

# Influence of continuous positive airway pressure on lipid profiles of obstructive sleep apnea

## A systematic review and meta-analysis

Yinghua Xu, BS<sup>a,\*</sup>, Haiyan Wu, MM<sup>b</sup>, Xiaoling Lu, MM<sup>b</sup>

### Abstract

**Background:** To investigate the influence of continuous positive airway pressure (CPAP) on lipid profiles of the patients with obstructive sleep apnea (OSA) in this meta-analysis.

**Methods:** Relevant studies reporting the correlation between CPAP and lipid profiles of OSA patients were searched in Pubmed, Cochrane Library and Embase before January 1, 2021. Data of eligible studies were extracted and analyzed using the fixed-effect or random-effect model. Standard mean difference (SMD) and 95% confidence interval (95% CI) were calculated to assess such influence. Subgroup analysis based on CPAP duration was further performed. STATA 12.0 was used in this meta-analysis.

**Results:** A total of 12 independent randomized controlled studies involved 1129 OSA patients were recruited in this meta-analysis. The analyzed lipid profiles included total cholesterol (TC), triglyceride (TG), low density lipoprotein (LDL) and high density lipoprotein (HDL). CPAP was not correlated to TC (SMD = -0.07, 95% CI = -0.33 to 0.19), TG (SMD = -0.01, 95% CI = -0.19 to 0.17), LDL (SMD = -0.01, 95% CI = -0.23 to 0.21) and HDL (SMD = 0.10, 95% CI = -0.03 to 0.22) in OSA patients. Moreover, CPAP duration (=12 weeks; >12 weeks; <12 weeks) also did not influence lipid profiles of OSA patients as well.

**Conclusions:** Regardless of the treatment in CPAP duration, it doses does not influence lipid profiles of OSA patients, including TC, TG, LDL and HDL. The results are inconsistent with previous findings, which should be further validated in the multi-center, long-term randomized controlled trials.

**Abbreviations:** CI = confidence interval, CPAP = continuous positive airway pressure, LDL = low density lipoprotein, OSA = obstructive sleep apnea, RCTs = randomized controlled studies, SMD = standard mean difference, TC = total cholesterol, TG = triglyceride.

**Keywords:** continuous positive airway pressure, lipid profiles, meta-analysis, obstructive sleep apnea

## 1. Introduction

Obstructive sleep apnea (OSA) is a common sleep disorder characterized by repeated apneas and hypopneas during sleep.<sup>[1,2]</sup> The prevalence of OSA ranges 9% to 38%, which can lead to sleep fragmentation and long-term intermittent hypoxia at night, and as a result, daytime sleepiness remarkably influences the quality of sleep and life, and even the cognitive impairment.<sup>[2]</sup> OSA has been considered as a source of multiple systemic diseases, which is a main factor influencing the lifespan.<sup>[3,4]</sup> However, the exact pathogenesis of OSA is unclear. Currently, obesity has been generally considered as a vital cause of OSA.<sup>[4,5]</sup> It is reported that at least 60% to 70% of OSA patients are obese population, who are usually combined with lipid metabolism disorders or

hyperlipidemia.<sup>[6,7]</sup> Therefore, the obesity might enhance the risk of OSA and its relevant complications. By detecting lipid profiles of OSA patients before and after the treatment and exploring the potential influencing factors are beneficial to apply timely health management of OSA patients.<sup>[8,9]</sup>

Continuous positive airway pressure (CPAP) applies a positive end expiration pressure in the process of intermittent positive pressure ventilation.<sup>[10,11]</sup> It is an effective approach in the treatment of OSA-induced nocturnal hypoxemia, apnea and daytime sleepiness.<sup>[12,13]</sup> So far, the conclusion about the influence of CPAP on blood lipids of OSA patients is inconsistent. Most studies focused on the change of lipid profiles before and after CPAP, and whether CPAP duration can influence lipid profiles of OSA patients is unknown.<sup>[14,15]</sup> Therefore, this meta-analysis

*This article does not contain any studies with human participants performed by any of the authors.*

*The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.*

*The authors have no funding and conflicts of interest to disclose.*

*Research involving human participants and/or animals.*

*All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.*

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How to cite this article: Xu Y, Wu H, Lu X. Influence of continuous positive airway pressure on lipid profiles of obstructive sleep apnea: A systematic review and meta-analysis. *Medicine* 2022;101:42(e31258).

Received: 2 April 2022 / Received in final form: 16 September 2022 / Accepted: 19 September 2022

<http://dx.doi.org/10.1097/MD.00000000000031258>

intends to investigate the role of CPAP, including its treatment duration on the changes of lipid profiles of OSA patients.

for this meta-analysis. The ethical approval was not necessary and waived.

**2. Methods**

This systematic review and meta-analysis were performed according to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis guidelines. No protocol was used

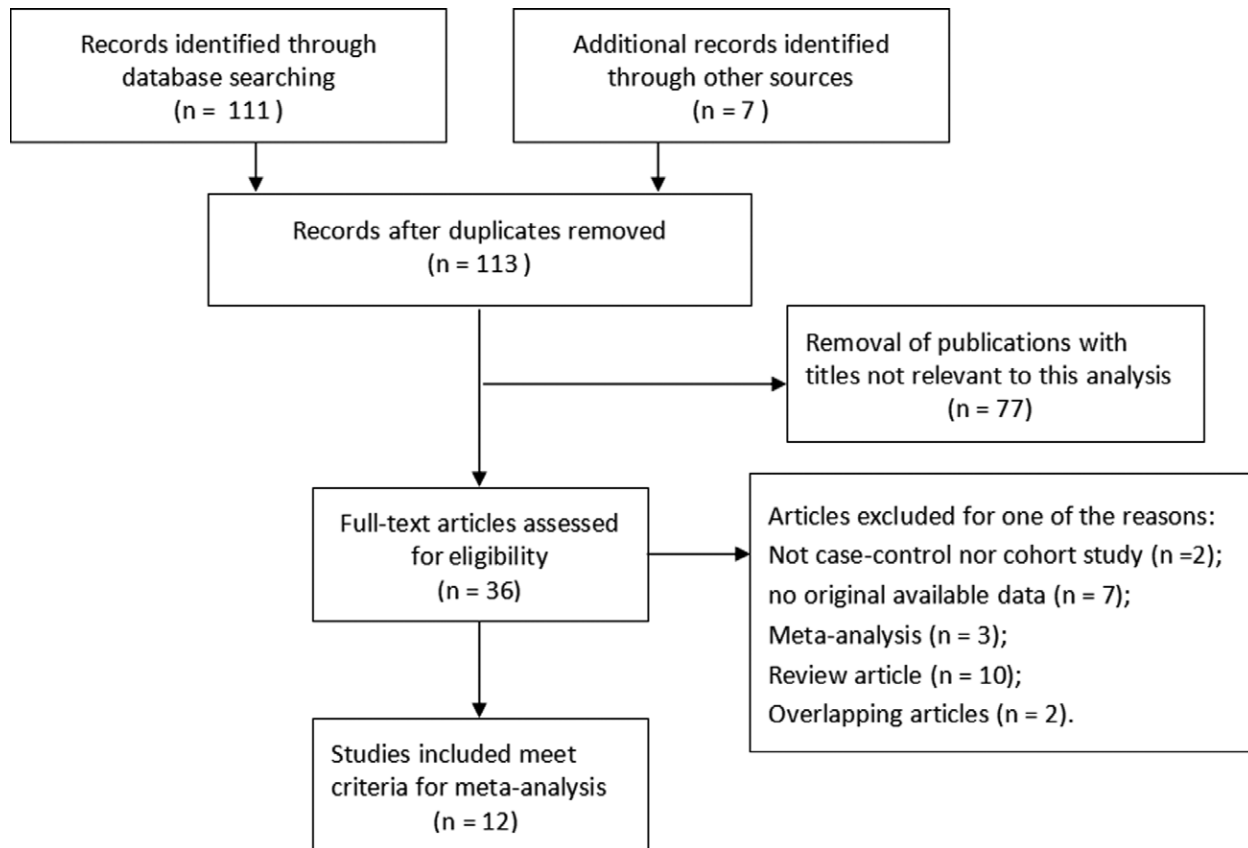
**2.1. Literature search**

By searching key words, including CPAP, OSA and lipid profiles in Pubmed, Cochrane Library and Embase, relevant randomized controlled studies (RCTs) published before January 1, 2021

**Table 1**  
**Characteristics of studies that investigated the continuous positive airway pressure (CPAP) effects on lipid profiles in obstructive sleep apnea.**

Author	Year	Country	Ethnicity	Number	Males (%)	Age range (years)	BMI (Kg/m <sup>2</sup> )	Diabetic mellitus	CPAP duration (weeks)	Study design	Outcome measures	II
Campos-Rodriguez	2017	Spain	Caucasian	307	0	57.1 ± 10.1	33.7 ± 4.8	NM	12		TC,TG, LDL,HDL	
Lam	2017	China	Asian	64	81.0	54.5 ± 9.3	30.8 ± 6.4	Yes	12		TC,TG, LDL,HDL	
Huang	2016	China	Asian	78	83.3	62.0 ± 6.5	23.0 ± 1.1	NM	24,48	Parallel	TC,TG, LDL,HDL	
Chirinos	2014	American	Mixed	119	57.5	49.0 ± NM	38.9 ± 6.5	NM	24	Parallel	TC,TG, LDL,HDL	
Garcia-Rio	2013	Spain	Caucasian	123	86.2	58.0 ± 11.0	27.3 ± 3.5	NM	2	Parallel	TC,TG, LDL,HDL	
Craig	2012	United Kingdom	Caucasian	195	78.5	57.9 ± 7.2	32.2 ± 5.6	Yes	24	Parallel	TC	
Kohler	2011	Switzerland	Caucasian	20	95.0	63.6 ± 5.1	32.9 ± 6.5	NM	2	Parallel	TC,TG, LDL,HDL	
Sharma	2011	India	Asian	43	84	45.0 ± 8.0	33.8 ± 4.7	NM	12	Cross-over	TC,TG, LDL,HDL	
Comondore	2009	United Kingdom	Caucasian	13	69	55.5 ± 7.1	31.1 ± NM	NM	4	Cross-over	TC,TG, LDL,HDL	
Coughlin	2007	United Kingdom	Caucasian	35	100	49.0 ± 8.3	36.1 ± 7.6	No	6	Cross-over	TC,TG, LDL,HDL	
Drager	2007	Brazil	Caucasian	24	100	45.5 ± 6.6	29.8 ± 2.9	No	16	Parallel	TC,TG, LDL,HDL	
Robinson	2004	United Kingdom	Caucasian	108	100	49.7 ± 10.3	35.6 ± 7.6	Yes	4	Parallel	TC,TG	

BMI = Body Mass Index; CPAP = continuous positive airway pressure, HDL = high density lipoprotein, LDL = low density lipoprotein, NM = not mentioned, TC = total cholesterol, TG = triglyceride.



**Figure 1.** Flow diagram of literature search and selection process.



particular, 8 studies analyzed Caucasian population, 3 studies analyzed Asian population, the last one is mixed population. Using the cutoff value of 12-week to distinguish CPAP duration, the number of studies of CPAP duration = 12 weeks, more than 12 weeks, shorter than 12 weeks is 3, 4, 5, respectively.

### 3.2. Quantitative synthesis results

The detailed data from this meta-analysis of the relationship between CPAP duration and blood lipid levels (TC, TG, LDL and HDL) in patients with OSA are shown in Table 2. As the results showed, CPAP was not correlated to TC (SMD = -0.07, 95% CI = -0.33 to 0.19), TG (SMD = -0.01, 95% CI = -0.19 to 0.17), LDL (SMD = -0.01, 95% CI = -0.23 to 0.21) and HDL (SMD = 0.10, 95% CI = -0.03 to 0.22) in OSA patients (Fig. 2A-D). Moreover, subgroup analysis by CPAP duration (=12 weeks; >12 weeks; <12 weeks) revealed that CPAP duration did not influence lipid profiles of OSA patients as well.

### 3.3. Sensitivity analysis

Sensitivity analysis was conducted for calculating SMD of the remaining data after removal of one single study each time. The pooled SMD of the remaining data was not affected every time we removed one study, suggesting that our results were robust (Fig. 3).

### 3.4. Publication bias

Funnel plots depicted based on the recruited studies were symmetrical, suggesting that there was no potential publication bias in the present meta-analysis (Fig. 4).

## 4. Discussion

OSA is a highly prevalent sleep disordered breathing, which is harmful to multiple systems and organs, and even causes respiratory accidents.<sup>[1-3]</sup> OSA has been well concerned since it seriously affects life quality of affected people.<sup>[4,5]</sup> However, the pathogenesis of OSA is still unclear. At present, the abnormal upper airway anatomy, pharyngeal respiratory muscle dysfunction, genetic factors, inflammatory factors, and metabolic factors that can aggravate upper airway stenosis and collapse are all risk factors of OSA, which can contribute to produce a series of mental, neurological, endocrine and other changes.<sup>[3-5]</sup> CPAP is a widely applied procedure featured by simple operations, non-invasiveness, and effective outcomes.<sup>[5]</sup> It is usually used in improving respiration and heart rate of critically ill patients. Nevertheless, many studies about the role of CPAP in stimulating the absorption of lung inflammation in children with severe pneumonia, reducing pulmonary complications, improving the prognosis and lowering the economic burden are rarely reported.<sup>[6,7]</sup>

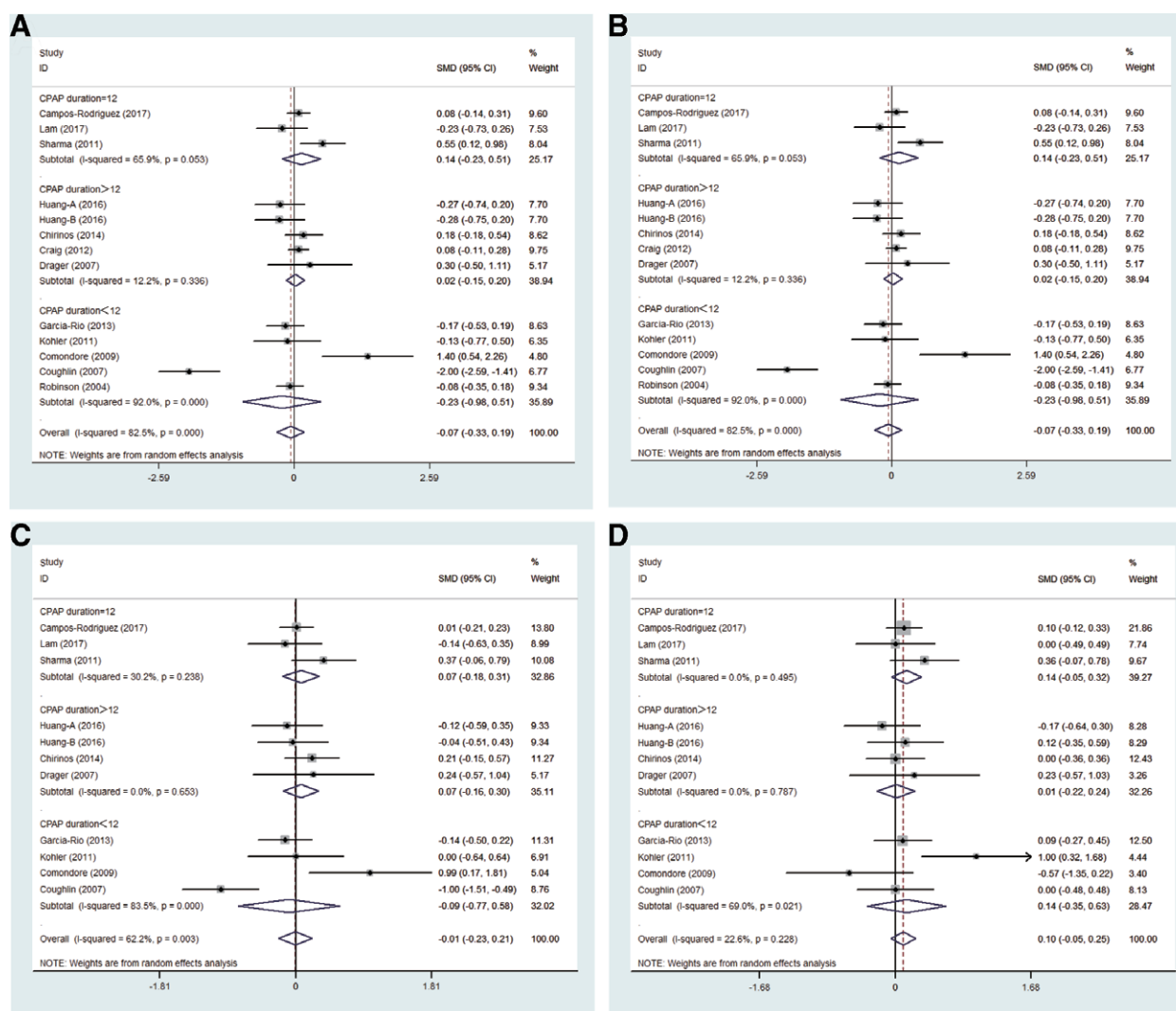
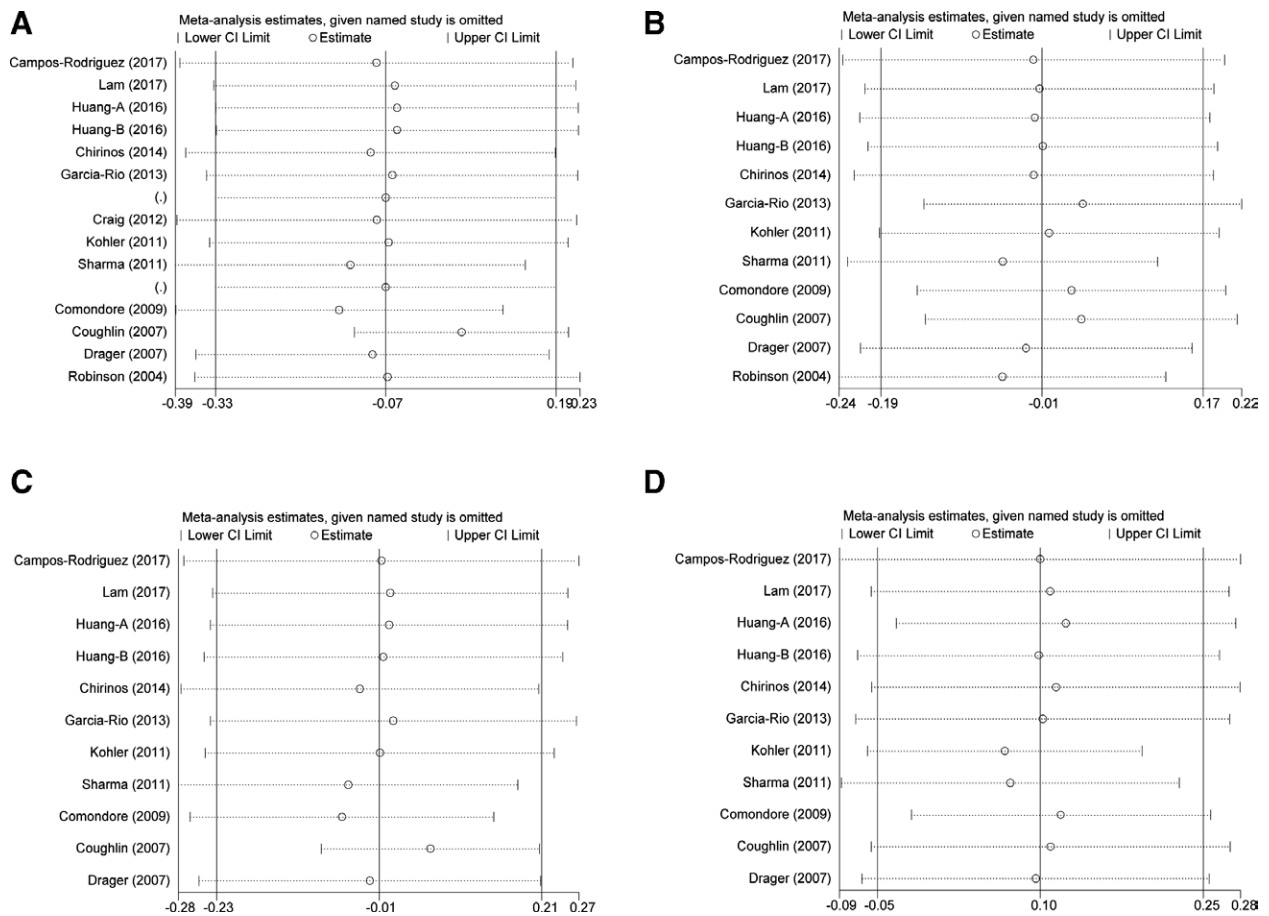


Figure 2. Forest plots of subgroup analysis about the influence of CPAP duration on lipid profiles in OSA patients in random-effects model. (A) Total cholesterol (TC), (B) triglyceride (TG), (C) low density lipoprotein (LDL), and (D) high density lipoprotein (HDL).



**Figure 3.** Sensitivity analysis using a random-effects model. (A) Total cholesterol (TC), (B) triglyceride (TG), (C) low density lipoprotein (LDL), and (D) high density lipoprotein (HDL).

Long-term sleep disorder can lead to multiple organ damages and system complications involving the cardiovascular system, respiratory system, endocrine system, nervous system and urinary system.<sup>[6–8]</sup> Obesity, lipid metabolism disorders, upper respiratory tract stenosis and blockage, endocrine disorders, tissue relaxation in old age, genetics and other factors are common causes of OSA.<sup>[8,9]</sup> With the improvement of living standards, the condition of central obesity in which the fat is mainly accumulated in the abdomen is commonly seen. It enhances the pressure on the thoracic cavity, moves the diaphragm up, and stimulates cardiovascular responses for a long time.<sup>[28]</sup> The patients with OSA are mostly characterized by a short neck, micrognathia and glossocoma. A large ratio of obese people has abnormal blood lipids, and hyperlipidemia is a risk factor for cardiovascular and cerebrovascular diseases.<sup>[8,28]</sup> Therefore, it is of great significance to analyze whether lipid profiles of OSA patients can be influenced by CPAP, especially its treatment duration.

Previous studies about the influence of CPAP on lipid profile of OSA patient is inconsistent.<sup>[14,15]</sup> Huang et al<sup>[19]</sup> suggested that CPAP did not significantly decrease blood lipids in non-obese coronary heart disease patients and OSA patients receiving a standardized lipid-lowering therapy. However, Drager et al<sup>[24]</sup> reported that the therapeutic strategy of OSA was able to markedly alleviate early symptoms of atherosclerosis, supporting the fact that OSA is an independent risk of atherosclerosis and lipid profiles do influence the effectiveness of CPAP on OSA patients. In this meta-analysis, the results showed that regardless of TC, TG, LDL and HDL, CPAP did not influence the levels of lipid profiles in OSA patients. Moreover, subgroup analysis

demonstrated that the treatment duration of CPAP also did not influence lipid profiles in OSA patients as well.

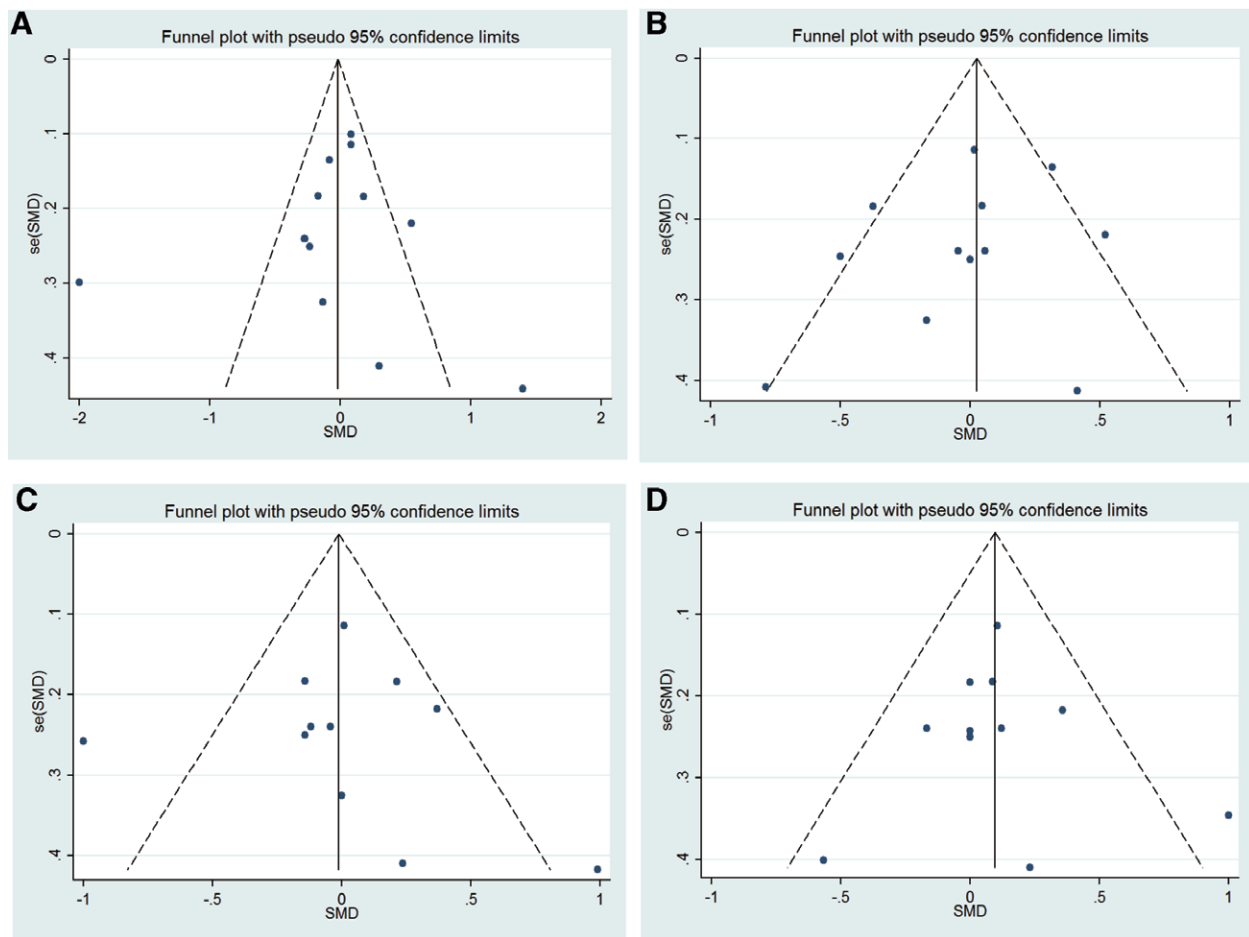
Some limitations were found in this study. First of all, the sample size of each hierarchical analysis was relatively small, which evidently restricted its validation. Secondly, a comprehensive analysis about the influence of CPAP duration on OSA patients with different races might result in a certain bias. Thirdly, African population was not involved, which resulted into a certain deviation might be resulted by a combined analysis of researched population in different ages and ethnicities. Taken together, our conclusion needs to be further validated in multi-center, high-quality RCTs with a larger sample size and multiple races.

### 5. Conclusion

Regardless of the treatment duration, CPAP dose not influence the lipid profiles of OSA patients, including TC, TG, LDL and HDL. In addition, the results are inconsistent with previous findings, which should be further validated in multi-center, larger sample size, long-term studies.

### Author contributions

**Conceptualization:** Haiyan Wu, Xiaoling Lu, Yinghua Xu.  
**Data curation:** Yinghua Xu.  
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**Methodology:** Haiyan Wu.



**Figure 4.** Begg funnel plots for assessing publication bias. (A) Total cholesterol (TC), (B) triglyceride (TG), (C) low density lipoprotein (LDL), and (D) high density lipoprotein (HDL).

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## References

- [1] Elfil M, Bahbah EI, Attia MM, et al. Impact of obstructive sleep apnea on cognitive and motor functions in parkinson's disease. *Mov Disord.* 2020;36:570–80.
- [2] De Meyer M, Vanderveken OM, De Weerd S, et al. Use of mandibular advancement devices for the treatment of primary snoring with or without obstructive sleep apnea (OSA): a systematic review. *Sleep Med Rev.* 2020;56:101407.
- [3] D'Souza H, Kapoor KG. Retinal vascular manifestations of obstructive sleep apnea. *Curr Opin Ophthalmol.* 2020;31:508–13.
- [4] Gottlieb DJ, Punjabi NM. Diagnosis and management of obstructive sleep apnea: a review. *JAMA.* 2020;323:1389–400.
- [5] Arnaud C, Bochaton T, Pepin JL, et al. Obstructive sleep apnoea and cardiovascular consequences: pathophysiological mechanisms. *Arch Cardiovasc Dis.* 2020;113:350–8.
- [6] Miller JD, Aronis KN, Chrispin J, et al. Obesity, exercise, obstructive sleep apnea, and modifiable atherosclerotic cardiovascular disease risk factors in atrial fibrillation. *J Am Coll Cardiol.* 2015;66:2899–906.
- [7] Ahmed MH, Byrne CD. Obstructive sleep apnea syndrome and fatty liver: Association or causal link? *World J Gastroenterol.* 2010;16:4243–52.
- [8] Gabryelska A, Lukasik ZM, Makowska JS, et al. Obstructive sleep apnea: From intermittent hypoxia to cardiovascular complications via blood platelets. *Front Neurol.* 2018;9:635.
- [9] Khalyfa A, Kheirandish-Gozal L, Gozal D. Circulating exosomes in obstructive sleep apnea as phenotypic biomarkers and mechanistic messengers of end-organ morbidity. *Respir Physiol Neurobiol.* 2018;256:143–56.
- [10] Verhulst S. Long term continuous positive airway pressure and non-invasive ventilation in obstructive sleep apnea in children with obesity and down syndrome. *Front Pediatr.* 2020;8:534.
- [11] Lin HJ, Yeh JH, Hsieh MT, et al. Continuous positive airway pressure with good adherence can reduce risk of stroke in patients with moderate to severe obstructive sleep apnea: an updated systematic review and meta-analysis. *Sleep Med Rev.* 2020;54:101354.
- [12] Chalegre ST, Lins-Filho OL, Lustosa TC, et al. Impact of CPAP on arterial stiffness in patients with obstructive sleep apnea: a meta-analysis of randomized trials. *Sleep Breath.* 2020;25:1195–202.
- [13] Resano-Barrio MP, Arroyo-Espiguero R, Viana-Llamas MC, et al. Obstructive sleep apnoea syndrome: continuous positive airway pressure therapy for prevention of cardiovascular risk. *Eur Cardiol.* 2020;15:e65.
- [14] Xu H, Yi H, Guan J, Yin S. Effect of continuous positive airway pressure on lipid profile in patients with obstructive sleep apnea syndrome: a meta-analysis of randomized controlled trials. *Atherosclerosis.* 2014;234:446–53.
- [15] Nadeem R, Singh M, Nida M, et al. Effect of CPAP treatment for obstructive sleep apnea hypopnea syndrome on lipid profile: a meta-regression analysis. *J Clin Sleep Med.* 2014;10:1295–302.
- [16] Campos-Rodriguez F, Gonzalez-Martinez M, Sanchez-Armengol A, et al. Effect of continuous positive airway pressure on blood pressure and metabolic profile in women with sleep apnoea. *Eur Respir J.* 2017;50:1700257.
- [17] Chirinos JA, Gurubhagavatula I, Teff K, et al. CPAP, weight loss, or both for obstructive sleep apnea. *N Engl J Med.* 2014;370:2265–75.
- [18] Garcia-Rio E, Alonso-Fernandez A, Armada E, et al. CPAP effect on recurrent episodes in patients with sleep apnea and myocardial infarction. *Int J Cardiol.* 2013;168:1328–35.

- [19] Huang Z, Liu Z, Zhao Z, et al. Effects of continuous positive airway pressure on lipidaemia and high-sensitivity c-reactive protein levels in non-obese patients with coronary artery disease and obstructive sleep apnoea. *Heart Lung Circ.* 2016;25:576–83.
- [20] Lam J, Lai A, Tam T, et al. CPAP therapy for patients with sleep apnea and type 2 diabetes mellitus improves control of blood pressure. *Sleep Breath.* 2017;21:377–86.
- [21] Comondore VR, Cheema R, Fox J, et al. The impact of CPAP on cardiovascular biomarkers in minimally symptomatic patients with obstructive sleep apnea: a pilot feasibility randomized crossover trial. *Lung.* 2009;187:17–22.
- [22] Coughlin SR, Mawdsley L, Mugarza JA, et al. Cardiovascular and metabolic effects of CPAP in obese males with OSA. *Eur Respir J.* 2007;29:720–7.
- [23] Craig SE, Kohler M, Nicoll D, et al. Continuous positive airway pressure improves sleepiness but not calculated vascular risk in patients with minimally symptomatic obstructive sleep apnoea: the MOSAIC randomised controlled trial. *Thorax.* 2012;67:1090–6.
- [24] Drager LF, Bortolotto LA, Figueiredo AC, et al. Effects of continuous positive airway pressure on early signs of atherosclerosis in obstructive sleep apnea. *Am J Respir Crit Care Med.* 2007;176:706–12.
- [25] Kohler M, Stoewhas AC, Ayers L, et al. Effects of continuous positive airway pressure therapy withdrawal in patients with obstructive sleep apnea: a randomized controlled trial. *Am J Respir Crit Care Med.* 2011;184:1192–9.
- [26] Robinson GV, Pepperell JC, Segal HC, et al. Circulating cardiovascular risk factors in obstructive sleep apnoea: data from randomised controlled trials. *Thorax.* 2004;59:777–82.
- [27] Sharma SK, Agrawal S, Damodaran D, et al. CPAP for the metabolic syndrome in patients with obstructive sleep apnea. *N Engl J Med.* 2011;365:2277–86.
- [28] Verboven K, Hansen D. Critical reappraisal of the role and importance of exercise intervention in the treatment of obesity in adults. *Sports Med.* 2020;51:379–89.