showed a trend across quartiles for all foods ($P < 0.0001$) except coffee drinks ($P = 0.112$).

Table 4:

Characteristics associated with adherence to dietary patterns and physical activity in a Midwestern cohort study of reproductive-age women

Characteristic	Beta (95% CI)	P-Value
<i>Prudent Diet</i> [†]		
African American	−0.36 (−0.68, −0.05)	0.02
College degree	0.47 (0.19, 0.75)	0.001
<i>Western Diet</i> [‡]		
Age, y	0.014 (0.0005, 0.028)	0.04
African American	0.34 (0.11, 0.57)	0.004
College degree	−0.33 (−0.54, −0.13)	0.002
<i>KPAS</i> [§]		
Age, y	−0.06 (−0.11, −0.005)	0.03
Has children	1.25 (0.51, 2.00)	0.01
Employed	1.65 (0.59, 2.72)	0.03
Highest ADI	−0.85 (−1.58, −0.11)	0.03

Linear regression models to assess variables associated with adherence to Prudent diet, Western diet, and KPAS. Dietary patterns controlled for daily caloric intake. Reference groups: unemployed, income \$25,000, non-African-American, no college degree, no children, lower 75%ile ADI.

[†]Adjusted-R²=0.34.

[‡]Adjusted R²=0.66.

[§]Adjusted R²=0.10.