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Physical Activity and Dietary Behavior in US Adults and Their Combined Influence on Health

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Abstract

Objective: To examine the association between objectively measured physical activity and dietary behavior and their combined effect on health.

Patients and Methods: Data for this study were obtained from the 2003-2006 National Health and Nutrition Examination Survey cycles. The data were evaluated between September 9, 2012, and August 14, 2013. As part of the national survey, participants wore an accelerometer for 4 or more days to assess physical activity, blood samples were obtained to assess various biological markers, and interviews were conducted to assess dietary behavior. We selected a sample of 5211 participants and categorized them into 4 groups: (1) healthy diet and active, (2) unhealthy diet and active, (3) healthy diet and inactive, and (4) unhealthy diet and inactive.

Results: A total of 16.5% of participants (weighted proportions) were classified as consuming a healthy diet and being sufficiently active. After adjustments, participants were 32% more likely to consume a healthy diet if they met physical activity guidelines. For nearly all biomarkers, those who consumed a healthy diet and were sufficiently active had the most favorable biomarker levels. Compared with those who consumed a healthy diet and were active, participants who consumed an unhealthy diet and were inactive were 2.4 times more likely to have metabolic syndrome.

Conclusion: Our findings indicate a relationship between objectively measured physical activity and dietary behavior and that participating in regular physical activity and eating a healthy diet are associated with better health outcomes when compared with diet or physical activity alone.

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Both dietary and physical activity behavior are independent predictors of numerous health outcomes among adults.[1-3] However, we have a limited understanding of the potential combined influence of dietary and objectively determined physical activity behavior among US adults. It is plausible to suggest that individuals who consume a healthy diet and are sufficiently active may have more favorable health outcomes than those who consume an unhealthy diet and are inactive.

Along these lines, the association between physical activity and dietary behavior is not clearly understood. Studies have examined this association,[4-9] but they are limited in the extent that they have exclusively used self-reported physical activity methodology, which is prone to considerable measurement error,[10] with some also only examining a single nutrient or limiting their examination to certain populations. Measurement error associated with self-reported physical activity creates serious challenges in delineating any potential combined dietary and physical activity effect. Specifically, this increased measurement error associated with self-reported physical activity likely creates bias in the estimated relative risk and may reduce statistical power to detect physical activity and diet—disease associations.[11]

To bridge these gaps in the literature, the present study employed a nationally representative sample of US adults and an objective measure of physical activity. The 2 objectives of the study were (1) to examine the association between physical activity and dietary behavior and (2) to examine the potential combined effect of physical activity and dietary behavior on biological (eg, total cholesterol) and health (eg, waist circumference) markers.

PATIENTS AND METHODS

Study Design and Participants

Data for this study were obtained from the 2003-2006 National Health and Nutrition

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Examination Survey (NHANES). The data were evaluated between September 9, 2012, and August 14, 2013. The NHANES is an ongoing survey conducted by the Centers for Disease Control and Prevention that uses a representative sample of noninstitutionalized US civilians, selected by a complex, multistage, stratified, clustered probability design. The multistage design consists of 4 stages: the identification of (1) counties and (2) segments (city blocks), (3) random selection of households within the segments, and (4) random selection of individuals within the households. Briefly, participants were interviewed in their homes and then subsequently examined in mobile examination centers by NHANES personnel. Further details about the NHANES can be found elsewhere.[12] The NHANES study procedures were approved by the National Center for Health Statistics ethics review board, with informed consent obtained from all participants before data collection.

In the 2003-2006 NHANES cycles, 20,470 participants were examined. For our study, the following participants were excluded: insufficient data or ineligible for the activity monitoring component, 10,718; missing dietary behavior, 358; less than 20 years old, 3500; pregnant, 236; and missing data on the covariates, 447. The remaining 5211 participants composed the analytic sample.

Measurement of Physical Activity

While attending the mobile examination center, participants were asked to wear an ActiGraph 7164 accelerometer during all activities except water-based activities and while sleeping. The accelerometer measured the frequency, intensity, and duration of physical activity by generating an activity count proportional to the measured acceleration. The accelerometer output is digitized using an analog-to-digital converter, and once digitized, the signal passes through a digital filter that detects accelerations ranging from 0.05 to 2.00*g* in magnitude with frequency responses ranging from 0.25 to 2.5 Hz to filter motion outside normal human movement. The filtered signal is then rectified and summed over a predetermined epoch period. After the activity count is sorted into an epoch, it is stored in the internal memory, and the integrator is reset to zero. Detailed information on the ActiGraph accelerometer can be found elsewhere.[13] Estimates for moderate to vigorous physical activity were summarized in 1-minute intervals. Activity counts of 2020 or more were classified as moderate to vigorous physical activity intensity.[14] For our analyses, and to represent habitual physical activity patterns, only participants with activity patterns of 10 or more hours per day for at least 4 days of monitoring data were included in the analyses.[14] To determine the amount of time the monitor was worn, nonwear was defined by a period of a minimum of 60 consecutive minutes of zero activity counts, with the allowance of 1 to 2 minutes of activity counts between 0 and 100.[14] Participants were classified as meeting physical activity guidelines if they engaged in 150 minutes of moderate-intensity or 75 minutes of vigorous-intensity physical activity per week or some combination of the two.[15] To account for the combination of moderate and vigorous physical activity, vigorous intensity was multiplied by 2 before being added to moderate intensity.[16] Therefore, participants could meet guidelines if they engaged in at least 150 minutes of moderate plus 2 × vigorous intensity physical activity per week. SAS statistical software version 9.2 (SAS Institute Inc) was used to reduce the accelerometry data using the SAS code provided by the National Cancer Institute. Using the SAS code, each participant's average time per day spent in physical activity from valid individual data were analyzed in this study.

Measurement of Dietary Behavior/Healthy Eating Index

Two 24-hour recalls were collected during the visit to the mobile examination center. Dietary intake may differ by weekday, especially weekend days. To capture intake on all days of the week, the 24-hour recalls were collected on every day of the week. The dietary interviewers used the NHANES III Dietary Data Collection system, which is an automated standardized interactive dietary interview and coding system. The Healthy Eating Index (HEI)-2005 was developed by the US Department of Agriculture as an indicator of dietary quality.[17] The HEI consists of 12 components (total fruit; whole fruit; total vegetable; dark green, orange vegetables and legumes; total grain; whole grain; milk; meat and beans; oil; saturated fats; sodium; and calories from solid fats, alcoholic beverages, and added sugars), with a maximum score of