# Association of Skipping Breakfast With Cardiovascular and All-Cause Mortality

**Article** *in* Journal of the American College of Cardiology · April 2019

DOI: 10.1016/j.jacc.2019.01.065



**7 authors**, including:

Shuang Rong
Wuhan University of Science and Technology
**36** PUBLICATIONS **757** CITATIONS
SEE PROFILE

Yangbo Sun
University of Iowa
**37** PUBLICATIONS **66** CITATIONS
SEE PROFILE

Buyun Liu
University of Iowa
**40** PUBLICATIONS **199** CITATIONS
SEE PROFILE

Wei Bao
University of Iowa
**173** PUBLICATIONS **3,090** CITATIONS
SEE PROFILE

JOURNAL OF THE AMERICAN COLLEGE OF CARDIOLOGY VOL. 73, NO. 16, 2019

PUBLISHED BY ELSEVIER

SPECIAL FOCUS ISSUE: CARDIOVASCULAR HEALTH PROMOTION

# Association of Skipping Breakfast With Cardiovascular and All-Cause Mortality

Shuang Rong, MD, PhD,[a,b] Linda G. Snetselaar, PhD,[b] Guifeng Xu, MD,[b] Yangbo Sun, MD, PhD,[b] Buyun Liu, MD, PhD,[b] Robert B. Wallace, MD,[b] Wei Bao, MD, PhD[b,c,d]

## ABSTRACT

**BACKGROUND** Skipping breakfast is common among U.S. adults. Limited evidence suggests that skipping breakfast is associated with atherosclerosis and cardiovascular disease.

**OBJECTIVES** The authors sought to examine the association of skipping breakfast with cardiovascular and all-cause mortality.

**METHODS** This is a prospective cohort study of a nationally representative sample of 6,550 adults 40 to 75 years of age who participated in the National Health and Nutrition Examination Survey III 1988 to 1994. Frequency of breakfast eating was reported during an in-house interview. Death and underlying causes of death were ascertained by linkage to death records through December 31, 2011. The associations between breakfast consumption frequency and cardiovascular and all-cause mortality were investigated by using weighted Cox proportional hazards regression models.

**RESULTS** Among the 6,550 participants (mean age 53.2 years; 48.0% male) in this study, 5.1% never consumed breakfast, 10.9% rarely consumed breakfast, 25.0% consumed breakfast some days, and 59.0% consumed breakfast every day. During 112,148 person-years of follow-up, 2,318 deaths occurred including 619 deaths from cardiovascular disease. After adjustment for age, sex, race/ethnicity, socioeconomic status, dietary and lifestyle factors, body mass index, and cardiovascular risk factors, participants who never consumed breakfast compared with those consuming breakfast everyday had hazard ratios of 1.87 (95% confidence interval: 1.14 to 3.04) for cardiovascular mortality and 1.19 (95% confidence interval: 0.99 to 1.42) for all-cause mortality.

**CONCLUSIONS** In a nationally representative cohort with 17 to 23 years of follow-up, skipping breakfast was associated with a significantly increased risk of mortality from cardiovascular disease. Our study supports the benefits of eating breakfast in promoting cardiovascular health. (J Am Coll Cardiol 2019;73:2025–32)


Cardiovascular disease (CVD) remains the leading cause of death in the United States and worldwide. Over the past decades, numerous dietary and lifestyle risk factors have been identified for CVD morbidity and mortality, forming the basis of the American Heart Association's Diet and Lifestyle Recommendations for Americans. However, previous dietary studies have focused mainly on dietary compositions and their combinations, such as dietary fats, seafood, and Mediterranean diet pattern, and so on. Less is known about the impact of common eating behaviors on CVD outcomes.

Breakfast is believed to be an important meal of the day, whereas there has been an increasing prevalence of skipping breakfast over the past 50 years in the United States, with as many as 23.8% of young people skipping breakfast every day (1–3). However,

Listen to this manuscript's audio summary by Editor-in-Chief Dr. Valentin Fuster on JACC.org.

From the [a]Department of Nutrition and Food Hygiene, School of Public Health, Medical College, Wuhan University of Science and Technology, Wuhan, China; [b]Department of Epidemiology, College of Public Health, University of Iowa, Iowa City, Iowa; [c]Obesity Research and Education Initiative, University of Iowa, Iowa City, Iowa; and the [d]Fraternal Order of Eagles Diabetes Research Center, University of Iowa, Iowa City, Iowa. The authors have reported that they have no relationships relevant to the contents of this paper to disclose.

Manuscript received September 3, 2018; revised manuscript received December 8, 2018, accepted January 8, 2019.

ISSN 0735-1097/$36.00 https://doi.org/10.1016/j.jacc.2019.01.065

JACC VOL. 73, NO. 16, 2019
APRIL 30, 2019:2025–32

**ABBREVIATIONS AND ACRONYMS**

**BMI** = body mass index

**CDC** = Centers for Disease Control and Prevention

**CI** = confidence interval

**CVD** = cardiovascular disease

**HEI-2010** = Healthy Eating Index-2010

**HR** = hazard ratio

**ICD** = International Statistical Classification of Diseases

**NCHS** = National Center for Health Statistics

**NDI** = National Death Index

**NHANES** = National Health and Nutrition Examination Survey

studies on the health effects of skipping breakfast are sparse. Accumulating evidence, although still limited, suggests that skipping breakfast is associated with increased risk of overweight/obesity (2,4), dyslipidemia (5,6), hypertension (7,8), type 2 diabetes (9,10), metabolic syndrome (11), coronary heart disease (12), and cerebrovascular disease (13). It is imperative to understand the long-term health impact of skipping breakfast on cardiovascular mortality in the general population.

The aim of our study was to examine the association of skipping breakfast with cardiovascular and all-cause mortality in a nationally representative cohort in the United States.

SEE PAGE 2033

## METHODS

**STUDY POPULATION.** The National Health and Nutrition Examination Survey (NHANES), conducted by the National Center for Health Statistics (NCHS) at the Centers for Disease Control and Prevention (CDC), is a large-scale, multistage, ongoing, nationally representative health survey of the civilian noninstitutionalized population in the United States (14–16). Each survey participant completed a household interview followed by a physical examination in a mobile examination center. NHANES has been approved by the NCHS Ethics Review Board. Written informed consent was obtained from all participants.

In this study, we used data from NHANES III (1988 to 1994), because information on breakfast eating was available during that period. NHANES III was conducted in two 3-year phases (1988 to 1991 and 1991 to 1994). Of the 39,695 participants in the NHANES III, 33,994 (86%) were interviewed in their homes by trained staff. Seventy-eight percent (30,818) of the selected persons were examined in the mobile examination center, and an additional 493 persons were given a special, limited examination in their homes. Detailed descriptions of NHANES III procedures, interviewing, questionnaires and data collection, quality control techniques, survey design, nonresponse, and sample weighting have been described extensively (17,18).

We included participants 40 to 75 years of age who were free of a history CVD or cancer disease at baseline and had mortality follow-up information including underlying cause of death. Considering individuals at exceptionally high risk of death may change their dietary intake, and therefore, their diet information may no longer represent their habitual consumption, we excluded those who died within 12 months of their NHANES III health examination. After further exclusion of participants who were pregnant, who had missing information on frequency of breakfast consumption, and who had daily total energy intake <500 kcal or >5,000 kcal, 6,550 subjects were included as the analytical sample.

**OUTCOME ASCERTAINMENT.** We used the NHANES III Public-Use Linked Mortality File through December 31, 2011, which was linked by the NCHS to the National Death Index with a probabilistic matching algorithm to determine the mortality status (19). National Death Index is an NCHS centralized database of all deaths in the United States. Data about underlying cause of death were used for case definition according to the 9th Revision International Statistical Classification of Diseases (ICD-9) through 1998, and the remainder for case definition according to the 10th Revision (ICD-10). In order to adjust for changes between the 2 coding systems, final causes of deaths occurring before 1999 were recorded into comparable ICD-10-based underlying-cause-of-death groups (19). The NCHS classified mortality from heart diseases, including acute rheumatic fever and chronic rheumatic heart diseases (codes I00-I09), hypertensive heart disease (codes I11), hypertensive heart and renal disease (codes I13), ischemic heart diseases (codes I20-I25) and other heart diseases (codes I26-I51), and mortality from cerebrovascular disease (i.e., stroke) (codes I60-I69) according to ICD-10 (20). We defined deaths from CVD as death from either heart disease or cerebrovascular disease. Follow-up of participants continued until death, with censoring at the time of death for those who died of causes other than CVD, or on December 31, 2011, for those who survived. Follow-up time for each person was calculated as the difference between the NHANES III examination date and the last known date alive or censored from the NHANES III mortality file.

**EXPOSURE MEASUREMENT.** All participants were asked "How often do you eat breakfast?" during the household interview, and the possible answers included "every day," "some days," "rarely," "never," and "weekends only." We merged the answer "weekends only" into the category "some days" for analysis. Finally, the frequency of breakfast eating was classified as "never," "rarely," "some days," and "every day."

**COVARIATE ASSESSMENT.** Information on age, sex, race/ethnicity, family income, smoking status, alcoholic intake, and physical activity was collected using standardized questionnaires during interviews. Race/ethnicity was classified as non-Hispanic white, non-Hispanic black, Mexican American, or other. Marital status was categorized as married (married and living

as married), widowed, divorced, and single (never married and separated). Family income-to-poverty ratios were categorized as ≤1.30, 1.31 to 3.50, and >3.50. A higher income-to-poverty ratio represents a higher family income status. Participants were categorized as nonsmoker, past smoker, and current smokers based on their responses to questions about smoking at least 100 cigarettes during their lifetime and whether they were currently smoking. The amount of alcohol consumed was determined based on the responses to 2 survey queries that questioned the number of days of drinking over the past 12 months and the number of drinks per day on a given drinking day (21). Current alcohol intake was categorized as none (0 g/day), moderate drinking (0.1 to 27.9 g/day for men and 0.1 to 13.9 g/day for women), and heavy drinking (≥28 g/day for men and ≥14 g/d for women) (22). For physical activity, the inactive group was defined as those with no reported leisure time physical activity, the active group was defined as those who had recommended levels of physical activity (23) (i.e., self-reported leisure time moderate activity [metabolic equivalents ranging from 3 to 6] of 5 or more times per week or leisure time vigorous activity [metabolic equivalents >6] 3 or more times per week), and the insufficiently active group was defined as those who were not inactive and did not meet the criteria for recommended levels of physical activity. Dietary information was collected through 24-h dietary recall interviews. Total energy intake was calculated using the U.S. Department of Agriculture Automated Multiple-Pass Method. We used the Healthy Eating Index-2010 (HEI-2010) to indicate the overall quality of diet (HEI-2010 score from 0 to 100, with 100 being the best-quality diet) (24).

Measurements of height, weight, and blood pressure were performed following a standardized protocol. Body mass index (BMI) was calculated as weight in kilograms divided by height in meters squared ($kg/m^2$, <25, 25 to 29.9, ≥30) (18). Hypertension was defined as currently taking antihypertensive medication, or if not, having systolic blood pressure level ≥130 mm Hg and/or diastolic blood pressure level ≥80 mm Hg, according to the 2017 American College of Cardiology/American Heart Association hypertension guidelines (25). Diabetes was defined as having been diagnosed with diabetes or currently taking insulin or were taking diabetes pills, or having a hemoglobin $A_{1c}$ level ≥6.5% or a fasting plasma glucose level ≥126 mg/dl (26). Dyslipidemia was defined as having a physician's diagnosis or currently taking cholesterol-lowering medications, or having a triglyceride level ≥150 mg/dl or high-density lipoprotein cholesterol level <40 mg/dl based on recommendations by the National Cholesterol Education Program Adult Treatment Panel III (27).

**STATISTICAL ANALYSIS.** All statistical analyses accounted for the complex, multistage, stratified, and cluster-sampling design (including oversampling of certain subpopulations) of NHANES by using sample weights, strata, and primary sampling units embedded in the NHANES data. Means and proportions of baseline characteristics were compared by using linear regression for continuous variables and logistic regression for categorical variables. The associations between breakfast consumption frequency and cardiovascular and all-cause mortality were investigated by using Cox proportional hazards regression models with the following covariates: age, sex, and race/ethnicity (model 1); model 1 plus marital status, family income level, smoking status, alcohol intake, and physical activity (model 2); model 2 plus total energy intake and overall diet quality indicated by HEI-2010 (model 3). We further adjusted for BMI, hypertension (yes/no), diabetes (yes/no), and dyslipidemia (yes/no) in a separate model (model 4). We have checked model assumptions for all the analyses. All statistical analyses were conducted using survey modules of SAS software version 9.4 (SAS Institute, Cary, North Carolina). Two-sided p values <0.05 was considered statistically significant.

## RESULTS

Among the 6,550 participants 40 to 75 years of age (mean age 53.2 years, SE ± 0.3; 48.0% male) in this study, 5.1% (n = 336) never consumed breakfast, 10.9% (n = 713) rarely consumed breakfast, 25.0% (n = 1,639) consumed breakfast some days, and 59.0% (n = 3,862) consumed breakfast every day. During 112,148 person-years of follow-up (median follow-up 18.8 years; maximum follow-up 23 years), 2,318 deaths occurred including 619 deaths from CVD. As shown in **Table 1**, participants who never consumed breakfast were more likely to be non-Hispanic black, former smokers, heavy drinkers, unmarried, physically inactive, and with less family income, lower total energy intake, and poorer dietary quality, when compared with those who regularly ate breakfast. As shown in **Table 2**, participants who never consumed breakfast were more likely to have obesity, and higher total blood cholesterol level than those who consumed breakfast regularly.

Participants who never consumed breakfast were at higher risk for death from CVD. After adjustment for age, sex, and race/ethnicity, participants who never consumed breakfast had a 75% higher risk of

**TABLE 1 Baseline Demographic and Lifestyle Characteristics of the Study Population, According to the Frequency of Breakfast Consumption**

| | Frequency of Breakfast Consumption | | | | |
|---|---|---|---|---|---|
| | Every Day (n = 3,862) | Some Days (n = 1,639) | Rarely (n = 713) | Never (n = 336) | p Value |
| Mean age, yrs | 55.62 ± 0.31 | 49.47 ± 0.40 | 49.54 ± 0.40 | 52.82 ± 0.85 | 0.005 |
| Sex, % | | | | | |
| Male | 45.81 ± 1.05 | 52.59 ± 1.53 | 49.49 ± 3.06 | 46.40 ± 4.22 | 0.030 |
| Female | 54.19 ± 1.05 | 47.41 ± 1.53 | 50.51 ± 3.06 | 53.60 ± 4.22 | |
| Race/ethnicity, % | | | | | |
| Non-Hispanic white | 79.77 ± 1.43 | 75.69 ± 1.75 | 79.18 ± 1.82 | 68.62 ± 4.14 | <0.001 |
| Non-Hispanic black | 7.98 ± 0.52 | 14.73 ± 1.09 | 11.56 ± 1.14 | 13.20 ± 1.67 | |
| Hispanic | 4.16 ± 0.39 | 4.34 ± 0.35 | 3.57 ± 0.36 | 4.13 ± 0.75 | |
| Other | 8.09 ± 1.24 | 5.24 ± 1.12 | 5.69 ± 1.32 | 14.05 ± 4.11 | |
| Marital status, % | | | | | |
| Married | 73.92 ± 1.01 | 73.93 ± 1.58 | 73.24 ± 2.46 | 68.60 ± 4.08 | 0.593 |
| Widowed | 7.80 ± 0.57 | 6.42 ± 0.81 | 6.94 ± 1.19 | 9.99 ± 2.10 | |
| Divorced | 10.30 ± 0.90 | 11.43 ± 1.15 | 13.43 ± 1.88 | 12.43 ± 2.24 | |
| Single | 7.89 ± 0.64 | 8.06 ± 0.91 | 6.31 ± 1.35 | 8.65 ± 3.49 | |
| Ratio of family income to poverty, % | | | | | |
| ≤1.30 | 7.71 ± 0.73 | 8.80 ± 1.32 | 9.26 ± 1.62 | 12.30 ± 2.92 | 0.193 |
| 1.31–3.50 | 34.59 ± 1.40 | 35.22 ± 1.90 | 33.87 ± 2.54 | 41.76 ± 3.96 | |
| >3.50 | 50.45 ± 1.88 | 50.39 ± 2.36 | 50.56 ± 3.43 | 38.71 ± 3.56 | |
| Missing | 7.25 ± 0.55 | 5.59 ± 0.84 | 6.32 ± 1.56 | 7.23 ± 2.25 | |
| Smoking status, % | | | | | |
| Nonsmoker | 47.63 ± 1.40 | 36.00 ± 1.36 | 29.75 ± 2.95 | 24.84 ± 3.32 | <0.001 |
| Current smoking | 34.82 ± 1.09 | 30.27 ± 1.52 | 33.70 ± 3.21 | 26.86 ± 4.03 | |
| Former smokers | 17.56 ± 1.01 | 33.73 ± 1.57 | 36.55 ± 3.59 | 48.30 ± 4.32 | |
| Alcohol drinking status, %* | | | | | |
| Nondrinker | 76.42 ± 1.24 | 72.11 ± 2.29 | 66.24 ± 3.41 | 70.12 ± 3.61 | <0.001 |
| Moderate drinking | 7.96 ± 0.78 | 8.03 ± 1.09 | 7.98 ± 1.93 | 5.07 ± 1.27 | |
| Heavy drinking | 11.17 ± 1.01 | 15.92 ± 1.68 | 21.44 ± 2.52 | 17.22 ± 2.53 | |
| Missing | 4.44 ± 0.64 | 3.95 ± 0.84 | 4.34 ± 1.19 | 7.59 ± 2.69 | |
| Physical activity, % | | | | | |
| Inactive | 13.84 ± 0.96 | 14.76 ± 1.30 | 15.56 ± 1.58 | 28.34 ± 2.55 | <0.001 |
| Insufficient | 41.39 ± 1.59 | 50.95 ± 1.66 | 50.00 ± 2.49 | 34.93 ± 2.94 | |
| Recommended level | 44.77 ± 1.77 | 34.29 ± 1.63 | 34.44 ± 2.57 | 36.74 ± 4.19 | |
| Mean total energy intake, kcal/day | 2,010.85 ± 24.99 | 2,097.99 ± 32.81 | 2,022.21 ± 43.43 | 1,733.58 ± 54.70 | <0.001 |
| Mean HEI-2010 | 68.08 ± 0.40 | 61.30 ± 0.58 | 60.40 ± 0.67 | 57.53 ± 1.17 | <0.001 |

Values are weighted mean ± SE for continuous variables or weighted % ± SE for categorical variables. *Nondrinker: 0 g/day; moderate drinking: 0.1 to 27.9 g/day for men and 0.1 to 13.9 g/day for women; heavy drinking: ≥28 g/day for men and ≥14 g/day for women.

HEI-2010 = Healthy Eating Index-2010.

all-cause mortality (hazard ratio [HR]: 1.75; 95% confidence interval [CI]: 1.46 to 2.10) and 2.58-fold higher risk of cardiovascular mortality (HR: 2.58; 95% CI: 1.64 to 4.06) compared with those who consumed breakfast every day. In the fully adjusted model, the multivariable-adjusted HRs for all-cause mortality and cardiovascular mortality for participants who never consumed breakfast were 1.19 (95% CI: 0.99 to 1.42) and 1.87 (95% CI: 1.14 to 3.04), respectively (**Table 3, Central Illustration**). Sensitivity analysis excluding participants with diabetes yielded similar results for both all-cause mortality and CVD mortality (data not shown).

We further examined the associations of breakfast eating with heart disease-specific and stroke-specific mortality separately (**Table 4**). Compared with those who consumed breakfast every day, participants who never consumed breakfast had a higher risk of heart disease-specific mortality (HR: 2.34; 95% CI: 1.44 to 3.80) and stroke-specific mortality (HR: 3.53; 95% CI: 1.40 to 8.95) in models adjusted for age, sex, race/ethnicity (**Table 4**). In the fully-adjusted model, the association between skipping breakfast and heart disease-specific mortality was moderately attenuated and became non-significant (HR: 1.59; 95% CI: 0.90 to

**TABLE 2 Distribution of CVD Risk Factors of the Study Population, According to the Frequency of Breakfast Consumption**

| CVD Risk Factors | Frequency of Breakfast Consumption | | | | p Value |
|---|---|---|---|---|---|
| | Every Day (n = 3,862) | Some Days (n = 1,639) | Rarely (n = 713) | Never (n = 336) | |
| BMI categories, % | | | | | |
| <25.0 | 37.45 ± 1.44 | 33.88 ± 1.70 | 38.34 ± 3.13 | 35.09 ± 3.75 | 0.001 |
| 25.0–29.9 | 37.21 ± 1.23 | 37.43 ± 2.07 | 33.98 ± 2.50 | 29.53 ± 3.41 | |
| ≥30.0 | 25.23 ± 1.16 | 28.65 ± 1.74 | 27.65 ± 2.50 | 34.21 ± 4.16 | |
| Hypertension, % | 54.97 ± 1.16 | 51.48 ± 1.76 | 53.21 ± 3.13 | 53.15 ± 4.04 | 0.050 |
| DBP, mm Hg | 76.46 ± 0.23 | 77.45 ± 0.41 | 77.78 ± 0.50 | 77.14 ± 0.68 | 0.269 |
| SBP, mm Hg | 127.79 ± 0.48 | 125.10 ± 0.74 | 125.49 ± 0.86 | 127.50 ± 1.43 | 0.919 |
| Diabetes, % | 15.14 ± 0.99 | 10.75 ± 1.12 | 8.91 ± 1.58 | 17.13 ± 3.00 | <0.001 |
| Fasting glucose, mg/dl | 104.24 ± 0.90 | 100.84 ± 1.20 | 100.55 ± 2.02 | 107.56 ± 3.31 | 0.338 |
| Dyslipidemia, % | 46.70 ± 1.85 | 46.90 ± 1.85 | 41.39 ± 2.60 | 47.75 ± 4.02 | 0.199 |
| TC, mg/dl | 216.09 ± 1.41 | 214.05 ± 1.53 | 220.59 ± 2.02 | 225.72 ± 3.51 | 0.005 |
| LDL-c, mg/dl | 135.39 ± 1.61 | 135.72 ± 1.86 | 140.54 ± 2.58 | 141.19 ± 6.55 | 0.304 |
| HDL-c, mg/dl | 50.81 ± 0.51 | 49.74 ± 0.63 | 52.35 ± 0.98 | 50.98 ± 1.50 | 0.478 |
| TG, mg/dl | 161.54 ± 4.77 | 153.61 ± 3.59 | 148.03 ± 6.87 | 167.40 ± 7.41 | 0.690 |

Values are weighted % ± SE for categorical variables or weighted mean ± SE for continuous variables.

BMI = body mass index; CVD = cardiovascular disease; DBP = diastolic blood pressure; HDL-c = high-density lipoprotein cholesterol; LDL-c = low-density lipoprotein cholesterol; SBP = systolic blood pressure; TC = total cholesterol; TG = triglycerides.

2.80). However, the association between skipping breakfast and stroke-specific mortality remained significant (HR: 3.39; 95% CI: 1.40 to 8.24).

## DISCUSSION

In this large prospective study of a nationally representative cohort with 17 to 23 years of follow-up, we found that skipping breakfast was significantly associated with an increased risk of cardiovascular mortality, especially stroke-specific mortality. The association was independent of demographic, socioeconomic, dietary, and lifestyle factors; BMI; and cardiovascular risk factors.

To the best of our knowledge, this is the first prospective analysis of skipping breakfast and risk of cardiovascular mortality. Our findings are generally in line with previous studies on the relationship between breakfast eating and CVD incidence. A cohort of male U.S. health professionals showed that men who skipped breakfast had a 27% higher risk of coronary heart disease compared with men who ate breakfast (12). Another prospective cohort study of a Japanese general population indicated 14%, 18%, and 36% greater risks for incident total CVD, total stroke, and hemorrhage stroke, respectively, among those skipping breakfast (13). A cross-sectional analysis performed within the Progression of Early Subclinical Atherosclerosis study indicated that skipping breakfast was associated with increased odds for prevalent noncoronary and generalized atherosclerosis independently of the presence of conventional cardiovascular risk factors (28). Recently, habitual breakfast skippers were found at increased risk for development of coronary artery disease and hypertension in Western India (29). In addition, longitudinal studies also showed that skipping breakfast may have detrimental effects on cardiometabolic risk factors, including general obesity, abdominal obesity, metabolic syndrome, hypertension, and higher fasting insulin, total cholesterol, and low-density lipoprotein cholesterol concentrations (6,11). Taken together, these studies as well as our findings

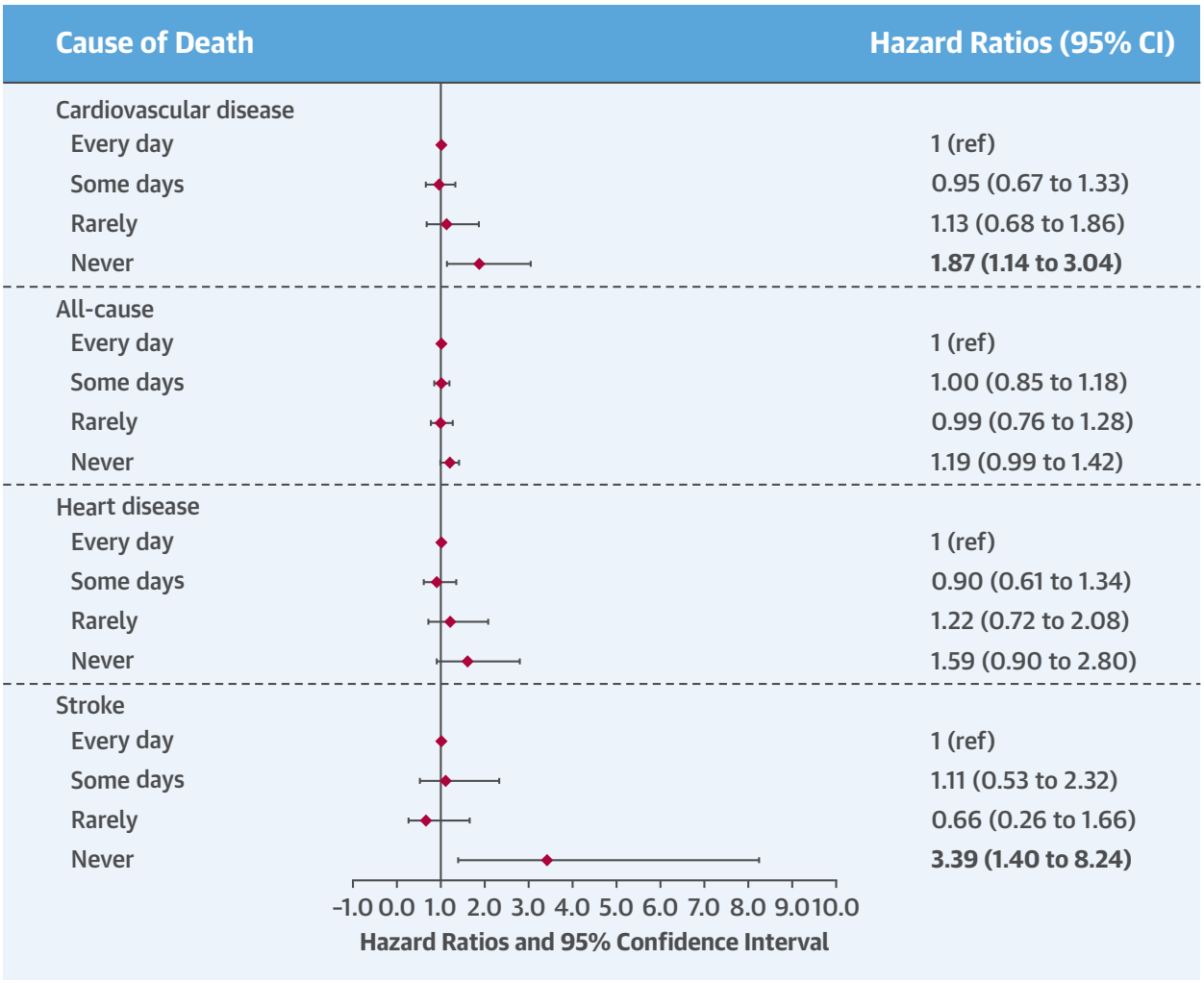
**TABLE 3 Associations of Breakfast Consumption Frequency With Cardiovascular and All-Cause Mortality in U.S. Adults 40 to 75 Years of Age**

| | Frequency of Breakfast Consumption | | | |
|---|---|---|---|---|
| | Every Day | Some Days | Rarely | Never |
| CVD mortality | | | | |
| Deaths/person-yrs | 415/64,594 | 114/29,290 | 49/12,655 | 41/5,609 |
| Unadjusted | 1 (ref) | 0.55 (0.39–0.77) | 0.63 (0.39–1.01) | 1.79 (1.02–3.15) |
| Model 1 | 1 (ref) | 1.09 (0.80–1.49) | 1.29 (0.80–2.08) | 2.58 (1.64–4.06) |
| Model 2 | 1 (ref) | 0.96 (0.70–1.32) | 1.10 (0.67–1.81) | 1.93 (1.16–3.19) |
| Model 3 | 1 (ref) | 0.94 (0.67–1.31) | 1.10 (0.67–1.80) | 1.84 (1.12–3.03) |
| Model 4 | 1 (ref) | 0.95 (0.67–1.33) | 1.13 (0.68–1.86) | 1.87 (1.14–3.04) |
| All-cause mortality | | | | |
| Deaths/person-yrs | 1,533/64,594 | 462/29,290 | 198/12,655 | 125/5,609 |
| Unadjusted | 1 (ref) | 0.67 (0.56–0.80) | 0.67 (0.53–0.84) | 1.27 (0.99–1.64) |
| Model 1 | 1 (ref) | 1.18 (1.01–1.38) | 1.22 (0.95–1.55) | 1.75 (1.46–2.10) |
| Model 2 | 1 (ref) | 1.01 (0.86–1.19) | 1.01 (0.77–1.30) | 1.23 (1.02–1.49) |
| Model 3 | 1 (ref) | 1.00 (0.84–1.18) | 0.98 (0.75–1.27) | 1.17 (0.96–1.42) |
| Model 4 | 1 (ref) | 1.00 (0.85–1.18) | 0.99 (0.76–1.28) | 1.19 (0.99–1.42) |

Values are n or weighted hazard ratio (95% confidence interval). Model 1: adjusted for age, sex, and race/ethnicity. Model 2: model 1 + marital status, family income level, smoking status, alcohol intake, physical activity. Model 3: model 2 + total energy intake and overall diet quality indicated by Healthy Eating Index-2010. Model 4: model 3 + body mass index, hypertension, diabetes mellitus, and dyslipidemia.

CVD = cardiovascular disease.

**CENTRAL ILLUSTRATION** **Hazard Ratios for Mortality From All Causes, Cardiovascular Disease, Heart Disease, and Stroke Based on Frequency of Breakfast Consumption**




**Rong, S. et al. J Am Coll Cardiol. 2019;73(16):2025-32.**

Hazard ratios were adjusted for age, sex, race/ethnicity, marital status, family income level, smoking status, alcohol intake, physical activity, total energy intake, overall diet quality indicated by Healthy Eating Index-2010, body mass index, hypertension, diabetes mellitus, and dyslipidemia. **Horizontal lines** represent 95% confidence intervals. CI = confidence interval.

underscore the importance of eating breakfast as a simple way to promote cardiovascular health and prevent cardiovascular morbidity and mortality.

Skipping breakfast is related to less daily total energy intake. In this study, participants who never consumed breakfast had 14% less daily total energy intake, compared with those who consumed breakfast every day. However, the reduced calorie intake may not explain the observed association between skipping breakfast and higher risk of cardiovascular mortality, because animal studies and some previous epidemiological studies have reported protective effects of caloric restriction on reducing the risk of chronic diseases and mortality (30,31). Several mechanisms may explain how skipping breakfast may induce cardiometabolic abnormalities and ultimately lead to cardiovascular mortality. First, skipping breakfast, which is related to changes in appetite and decreased satiety, might lead to overeating later and impairment in insulin sensitivity (32-34). By contrast, eating breakfast has a beneficial effect on appetite regulation and also improves the glycemic response at the next eating occasion with increased sensitivity to insulin (35,36). Second, skipping breakfast was

associated with stress-independent overactivity in the hypothalamic-pituitary-adrenal axis because of a longer period of fasting, leading to elevated blood pressure in the morning (7). Eating breakfast has also been shown to help lower blood pressure (37,38), which in turn may prevent blood vessel clogging, hemorrhage, and cardiovascular events. Third, skipping breakfast might also induce deleterious changes in lipid levels, such as higher total cholesterol and atherogenic low-density lipoprotein cholesterol concentrations, which are independent risk factors of atherosclerosis (6,28). Fourth, skipping breakfast may be a behavioral marker for unhealthy dietary and lifestyle habits (39). However, in this study, we have adjusted for a variety of dietary and lifestyle factors including smoking, alcohol drinking, physical activity, total energy intake, and overall diet quality, and the association between skipping breakfast and cardiovascular mortality remained significant.

**STUDY STRENGTHS.** The major strengths of this population-based study are the use of a nationally representative sample, which facilitates generalization of the findings to the general population in the United States, the long-term follow-up period of up to 23 years, and the low rates of unmatched records in the NHANES III Linked Mortality File. In addition, with the comprehensive data collected in NHANES III, we were able to control potential confounding effects from a variety of demographic, socioeconomic, lifestyle, and dietary factors.

**STUDY LIMITATIONS.** First, we did not have information about what foods and beverages NHANES III participants consumed for breakfast. Beyond the health benefits of eating breakfast compared with skipping breakfast, it is interesting to understand how different choices of foods and beverages for breakfast will affect mortality risk. Second, we were not able to assess the effects of changes in breakfast eating habits during the follow-up on cardiovascular and all-cause mortality, because information on breakfast eating in NHANES III was collected only at baseline. Third, the NHANES III Linked Mortality File identified causes of death through linkage to the National Death Index, which is based on death certificates. Although this approach has been previously validated by the CDC and used in many CDC reports or relevant published reports, we could not rule out the possibility of errors in classification of the cause of death. Finally, although we have adjusted for many potential confounders, we could not completely rule out the possibility of residual confounding by unmeasured factors.

**TABLE 4 Associations of Breakfast Consumption Frequency With Heart Disease and Stroke Mortality in U.S. Adults 40 to 75 Years of Age**

| | Frequency of Breakfast Consumption | | | |
|---|---|---|---|---|
| | Every Day | Some Days | Rarely | Never |
| Heart disease mortality | | | | |
| Deaths/person-yrs | 312/64,594 | 88/29,290 | 39/12,655 | 33/5,609 |
| Unadjusted | 1 (ref) | 0.55 (0.37–0.81) | 0.71 (0.42–1.21) | 1.61 (0.90–2.87) |
| Model 1 | 1 (ref) | 1.09 (0.76–1.56) | 1.45 (0.86–2.45) | 2.34 (1.44–3.80) |
| Model 2 | 1 (ref) | 0.94 (0.65–1.36) | 1.22 (0.71–2.09) | 1.71 (0.99–2.98) |
| Model 3 | 1 (ref) | 0.90 (0.62–1.33) | 1.19 (0.69–2.03) | 1.58 (0.90–2.78) |
| Model 4 | 1 (ref) | 0.90 (0.61–1.34) | 1.22 (0.72–2.08) | 1.59 (0.90–2.80) |
| Stroke mortality | | | | |
| Deaths/person-yrs | 103/64,594 | 26/29,290 | 10/12,655 | 8/5,609 |
| Unadjusted | 1 (ref) | 0.55 (0.29–1.05) | 0.32 (0.14–0.73) | 2.57 (0.90–7.35) |
| Model 1 | 1 (ref) | 1.09 (0.55–2.12) | 0.66 (0.28–1.55) | 3.53 (1.40–8.95) |
| Model 2 | 1 (ref) | 1.01 (0.51–2.00) | 0.59 (0.24–1.46) | 2.99 (1.21–7.40) |
| Model 3 | 1 (ref) | 1.07 (0.53–2.15) | 0.64 (0.26–1.59) | 3.25 (1.34–7.90) |
| Model 4 | 1 (ref) | 1.11 (0.53–2.32) | 0.66 (0.26–1.66) | 3.39 (1.40–8.24) |

Values are n or weighted hazard ratio (95% confidence interval). Model 1: adjusted for age, sex, and race/ethnicity. Model 2: model 1 + marital status, family income level, smoking status, alcohol intake, and physical activity. Model 3: model 2 + total energy intake and overall diet quality indicated by Healthy Eating Index-2010. Model 4: model 3 + body mass index, hypertension, diabetes mellitus, and dyslipidemia.

## CONCLUSIONS

In this large prospective study of U.S. adults 40 to 75 years of age, we found that skipping breakfast was significantly associated with an increased risk of death from CVD. Our study supports the benefits of eating breakfast in promoting cardiovascular health.

**ACKNOWLEDGMENTS** The authors thank the participants and staff of the National Health and Nutrition Examination Survey III 1988 to 1994 for their valuable contributions.

**ADDRESS FOR CORRESPONDENCE:** Dr. Wei Bao, Department of Epidemiology, College of Public Health, University of Iowa, 145 North Riverside Drive, Room S431 CPHB, Iowa City, Iowa 52242. E-mail: wei-bao@uiowa.edu. Twitter: @UIowaCPH.

## PERSPECTIVES

**COMPETENCY IN MEDICAL KNOWLEDGE:** Regularly skipping breakfast in a middle-aged and older population without known CVD is associated with an increased risk of death from CVD.

**TRANSLATIONAL OUTLOOK:** Further studies are needed to elucidate the biological mechanisms underlying this association to optimize the impact of a targeted intervention that might improve cardiovascular health.

## REFERENCES

**1.** Haines PS, Guilkey DK, Popkin BM. Trends in breakfast consumption of US adults between 1965 and 1991. J Am Diet Assoc 1996;96:464–70.

**2.** Deshmukh-Taskar P, Nicklas TA, Radcliffe JD, O'Neil CE, Liu Y. The relationship of breakfast skipping and type of breakfast consumed with overweight/obesity, abdominal obesity, other cardiometabolic risk factors and the metabolic syndrome in young adults. The National Health and Nutrition Examination Survey (NHANES): 1999-2006. Public Health Nutr 2013;16:2073–82.

**3.** Kant AK, Graubard BI. 40-year trends in meal and snack eating behaviors of American adults. J Acad Nutr Diet 2015;115:50–63.

**4.** van der Heijden AA, Hu FB, Rimm EB, van Dam RM. A prospective study of breakfast consumption and weight gain among U.S. men. Obesity (Silver Spring) 2007;15:2463–9.

**5.** Farshchi HR, Taylor MA, Macdonald IA. Deleterious effects of omitting breakfast on insulin sensitivity and fasting lipid profiles in healthy lean women. Am J Clin Nutr 2005;81:388–96.

**6.** Smith KJ, Gall SL, McNaughton SA, Blizzard L, Dwyer T, Venn AJ. Skipping breakfast: longitudinal associations with cardiometabolic risk factors in the Childhood Determinants of Adult Health Study. Am J Clin Nutr 2010;92:1316–25.

**7.** Witbracht M, Keim NL, Forester S, Widaman A, Laugero K. Female breakfast skippers display a disrupted cortisol rhythm and elevated blood pressure. Physiol Behav 2015;140:215–21.

**8.** Lee TS, Kim JS, Hwang YJ, Park YC. Habit of eating breakfast is associated with a lower risk of hypertension. J Lifestyle Med 2016;6:64–7.

**9.** Ballon A, Neuenschwander M, Schlesinger S. Breakfast skipping is associated with increased risk of type 2 diabetes among adults: a systematic review and meta-analysis of prospective cohort studies. J Nutr 2019;149:106–13.

**10.** Bi H, Gan Y, Yang C, Chen Y, Tong X, Lu Z. Breakfast skipping and the risk of type 2 diabetes: a meta-analysis of observational studies. Public Health Nutr 2015;18:3013–9.

**11.** Odegaard AO, Jacobs DR Jr., Steffen LM, Van Horn L, Ludwig DS, Pereira MA. Breakfast frequency and development of metabolic risk. Diabetes Care 2013;36:3100–6.

**12.** Cahill LE, Chiuve SE, Mekary RA, et al. Prospective study of breakfast eating and incident coronary heart disease in a cohort of male US health professionals. Circulation 2013;128:337–43.

**13.** Kubota Y, Iso H, Sawada N, Tsugane S, Group JS. Association of breakfast intake with incident stroke and coronary heart disease: the Japan Public Health Center-Based Study. Stroke 2016;47:477–81.

**14.** National Center for Health Statistics. Plan and Operation of the Third National Health and Nutrition Examination Survey (NHANES III, 1988-94): Reference Manuals and Reports: Weighting and Estimation Methodology Report. Hyattsville, MD: Centers for Disease Control and Prevention, 1998.

**15.** National Center for Health Statistics. National Health and Nutrition Examination Survey: NHANES Questionnaires, Datasets, and Related Documentation. Available at: https://wwwn.cdc.gov/nchs/nhanes/Default.aspx. Accessed January 28, 2012.

**16.** Ahluwalia N, Dwyer J, Terry A, Moshfegh A, Johnson C. Update on NHANES dietary data: focus on collection, release, analytical considerations, and uses to inform public policy. Adv Nutr 2016;7:121–34.

**17.** National Center for Health Statistics, U.S. Department of Health and Human Services. NHANES III Reference Manuals and Reports (CD-ROM). Hyattsville, MD: Centers for Disease Control and Prevention, 1996.

**18.** Plan and operation of the Third National Health and Nutrition Examination Survey, 1988-94. Series 1: programs and collection procedures. Vital Health Stat 1 1994:1–407.

**19.** National Center for Health Statistics. NCHS 2011 Linked Mortality Files Matching Methodology. Hyattsville, MD: Office of Analysis and Epidemiology, 2013.

**20.** World Health Organization. International Statistical Classification of Diseases and Related Health Problems: Tenth Revision. 2nd edition. Geneva, Switzerland: World Health Organization, 2004.

**21.** Liangpunsakul S. Relationship between alcohol intake and dietary pattern: findings from NHANES III. World J Gastroenterol 2010;16:4055–60.

**22.** U.S. Department of Agriculture and U.S. Department of Health and Human Services. 2015-2020 Dietary Guidelines for Americans. 8 edition. Washington, DC: U.S. Government Printing Office, 2015.

**23.** Pate RR, Pratt M, Blair SN, et al. Physical activity and public health. A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. JAMA 1995;273:402–7.

**24.** Retnakaran R, Qi Y, Connelly PW, Sermer M, Hanley AJ, Zinman B. Low adiponectin concentration during pregnancy predicts postpartum insulin resistance, beta cell dysfunction and fasting glycaemia. Diabetologia 2010;53:268–76.

**25.** Whelton PK, Carey RM, Aronow WS, et al. 2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults: executive summary: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. J Am Coll Cardiol 2018;71:2199–269.

**26.** Menke A, Casagrande S, Geiss L, Cowie CC. Prevalence of and trends in diabetes among adults in the United States, 1988-2012. JAMA 2015;314:1021–9.

**27.** National Cholesterol Education Program (NCEP). Expert Panel on Detection Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). Third Report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III) final report. Circulation 2002;106:3143–421.

**28.** Uzhova I, Fuster V, Fernandez-Ortiz A, et al. The importance of breakfast in atherosclerosis disease: insights from the PESA study. J Am Coll Cardiol 2017;70:1833–42.

**29.** Sharma K, Shah K, Brahmbhatt P, Kandre Y. Skipping breakfast and the risk of coronary artery disease. QJM 2018;111:715–9.

**30.** Most J, Tosti V, Redman LM, Fontana L. Calorie restriction in humans: an update. Ageing Res Rev 2017;39:36–45.

**31.** Ahmet I, Tae HJ, de Cabo R, Lakatta EG, Talan MI. Effects of calorie restriction on cardioprotection and cardiovascular health. J Mol Cell Cardiol 2011;51:263–71.

**32.** Alwattar AY, Thyfault JP, Leidy HJ. The effect of breakfast type and frequency of consumption on glycemic response in overweight/obese late adolescent girls. Eur J Clin Nutr 2015;69:885–90.

**33.** Astbury NM, Taylor MA, Macdonald IA. Breakfast consumption affects appetite, energy intake, and the metabolic and endocrine responses to foods consumed later in the day in male habitual breakfast eaters. J Nutr 2011;141:1381–9.

**34.** Reutrakul S, Hood MM, Crowley SJ, Morgan MK, Teodori M, Knutson KL. The relationship between breakfast skipping, chronotype, and glycemic control in type 2 diabetes. Chronobiol Int 2014;31:64–71.

**35.** Jovanovic A, Gerrard J, Taylor R. The second-meal phenomenon in type 2 diabetes. Diabetes Care 2009;32:1199–201.

**36.** Gwin JA, Leidy HJ. A review of the evidence surrounding the effects of breakfast consumption on mechanisms of weight management. Adv Nutr 2018;9:717–25.

**37.** Ahuja KD, Robertson IK, Ball MJ. Acute effects of food on postprandial blood pressure and measures of arterial stiffness in healthy humans. Am J Clin Nutr 2009;90:298–303.

**38.** Peitzman SJ, Berger SR. Postprandial blood pressure decrease in well elderly persons. Arch Intern Med 1989;149:286–8.

**39.** Park S, Rim SJ, Lee JH. Associations between dietary behaviours and perceived physical and mental health status among Korean adolescents. Nutr Diet 2018;75:488–93.

**KEY WORDS** all-cause mortality, cardiovascular mortality, skipping breakfast