

Original Article

Coconut oil is associated with a beneficial lipid profile in pre-menopausal women in the Philippines

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Coconut oil is a common edible oil in many countries, and there is mixed evidence for its effects on lipid profiles and cardiovascular disease risk. Here we examine the association between coconut oil consumption and lipid profiles in a cohort of 1,839 Filipino women (age 35-69 years) participating in the Cebu Longitudinal Health and Nutrition Survey, a community based study in Metropolitan Cebu. Coconut oil intake was estimated using the mean of two 24-hour dietary recalls (9.5±8.9 grams). Lipid profiles were measured in morning plasma samples collected after an overnight fast. Linear regression models were used to estimate the association between coconut oil intake and each plasma lipid outcome after adjusting for total energy intake, age, body mass index (BMI), number of pregnancies, education, menopausal status, household assets and urban residency. Dietary coconut oil intake was positively associated with high density lipoprotein cholesterol especially among pre-menopausal women, suggesting that coconut oil intake is associated with beneficial lipid profiles. Coconut oil consumption was not significantly associated with low density lipoprotein cholesterol or triglyceride values. The relationship of coconut oil to cholesterol profiles needs further study in populations in which coconut oil consumption is common.

Key Words: cholesterol, cardiovascular disease, nutrition, saturated fat, nutrition transition

INTRODUCTION

Cardiovascular diseases (CVD) figures prominently as public health problems in the Philippines and are now the leading causes of death.¹ One dietary risk factor of particular importance to CVD risk is coconut oil, which is the most commonly used cooking oil in the country.² Coconut oil is high in saturated fats, and thus, there are concerns that it could lead to a more atherogenic lipid profile.^{3,4} Consistent with this concern, some studies have found that coconut oil supplementation increases adverse lipids, thus potentially elevating CVD risk.^{5,6} However, some of these studies have been criticized for using hydrogenated coconut oils.⁷ Hydrogenation increases stability of the oils at room temperature and aids cooking, but results in increased levels of trans-fatty acids which have been linked to adverse lipid profiles and heightened risk for CVD.⁸ Thus, past studies may not reflect the effect of naturally occurring oils on cardiovascular risk.

When non-hydrogenated coconut oil supplements have been provided, studies often find evidence for modest benefits of coconut oil consumption on lipid profiles.^{9,10} Animal studies have shown that coconut oil lowered total cholesterol, low density lipoprotein cholesterol (LDL-c) and triglyceride levels and increased high density lipoprotein cholesterol (HDL-c) values.¹¹

Other studies of the effect of coconut oil on cholesterol suggested beneficial health effects. A study of a cohort of women showed that coconut based diets lowered post-prandial plasminogen. In addition, lipoprotein(a) was lowered when the diet was high in saturated fat using coconut oil.¹² Similarly, a study of individuals with moderately elevated cholesterol found that levels of total and LDL cholesterol were lower in individuals consuming a coconut oil diet compared to those consuming safflower oil and butter.⁹ Studies of other populations that use coconut as a staple food are also consistent with neutral or beneficial effects on CVD risk. A case control study in Western Sumatra showed that coconut consumption has no effect on cardiovascular heart diseases,¹³ while studies on Pacific Islanders and inhabitants of Sri Lanka, have traditionally reported a low incidence of cardiovascular diseases.^{14,15}

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Clarifying the health impacts of coconut oil may have greatest importance for populations like the Philippines, where coconut oil is the most commonly used cooking oil. At present, little is known about the relationship between coconut oil and lipid profiles or cardiovascular disease in the Philippines. Interestingly, data from the Philippine National Nutrition Survey of 2003 revealed a relatively low incidence of hypercholesterolemia, hypertension, stroke and angina in the Bicol Region, where diets include higher coconut consumption compared to other regions.¹⁶ Here we seek to shed light on the health impacts of coconut oil by describing patterns of coconut oil consumption and by evaluating the association between coconut oil intake and plasma lipid profiles in a healthy population of Filipino women living in and around Metropolitan Cebu, Philippines

MATERIALS AND METHODS

Subjects

The Cebu Longitudinal Health and Nutrition Survey (CLHNS) began in 1983 with the recruitment of 3,327 pregnant women, representative of the childbearing population in Metropolitan Cebu. The women have been followed through multiple rounds of data collection since 1983. Data for the current analyses of longitudinal adiposity come from 2005, when blood was collected for lipid analysis. Lipid analysis was conducted on samples from 1,896 women ranging in age from 35–69 years old. Of those women, 1,839 had complete anthropometric, diet and socio-economic information, were not pregnant, and not using hormone replacement therapy or lipid lowering medications. All data were collected under conditions of informed consent with institutional ethics review board approval from the University of North Carolina, Chapel Hill and Northwestern University.

We evaluated how our sample differed from the original cohort as assessed when the study started in 1983. Compared to those lost to follow up, participants remaining in this study did not differ in height and household size but differed in body mass index (BMI), education and income. The subjects in this study were smaller, less educated and of lower income.

Methods

After a 12-hour overnight fast, blood samples were collected using EDTA-coated tubes. Frozen blood samples were shipped to the Emory Lipid Research Laboratory for lipid analysis. Total lipids were determined by enzymatic methods using reagents from Beckman Diagnostics (Palo Alto, CA) on a CX5 chemistry analyzer. HDL-cholesterol was determined using the homogenous assay direct HDL-C (Genzyme Corporation, Exton, PA). LDL cholesterol was determined using the Friedewald calculation. The Emory Lipid Research Laboratory is a participant in the CDC/NHLBI Lipid Standardization Program to ensure accuracy and precision of the determinations.

Coconut oil intake was measured using the mean of two 24-hour dietary recalls taken on consecutive days. Very few women reported directly consuming coconut oil (where oil was added to cooked rice). Most of the coconut oil was consumed through fried or sautéed items. The amount of oil absorbed through frying or sautéing were

estimated based on the weight (edible portion only) and type of food that was fried or sautéed (e.g. 5 grams of oil per 30–50 grams food). A majority (about 92%) of the sample women used coconut oil for cooking. Intake was categorized into low, medium and high according to tertiles. Those with no reported intake of coconut oil (~8%) were classified as having low coconut oil intake since similar results were obtained when the no coconut oil intake group were coded as their own group. Energy and other nutrient intakes from the 24-hour recalls were estimated using the 1997 Philippine Food Composition Tables.¹⁷

For regression analysis, potential effect modifiers or confounders included individual characteristics (age, total energy intake, BMI, number of pregnancies, education, level of energy expenditure at work and menopausal status), household assets, and an index of urbanicity that has been shown to characterize the relationship of rapid urbanization and health especially in developing countries like the Philippines.¹⁸

Statistical analysis

All analyses were performed using STATA Statistical Package v. 10 (College Station, TX). The lipid measures were treated as continuous and triglyceride values were log transformed to approximate a normal distribution. To determine effect measure modification we used the likelihood-ratio test ($p < 0.10$) comparing models with interaction and without interaction terms which identified menopausal status as a modifier. Thus, we stratified models on menopausal status, with pre-menopausal women defined as women who never reported being in a state of menopause while post-menopausal women included women who reported themselves as menopausal or were at least 55 years old. We used backward elimination and a change-in-estimate approach to determine which variables confound the association between coconut oil and lipid measures. If the exclusion of the variable in the model substantially (>10%) changed the coconut oil coefficients the variable was retained in the model and considered as a confounder.

RESULTS

The characteristics of the sample women are shown in Table 1. Educational attainment was generally low with many women only completing elementary school education. There was a substantial prevalence of overweight (42.2%) using the recommended body mass index cut points for Asian populations.¹⁹ Nearly half of the sample had reached menopause.

Stratifying the women according to their menopausal status revealed that post-menopausal women tended to be older, had experienced more pregnancies, had lower BMI, were less educated, and were from households with fewer assets. When compared to pre-menopausal women, a smaller proportion of post-menopausal women were from urban areas. Post-menopausal women had higher CVD disease risk as indicated by their lipid profiles, including higher total and LDL cholesterol, triglycerides and TC/HDL ratio, and lower HDL-c levels compared to pre-menopausal women. On average, women in the sample consumed an estimated 9.5 grams of coconut oil each day,

Table 1. Characteristics of all sample women and stratified on menopausal status

Characteristic	All (n=1,839) Mean ± SD	Menopausal Status	
		Pre-menopausal (n=1,121) Mean ± SD	Post-menopausal (n=718) Mean ± SD
Socio-demographic			
Age (yr)	48.4±6.0	45.0±3.8	53.8±4.9**
Body mass index (kg/m ²)	24.3±4.4	24.8±4.3	23.5±4.4**
Proportion overweight and obese (%)	42.2	46.2	35.9**
Number of pregnancies	6.6±3.0	6.00±2.7	7.4±3.3**
Education (yr)	6.9±3.2	7.2±3.0	6.4±3.6**
Urbanicity index	40.2±13.7	40.9±13.3	39.2±14.3**
Household assets score	5.2±1.9	5.3±1.9	5.0±2.0**
Coconut oil intake (g/day)	9.5±8.9	10.3±9.2	8.4±8.4**
Lipid profiles			
Total cholesterol (mg/L)	186.5±38.9	181.6±36.4	194.2±41.1**
HDL-c (mg/dL)	40.9±10.3	41.4±10.1	40.0±10.5*
LDL-c (mg/dL)	119.4±33.2	115.8±31.3	125.0±35.3**
Triglycerides (mg/dL)	130.8±85.3	121.4±68.3	145.3±105.0**
TC/HDL	4.8±1.4	4.6±1.2	5.1±1.6**

*significant at $p < 0.05$ ** significant at $p < 0.01$

Table 2. Selected socio-demographic characteristics and lipid profile of sample women by level of coconut oil intake[†]

Characteristics	Level of coconut oil intake			<i>p</i> -value [‡]
	Low (n=676)	Medium (n=583)	High (n=580)	
Socio demographic				
Age (yrs)	49.3±6.4	48.2±6.1	47.7±5.3	0.001
Body mass index (kg/m ²)	23.4±4.2	24.6±4.4	25.2±4.3	0.001
Number of pregnancies	7.4±3.1	6.4±3.0	5.8±2.7	0.001
Post-menopause (%)	45.4	37.9	32.8	0.001
Education (yrs)	5.6±2.7	6.9±3.1	8.3±3.3	0.001
Total energy intake (kcal)	864.7±384.6	1132.1±396.0	1460.8±511.3	0.001
Urbanicity index	36.2±15.2	40.8±13.1	44.4±10.9	0.001
Household assets score	4.6±1.8	5.3±1.9	5.9±1.9	0.001
Lipid profiles				
Total cholesterol (mg/dL)	179.6±38.3	188.0±37.4	194.2±39.5	0.001
HDL-c (mg/dL)	39.2±10.0	41.2±10.2	42.4±10.5	0.001
LDL-c (mg/dL)	114.9±33.5	119.4±31.9	124.8±33.4	0.001
Triglycerides (mg/dL)	127.4±81.9	131.4±82.8	133.9±91.4	0.001
Total Cholesterol-HDL ratio	4.8±1.4	4.8±1.4	4.8±1.5	0.81

[†]All values are means and ± SD unless indicated. [‡]*p*-values based on ANOVA for means and Pearson's χ^2 for proportions.

with pre-menopausal women reporting higher intake than post-menopausal women.

Coconut oil intake which was classified into tertiles showed that consumption of coconut oil was higher among women who were younger, more educated, or who had lower BMI and fewer pregnancies (Table 2). Similarly, coconut oil intake was higher among women living in households with more assets and in more urban areas and with higher total energy intake. The estimated energy intakes based on the 24-hour dietary recalls in this sample are consistently low across all survey years as observed in studies using these sample women.²⁰ Similarly, lipid measures (TC, HDL-c, LDL-c, triglyceride levels) increased with increasing intake of coconut oil.

In multiple regression models, coconut oil consumption (expressed as tertiles) was positively associated with TC and HDL-c, especially among pre-menopausal women (Table 3). Among pre-menopausal women, being in the high tertile of coconut oil intake was associated with high TC levels compared to low coconut oil intake. This was

also shown in relation to HDL-c levels among pre-menopausal women where being in moderate or high tertiles of coconut oil intake was associated with significantly higher HDL-c compared to women with lower coconut oil intake. On average, pre-menopausal women in the highest tertile intake of coconut oil have about 2 mg/dL higher HDL-c compared to pre-menopausal women in the lowest coconut oil consumption tertile. Compared to women in the lowest tertile of intake, TC was significantly increased among the highest intake tertile, but this may be attributed to increased HDL-c. Dietary coconut oil intake was not associated with TC and HDL-c in post-menopausal women, and it did not relate to LDL-c, triglycerides or the TC/HDL ratio in either pre-menopausal or post-menopausal women.

DISCUSSION

Mean total cholesterol, LDL-c and triglyceride levels and TC/HDL ratio of the sample women were within the desirable limits set by WHO.²¹ The high prevalence of low

Table 3. Regression coefficients relating tertiles of dietary coconut oil intake to lipid values for all women[†] stratified by menopausal status[‡]

Lipid values	All Women (n=1,839) (95% CI)	Menopause status	
		Pre-menopausal (n=1,121) (95% CI)	Post-menopausal (n=718) (95% CI)
Total cholesterol (mg/dL)			
Low	Reference	Reference	Reference
Medium	1.7 (-2.4,5.8)	5.2 (-0.02,10.3)	-3.2 (-10.2,3.7)
High	4.4 (-0.3,9.1)	6.2* (0.4,12.0)	1.3 (-6.9,9.4)
R ²	0.2	0.1	0.2
HDL-c (mg/dL)			
Low	Reference	Reference	Reference
Medium	1.0 (-0.1,2.2)	1.9* (0.4,3.4)	-0.1 (-2.0,1.8)
High	1.5* (0.2,2.8)	2.2* (0.5,3.8)	0.4 (-1.8,2.6)
R ²	0.1	0.1	0.04
LDL-c (mg/dL)			
Low	Reference	Reference	Reference
Medium	0.9 (-2.8,4.6)	4.2 (-0.4,8.8)	-3.7 (-9.9,2.5)
High	3.4 (-0.8,7.6)	4.0 (-1.1,9.1)	2.6(-4.6,9.9)
R ²	0.1	0.1	0.1
Triglycerides (log mg/dL)			
Low	Reference	Reference	Reference
Medium	-0.01 (-0.1,0.04)	-0.04 (-0.1,0.02)	0.03 (-0.1,0.1)
High	-0.02(-0.1,0.04)	-0.03 (-0.1,0.04)	-0.02 (-0.1,0.1)
R ²	0.1	0.1	0.1
TC/HDL ratio			
Low	Reference	Reference	Reference
Medium	-0.1 (-0.2,0.1)	-0.1 (-0.3,0.1)	-0.1 (-0.3,0.2)
High	-0.1 (-0.2,0.1)	-0.1 (-0.3,0.1)	-0.1 (-0.4,0.3)
R ²	0.1	0.04	0.1

[†]adjusted for total energy intake, age, body mass index, number of pregnancies, level of energy expenditure at work, education, menopausal status and household assets. [‡]adjusted for total energy intake, age, body mass index, number of pregnancies, level of energy expenditure at work, education and household assets. *significant at $p < 0.05$

HDL among the women in this sample is expected to increase risk of developing CVD. This low HDL level may reflect an isolated low HDL phenotype common in Asian populations or the presence of HDL suppressing genetic polymorphisms shaping their lipid profiles as shown in this sample of women.²² However, our analysis showed that low HDL-c is common in this population despite the relatively high coconut oil intake, which is associated with elevated HDL-c levels. Our findings thus add to growing evidence that coconut oil intake could have beneficial effects on lipid profiles and cardiovascular disease risk.

We examined the association of coconut oil intake with lipid profiles of Filipino women using the two day 24-hour dietary food recall. The dietary intake of coconut oil was shown to have a positive association with TC and HDL-c especially for pre-menopausal women which is consistent with prior studies^{9,10} Although the difference in HDL-c predicted by coconut oil intake was modest, it is likely to have clinical relevance at the population level. Clinical trials and epidemiologic studies have previously shown that a 1 mg/dL increase in HDL-c predicts a 2-3% reduction in heart disease risk.²³ In this study, high coconut oil consumption predicted a statistically significant increase in HDL-c of 2 mg/dL. In contrast to these possible benefits of coconut oil consumption on HDL-c, we found no association between coconut oil and LDL-c, triglyceride levels and TC/HDL ratio.

Menopause was a significant modifier of the relationship between coconut oil and lipid levels in these women. This finding supports an earlier study that showed a protective effect of endogenous estrogen with increased HDL-c levels and reduced LDL levels among pre-menopausal women compared to post-menopausal women.²⁴ Although we did not have hormonal data available for this cohort of women, the reduction in estrogen production at menopause is known to influence lipid metabolism and could help account for the interactions between coconut oil consumption and menopausal status noted here.²⁵ Future studies will be necessary to investigate the possible role of gonadal steroids as moderating influence on the relationship between dietary coconut oil intake and lipid profiles.

In sum, we provide some of the first evidence for a relationship between high coconut oil consumption and beneficial lipid profiles in the Philippines. Oil consumption was lower in the CLHNS sample compared to the country (with 18%) or with other developed countries like the United States (with 33%) yet the positive effects on the good cholesterol was shown.^{26,27} Although our data are observational and thus incapable of establishing causality, the relationships that we document are consistent with findings from prior clinical trials that show similar beneficial effects in other populations. In light of the high levels of coconut oil consumption in many tropical regions of Asia and the Pacific, further studies are needed

to clarify the population health effects of this common edible oil.

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AUTHOR DISCLOSURES

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菲律賓停經前婦女之椰子油攝取與有益的血脂質相關

椰子油在許多國家是一種常用的食用油，但其對於血脂影響及心血管疾病之風險並未定論。本研究以菲律賓宿霧市健康與營養調查(Cebu Longitudinal Health and Nutrition Survey)其中的婦女世代為調查對象，共 1839 位，年齡為 35-69 歲，探討她們的椰子油攝取與血脂之相關性。椰子油攝取量是由兩次 24 小時飲食回憶資料求得之平均值(9.5±8.9 克)。由空腹抽血樣本，分析各項血脂的指標。以線性迴規模式，校正總能量、年齡、身體質量指數、懷孕次數、教育程度、停經狀態、家戶所得及城市居住等變項後，評估椰子油攝取與血脂之間的相關性。結果發現，椰子油攝取與低密度脂蛋白或三酸甘油酯沒有顯著相關，然而與高密度脂蛋白呈正相關，尤以停經前婦女更為明顯，顯示椰子油攝取與有益的血脂質有關。針對經常食用椰子油的族群，需再進一步探討椰子油與血膽固醇的關連。

關鍵字：膽固醇、心血管疾病、營養、飽和脂肪、營養過渡期