

## Review Article

# Association of lipid profile levels in premenopausal and postmenopausal women with breast cancer: a meta-analysis

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**Abstract:** Background: Published epidemiological evidence of the association between circulating lipids and lipoproteins and breast cancer (BC) in premenopausal and/or postmenopausal women remains controversial. A meta-analysis was therefore designed to estimate a more accurate association. Methods: Systematic literature retrieval was performed on the databases of Web of Science, PubMed and Cochrane library up to December 1th, 2015. Only studies reporting the data on the association of lipid components with premenopausal and/or postmenopausal BC patients were included. The pooled estimates of standardized mean difference (SMD) with 95% confidence intervals (CIs) were calculated by fixed-effect model or random-effect model. Results: A total of 12 studies which documented 9 investigations in premenopausal and postmenopausal women and 3 investigations in postmenopausal women containing 1042 BC patients and 1283 normal controls were included in the systematic review. In premenopausal group, the pooled SMD of triglyceride (TG) was 0.33 (95% CI: 0.07 to 0.59). In postmenopausal group, the pooled SMDs of triglyceride (TG) and high density lipoprotein cholesterol (HDL-C) were 0.94 (95% CI 0.33 to 1.55), and -0.62 (95% CI: -1.11 to -0.13), respectively. No significant differences were noted for total cholesterol (TC), low density lipoprotein cholesterol (LDL-C), apolipoprotein A1 (ApoA1), and apolipoprotein B (ApoB) between premenopausal and postmenopausal cases and controls. Conclusions: The study showed that TG levels were higher in both premenopausal and postmenopausal BC compared with controls. An inverse association between levels of HDL-C and BC was detected among postmenopausal women. The results should be interpreted with caution on account of methodological flaws.

**Keywords:** Lipid profile, lipoproteins, cholesterol, breast cancer, meta-analysis

## Introduction

Breast cancer (BC) is one of the most common sites of carcinomas among women in both developed and developing countries. It usually occurs in the upper outer quadrant of the breast and is characterized by breast mass, nipple discharge, skin change, abnormal nipple and areola, and enlargement of lymph node in the armpit. Infiltrating ductal carcinoma is a common pathological type of BC, accounting for about 80% to 90% [1]. Women would turn pale at the mentioning of BC for its high morbidity and mortality among females. According to the report of GLOBOCAN 2012, an estimated 1,676,600 women were diagnosed as new BC

cases and 521,900 cases died worldwide, which accounted for 25.16% (1,676,600/6,663,000) of all cancer cases and 14.71% (521,900/3,548,200) of all cancer deaths among females [2]. BC is the primary cause of death in women aged between 40 and 44 [3]. The incidence and mortality rates of this disease varied widely among Europe, North America, Africa and Asia, which was attributed partially to the differences in the racial background, lifestyle and availability of medical conditions [2, 4]. Though the underlying etiology of BC has been unclear, a number of epidemiological studies and clinical trials have postulated that various factors including BRCA1/2, estrogen, insulin, age of menarche, pregnancy,

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menopause status, oral contraceptive, obesity, inadequate exercise, smoking, alcohol intake, environmental exposure, socioeconomic conditions as well as family history of BC probably exerted a positive influence on or were responsible for the risk of BC, and the menopause was more likely to be a crucial risk factor [5-8]. It was well known that menopausal transition, an inevitable physiological period for each woman, which was usually accompanied by marked changes in multiple reproductive hormonal and a constellation of physical changes, including lipids, cholesterol, circulating estrogen, was considered to be associated with an increased subsequent BC risk [9, 10].

In recent years, numerous studies have suggested that the changes in some of serum lipids and lipoproteins, including total cholesterol (TC), triglyceride (TG), high density lipoprotein cholesterol (HDL-C), low density lipoprotein cholesterol (LDL-C), apolipoprotein A1 (ApoA1), and apolipoprotein B (ApoB), played a potential role in various types of diseases and cancer risk, such as coronary heart disease risk, ovarian neoplasm, colorectal neoplasm and BC. For instance, the low levels of HDL-C and high levels of TC and LDL-C were reported to be associated with coronary heart disease risk [11]; the decreased TC levels increased the risk of ovarian neoplasm [12]; the LDL-C levels were linked to colorectal neoplasm [13]. Among these, BC was the focus of oncology field at all times. Evidence regarding the relationships between lipid profile and possible pathogenesis of BC has been speculated in published researches. The endogenous sex steroid hormones probably increased the risk of BC directly, for the reason that serum cholesterol was the precursor to steroid hormone synthesis [14]. The lipids metabolism in mammary tissue was affected by gonadal hormones, and malignant proliferation of breast tissue was related to alterations in levels of lipid profiles [15]. The lipids and lipoproteins fostered tumor growth and metabolic abnormality of lipids and lipoproteins occurred in malignant tissue [16]. The host immune mechanism was suggested to be significantly affected by alterations in serum lipids and lipoproteins [17]. The association between elevated levels of insulin-like growth factor-I (IGF-I) in premenopausal women and increased risk of BC in postmenopausal women has been demonstrated as well [18]. In addition, Calle [19]

indicated that in postmenopausal women, the weakened conversion of androgens to estrone in adipose tissue might decrease levels of sex hormone-binding globulin and elevate levels of circulating estradiol, which possibly increased BC risk. Despite all these, a more detailed role of serum lipids in the pathogenesis of BC still remains unclear and controversial.

Although dozens of studies regarding the potential roles of lipid profile levels on BC risk have been conducted, results of existing reported studies on this association are inconclusive. This was partly because of the small number of patients and controls, study design, as well as heterogeneity among different populations in different studies. For example, the data reported by Alexopoulos [20] suggested increased levels of LDL-C and HDL-C among BC cases compared with controls, which differed from the findings of previous studies by Schreier, Borrelli and Kokoglu [21-23]. Furthermore, few observational studies have systematically assessed the association of BC with alterations in concentrations of TC, TG, HDL-C, LDL-C, ApoA1, and ApoB. In our study, a meta-analysis, therefore, was performed to derive a more accurate estimation on the association of serum lipid profile with BC among BC patients in comparison with normal women taking account of menopausal status, and to provide evidence for public health implications for BC diagnosis and prevention.

### Material and methods

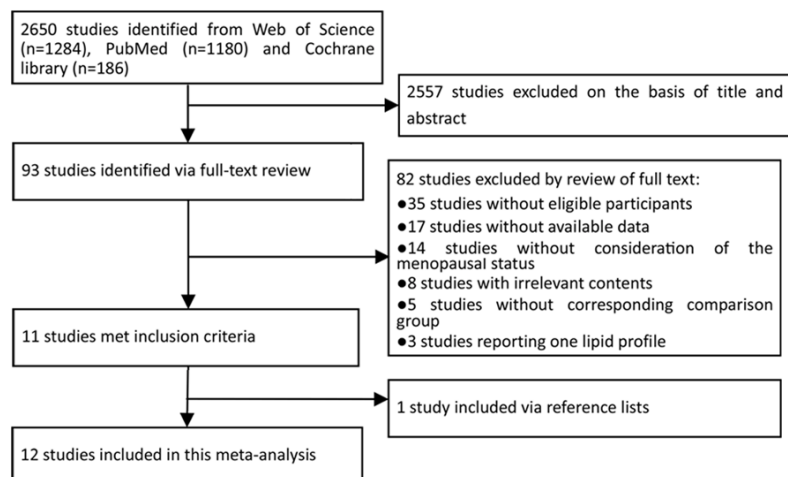
#### *Search strategy*

A systematic literature retrieval was performed on Web of Science, PubMed and Cochrane library using the following terms "(lipid OR cholesterol OR lipoprotein OR dyslipidemia) AND (cancer OR carcinoma OR oncology OR tumour OR tumor OR neoplasm\* OR malignant\*) AND breast AND (premenopausal OR postmenopausal OR menopause)" to identify relevant published studies up to December 1th, 2015. No restrictions were added to the search. Furthermore, we also checked the reference lists of original papers to include relevant articles as many as possible.

#### *Inclusion and exclusion criteria*

The articles were eligible for this meta-analysis based on the following criteria: (1) written in English; (2) investigating the associations

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**Figure 1.** Flow diagram of study selection process.

between BC and serum lipids including at least two of the selected lipids components (TC, TG, HDL-C, LDL-C, ApoA1, ApoB) with consideration of menopausal status; (3) case-control or cohort study; (4) mean and standard deviation of lipids levels were available or provided sufficient continuous data on lipid profile levels in BC patients and normal controls for calculating them; (5) the patients had no history of any major illness or metabolic syndrome which might alert lipids metabolism and were not performed by chemotherapy, radiotherapy or other drugs treatment before the blood samples collection. The exclusion criteria were as below: (1) the study was case report, review, or comment; (2) the data on serum lipids levels were not available or unclear; (3) the study was experimental research on animals.

### Data extraction and quality assessment

All eligible articles were reviewed and extracted by two investigators (Yunwu Zhao and Cheng Bian) independently according to inclusion and exclusion criteria. The following information was extracted from included studies using a data-extracting form: name of first author, year of publication, county, type of study design, number of cases and controls, age, timing of blood samples measurement, measured variables of serum lipid profile components; serum lipids test method, source of control as well as matching. The values of TC, TG, HDL-C, and LDL-C in units of mmol/L were converted into units of mg/dL using conversion factors. If different opinions existed in the process of data extraction, two investigators (Yunwu Zhao and

Cheng Bian) discussed this discrepancy exhaustively until an agreement was reached. The Newcastle-Ottawa Scale (NOS) quality assessment scale which consisted of four questions about selection populations, one question about comparability of groups, and three questions about exposure or outcome assessment, totaling eight questions with nine points was used to evaluate the methodological quality of included studies [24].

### Statistical analysis

The lipid profile levels in premenopausal BC patients and normal controls, and postmenopausal cases and controls were assessed in this meta-analysis. If cases or controls were not further divided into premenopausal and postmenopausal groups, the data would not be extracted for analysis. The pooled estimates of standardized mean difference (SMD) with 95% confidence intervals (CIs) were calculated by fixed-effect model or random-effect model depending on the effect of heterogeneity.  $Q$  statistic and  $I^2$  were used to estimate the effect of heterogeneity among studies [25].  $P$  value of  $Q$  statistic  $> 0.05$  and  $I^2 < 50\%$  were not considered as significant heterogeneity, and fixed-effect model was used to calculate the pooled effect size; otherwise, random-effect model was used. Sensitivity analysis was applied to compare changes of pooled size after excluding any study. Egger's regression test was performed to assess potential publication bias [26].  $P$  value of Egger's regression test  $< 0.05$  was considered as significant publication bias. Stata version 11.0 was used to perform statistical analyses.

## Results

### Studies selected

After the systematic literature retrieval, 2650 studies were retrieved from the databases of Web of Science, PubMed and Cochrane library according to the established retrieval strategy. 2557 studies were excluded after initially reviewing the title and abstract and 93 studies remained to be the full-text review. Among

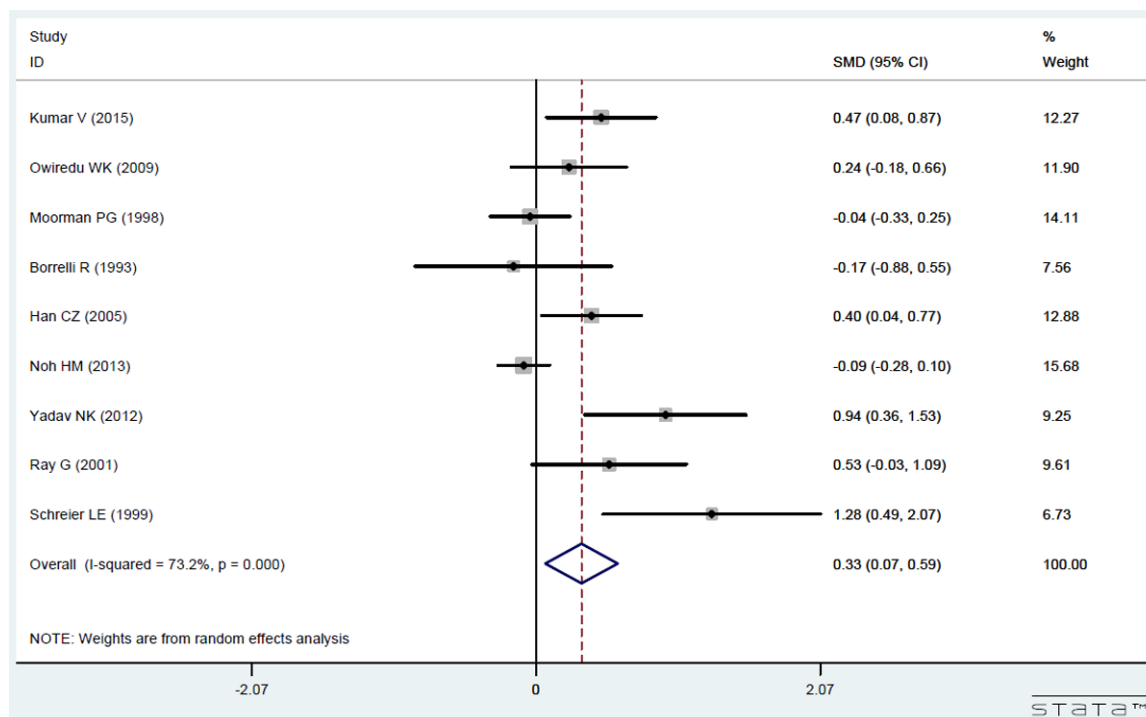
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**Table 1.** Characteristics of studies included in meta-analysis

First author and year	County	Study Design	Cases/ Controls	Age range or mean age (SD)	Menopausal status	Blood samples collection	Lipid profile test methods	Measured variable	Source of control	Matched by	Quality score
Kumar V (2015) [27]	India	Case-control	100/100	53.27/44.55	Pre- and post-	Fasting > 8 h	Enzymatic, Friedewald equation	TC, TG, HDL-C, LDL-C	HC	NA	7
Owiredu WK (2009) [28]	Ghana	Case-control	100/100	48.21 (13.69)/42.64 (13.4)	Pre- and post-	Fasting (12-16 h)	Enzymatic	TC, TG, HDL-C, LDL-C	HC	Age	7
Delimaris I (2007) [29]	Greece	Case-control	17/30	53-70/54-77	Post-	Fasting > 12 h	Automated ILAB-600 analyzer	TC, HDL-C, LDL-C	HC	Age, weight	8
Michalaki V (2005) [30]	Greece	Case-control	56/26	67.5 (13.7)/65.3 (17.4)	Post-	Fasting (12-14 h)	Enzymatic	TC, TG, HDL-C	HC	Age	7
Moorman PG (1998) [31]	United States	Nested case-control	196/196	33.1/33.1	Pre- and post-	NA	Enzymatic, Friedewald equation	TC, TG, HDL-C, LDL-C	HC	Age, date of examination	7
Borrelli R (1993) [22]	Italy	Case-control	42/24	56.1/44.0	Pre- and post-	Fasting	NA	TC, TG, HDL-C	BBD	NA	6
Han CZ (2005) [32]	China	Case-control	90/103	45.88 (9.20)/46.58 (9.60)	Pre- and post-	Fasting	Biochemistry Auto-analyzer	TC, TG, HDL-C, LDL-C, ApoA1, ApoB	HC	Age, region	7
Noh HM (2013) [33]	Korea	Case-control	270/540	51.6/51.8	Pre- and post-	Fasting > 12 h	Enzymatic	TG, HDL-C	HC	Age	8
Yadav NK (2012) [34]	Nepal	Case-control	69/70	25-70/25-70	Pre- and post-	NA	Semi auto-analyzer	TC, TG, HDL-C, LDL-C	HC	NA	7
Ray G (2001) [35]	India	Case-control	54/42	46.9/47.2	Pre- and post-	NA	Enzymatic, Friedewald equation	TC, TG, HDL-C, LDL-C	MSP	Age	7
Schreier LE (1999) [21]	Argentina	Case-control	30/30	28-72/NA	Pre- and post-	Fasting > 12 h	Enzymatic, Electroimmunodiffusion	TC, TG, HDL-C, LDL-C, ApoA1, ApoB	HC	Age	8
Kokoglu E (1994) [23]	Turkey	Case-control	18/22	52.9 (7.7)/51.6 (8.2)	Post-	Fasting	Enzymatic, Friedewald equation	TC, TG, HDL-C, LDL-C	HC	Age	6

NA: not available; TC: total cholesterol; TG: triglyceride; HDL-C: high density lipoprotein cholesterol; LDL-C: low density lipoprotein cholesterol; ApoA1: apolipoprotein A1, ApoB: apolipoprotein B; Pre-: premenopausal; Post: postmenopausal; SD: standard deviation; HC: health control; BBD: benign breast disease; MSP: minor surgical problems.

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**Figure 2.** Forest plot of SDM between TG and premenopausal breast cancer.

them, 35 studies without eligible participants, 17 studies without available data, 14 studies without consideration of the menopausal status, 8 studies with irrelevant contents, 5 studies without corresponding comparison group in premenopausal and postmenopausal normal controls, and 3 studies reporting one lipid profile under investigation were excluded on the basis of full-text review. One study was included via reference lists. Ultimately, 12 studies were eligible for the inclusion criteria and included in this meta-analysis. Detailed process for screening eligible studies was presented in **Figure 1**.

### Study characteristics

The 12 studies documented 9 investigations in premenopausal and postmenopausal women and 3 investigations in postmenopausal women, containing 1042 BC patients and 1283 controls (health women, benign breast disease patients and women with minor surgical problems), of which 2 were conducted in India, 2 in Greece, 1 each in Ghana, United States, Italy, China, Korea, Nepal, Argentina, and Turkey [21-23, 27-35]. 11 out of the 12 studies were case-control studies and one was

nested case-control study. The sample sizes of the eligible studies ranged from 40 to 810. 9 studies made investigations on the relationship of premenopausal and postmenopausal BC patients with lipid profile levels, and 3 studies on postmenopausal cases. BC was confirmed by mammography and/or histological examination. The method of blood samples collection in most studies ( $n = 8$ ) was fasting blood. Enzymatic analysis ( $n = 8$ ) and automated/semi automated analyzer ( $n = 3$ ) were used to estimate lipid profiles. The sampled participants in 9 studies were matched by age. The quality scores of included studies ranged from 6 to 8. Detailed characteristics of eligible studies were showed in **Table 1**.

### Lipid profile levels in premenopausal and postmenopausal BC

The pooled estimates of SMDs were calculated by random-effect model on account of the significant heterogeneity among studies. In premenopausal group, the results showed a significant association between increased levels of TC (SMD = 0.68, 95% CI: 0.08 to 1.28;  $I^2 = 92.0\%$ ) and BC based on the estimation of eight studies. However, after one study was excluded

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**Table 2.** Summary of pooled estimates of standardized mean difference (SMD) with 95% confidence intervals (CIs)

Analysis	Premenopausal							Postmenopausal						
	Number of studies	SMD (95% CI)	Heterogeneity			Publication bias		Number of studies	SMD (95% CI)	Heterogeneity			Publication bias	
			Q	P	I <sup>2</sup> (%)	t	P			Q	P	I <sup>2</sup> (%)	t	P
TC	7	0.33 (-0.10 to 0.78)	36.66	< 0.001	83.6	0.48	0.652	11	0.60 (-0.05 to 1.24)	178.39	< 0.001	94.4	0.87	0.406
TG	9	0.33 (0.07 to 0.59)	29.9	< 0.001	73.2	3.18	0.015	11	0.94 (0.33 to 1.55)	203.15	< 0.001	95.1	3.02	0.014
HDL-C	9	-0.31 (-0.62 to 0.01)	43.55	< 0.001	81.6	-1.08	0.314	12	-0.62 (-1.11 to -0.13)	158.03	< 0.001	93.0	-2.64	0.025
LDL-C	7	0.28 (-0.01 to 0.38)	16.95	0.009	64.6	0.32	0.762	8	0.26 (-0.05 to 0.57)	23.88	0.001	70.7	0.35	0.736
ApoA1	2	-0.25 (-0.57 to 0.07)	0	0.978	0	-	-	2	0.07 (-0.55 to 0.69)	2.14	0.143	53.3	-	-
ApoB	2	-0.06 (-0.38 to 0.26)	0.19	0.666	0	-	-	2	0.11 (-0.48 to 0.69)	1.91	0.167	47.7	-	-

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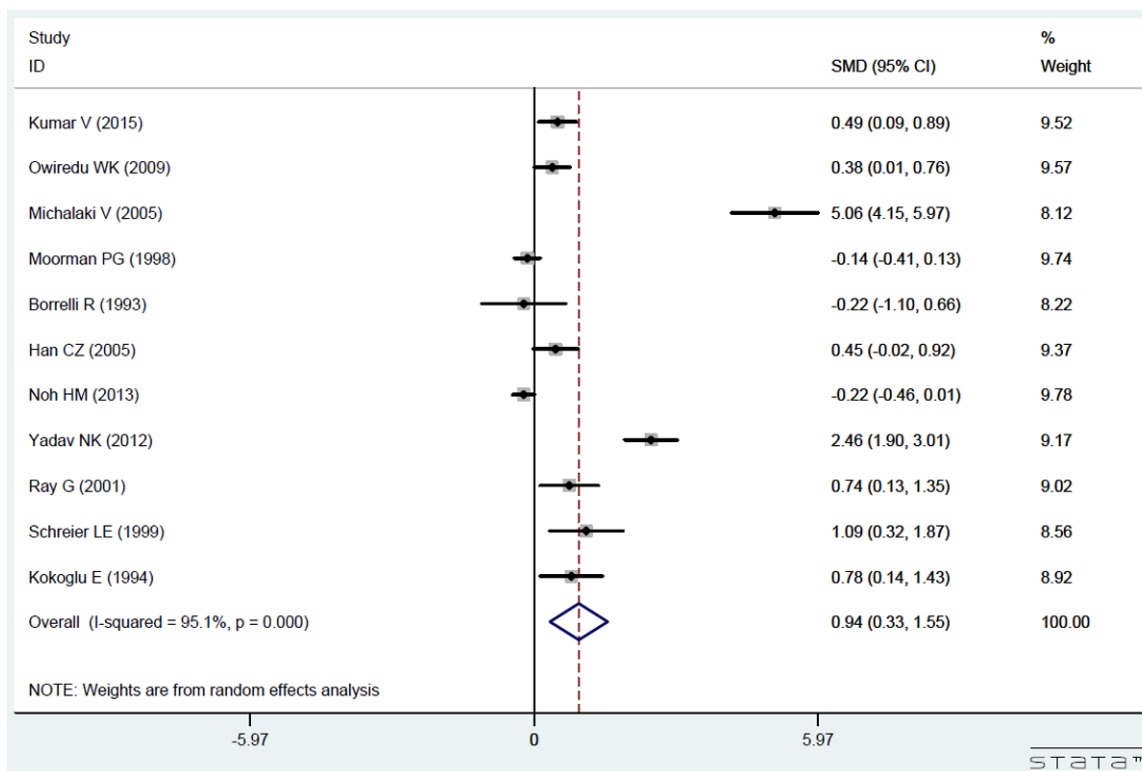


Figure 3. Forest plot of SDM between TG and postmenopausal breast cancer.

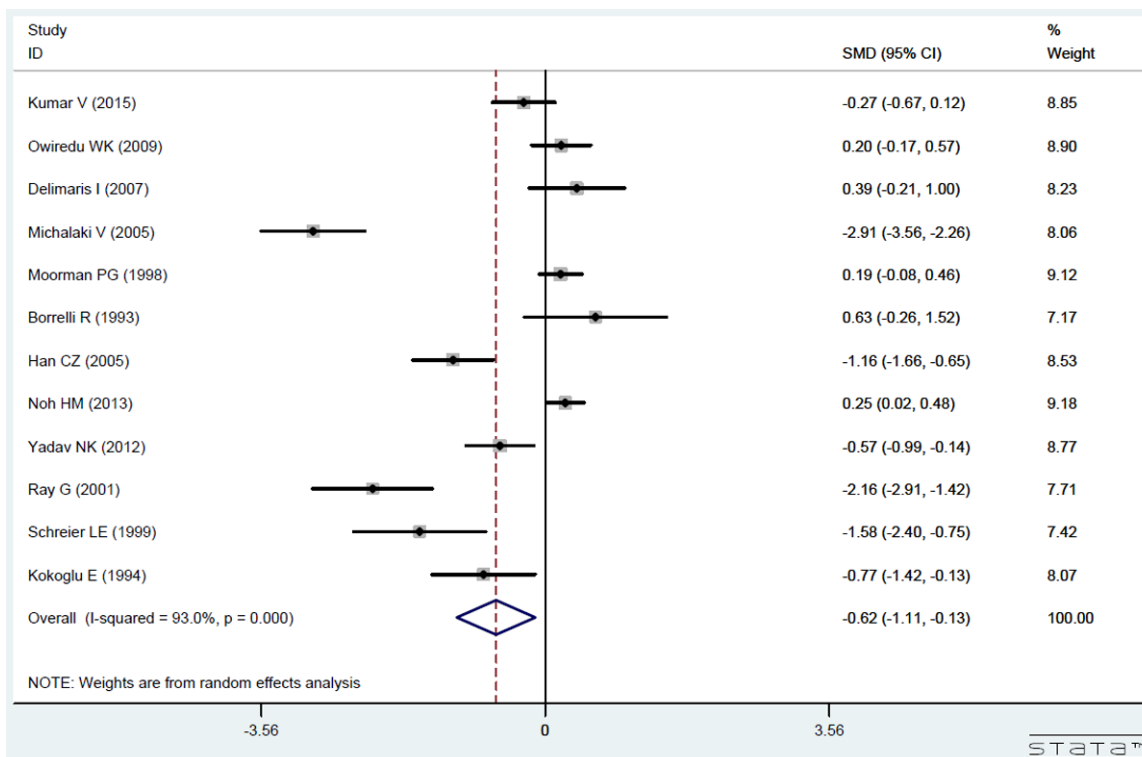


Figure 4. Forest plot of SDM between HDL-C and postmenopausal breast cancer.



[34], the pooled SMD was amended to 0.33 (95% CI: -0.10 to 0.78;  $I^2 = 83.6\%$ ), and the association was no longer statistically significant. The level of TG (SMD = 0.33, 95% CI: 0.07 to 0.59;  $I^2 = 73.2\%$ ) was significantly higher than that in controls (**Figure 2**). No significant association of BC with levels of HDL-C (SMD = -0.31, 95% CI: -0.62 to 0.01;  $I^2 = 81.6\%$ ) and LDL-C (SMD = 0.28, 95% CI: -0.01 to 0.38;  $I^2 = 64.6\%$ ) was observed. Sensitivity analysis showed that no significant changes were found in pooled SMDs of TG, HDL-C and LDL-C when a single study was sequentially excluded. Two studies investigating the association between levels of ApoA1, ApoB and BC, the pooled SMDs were performed with a fixed-effect model. No significant difference in ApoA1 (SMD = -0.25, 95% CI: -0.57 to 0.07;  $I^2 = 0\%$ ), ApoB (SMD = -0.06, 95% CI: -0.38 to 0.26;  $I^2 = 0\%$ ) was observed, with a non-significant heterogeneity among studies (**Table 2**).

In postmenopausal group, the result did not reveal a significant association between BC and levels of TC (SMD = 0.60, 95% CI: -0.05 to 1.24;  $I^2 = 94.4\%$ ). The pooled SMDs between TG, HDL-C and BC were 0.94 (95% CI: 0.33 to 1.55;  $I^2 = 95.1\%$ ), and -0.62 (95% CI: -1.11 to -0.13;  $I^2 = 93.0\%$ ) respectively, which revealed a significant association of increased levels of TG, and decreased level of HDL-C with BC (**Figures 3, 4**). There were no significant changes in pooled SMDs of TC, TG, and HDL-C by performing the sensitivity analysis. When one study was excluded [34], the pooled SMD of LDL-C was also amended from 0.43 (95% CI: 0.01 to 0.85;  $I^2 = 86.3\%$ ) to 0.26 (95% CI: -0.05 to 0.57;  $I^2 = 70.7\%$ ), which showed a non-significant association between levels of LDL-C and BC. The pooled SMDs of ApoA1 (SMD = 0.07, 95% CI: -0.55 to 0.69;  $I^2 = 53.3\%$ ) and ApoB (SMD = 0.11, 95% CI: -0.48 to 0.69;  $I^2 = 47.7\%$ ) did not show statistic significance in postmenopausal group (**Table 2**).

#### *Publication bias*

No significant publication bias was detected in the analyses of the association of BC with TC, HDL-C, and LDL-C in premenopausal group and TC, LDL-C in postmenopausal group by performing Egger's regression test. Nonetheless, the value of TG ( $t = 3.18$ ,  $P = 0.015$ ) in premenopausal group and TG ( $t = 3.02$ ,  $P = 0.014$ ),

HDL-C ( $t = -2.64$ ,  $P = 0.025$ ) in postmenopausal group indicated the obvious evidence for publication bias (**Table 2**).

#### **Discussion**

The results of current meta-analysis suggested that levels of TC in premenopausal and postmenopausal BC were not statistically significant compared with controls, which was in agreement with results reported by other studies [36, 37]. However, some researchers have found a significant increase in TC levels of premenopausal or postmenopausal cases. Abu-Bedair [38] reported a 15% increase in TC levels of premenopausal patients, which was similar with the results of Bani [39]. Gillmer [40] revealed that compared with the influence of sex hormones on HDL-C, its influence on TC in postmenopausal women was relatively weaker due to the changes in androgen levels. This might be a plausible explanation for the different associations of postmenopausal BC with levels of TC and HDL-C.

We found significant increased levels of TG in both premenopausal and postmenopausal cases. Some other studies have indicated a positive association of TG levels with either premenopausal cancer patients [41] or postmenopausal patients [42]. Moysich [41] indicated that the elevated TG levels significantly increased BC risk, and this association might be modified by Apolipoprotein E4 genotype. The potential biological role of TG in BC has been suggested that increased levels of TG were closely related to decreased concentrations of sex hormone-binding globulin, which increased the amount of free estradiol and developed BC risk [43]. In addition, an interesting finding was reported that in BC progression, the elevated levels of TG also were accompanied by a decrease in HDL-C levels, which attributed to the increased production of tumor necrosis factor  $\alpha$  [44]. This finding was highly, but not completely correlated with the respective results of TG and HDL-C in present study.

It was found that HDL-C levels were significantly lower in postmenopausal cases than controls, but not in premenopausal cases in present study. Similar findings were also confirmed in a Norwegian cohort study reported by Furberg [45], a prospective cohort study reported by Hoyer [46] and a latest meta-analysis of pro-



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spective cohort study reported by Ni and Liu [47], whereas another study has reported an inverse association of HDL-C levels with BC only in nonobese premenopausal women [48]. Evidence indicated that the HDL-C alone or in combination with estrogen or mammographic density acted on the likelihood of developing BC [49, 50]. Kaji suggested that low levels of HDL-C were linked to low-grade inflammation and proinflammatory cytokines, which might increase risks of BC by stimulating breast cell proliferation, especially hormone-independent [51].

The association between LDL-C levels and postmenopausal BC was not statistically significant after excluding one study in this study. However, in other case-control and prospective studies, the evidence that the postmenopausal BC had significantly higher levels of LDL-C than controls has been provided [30, 52]. The possible role of LDL-C on BC was thought to be that the LDL-C was more susceptible to oxidation, which led to the formation of lipid peroxidation metabolites [53]. The damage of cellular and molecular usually occurs during oxidative stress, contributing to the development of cell proliferation and malignant conversions [54]. Moreover, Dos [55] suggested that LDH-C promoted BC progression by activating signaling pathway of ErbB2 and inducing expression of adhesion molecules.

In comparison of ApoA1 with ApoB between premenopausal and postmenopausal study and control groups, no significant differences were noted in our study, which might be attributed to the small number of studies included in present study. Evidence regarding the relationship between ApoA1, ApoB and overall BC risk was documented in previous studies with conflicting results: regarding ApoA1 and BC, three showed a positive association [9, 32, 56], one showed an inverse association [57], and two showed no association [21, 58]; regarding ApoB and BC, five showed no association [21, 32, 56-58] and one showed an inverse association [9]. The results of Martin [9] should be interpreted with caution because women who were involved in this study had extensive mammographic density, which was suggested to be linked with the increased BC risk. ApoA1 has been suggested to play a potential role in the development of BC through inhibition of cell

proliferation and cell cycle progression in vascular smooth muscle cells [59].

There were several potential limitations that should be noted in this meta-analysis. Firstly, the controls in one included study were benign breast disease (BBD) women who might not be representatives of normal women. However, the net effect of assessment was likely to be better given that any difference between BC patients and BBD women seemed to be matched and estimated effectively [22]. Secondly, the published bias was detected given that positive results were more likely to be published. Third, the results of TG and LDL-C were not robust when the sensitive analysis was performed by excluding a single study sequentially. Finally, the heterogeneity among studies was significant in this meta-analysis, which might be an influence factor in our result. In view of limited information included in present studies, subgroup analysis was not performed and underlying confounding factors were not adequately taken into consideration. According to the epidemiological evidences on the risk factors of BC, we speculated that the heterogeneity in present studies mainly stemmed from the type and stage of BC, individual characteristics (ethnicity, body mass index (BMI), lifestyle, et al), and method and design of each study. It was reported that a significant association of HDL-C with postmenopausal BC was confined to obese women (BMI > 25 kg/m<sup>2</sup>) [45]. Compared with the normal control group, the levels of TC and LDL-C were significantly higher in four stages (tumor node metastasis (TNM) classification) of BC [60]. The levels of TC in ductal carcinoma was significantly higher than that in intraductal and infiltrating ductal carcinoma, and the levels of LDL-C was higher in all types of BC than in controls [61].

Despite these limitations, some strength in this meta-analysis should be highlighted. First, in addition to the unavailable information in one study [22], the patients who were involved in each study had no history of any major illness or metabolic syndrome which might alert lipids metabolism and were not performed by chemotherapy, radiotherapy or any other drugs treatment before the blood samples collection, which contributed to ruling out the preclinical effect on BC and getting a better understanding of the association between lipid profile and

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BC. Second, the moderate sample sizes in this research contributed to the moderate statistical power.

In conclusion, the results in this meta-analysis suggested that TG levels were higher in both premenopausal and postmenopausal BC compared with normal controls. An inverse association between levels of HDL-C and BC was detected among postmenopausal women. The association of lipid profile levels in premenopausal and postmenopausal women with BC still seems to be controversial. Further studies with larger samples, better design as well as full consideration of potential confounding factors are warranted.

### Disclosure of conflict of interest

None.

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