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The effect of daily peanut consumption on indicators of metabolic health among healthy young women

Nicole Reeder[1], Terezie Tolar-Peterson[1,2*], Grace A. Adegoye[1,3], Erin Dickinson[1], Emily McFatter[1]

[1]Department of Food Science, Nutrition, and Health Promotion, Mississippi State University, Mississippi State, Mississippi, 39762, USA; [2]Department of Health Science and Human Ecology, California State University San Bernardino, San Bernardino, California, 92359; [3] Department of Nutrition and Health Science, Ball State University, Muncie, IN, 47306, USA

***Corresponding author:** Dr. Terezie Tolar-Peterson, Department of Health Science and Human Ecology, California State University San Bernardino, San Bernardino, California, 92359, USA

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ABSTRACT

Background: Regular consumption of nuts and peanuts may reduce the risk of cardiovascular disease due to the bioactive compounds found within them. Previous research suggests that including nuts and seeds as part of an overall healthy dietary pattern may help manage blood pressure, cholesterol, triglyceride, and fasting blood glucose levels, but few studies have examined the specific effect of dry-roasted, skinless peanuts on these outcomes.

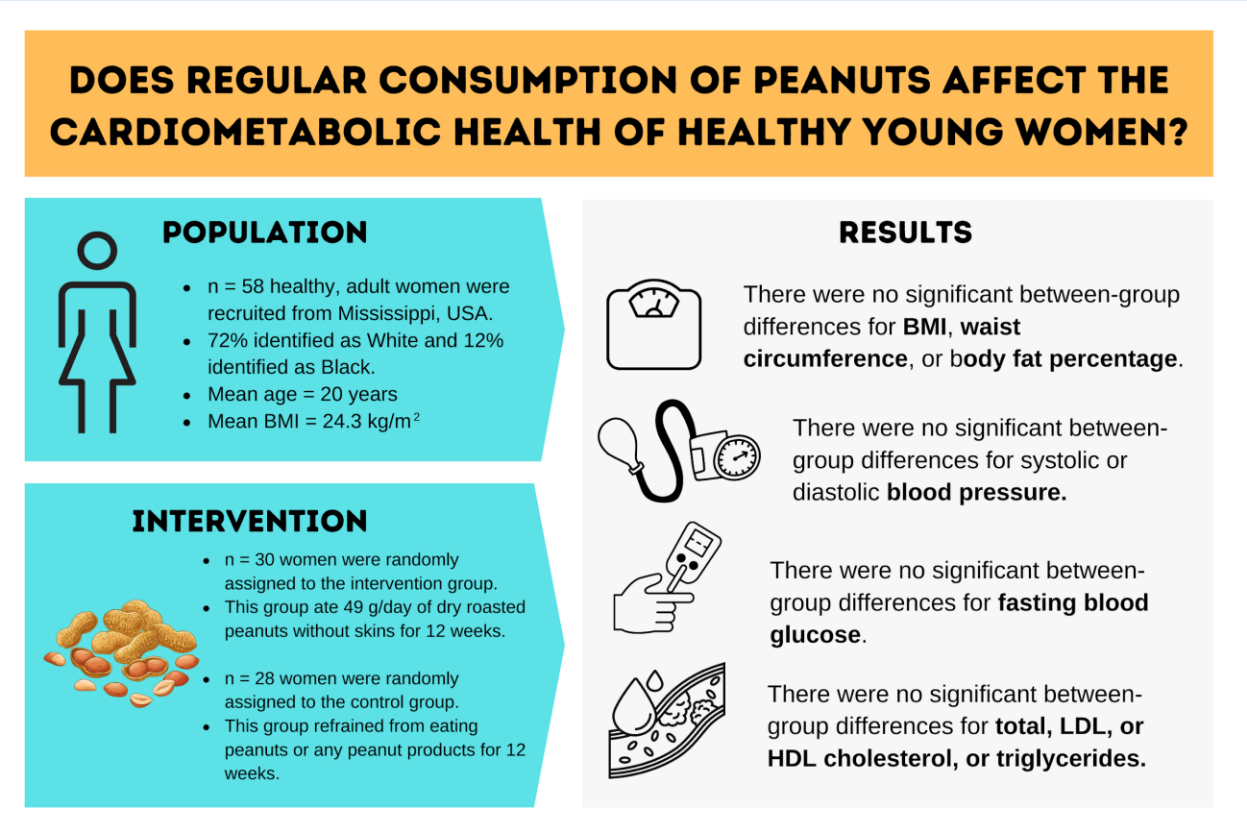
Objective: The objective was to examine the effect of regular consumption of dry-roasted, skinless peanuts on markers of metabolic health among women.

Methods: This was a pre-post test study. Eligible women were randomized into either the intervention group (49 g peanuts/day, n=30) or the control group (participants' usual diet minus peanuts, n=28) for 12 weeks. Anthropometrics, cholesterol, triglyceride, fasting blood glucose, and blood pressure levels were measured at baseline and end-line.

Results: There were no significant between-group differences for any of the outcomes of interest. For the peanut group, there was a significant within-group decrease in systolic blood pressure (-7.0 mmHg; 95% CI: 1.3, 12.6), and a significant increase in total: HDL cholesterol ratio from baseline to endline (0.2; 95% CI: -0.3, 0.02). There was a significant within-group decrease in diastolic blood pressure for the control group (-6.3 mmHg; 95% CI: 2.0, 10.6).

Conclusion: Among healthy young women, the addition of daily peanuts to a usual diet does not appear to negatively affect body composition as measured by BMI, waist circumference, and body fat percentage. Further research is needed to fully elucidate the effect of peanut consumption on indicators of cardiovascular health in different populations.

Keywords: Nuts, Peanuts, Blood Pressure, Cholesterol, Metabolic Health, Women



INTRODUCTION

A diet that includes nuts is associated with a reduced risk of cardiovascular disease and cardiovascular disease risk factors [1–4]. Peanuts and tree nuts may lower blood pressure, improve insulin sensitivity, and reduce the risk of dyslipidemia [5–7]. Nuts contain unsaturated fatty acids, fiber, antioxidants, and phytochemicals, all of which contribute to their positive effect on health [8]. Long-term nut consumption is also associated with a lower risk of obesity and less weight gain over time, could be due to the satiating effect of the fiber in nuts [9]. While many epidemiological studies have looked broadly at the consumption of both tree nuts and peanuts as a group, peanuts have unique nutritional characteristics that differentiate them from other commonly consumed nuts.

Peanuts are a legume and contain more protein and carbohydrates than tree nuts such as walnuts and almonds. In the United States, about 7.9 pounds of peanuts per capita are consumed each year [10]. Peanuts contain monounsaturated fatty acids and have a low glycemic index which may help with blood glucose control, both acutely and long-term [11]. Adding a small quantity of peanut butter to an otherwise high glycemic breakfast significantly lowers the glycemic response post-

meal, [12], and over time, habitual peanut consumption may have a favorable effect on fasting insulin [6]. Peanut supplementation of the habitual diet has also been associated with improvements in HDL cholesterol and total cholesterol (TC)/HDL ratio among men with hypercholesterolemia, and improvements in total cholesterol levels and LDL cholesterol levels among hypercholesterolemic women [13-14]. Acutely, the inclusion of peanuts as part of a high-fat meal also improves post-prandial triglyceride response among overweight and obese men [15]. Peanuts may also help with weight maintenance or weight loss. Similar weight loss has been achieved among adults who follow a traditional energy-restricted low-fat diet, and adults who consume an energy-restricted diet with peanut consumption twice a day before meals, [16] and among healthy, normal-weight adults, regular consumption of peanuts for 19 weeks increases resting energy expenditure by 11% [17]. These findings collectively suggest that peanuts may be beneficial for cardiovascular disease prevention, especially for adults who may already have insulin resistance or dyslipidemia.

The cardioprotective effect of peanuts may be due to their polyphenol content. Peanuts contain phenolic acids, flavonoids, stilbenes, and lignans [18]. Peanuts are one of the primary dietary sources of resveratrol, a polyphenol known for its antioxidant activity and potential to help decrease the risk of cardiovascular disease, cancer, and Alzheimer's disease [19]. Resveratrol may reduce the risk of atherosclerosis and type II diabetes by reducing the oxidative and inflammatory responses of high-fat high-carbohydrate meals [20]. Resveratrol also upregulates endothelial nitric oxide synthase which leads to vasodilation and increased blood flow [20]. Finally, some studies have found resveratrol supplementation to decrease total and LDL cholesterol levels, particularly among people who have elevated blood lipid profiles at baseline [21–23].

The risk of obesity, hypertension, insulin resistance, and dyslipidemia can be attenuated by modifiable risk factors such as following a healthy dietary pattern. One potentially easy lifestyle modification that could be made to promote metabolic health is including nuts such as peanuts as part of an overall healthy diet. Little is known, however, about the metabolic response to habitual peanut consumption among healthy young adults who have not yet developed many of these cardiovascular disease risk factors that develop further into adulthood. Young adulthood is a critical period of development and provides an important opportunity for proactively focusing on maintaining healthy blood glucose and lipid levels for the prevention of chronic diseases later in life [24]. Therefore, the objective of this study was to determine the effect of daily consumption of dry-roasted peanuts without skins on various markers of metabolic health among women.

METHODS

Study Design: Details of this study, including participant recruitment, have been previously published elsewhere [25]. In brief, participants in the intervention group consumed 49 g (1.75 oz) of peanuts per day, and participants in the control group were instructed to continue following their usual diet, sans peanuts, for 12 weeks. Selection bias was minimized by not having overly stringent eligibility criteria and by randomizing participants to the treatment group. Eligibility criteria included being a woman aged 18 or older, being enrolled as a student at Mississippi State University, not having any significant health history, and not having any allergies or intolerances to peanuts. The sample size was based on logistical constraints including budget and personnel and upon a literature search of studies with similar objectives. The study protocol was approved by the Mississippi State University Institutional Review Board (IRB 21-260).

Anthropometrics and blood pressure: Each participant's height was measured using a touchless digital stadiometer (Detector SONARIS) at visit one. Height measurements were then entered into a bioelectrical impedance analysis body composition scale (TANITA MC-780U, Tanita Corp., Tokyo, Japan) for further anthropometric measurements, which were taken at baseline and end-line. The TANITA MC-780U provides whole-body and segmental body composition measurements in under 20 seconds, including weight, body fat percentage, bone mass, muscle mass, and visceral fat rating. Waist circumference was measured to the nearest sixteenth of an inch using a plastic tape measured at the level of the iliac crest. All measurements were conducted with participants in light clothing and without shoes. Blood pressure was measured following standard manufacturer protocol using an Omron HEM-705CPN automatic blood pressure cuff (Omron Corp., Kyoto, Japan) at baseline (visit 1) and ending (final study visit).

Fasting blood glucose and lipid panel: Participants were asked to fast in the time before their baseline and end-line visits in preparation for glucose and lipid testing (no food or drinks, except water, for at least eight hours before the visit). To minimize participant burden, all baseline and end-line visits were scheduled in the morning. Glucose and lipids were tested using the CardioCheck Plus test system with PTS Panels test strips (PTS Diagnostics, Whitestown, IN, USA). This system meets NCEP guidelines for accuracy and precision and provides a full lipid panel in as little as 90 seconds with just 40 µL of blood from a fingerstick [26]. After applying a blood sample to the lipid and electrochemical glucose test strips, the device measures total cholesterol, HDL cholesterol, triglycerides, and glucose, and from those values, calculates LDL cholesterol, total cholesterol (TC)/HDL ratio, LDL/HDL ratio, and non-HDL cholesterol. The device provides numeric results for cholesterol levels between 100-400 mg/dL, HDL cholesterol levels between 15-100 mg/dL, triglycerides between 50-500 mg/dL, and glucose between 40-600 mg/dL. If results above or below the measuring range are detected, results will read as simply less than or greater than the minimal or maximum detectable value. All manufacturer protocols were followed for device calibration and use.

Statistical analyses: A statistical analysis was carried out for all participants with complete data using SAS version 9.4. Descriptive statistics were calculated for all variables using means, standard deviations, frequencies, and percentages. Baseline characteristics of the peanut and control groups were compared using t-tests for continuous variables and chi-square tests for categorical variables. Variables were visually assessed for normality using QQ plots before analysis. A series of ANCOVA tests were conducted to determine the effect of each group (peanut vs control) on each outcome of interest. Endline measurements were used as dependent variables and baseline measurements were included as covariates [27]. For analyses of blood lipid levels, to avoid excluding an excessive number of participants for missing values, participants with a triglyceride reading of "<50 mg/dL" had a triglyceride level of 50 mg/dL imputed for analysis. LDL cholesterol was then computed for each of these participants using the Friedewald equation and the imputed value of 50 mg/dL for triglycerides [28]. All tests were two-tailed, and the alpha was set at 0.05.

RESULTS

Of the seventy-five women who began the study, ten dropped out, leaving the remaining 65 women having completed the study. This data analysis only includes 58 women because seven had missing or incomplete baseline or end-line data for the variables being analyzed. Participants had a mean age of 20.0 ± 1.6 years, and 72.4% were White (Table 1). The mean overall BMI for participants was 24.3 ± 4.8 kg/m^2, which is considered

within the "healthy" range for BMI. Baseline values for fasting blood glucose, cholesterol, and triglyceride levels also fell primarily into normal ranges. Overall study compliance was high, with women in the intervention group consuming their snack packs of peanuts on 84% of the days in the study period, and women in the control group avoiding peanut consumption for 96% of the days in the study period. Baseline values did not differ between the intervention and control groups, apart from LDL cholesterol levels and TC/HDL cholesterol ratios being slightly higher at baseline for the control group ($p < 0.05$ for each).

Table 1. Baseline characteristics of study participants, overall and between-group differences

Characteristic	Overall (n=58)	Peanut group (n=30)	Control group (n=28)	*P*[1]
Age (years)	20.0 ± 1.6	20.3 ± 1.7	19.7 ± 1.3	0.201
Race				0.869
White	42 (72.4)	22 (73.3)	20 (71.4)	
Black	7 (12.1)	3 (10.0)	4 (14.3)	
Other	9 (15.5)	5 (16.7)	4 (14.3)	
BMI (kg/m^2)	24.3 ± 4.8	23.6 ± 4.2	25.0 ± 5.4	0.262
Waist circumference (inches)	31.6 ± 5.1	30.9 ± 4.2	32.4 ± 5.9	0.267
Body fat percentage	29.6 ± 7.4	29.0 ± 6.8	30.2 ± 8.1	0.535
Systolic BP (mmHg)	115.2 ± 10.0	113.3 ± 10.5	117.5 ± 9.2	0.179
Diastolic BP (mmHg)	73.6 ± 10.0	71.2 ± 10.1	76.4 ± 9.3	0.078
Fasting blood glucose (mg/dL)	96.8 ± 8.5	95.9 ± 8.2	97.8 ± 8.9	0.421
Cholesterol, total (mg/dL)	173.8 ± 38.8	164.5 ± 41.3	183.8 ± 33.8	0.058
Cholesterol, HDL (mg/dL)	63.9 ± 13.6	65.3 ± 12.8	62.4 ± 14.4	0.425
Cholesterol, LDL (mg/dL)	92.1 ± 32.2	82.5 ± 33.0	102.4 ± 28.3	**0.017**
Total: HDL cholesterol ratio	2.8 ± 0.7	2.5 ± 0.5	3.0 ± 0.7	**0.003**
Triglycerides (mg/dL)	89.8 ± 31.6	84.4 ± 30.9	95.5 ± 31.9	0.187

SD, standard deviation. BMI, body mass index. BP, blood pressure. Variables are presented as means ± standard deviations or counts and percentages. [1]p-values are calculated from chi-square or t-tests

There were no significant between-group effects for BMI (peanut vs control group mean difference: -0.01; 95% CI: -0.43, 0.41), waist circumference (-0.03 inches; 95% CI: -1.3, 0.8), or body fat percentage (0.3%; 95% CI: -0.7, 1.3) (Table 2). Additionally, there were no significant differences observed between the two groups for systolic or diastolic blood pressure. There were no significant between-group differences for fasting blood glucose (15.0 mg/dL; 95% CI: -12.1, 42.2), total, HDL, LDL cholesterol, or triglyceride levels.

For the peanut group, there was a significant within-group decrease in systolic blood pressure from baseline

to endline (7.0 mmHg; 95% CI: 1.3, 12.6), and a significant increase in TC/HDL cholesterol ratio from baseline to endline (0.2; 95% CI: -0.3, 0.02). There was a significant within-group difference from baseline to endline for diastolic blood pressure in the control group, with a mean decrease of 6.3 mmHg (95% CI: 2.0, 10.6).

Table 2. Comparison of baseline and endline scores for indicators of cardiometabolic health[1]

	Peanut Group (n = 30)			Control Group (n = 28)				
Outcome	Baseline	Endline	Within-group difference	Baseline	Endline	Within-group difference	Between-group Effect[2]	Between-group *p*-value[3]
BMI	23.6 ± 4.2	23.9 ± 4.6	-0.3 (-0.6, 0.03)	25.0 ± 5.4	25.3 ± 5.5	-0.3 (-0.6, 0.02)	-0.01 (-0.43, 0.41)	0.961
Waist circumference (inches)	30.9 ± 4.2	31.3 ± 4.5	-0.4 (-1.1, 0.3)	32.4 ± 5.9	32.3 ± 5.3	0.06 (-0.8, 0.9)	-0.3 (-1.3, 0.8)	0.600
Body fat percentage	29.0 ± 6.8	28.7 ± 6.8	0.5 (-0.3, 1.3)	30.2 ± 8.1	29.9 ± 8.1	0.2 (-0.4, 0.9)	0.3 (-0.7, 1.3)	0.552
Systolic BP, mmHg	113.3 ± 10.5	105.7 ± 11.7	**7.0 (1.3, 12.6)**	117.5 ± 9.2	109.9 ± 9.1	5.4 (-1.2, 12.0)	4.0 (-2.8, 10.8)	0.237
Diastolic BP, mmHG	71.2 ± 10.1	70.0 ± 9.1	0.7 (-5.0, 6.3)	76.4 ± 9.3	69.0 ± 9.5	**6.3 (2.0, 10.6)**	-3.1 (-9.1, 2.9)	0.300
Fasting blood glucose, mg/dL	95.9 ± 8.2	92.0 ± 9.9	4.0 (-0.6, 8.6)	97.8 ± 8.9	108.5 ± 71.9	-10.7 (-38.8, 17.3)	15.0 (-12.1, 42.2)	0.272
Cholesterol, total, mg/dL	164.5 ± 41.3	167.3 ± 32.4	-2.8 (-13.9, 8.3)	183.8 ± 33.8	178.4 ± 28.0	7.6 (-0.7, 15.9)	-1.7 (-13.3, 9.9)	0.770
Cholesterol, HDL, mg/dL	65.3 ± 12.8	62.0 ± 11.0	3.3 (-0.3, 7.0)	62.4 ± 14.4	59.7 ± 15.8	2.6 (-1.1, 6.8)	-0.3 (-5.2, 4.7)	0.916
Cholesterol, LDL, mg/dL	82.5 ± 33.0	84.3 ± 27.8	-5.4 (-15.2, 4.3)	102.4 ± 28.3	98.5 ± 24.9	5.6 (-2.4, 13.6)	-1.1 (-12.6, 10.5)	0.854
Total: HDL cholesterol ratio	2.5 ± 0.5	2.7 ± 0.5	**-0.2 (-0.3, -0.02)**	3.0 ± 0.7	3.2 ± 1.2	-0.1 (-0.5, 1.2)	-0.03 (-0.45, 0.38)	0.866
Triglycerides, mg/dL	84.4 ± 30.9	87.0 ± 61.3	-2.4 (-23.5, 18.7)	95.5 ± 31.9	100.9 ± 44.3	-3.8 (-17.3, 9.6)	2.9 (-22.6, 28.5)	0.818

[1]Baseline and endline values are presented as mean ± standard deviation. [2]Values are the least squares mean effect estimate and 95% CI. [3]P-values from ANCOVA tests adjusted for baseline scores. The P-value represents the main effect of a group (treatment vs control group).

DISCUSSION

The findings from this study suggest that for healthy young women, 12 weeks of daily peanut consumption does not significantly alter blood pressure, fasting blood glucose, cholesterol, or triglyceride levels. Twelve weeks of daily peanut consumption also did not appear to increase BMI, body fat percentage, or waist circumference, signifying that peanuts might be helpful for weight maintenance. Moreover, while only significant at the within-group level, the 7.0 mmHg decrease in systolic blood pressure from baseline to endline for the peanut group warrants further exploration. In summary, daily snacking of dry-roasted peanuts without skins by healthy women does not appear to significantly alter markers of cardiometabolic health but may support healthy weight maintenance into older adulthood.

Maintaining a healthy blood pressure helps reduce the risk of cardiovascular disease. While this study did not detect any between-group differences in systolic or diastolic blood pressure, there was a within-group decrease in systolic blood pressure for the intervention group. Previous studies looking at peanuts and blood pressure have found that adding peanuts to the diet may reduce systolic and/or diastolic blood pressure for adults at greater risk of cardiovascular disease. In one such study, overweight adults at risk of type 2 diabetes who consumed 35 g of dry-roasted peanuts twice a day, had a significantly greater reduction in systolic blood pressure after six months compared to adults on a low-fat control diet (−5.33 mmHg; 95% CI, −9.23, −1.43) [16]. Another study that included participants at high and low risk of cardiovascular disease found that participants at higher risk of cardiovascular disease saw a decrease in diastolic blood pressure following 12 weeks of peanut consumption, but participants at a lower risk of cardiovascular disease did not see any significant changes in blood pressure [29]. Since the participants in our study were all healthy young adults, they may have been less likely to see significant alterations in their blood pressure because of the intervention, compared to the adults at greater risk of chronic disease in the two aforementioned studies.

Nevertheless, nuts such as peanuts are low in sodium and contain many nutrients that may potentially be protective against hypertension such as unsaturated fatty acids, fiber, magnesium, potassium, calcium, and antioxidants [30]. Lifestyle modifications such as following a healthy dietary pattern are important for preventing and treating hypertension [31] and incorporating peanuts into the diet may be one way to help achieve that.

Following a healthy dietary pattern is also an important modifiable risk factor for maintaining or achieving healthy cholesterol, triglyceride, and blood glucose levels. Peanuts may have a cardioprotective effect by helping to maintain endothelial function. Endothelial dysfunction is a primary precursor to atherosclerosis that causes impaired vasodilation and limited production and availability of nitric oxide, which impairs atherosclerotic lesions from developing on the epithelium [32]. Peanuts are a good source of the amino acid L-arginine, which is used to synthesize the vasodilator nitric oxide [33,34]. Peanuts are also a good source of phenolic compounds that may protect against post-prandial oxidative stress and inflammation [35,36]. Eating peanuts with skins has been shown to acutely reduce the inflammatory markers TNF-alpha and IL-10 [37] and blunt the post-prandial serum triglyceride response among overweight men [15]. In this study of healthy young women, we detected minimal changes in blood lipid and glucose levels after 12 weeks of peanut supplementation, except for a small within-group increase in the TC/HDL ratio for the peanut group.

These findings are contrary to other studies that have been conducted with adults who are older and already have elevated lipid and/or fasting blood glucose levels. For example, in one study, hypercholesterolemic, post-menopausal women who consumed 35-68g of high-

oleic dry-roasted peanuts per day for six months decreased their total and LDL-C levels compared to women who followed a low-fat diet [14]. These women started the study with serum cholesterol levels ranging from 220-300 mg/dL compared to the participants in this current study who had a mean total cholesterol level of 174 mg/dL at baseline. In addition, the unique high-oleic cultivar of peanuts used in the aforementioned study may have contributed to differences in findings. About 80% of the lipid content in high-oleic peanuts is from monounsaturated fatty acids, which contain 60-70% more oleic acid than other more common peanuts [38]. This is significant because diets higher in unsaturated fatty acids such as oleic acid and lower in saturated fats are associated with lower cholesterol levels [39]. In another study, men with baseline total cholesterol levels between 200-350mg/dL were supplemented with 60-93 g of freshly roasted, lightly salted peanuts per day for four weeks. Compared to their usual diet, the peanut supplementation significantly reduced their TC/HDL ratio and LDL cholesterol levels and increased their HDL cholesterol levels [13]. Contrary to this, we found a small but significant within-group increase in the TC/HDL ratio for the peanut group; thus, the effect of peanuts on the TC/HDL ratio among different populations warrants further research.

There is some evidence to suggest that persons at greater risk of cardiovascular disease may have greater reductions in blood pressure, cholesterol, and triglyceride levels with daily peanut consumption compared to persons who are less at risk of cardiovascular disease [29]. Our study did not find significant changes in blood lipid levels with habitual peanut consumption, which may be due to our participants being relatively young and healthy at baseline. Similarly, previous work examining the effects of habitual peanut consumption on fasting blood glucose levels found beneficial effects of peanuts, but most of these studies focused on populations who already have type 2 diabetes or insulin resistance [3,40,41]. Patients with type II diabetes who were put on a low-carb diet coupled with 50-60 g of peanuts (unsalted and with skins) per day had lower fasting blood glucose and lower 2-hour postprandial blood glucose levels compared to baseline after three months of the low-carb with peanuts diet [3]. Another study that included patients with type II diabetes found that a low-carb diet coupled with 75 g/day of peanuts and tree nuts reduced HbA1c levels by 2.0 mmol/mol (95% CI: -3.8, -0.3 mmol/mol) after three months of following the new diet [40]. Finally, a study done on a group of women with obesity who were at risk of developing type II diabetes found that when 42 g of peanut butter was added to a meal containing 75 g of carbohydrates, post-meal glucose responses were lower than when consuming a no-peanut control meal; however, glucose responses were not significantly lower when whole peanuts were paired with the meal [41]. In this case, the authors speculated that peanut butter may have a greater beneficial effect than whole peanuts on moderating postprandial glucose responses due to the greater lipid bioavailability in the peanut butter form [41]. Nevertheless, more research is necessary to understand the effects of different types of peanuts and peanut-containing foods on blood lipid and glucose levels among populations at varying levels of risk of developing chronic diseases.

Previous research has suggested that peanut consumption may be inversely associated with body weight due to the satiating effect of peanuts' high fiber and protein content, and due to the inefficient absorption of fat from peanuts in the body [14,42–45]. In this study, participants who were instructed to incorporate 290 kcal/day of peanuts into their usual daily diets did not have any significant increases in BMI, body fat percentage, or waist circumference after 12 weeks. Since participants were not given any dietary substitution instructions and were simply advised to consume one pack of peanuts each day, it is likely that participants

naturally compensated by consuming less of other foods than they would normally consume. Similarly, in another study, adults who consumed 505 kcal/day of peanuts over a period of eight weeks were observed to have adjusted their daily energy intake by about 300 kcal/day despite no specific instructions to do so [17]. These same participants also gained less weight than what would theoretically be expected when adding 500 kcal/day over a period of eight weeks [17]. There is some evidence to suggest that compensatory dietary changes that occur with the addition of peanuts to the diet may differ by gender, with women tending to reduce consumption of sweet snacks and men tending to reduce the consumption of savory snacks when peanuts are added [46]. These findings add to the body of evidence that peanuts are a highly satiating snack food, that when consumed in place of other less healthy snacks, may help adults maintain a healthy weight.

The findings of this study should be considered within the limitations and strengths of the study. This study was not blinded due to the nature of the intervention, and it did not include a cross-over component due to scheduling constraints for participants who were students and would travel home for extensive periods of time over summer and holiday breaks. Additionally, since our study focused on young women who mostly had healthy blood pressure, BMI, blood lipid, and blood glucose levels at baseline, the effect of peanut supplementation on biomarkers of metabolic health in this population may have been smaller and more difficult to detect compared to the effect seen in populations at greater risk of cardiovascular disease and type II diabetes. Another important limitation to consider is that this study was conducted among free-living adults and the findings may be influenced by other foods participants in the treatment and control groups were or were not consuming. Strengths of this study include a randomized design, a relatively homogenous study sample to minimize extraneous sources of variation, and a high level of study compliance by both the intervention and control groups. Finally, while this study used a validated, FDA-approved device to measure blood glucose and blood lipid levels with a capillary blood sample, it should be noted that capillary blood cholesterol measurements may err slightly higher than venous measurements [47-48].

These findings are relevant to many populations as peanuts are widely consumed throughout the world. They are versatile and can be consumed raw, or processed via boiling, roasting, extracting their oil, grinding them into peanut butter, or adding them to other foods; though, different forms will differ in the bioactive compounds that they retain. The Functional Food Center considers a functional food to be “a natural or processed food that contains biologically active compounds, which, in defined, effective, non-toxic amounts, provides a clinically proven and documented health benefit utilizing specific biomarkers, to promote optimal health and reduce the risk of chronic/viral diseases and manage their symptoms” [49]. By this definition, peanuts may be classified as a functional food and should be further studied to compare the effects of chronic consumption on blood glucose and lipid levels in different populations.

CONCLUSION

In conclusion, this study provides further evidence that the inclusion of peanuts as part of an overall healthy dietary pattern is supportive of healthy weight maintenance in adults and that the addition of peanuts to the diet does not adversely affect measures of cardiometabolic health in young adults who are healthy at baseline. Overall, any beneficial effects of peanut consumption on biomarkers of metabolic health may be smaller for healthier or younger women compared to older adults who are at greater risk for cardiovascular disease, but more research is needed to confirm this. Future studies should also consider comparing different

peanut products, particularly peanuts with skin and peanut butter, as they may have greater health benefits lending to their higher polyphenol content.

Abbreviations: BMI: body mass index; BP: blood pressure, FDA: United States Food and Drug Administration, TC: total cholesterol.

Competing interests: None

Author contributions: TTP, GA, and NR designed the research. NR, GA, ED, and EM conducted research. NR analyzed the data and wrote the first draft of the manuscript. TTP, GA, ED, and EM reviewed the manuscript. All authors reviewed and approved the final version of the paper.

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