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# Coconut oil predicts a beneficial lipid profile in pre-menopausal women in the Philippines

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## Abstract

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 City. Coconut oil intake was measured as individual coconut oil intake calculated using two 24-hour dietary recalls (9.54 ± 8.92 grams). Cholesterol profiles were measured in plasma samples collected after an overnight fast. Mean lipid values in this sample were total cholesterol (TC) (186.52 ± 38.86 mg/dL), high density lipoprotein cholesterol (HDL-c) (40.85 ± 10.30 mg/dL), low density lipoprotein cholesterol (LDL-c) (119.42 ± 33.21 mg/dL), triglycerides (130.75 ± 85.29 mg/dL) and the TC/HDL ratio (4.80 ± 1.41). 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 HDL-c levels.

### Keywords

cholesterol; coconut oil; cardiovascular disease

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Cardiovascular diseases (CVD) figure prominently as public health problems in the Philippines, and are now the leading causes of death in the country (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 more artherogenic lipid profiles (3, 4). Some past 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 for cooking, but results in increased levels of trans-fatty acids have been linked to adverse lipid profiles and heightened risk for CVD (8). These studies may not reflect the effect of naturally occurring oils. Reiser similarly (9) notes that studies in humans have often been conducted in the absence of a neutral diet with coconut oil consumption compared with polyunsaturated fatty acids which have known hypocholesterolemic effects.

When non-hydrogenated coconut oil supplements have been provided, studies often find evidence for modest benefits of coconut oil consumption on lipid profiles (10,11). Animal studies have shown that coconut oil in particular lowered total cholesterol, lipoproteins and phospholipids (12). The reason for this is that coconut oil is composed of medium chain fatty acids which are rapidly metabolized in the liver into energy and does not participate in the biosynthesis and transport of cholesterol (13). In fact, coconut has lauric, capryllic, capric, myristic, palmitic fatty acids. Animal studies have shown that capryllic and capric fatty acids have no effect on cholesterol levels while lauric, myristic and palmitic fatty acids are equivalent in their cholesterol raising potential (14). Coconut oil which is rich in lauric acid has less effect on total cholesterol and LDL-c and is a better alternative to butter and hydrogenated vegetable fats (10).

Further studies on coconut revealed the beneficial effects of this tropical fruit. A study of a cohort of women showed that coconut based diets lowered the postprandial tissue plasminogen and lipoprotein (a) – a blood marker associated with the risk of heart attack. Lipoprotein (a) was lowered when the diet was high in saturated fat using coconut oil (15). Similarly, a study of individuals with moderately elevated levels of cholesterol showed that levels of total and LDL-c were lower in individuals consuming coconut oil diet compared to those consuming safflower oil and butter (10). Studies on Pacific Islanders who have coconut as their staple food have traditionally had a low incidence of cardiovascular diseases (16) and population studies in Sri Lanka have shown that consumption of coconut is not associated with cardiovascular diseases (13).

The question of 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 country 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 have high levels of coconut consumption compared to the other regions (17). 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 Cebu City, Philippines, and its environs.

## SUBJECTS AND METHODS

### Subjects

The Cebu Longitudinal Health and Nutrition Survey (CLHNS) began in 1983 with the recruitment of 3327 pregnant women representative of the childbearing population in Cebu City. 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 nor using hormone replacement therapy nor lipid lowering medications. All data were collected under conditions of informed consent with institutional 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 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 intake were 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. 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 (18).

For regression analysis, potential effect modifiers or confounders considered 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 (19).

### 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 LR 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 fifty-five 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 in the sample was generally low with many women only completing elementary school education. There was a substantial prevalence of overweight using the recommended body mass index cut points for Asian populations (20). 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. A smaller proportion of these 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 9.54 grams of coconut oil each day, with pre-menopausal women reporting higher intake than post-menopausal women.

Coconut oil intake was biased towards the younger, more educated women and those with smaller BMI, and less pregnancies but not for post-menopausal women (Table 2). Similarly, coconut oil intake was higher among women living in households with more assets and in more urban areas. The level of coconut oil intake was higher among women with more total energy intake. Similarly, lipid measures (TC, HDL-c, LDL-c, triglyceride levels) increased with increasing intake of coconut oil.

Among the lipid measures, TC and HDL-c were associated with dietary coconut oil use, 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. 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 low HDL readings for these women indicate that they may be at risk of cardiovascular disorders. 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 coconut oil intake may enhance HDL-c levels.

We examined the association of coconut oil intake with the lipid profile of Filipino women using the two-day 24-hour dietary food recall. The dietary intake of coconut oil was shown to have a preventive effect especially for both pre-menopausal women and supportive of studies that have shown coconut oil intake to have beneficial effects (10,11).

The results that showed coconut oil did not elevate TC, triglyceride levels and TC/HDL ratio in general even if menopausal status was accounted for.

Menopause was a significant modifier of the relationship between coconut oil and lipid levels. 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 (23). According to Sacks (24) “the hormonal changes associated with menopause, including low plasma levels of estrogen and a marked increase in leutenizing and follicle stimulating hormone levels have a positive effect on the metabolism of plasma lipids and lipoproteins”. The reduction in estrogen levels brought by menopause has an apparent adverse effect on the plasma lipids and lipoproteins (25).

This study because of its design has not been able to control for other external factors and is less stringent than a randomized controlled trial. However, this study has its merits of having a large sample population and high quality data. With the use of two measures of coconut oil intake, it has shown the importance of coconut oil on lipid measures. It is one of the few studies from the Philippines that support the beneficial effects of coconut oil use. Oil consumption was lower in the CLHNS sample compared to the country with 18% (26) than in other developed countries like the United States with 33% (27) yet the positive effects on the good cholesterol was shown. Further studies need to be explored to determine the association of coconut oil consumption in other populations to provide evidence on the positive effects of coconut oil usage and correct the notion that coconut oil is harmful to one's health.

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## Table 1

Characteristics of sample women in general and according to their menopausal status

| | | Menopausal Status | |
|---|---|---|---|
| | All (n=1,839) | Pre-menopausal (n=1,121) | Post-menopausal (n=718) |
| **Characteristic** | **Mean ± SD** | **Mean ± SD** | **Mean ± SD** |
| Socio-demographic | | | |
| Age (in years) | 48.45±6.02 | 45.04±3.75** | 53.79±4.92 |
| Body mass index (kg/m$^2$) | 24.33±4.37 | 24.84±4.25** | 23.53±4.43 |
| Proportion overweight and obese (%) | 42.20 | 46.21** | 35.93 |
| Number of pregnancies | 6.57±3.03 | 6.00±2.71** | 7.45±3.29 |
| Education (in years) | 6.86±3.24 | 7.16±2.97** | 6.38±3.57 |
| Urbanicity index | 40.21±13.72 | 40.89±13.27** | 39.17±14.32 |
| Household assets score | 5.21±1.92 | 5.32±1.88** | 5.04±1.97 |
| Coconut oil intake (grams/day) | 9.54±8.92 | 10.26±9.20** | 8.42±8.36 |
| Lipid profiles | | | |
| Total cholesterol (mg/L) | 186.52±38.86 | 181.62±36.39** | 194.17±41.13 |
| HDL-c (mg/dL) | 40.85±10.30 | 41.36±10.11* | 40.03±10.53 |
| LDL-c (mg/dL) | 119.42±33.21 | 115.85±31.33** | 125.01±35.26 |
| Triglycerides (mg/dL) | 130.75±85.29 | 121.42±68.27** | 145.32±104.97 |
| TC/HDL | 4.80±1.41 | 4.59±1.25** | 5.13±1.57 |

* significant at $p<0.05$

** significant at $p<0.01$

## Table 2

Level of coconut oil intake by selected socio-demographic characteristics and lipid profile of sample women

| Characteristics | Level of coconut oil intake | | | |
|---|---|---|---|---|
| | **Low (n=676)** | **Medium (n=583)** | **High (n=580)** | **p-value[1]** |
| Socio demographic | | | | |
| Age ( in yrs) | 49.29± 6.39 | 48.22± 6.11 | 47.71± 5.34 | 0.001 |
| Body mass index (kg/m$^2$) | 23.40±4.24 | 24.55± 4.36 | 25.19± 4.32 | 0.001 |
| Number of pregnancies | 7.35± 3.13 | 6.42± 2.98 | 5.80± 2.74 | 0.001 |
| Post-menopause (%) | 45.41± 49.83 | 37.91± 48.56 | 32.76± 46.97 | 0.001 |
| Education (in yrs) | 5.55± 2.70 | 6.91± 3.11 | 8.32±3.31 | 0.001 |
| Total energy intake (kcal) | 864.68± 384.61 | 1132.12± 396.02 | 1460.83± 511.29 | 0.001 |
| Urbanicity index | 36.15± 15.21 | 40.76± 13.08 | 44.40± 10.89 | 0.001 |
| Household assets score | 4.59± 1.75 | 5.28±1.88 | 5.86±1.91 | 0.001 |
| Lipid profiles | | | | |
| Total cholesterol (mg/dL) | 179.58± 38.33 | 187.99± 37.42 | 194.15± 39.48 | 0.001 |
| HDL-c (mg/dL) | 39.25± 10.03 | 41.15± 10.16 | 42.41± 10.48 | 0.001 |
| LDL-c (mg/dL) | 114.90± 33.53 | 119.36± 31.88 | 124.77± 33.42 | 0.001 |
| Triglycerides (mg/dL) | 127.42±81.93 | 131.43±82.83 | 133.94±91.37 | 0.001 |
| Total Cholesterol-HDL ratio | 4.81± 1.40 | 4.77± 1.36 | 4.82± 1.47 | 0.81 |

[1] p-values based on Pearson's $\lambda^2$

## Table 3

Regression coefficients relating tertiles of dietary coconut oil intake to lipid values for all women[1] and according to menopausal status[2]

| Lipid values | All Women (n=1,839) β 95% CI) | Menopause status: Pre menopausal (n=1,121) β 95% CI) | Menopause status: Post menopausal (n=718) β 95% CI) |
|---|---|---|---|
| Total cholesterol (mg/dL) | | | |
| Low | Reference | Reference | Reference |
| Medium | 1.70 (−2.45, 5.85) | 5.16 (−0.02, 10.34) | −3.24 (−10.21, 3.73) |
| High | 4.40 (−0.33, 9.12) | 6.24* (0.45,12.04) | 1.26 (−6.92, 9.45) |
| $R^2$ | 0.16 | 0.13 | 0.16 |
| HDL–c (mg/dL) | | | |
| Low | Reference | Reference | Reference |
| Medium | 1.04 (−0.13, 2.21) | 1.91* (0.40,3.41) | −0.12 (−2.01, 1.77) |
| High | 1.48* (0.15,2.81) | 2.17* (0.49,3.85) | 0.38 (−1.85,2.60) |
| $R^2$ | 0.05 | 0.06 | 0.04 |
| LDL-c (mg/dL) | | | |
| Low | Reference | Reference | Reference |
| Medium | 0.87 (−2.81, 4.55) | 4.17 (−0.42, 8.77) | −3.67 (−9.86, 2.49) |
| High | 3.36 (−0.82, 7.55) | 4.00 (−1.14, 9.14) | 2.63(−4.62, 9.88) |
| $R^2$ | 0.10 | 0.080 | 0.09 |
| Triglycerides (log mg/dL) | | | |
| Low | Reference | Reference | Reference |
| Medium | −0.01 (0.06, 0.04) | −0.04 (−0.11, 0.02) | 0.03 (−0.06, 0.12) |
| High | −0.02(−0.08, 0.04) | −0.03 (−0.11, 0.043) | −0.02 (−0.13, 0.08) |
| $R^2$ | 0.12 | 0.11 | 0.13 |
| TC/HDL ratio | | | |
| Low | Reference | Reference | Reference |
| Medium | −0.09 (−0.24, 0.07) | −0.11 (−0.29, 0.08) | −0.06 (−0.34, 0.22) |
| High | −0.06 (−0.24, 0.12) | −0.07 (−0.28, 0.14) | −0.05 (−0.38, 0.28) |
| $R^2$ | 0.08 | 0.04 | 0.06 |

[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

[2] 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

** significant at p<0.01