Fried potato consumption is associated with elevated mortality: an 8-y longitudinal cohort study

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ABSTRACT

Background: Few studies have assessed the association between potato consumption and mortality.

Objective: We investigated whether potato consumption (including fried and unfried potatoes) is associated with increased premature mortality risk in a North American cohort.

Design: A longitudinal analysis included 4440 participants aged 45–79 y at baseline with an 8-y follow-up from the Osteoarthritis Initiative cohort study. Potato consumption (including fried and unfried potatoes) was analyzed by using a Block Brief 2000 food-frequency questionnaire and categorized as ≤1 time/mo, 2–3 times/mo, 1 time/wk, 2 times/wk, or ≥3 times/wk. Mortality was ascertained through validated cases of death. To investigate the association between potato consumption and mortality, Cox regression models were constructed to estimate HRs with 95% CIs, with adjustment for potential confounders.

Results: Of the 4400 participants, 2551 (57.9%) were women with a mean ± SD age of 61.3 ± 9.2 y. During the 8-y follow-up, 236 participants died. After adjustment for 14 potential baseline confounders, and taking those with the lowest consumption of potatoes as the reference group, participants with the highest consumption of potatoes did not show an increased risk of overall mortality (HR: 1.11; 95% CI: 0.65, 1.91). However, subgroup analyses indicated that participants who consumed fried potatoes 2–3 times/wk (HR: 1.95; 95% CI: 1.11, 3.41) and ≥3 times/wk (HR: 2.26; 95% CI: 1.15, 4.47) were at an increased risk of mortality. The consumption of unfried potatoes was not associated with an increased mortality risk.

Conclusions: The frequent consumption of fried potatoes appears to be associated with an increased mortality risk. Additional studies in larger sample sizes should be performed to confirm if overall potato consumption is associated with higher mortality risk. This trial was registered at clinicaltrials.gov as NCT00080171. *Am J Clin Nutr* 2017;106:162–7.

Keywords: mortality, potato, risk factor, Osteoarthritis Initiative.

INTRODUCTION

White potatoes have been a staple food in many traditional diets of the Western world (1). In recent years, the overall consumption of potatoes has declined in the United States, but processed potato intake (e.g., French fries and chips) has dramatically increased (2). Potatoes are rich in starch and have a high glycemic index, which has been associated with an increased risk of developing obesity, diabetes, and cardiovascular disease (CVD) (3). However, compared with other common carbohydrate sources, potatoes have a low energy density because of their high water content (4). In addition, potatoes provide other important micronutrients, which are all associated with a decreased risk of morbidity and mortality (5). Therefore, potatoes represent a contradictory food because they contain both macro- and micronutrients with possible beneficial and harmful effects on health.

The literature on potato consumption and common medical conditions is equivocal. A study that included 3 North American cohorts reported that greater consumption of potatoes

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Supplemental Figure 1 is available from the "Online Supporting Material" link in the online posting of the article and from the same link in the online table of contents at http://ajcn.nutrition.org.

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(i.e., ≥7 servings/wk) was associated with a 33% higher risk of diabetes, independently of several potential confounders (6). In this study, even the intake of 3 servings/wk was associated with an increased risk of diabetes of 4% for baked, boiled, or mashed potatoes, and an increased risk of 19% for French fries (6). The use of fried potatoes is probably associated with a higher risk of diabetes and other comorbidities for several reasons, such as cooking with *trans* fats (6). These findings were confirmed in the Nurses' Health Study (7). On the contrary, a study conducted in Sweden in 69,313 men and women failed to find any significant associations between higher potato consumption and the risk of CVD morbidity and mortality during a 13-y follow-up (8). A systematic review published in 2016, which included 5 observational studies in a total of 170,413 healthy subjects, did not provide any conclusive evidence to suggest an association between potato intake and the risk of developing obesity, type 2 diabetes, and CVD (9). However, in the same review, the consumption of French fries and fried potatoes was associated with a slightly higher risk of obesity and diabetes (9). Despite these previous studies, to the best of our knowledge no previous study has investigated whether potato consumption is associated with premature mortality.

Given that potatoes are widely consumed in North America and Europe, and no data are available on the association with mortality, the current study aimed to investigate whether a higher consumption of potatoes is associated with an increased risk of death in a longitudinal cohort study of men and women participating in the Osteoarthritis Initiative (OAI). As a secondary objective, we investigated whether a higher consumption of fried and unfried potatoes is associated with a higher mortality risk.

METHODS

Data source and subjects

Data were obtained from the OAI database (10), which is available for public access at http://www.oai.ucsf.edu/. The specific data sets used were registered during the baseline and screening evaluations (V00), and mortality data were available until 96 mo from baseline (V10). The OAI includes patients at high risk of knee osteoarthritis, who were recruited at 4 clinical centers in the United States (Baltimore, Maryland; Pittsburgh, Pennsylvania; Pawtucket, Rhode Island; and Columbus, Ohio) between February 2004 and May 2006. Subjects were eligible if they *1*) had knee osteoarthritis and reported knee pain in a 30-d period in the past 12 mo or *2*) were at high risk of developing knee osteoarthritis (e.g., overweight or obese, knee injury or operation, parents or siblings with total knee replacement, frequent knee-bending activities that increase risk, and hand or hip osteoarthritis) (10).

All of the participants provided written informed consent. The OAI study protocol was approved by the institutional review board of the Osteoarthritis Initiative Coordinating Center, University of California at San Francisco. This trial was registered at clinicaltrials.gov as NCT00080171.

Potato consumption (exposure)

Participants' dietary patterns were analyzed by using the semiquantitative Block Brief 2000 food-frequency questionnaire at baseline (11, 12). This validated tool, which contains a list of 70 food items, was designed to assess the individual's food and beverage consumption over the past year. The frequency of food consumption of the included items was reported at 9 levels of intake from "never" to "every day." There were also 7 dietary behavior questions on food preparation methods and fat intake, 1 question on fiber intake, and 13 questions with regard to vitamins and minerals.

Potato consumption was assessed through 2 specific questions. The first question considered the consumption of French fries, fried potatoes, or hash browns. The second question considered the consumption of white unfried potatoes, including boiled, baked, and mashed potatoes and potato salad. Although data on sweet potatoes were available, this information was not included due to the different composition between sweet and white potatoes. Potato consumption was categorized into 5 groups from the 9 available categories because too few participants "never" consumed potatoes or consumed potatoes "few times" or ">4 times/weekly" during the previous year. Therefore, the 5 categories were as follows: ≤1 time/mo, 2–3 times/mo, 1 time/wk, 2 times/wk, and ≥3 times/wk.

Outcome

The study's outcome of interest was all-cause mortality. In the OAI, mortality was confirmed and adjudicated by several methods (autopsy report, coroner's report, death certificate medical records, National Death Index, obituary, or Social Security Death Index).

Covariates

We identified numerous potential confounders that may influence the relation between potato consumption and mortality, including the following: BMI; weekly alcohol consumption, total energy intake, and adherence to a Mediterranean diet (12, 13); physical activity evaluated by using the Physical Activity Scale for the Elderly (14); depressive symptoms evaluated through the Center for Epidemiologic Studies–Depression scale (15); ethnicity; smoking habits, educational level, and yearly income (<$50,000, ≥$50,000, or missing data); and variables pertaining to physical health status. Validated general health measures of self-reported comorbidities were assessed by using the modified Charlson comorbidity score (16). The medical morbidities that were assessed by using this score included diseases and disorders common in North Americans such as fractures, heart attack and failure, stroke, diabetes, and cancer (17).

Statistical analyses

Normal distributions of continuous variables were tested by using the Kolmogorov-Smirnov test. Data are shown as means ± SDs for quantitative measures and as frequencies and percentages for all discrete variables. *P* values for trends were calculated by using the Jonckheere-Terpstra test for continuous variables and the Mantel-Haenszel chi-square test for categorical variables.

Incidence rates are reported as number of deaths per 1000 persons-years. The proportional hazards assumption was checked by plotting the Schoenfeld residuals compared with time without any violation and then Cox regression analyses were performed (18). The basic model was adjusted for age and sex. In addition to age and sex, the fully adjusted model adjusted for ethnicity (white compared with other), BMI (continuous), education (higher degree compared with lower), smoking habits (current and previous compared with never), yearly income (categorized as ≥$50,000, <$50,000, or missing data), Physical Activity Scale for the Elderly (continuous), Charlson comorbidity index (continuous), daily energy intake (continuous), and Center for Epidemiologic Studies–Depression scale (continuous). These covariates used for adjustment were factors significantly different across potato consumption categories (considering a P value <0.10) or significantly associated with death according to univariate analysis ($P < 0.05$). We also conducted the same analyses and investigated the association between the consumption of fried and unfried potatoes and mortality separately. In these analyses, we added the consumption of unfried potatoes in the model when conducting the analyses for fried potatoes and vice versa. In all of the analyses, Cox regression analysis data are reported as HRs with 95% CIs.

To test the robustness of our analyses, sensitivity analyses were conducted to evaluate the interaction between potato consumption and selected factors [e.g., sex, race/ethnicity, education, smoking habits, yearly income, presence or absence of diseases at baseline, BMI (in kg/m^2) ≥25 or <25] in predicting mortality, but no moderator emerged as significant. Multicollinearity among covariates was assessed by using the variance inflation factor, with a score of 2 leading to the exclusion of a variable, but no variable was excluded for this reason.

All of the analyses were performed by using SPSS 17.0 for Windows (SPSS, Inc.). All of the statistical tests were 2-tailed, and significance was assumed for a P value <0.05.

RESULTS

Sample selection

The OAI data set initially included a total of 4796 North American participants. At baseline, 130 participants were excluded due to insufficient information on potato consumption and another 266 had implausible calorie intakes (<800 and >4200 kcal for men; <500 and >3500 kcal for women). Thus, 4400 participants were eligible for this study (**Supplemental Figure 1**).

Descriptive characteristics

Of the 4400 participants, there were 2551 women and 1849 men. The mean ± SD age was 61.3 ± 9.2 y (range: 45–79 y). Most of the participants consumed potatoes (n = 1174; 26.7%) 2–3 times/mo.

Table 1 shows the participants' characteristics by total potato intake. Those who consumed potatoes ≥3 times/wk (reflecting the highest consumption of potatoes) were older (P-trend < 0.0001), were more likely to be male (P-trend < 0.0001) and white (P-trend < 0.0001), and had a lower educational level (P-trend < 0.0001) with respect to those in the other categories. They were also less adherent to a Mediterranean diet (P-trend < 0.0001) and had more comorbidities (P-trend = 0.003) than other participants, in particular CVDs (Table 1).

Potato consumption and mortality

During the 8-y follow-up, 236 people (5.4% of the baseline population) died, indicating a global mortality rate of 13 (95% CI: 11–17)/1000 person-years. **Table 2** shows the association

TABLE 1
Characteristics of the participants according to frequency of potato consumption[1]

	≤1 time/mo (n = 761)	2–3 times/mo (n = 1174)	1 time/wk (n = 930)	2 times/wk (n = 942)	≥3 times/wk (n = 593)	P-trend[2]
General characteristics						
Age, y	61.4 ± 8.7[3]	60.9 ± 9.2	61.0 ± 9.0	60.9 ± 9.4	63.1 ± 9.6	<0.0001
PASE, points	157.4 ± 79.7	162.0 ± 83.6	165.1 ± 80.0	163.5 ± 83.5	150.5 ± 80.6	0.006
Female sex, n (%)	530 (69.6)	699 (59.5)	514 (55.3)	493 (52.3)	315 (53.1)	<0.0001
White race/ethnicity, n (%)	593 (78.0)	890 (75.9)	776 (83.4)	780 (82.9)	485 (81.8)	<0.0001
Smoking (previous or current), n (%)	371 (49.1)	557 (47.6)	425 (46.0)	430 (45.8)	295 (49.9)	0.77
Graduate degree, n (%)	269 (35.4)	346 (29.5)	292 (31.4)	274 (29.1)	147 (24.8)	<0.0001
Yearly income ≥$50,000, n (%)	451 (59.3)	677 (57.7)	617 (66.3)	555 (58.9)	293 (49.4)	0.03
Nutritional variables						
Energy intake, kcal/d	1149.7 ± 424.7	1308.7 ± 474.1	1435.5 ± 484.6	1600.5 ± 564.9	1745.4 ± 644.9	<0.0001
Alcohol drinks, n/wk	1.75 ± 1.46	1.73 ± 1.46	1.77 ± 1.44	1.74 ± 1.54	1.71 ± 1.56	0.94
Adherence to Mediterranean diet, points	27.6 ± 5.6	27.4 ± 4.9	27.8 ± 4.7	28.6 ± 4.7	30.0 ± 5.3	<0.0001
Medical variables						
BMI, kg/m^2	28.0 ± 4.7	28.8 ± 4.8	28.9 ± 4.8	28.9 ± 4.8	28.5 ± 4.8	0.001
CES-D, points	6.5 ± 7.3	6.7 ± 7.1	6.3 ± 6.3	6.5 ± 6.9	7.2 ± 7.3	0.18
Charlson comorbidity index, points	0.4 ± 1.0	0.4 ± 0.8	0.3 ± 0.8	0.4 ± 0.8	0.5 ± 1.0	0.003
Fractures, n (%)	135 (17.8)	200 (17.1)	161 (17.4)	158 (16.8)	130 (22.0)	0.14
Heart attack, n (%)	8 (1.1)	27 (2.4)	13 (1.4)	17 (1.8)	22 (3.7)	0.02
Heart failure, n (%)	12 (1.6)	21 (1.8)	15 (1.6)	22 (2.4)	18 (3.1)	0.04
Stroke, n (%)	21 (2.8)	41 (3.5)	24 (2.6)	29 (3.1)	18 (3.1)	0.96
Diabetes, n (%)	62 (8.3)	97 (8.4)	64 (7.0)	66 (7.2)	52 (8.9)	0.78
Cancer, n (%)	37 (4.9)	65 (5.5)	40 (4.3)	38 (4.0)	32 (5.4)	0.59

[1] CES-D, Center for Epidemiologic Studies–Depression scale; PASE, Physical Activity Scale for the Elderly.
[2] P values for trends were calculated by using the Jonckheere-Terpstra test for continuous variables and the Mantel-Haenszel chi-square test for categorical variables.
[3] Mean ± SD (all such values).

TABLE 2
Association between potato consumption and mortality

	Incidence (number of deaths/1000 person-years) (95% CI)	Basic-adjusted model[1]		Fully adjusted model[2]	
		HR (95% CI)	*P*	HR (95% CI)	*P*
≤1 time/mo	6 (3, 10)	1 (reference)		1 (reference)	
2–3 times/mo	12 (4, 19)	1.04 (0.65, 1.64)	0.89	1.16 (0.72, 1.87)	0.54
1 time/wk	10 (6, 14)	1.21 (0.76, 1.40)	0.43	1.34 (0.82, 2.18)	0.24
2 times/wk	16 (9, 22)	1.36 (0.86, 2.15)	0.18	1.59 (0.98, 2.57)	0.06
≥3 times/wk	18 (7, 29)	0.94 (0.56, 1.56)	0.80	1.11 (0.65, 1.91)	0.71

[1] The basic-adjusted model included as covariates age (continuous) and sex.

[2] The fully adjusted model included as covariates age (continuous), sex, race/ethnicity (white vs. other), BMI (continuous), education (degree vs. others), smoking habits (current and previous vs. others), yearly income (categorized as ≥$50,000, <$50,000, or missing data), Physical Activity Scale for Elderly score (continuous), Charlson comorbidity index (continuous), daily energy intake (continuous), alcohol consumption (weekly), adherence to a Mediterranean diet, and Center for Epidemiologic Studies–Depression scale (continuous).

between overall potato consumption and mortality. The nonadjusted incidence of mortality was 3 times higher in those consuming the greatest amount of potatoes (≥3 times/wk) compared with those consuming potatoes <1 time/mo. However, by using Cox regression analysis, adjusted for 14 potential baseline confounders, and taking those with the lowest consumption of potatoes as the reference, participants with the highest consumption of potatoes did not have any increased risk of mortality (HR: 1.11; 95% CI: 0.65, 1.91; *P* = 0.71; Table 2).

Table 3 shows Cox regression analyses for fried and unfried potatoes with death as the outcome. After adjustment for all baseline potential confounders, a higher consumption of unfried potatoes was not associated with any increased risk of death (HR: 0.89; 95% CI: 0.51, 1.55; *P* = 0.67 for participants consuming unfried potatoes ≥3 times/wk compared with ≤1 time/mo). On the contrary, the RR of mortality was more than doubled among those who consumed fried potatoes >2 times/wk (HR: 1.95; 95% CI: 1.11, 3.41; *P* = 0.02) or ≥3 times/wk (HR: 2.26; 95% CI: 1.15, 4.47; *P* = 0.02).

DISCUSSION

In this cohort study, we found that, overall, white potato consumption was not associated with a higher risk of mortality after adjustment for pertinent confounders. However, the consumption of fried potatoes >2 times/wk was consistently associated with an increased mortality risk in this population of older adults.

Overall, in this cohort, the consumption of potatoes was very high. The great majority of the participants included in the OAI consumed potatoes ≥2–3 times/mo, and a third of participants consumed potatoes ≥3 times/wk. This intake is in line with the data in a 2013 report of the USDA, which showed that, on average, American citizens consumed 115.6 pounds of white potatoes/y, of which approximately two-thirds are French fries, potato chips, and other frozen or processed potato products (2). White potatoes accounted for 30% of the 384.4 pounds/person of vegetable and legume intakes (2). In our cohort, a higher intake of potatoes was associated with several other potential mortality risk factors, such as male sex (19), higher frequency of comorbidities, higher BMI (20), and lower adherence to a Mediterranean diet score. However, to our knowledge, it has not been established whether frequent potato consumption is associated with higher mortality risk, independently of adiposity and other age-associated metabolic conditions and diseases.

In our study, overall potato consumption was not associated with an increased risk of all-cause mortality, which is in partial

TABLE 3
Association between fried and unfried potato consumption and mortality

	Incidence (number of deaths/1000 person-years) (95% CI)	Basic-adjusted model[1]		Fully adjusted model[2]	
		HR (95% CI)	*P*	HR (95% CI)	*P*
Unfried potatoes					
≤1 time/mo	9 (2, 17)	1 (reference)		1 (reference)	
2–3 times/mo	12 (6, 17)	1.15 (0.75, 1.75)	0.53	1.24 (0.81, 1.91)	0.33
1 time/wk	13 (5, 20)	1.16 (0.74, 1.82)	0.53	1.18 (0.73, 1.90)	0.50
2 times/wk	21 (10, 33)	1.44 (0.94, 2.20)	0.09	1.50 (0.94, 2.39)	0.09
≥3 times/wk	12 (4, 19)	0.82 (0.49, 1.37)	0.44	0.89 (0.51, 1.55)	0.67
Fried potatoes					
≤1 time/mo	10 (6, 14)	1 (reference)		1 (reference)	
2–3 times/mo	12 (7, 18)	1.38 (0.98, 1.90)	0.07	1.37 (0.99, 1.91)	0.06
1 time/wk	9 (5, 13)	1.12 (0.73, 1.72)	0.61	1.10 (0.70, 1.71)	0.68
2 times/wk	18 (6, 31)	1.90 (1.10, 3.27)	0.02	1.95 (1.11, 3.41)	0.02
≥3 times/wk	32 (7, 57)	2.56 (1.35, 4.83)	0.004	2.26 (1.15, 4.47)	0.02

[1] The basic-adjusted model included as covariates age (continuous) and sex.

[2] The fully adjusted model included as covariates age (continuous), sex, race/ethnicity (white vs. other), BMI (continuous), education (degree vs. others), smoking habits (current and previous vs. others), yearly income (categorized as ≥$50,000, <$50,000, or missing data), Physical Activity Scale for Elderly score (continuous), Charlson comorbidity index (continuous), daily energy intake (continuous), alcohol consumption (weekly), adherence to a Mediterranean diet, and Center for Epidemiologic Studies–Depression scale (continuous). In the analyses of unfried potatoes, the consumption of fried potatoes was added as a covariate in the fully adjusted model and vice versa.

agreement with other published data (8). The only study that addressed mortality was limited by the fact that only CVD mortality was considered and did not find any association between a higher consumption of potatoes and CVD-related death risk (8). It is possible that the high content of fiber, vitamins, and micronutrients in white potatoes could have counterbalanced the detrimental effects of their high glycemic index (5). However, given that this is an emerging field and that our data are preliminary, larger prospective studies are required to further investigate this relation.

Although overall potato consumption was not related to mortality, interestingly, our data suggest that the consumption of fried potatoes is associated with a significantly higher risk of mortality. The consumption of fried potatoes >2 times/wk was associated with a more than doubled risk of death independently of several other confounders. Many factors could explain these findings. First, French fries and fried potatoes typically contain high amounts of dietary fat (including *trans* fat) and added salt, which may increase the risk of death, particularly of CVD (21). Second, a higher consumption of fried potatoes could increase the risk of other chronic diseases, such as obesity (22, 23), hypertension (24), and diabetes (6), which are also powerful risk factors for CVD. One epidemiologic study conducted in Sweden found no association between fried potatoe intake and CVD mortality (8). Therefore, more studies are warranted to understand whether a higher consumption of fried potatoes is associated with higher CVD and cancer mortality due to higher intakes of *trans* fatty acids, oxidized lipids, acrolein, acrylamide, furan, and glycidamide (25, 26). Third, people who consume fried potatoes more frequently might have other unhealthy dietary habits, such as increased consumption of processed red meat, salty foods, and sugar-sweetened beverages, which may increase the risk of death (27, 28). Finally, a lower socioeconomic status could play a role in the association between a high consumption of fried potatoes and mortality. However, in our study, this association was still significant even after we adjusted our analyses for both educational and income levels, which suggests a marginal role of socioeconomic status.

Although our data are relatively novel, some limitations should be noted. The main limitation is that we were not able to assess cause-specific mortality. Second, we were unable to assess the influence of biohumoral markers (e.g., inflammation, insulin resistance, oxidative stress) on the association between potato consumption and mortality. Third, the medical conditions were self-reported and could have introduced some level of bias. Fourth, nutritional intake could have suffered from selective and potentially inaccurate recall, and this may have influenced our results. Finally, because we did not consider changes in dietary habits between baseline and follow-up, this also could have introduced bias.

In conclusion, our data suggest that overall potato consumption was not associated with a higher risk of death in a cohort of North American men and women. On the contrary, frequent consumption of fried potatoes significantly increased overall mortality risk. Future studies are warranted to elucidate the role of potato consumption on cause-specific mortality.

The authors' responsibilities were as follows—NV, MN and AK: analyzed the data; BS, MS, AV, JD, and DN: wrote the manuscript; GC, PS, SM, and LF: critically revised the final version; NV: had primary responsibility for the final content; and all authors: read and approved the final manuscript. None of the authors reported a conflict of interest related to the study.

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