Review

Prevalence of non-alcoholic fatty liver disease in postmenopausal woman: systematic review and meta-analysis

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Background: Non-alcoholic fatty liver disease (NAFLD) has long been considered to be most prevalent chronic hepatic disease. However, the overall prevalence of NAFLD in postmenopausal women was largely unknown. *Objectives*: In the current study, we aimed to investigate the overall prevalence of NAFLD in postmenopausal women in order to provide more information for clinical work. *Methods*: A systematic search was conducted in Medline, Embase, web of science and Cochrane for articles in the English language from inception until May 2020. Wilson score method was used to calculate the 95% confidence interval (95% CI) and DerSimonian-Laird random-effects model with Freeman-Tukey double arcsine transformation was used for estimating pooled overall prevalence. *Results*: Our search returned 4465 records. After removed duplicates and screened titles, abstract and full content of articles, 25 studies were retrieved. Overall, the NAFLD prevalence was 30.81% (95% CI 24.75-37.22). The prevalence of NAFLD in postmenopausal women was 31.64% (95% CI 25.82-37.77) in Asia countries compared to 27.99% (95% CI 11.21-48.72) in Non-Asia countries. Ultrasound was the most commonly used diagnostic technique in diagnosing NAFLD in postmenopausal women, lead a higher prevalence of NAFLD (32.77%, 95% CI 27.43-38.35) than computed tomography (CT, 5.64%, 95% CI 4.82-6.52) or fatty live index (FLI, 17.33%, 95% CI 11.72-23.78, $P < 0.01$). *Conclusion*: Approximately one third of postmenopausal women presented with NAFLD indicated a rather high prevalence which call for the attention of primary care physicians, specialists, and health policy makers.

Keywords

NAFLD; Prevalence; Complication; Postmenopausal woman

1. Introduction

Non-alcoholic fatty liver disease (NAFLD), once considered a disease of western, now is affecting the global population [1, 2]. Although NAFLD has a benign course in the majority of individuals, a subset of patients develops non-alcoholic steatohepatitis (NASH), a more serious form of liver damage with various degrees of fibrosis. They can further develop into end-stage liver diseases, including liver cirrhosis and hepatocellular carcinoma (HCC) [3]. Given its high prevalence among general population, even a small proportion of patients developing end-stage liver disease will impose an emerging global health burden.

Liver diseases increased in parallel to age, and its prevalence increased among woman aged range from 40 to 49 years and post menopause, indicating that the metabolism of sexual steroid hormones might play a vital role in NAFLD pathogenesis in woman [4]. Previous studies documented that drastic physiological and biological changes occurred in postmenopausal woman which including fat accumulation and unfavorable metabolic alterations (e.g., dyslipidemia and glucose intolerance), both of which are associated with development of insulin resistance, cardiovascular disease and NAFLD [5–7]. In this manner, a heightened awareness of complications of metabolic and hormonal changes and their associations with chronic disease is necessary in the evaluation and care of women who are postmenopausal. In current study, we pooled estimates of NAFLD prevalence for postmenopausal women so as to assist stakeholders with bettering comprehend the current circumstances of NAFLD in postmenopausal, which could prompt the advancement of methodologies to build disease mindfulness and intercessions to diminish the ailment trouble. Future investigation ought to be given to defining the economic and public health burden of the NAFLD pandemic.

2. Methods

2.1 Search strategy

Systematic search was conducted by a biomedical information specialist of the medical library in database of Medline, Embase, web of science and Cochrane, with an comprehensive arrangement of search terms identified with "NAFLD", "postmenopausal", "prevalence", "epidemiology". Current study was reported in conformity to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) [8]. Institutional review board approval was not required because our study only included previous published data.

2.2 Search selection criteria

Studies were included in the event that they met following criteria: (1) studies concerning about the prevalence

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of NAFLD in postmenopausal woman; (2) more than 30 individual included; (3) NAFLD diagnosed by imagological examination (ultrasound, computed tomography scan, and magnetic resonance imaging/spectroscopy), liver biopsy, and/or blood testing/predictive indices (fatty liver index or hepatic steatosis index), transient elastography.

Studies were excluded as follows: (1) Studies are review, systematic review, correspondence, meta-analysis, case reports, perspectives and abstracts; (2) animal study; (3) no primary data or incomplete data; (4) duplicate data; (5) the studies did not identify patients with NAFLD; (6) investigations included other cause of fatty liver disease (e.g. Wilson liver disease or viral hepatitis B and C infection); (7) excess alcohol consumption; (8) patients with preexisting diseases, such as human immunodeficiency virus (HIV) co-infected.

Two authors (XX and LY) worked independently to identify eligible studies, make an assessment of the methodological validity for candidate study, and extracted data by using a specially designed collection forms developed for this study. The authors settled discrepancies by jointly inspecting the study being referred to. On the off chance that no accord was reached, a third author (LH), unaware of prior determinations, worked as an arbiter.

2.3 Data extraction

Two authors (XX and YL) independently reviewed and extracted data from the included studies by utilizing the data extract form. When duplicate data were identified, the duplicate with the smallest sample size or shortest duration of follow-up were excluded. The most important part for this meta-analysis was the prevalence of NAFLD in postmenopausal women. In addition, we pooled estimate the prevalence in subgroups, including different countries, continents, country development, country income, study period, study quality and diagnostic techniques. Besides, we also pooled estimate the prevalence of complications among NAFLD patients.

2.4 Quality assessment

Newcastle-Ottawa Scale, which is comprised of three domains (selection, comparability, and outcome), was used to assess the quality of included studies. This scale assigns a maximum score of five for selection, two for comparability, and two for outcome. Studies scoring 1-3, 4-6 and 7-9 were defined as low quality, average quality and high quality, respectively [9]. To increase transparency and ensure all accessible data in this area was reported, studies were not excluded on the basis of their quality score (Supplementary Table 1 and 2).

2.5 Statistics analysis

All the pooled estimates in current meta-analysis were calculated by using the Metaprop [10] module in the R-3.5.3 statistical software package. Wilson score method was used to calculate the 95% confidence interval (95% CI) and DerSimonian-Laird random-effects model with Freeman-Tukey double arcsine transformation was used for calculating pooled estimates of prevalence. Heterogeneity across the included studies was assessed using the Cochran Q statistics and I^2 statistics, with I^2 statistics ranged from 25%-50%, 50%-75%, and $>$ 75% considered as mild, moderate, and severe heterogeneity, respectively. As all the pooled estimates in current study with severe heterogeneity, random-effect model was used for all calculations. *P* value was used to compare the difference of subgroups. *P* value $<$ 0.05 was considered with significant difference. Egger regression test were used to assess potential publication biases.

3. Results

3.1 Search results

Our search returned 4465 records. 3872 records were retained after removal of duplicates. We screened the titles and abstracts and excluded 3677 ineligible records. Full texts of the remaining 195 records were assessed for eligibility, of which 170 studies were excluded. As a result, 25 studies fulfill our inclusion criteria (Fig. 1).

3.2 Characteristics of included studies

The mean quality of the including studies was 7.76. As a result, 24 high quality and 1 fair quality studies were further included in meta-analysis. All of these included studies were cross-sectional studies in general population by health checkup.

3.3 Statistical results

Overall, 25 studies from 7 countries (China [n = 8], Japan [n = 1], South Korea [n = 100], Mexico [n = 1], USA [n = 1], Montenegro [n = 1], Brazil [n = 3]) comprised of 21550 individuals [11–35]. A total of 5457 participates were diagnosed as NAFLD with a pooled estimate prevalence rate of 30.81% (95% CI 24.75-37.22, I^2 = 99%, Fig. 2). By egger test, we did not detect any publication bias in current study (*P* = 0.03, Fig. S1). By stratified data according to different countries, the highest NAFLD prevalence were found in Mexico with a pooled estimate rate of 42.11% (95% CI 29.70-55.04) compared to the lowest prevalence in USA (5.64%, 95% CI 4.82-6.52), but only limited studies included in those countries. South Korea contained most individuals in current meta-analysis with a pooled estimates of 30.29% (95% CI 23.24-37.85, I^2 = 98%, Fig. 3).

For subgroup analysis, the prevalence of NAFLD in postmenopausal women was 31.64% (95% CI 25.82-37.77, I^2 = 99%) in Asia countries compared to 27.99% (95% CI 11.21-48.72, I^2 = 99%) in Non-Asia countries (*P* = 0.73, Fig. 3). The prevalence was higher in developing countries (35.13%, 95% CI 27.79-43.39, I^2 = 98%) than that of developed countries (26.34%, 95% CI 18.50-35.02, I^2 = 99%, *P* = 0.14, Fig. 3), although without significant difference. The studies were further stratified by country income from world bank list of economies. The prevalence was (35.13%, 95% CI 27.79-43.39, I^2 = 99%) and (26.34%, 95% CI 18.50-35.02, I^2 = 99%) for high and upper-middle income countries, respectively (*P* = 0.14, Fig. 3). In addition, we found an unbalanced

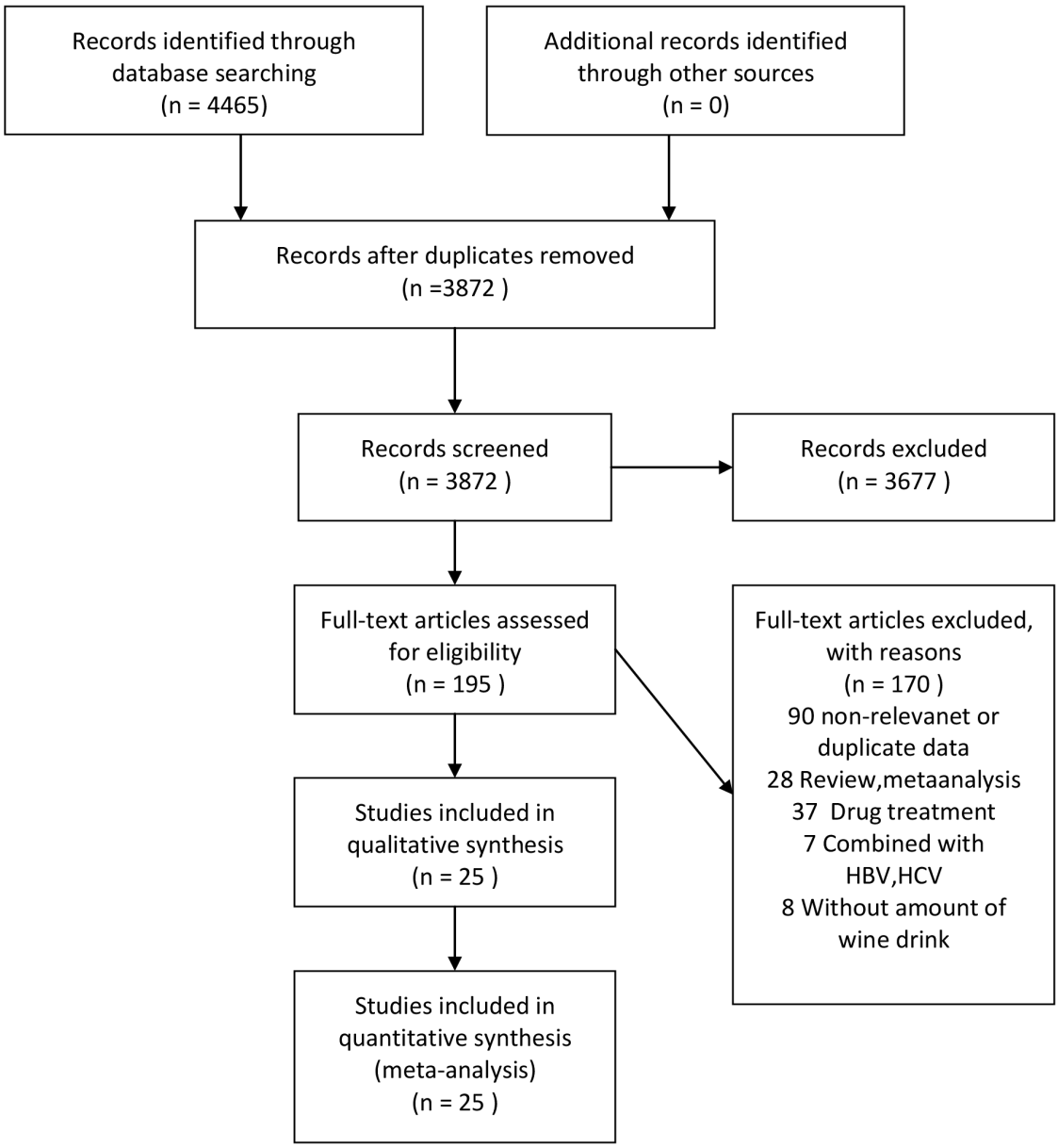

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Fig. 1. The flow chart of literature retrieval.

pooled estimates of prevalence among different diagnostic techniques. The highest prevalence was found in individuals diagnosed by ultrasound (32.77%, 95% CI 27.43-38.35, I^2 = 99%), followed by fatty liver index (FLI, 17.33%, 95% CI 11.72-23.78) and CT (5.64%, 95% CI 4.82-6.52, $P < 0.01$, Fig. 3). There is little difference of prevalence in studies published after 2010 (31.94%, 95% CI 23.18-41.39, I^2= 98%) than those published before 2010 (32.14%, 95% CI 19.17-46.71, *P*

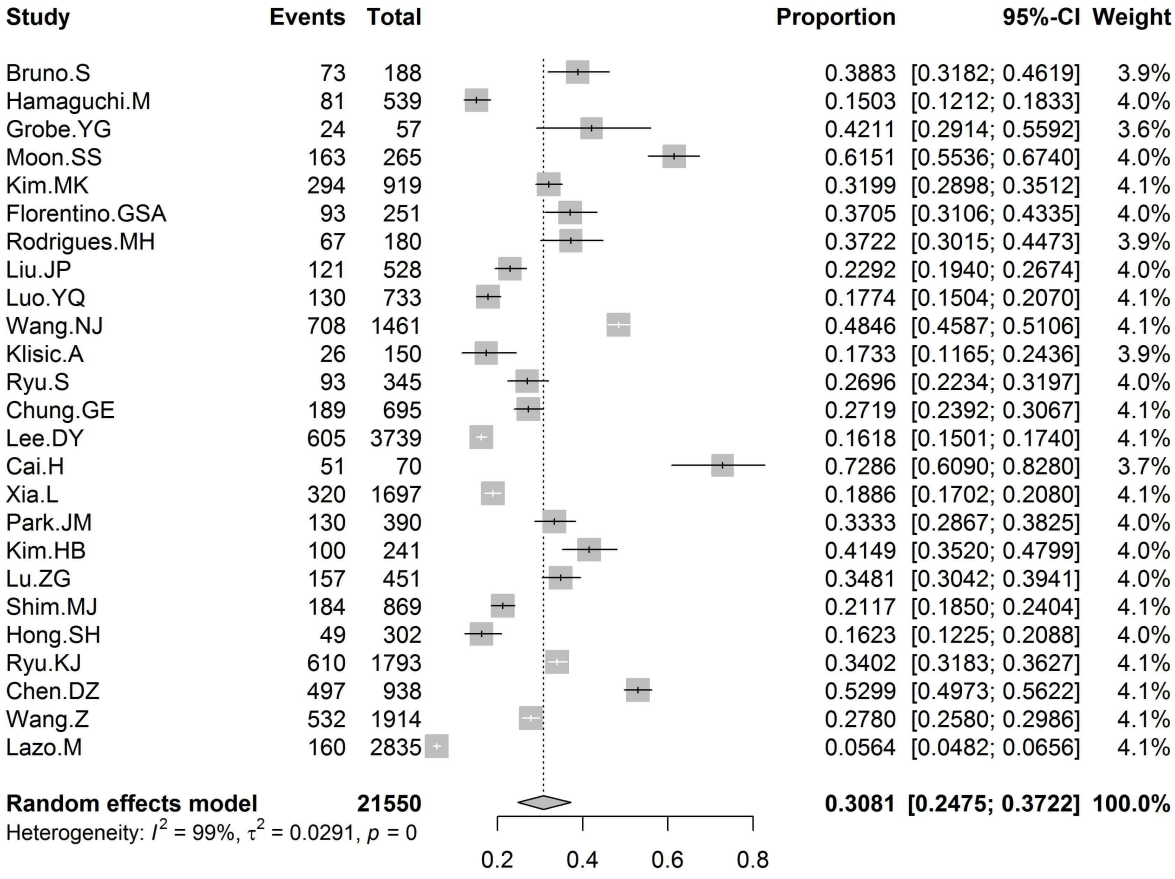

Fig. 2. Overall non-alcoholic fatty liver disease prevalence among postmenopausal women.

= 0.99, I^2 = 99%, Fig. 3). The prevalence of quality assessment score above 8 points (30.40%, 95% CI 22.09-39.41, I^2 = 99%) was slightly lower than that of studies below 8 points without significant difference (31.54%, 95% CI 23.06-40.69, P = 0.48, I^2 = 98%, Fig. 3). Moreover, we pooled estimates of prevalence for complications in NAFLD patients. The pooled estimates of metabolic syndromes (MetS), hypertension, type 2 diabetes mellitus (T2DM) and dyslipidemia was 56.92% (95% CI 41.27-71.90), 37.18% (95% CI 21.52-54.36), 18.86% (95% CI 8.82-31.61) and 40.89% (95% CI 11.76-74.17), respectively (Fig. 4).

4. Discussion

This systematic review and meta-analysis comprised of 25 studies in order to determine the NAFLD prevalence in postmenopausal woman. From the available data, we estimated that about one third of postmenopausal woman presented with NAFLD. The prevalence of NAFLD in postmenopausal women was 31.64% (95% CI 25.82-37.77) in Asia countries compared to 27.99% (95% CI 11.21-48.72) in Non-Asia countries. Interestingly, we also found that postmenopausal woman diagnosed by US lead a higher prevalence of NAFLD than CT or FLI. Adipose development and deposition was regulated and adjusted by estrogen in women.

Estrogen may support subcutaneous deposition of adipose, thus leading to increased subcutaneous fat and total body fat in women as compared to men [36]. Before menopause, the accumulation of visceral fat among women appears to be inhibited. Yet both the fat distribution and menopause shifted in tandem with age. Women are getting subcutaneous abdominal fat with increased age. After menopause total body fat and visceral fat rise while energy and physical activity decrease [7]. While research indicated that woman developed NAFLD 10 years later than man due to the deficiency of estrogen, the prevalence of NAFLD in postmenopausal was still largely unknown. In the current study, we observed a higher prevalence of NAFLD among postmenopausal women than in general population [37].

The effect of the diagnostic modality used to diagnose NAFLD was one of the important findings in the current research. Of a technique note, the only gold standard to diagnose NAFLD is liver biopsy. However, due to its invasiveness and high cost, it cannot be performed in a large-scale population. Of the imaging techniques, CT and MRI used for detecting the hepatic steatosis revealed parallel sensitivity and specificity ($\geq$ 80%) with US [38–40]. But benefit from the low cost, short time consuming, broad commercial availability and safety, with sensitivity and specificity was 84.8% and 94.7%, respectively, US is the first-line imaging test for NAFLD diagnosis [41]. In the current study, we observed an

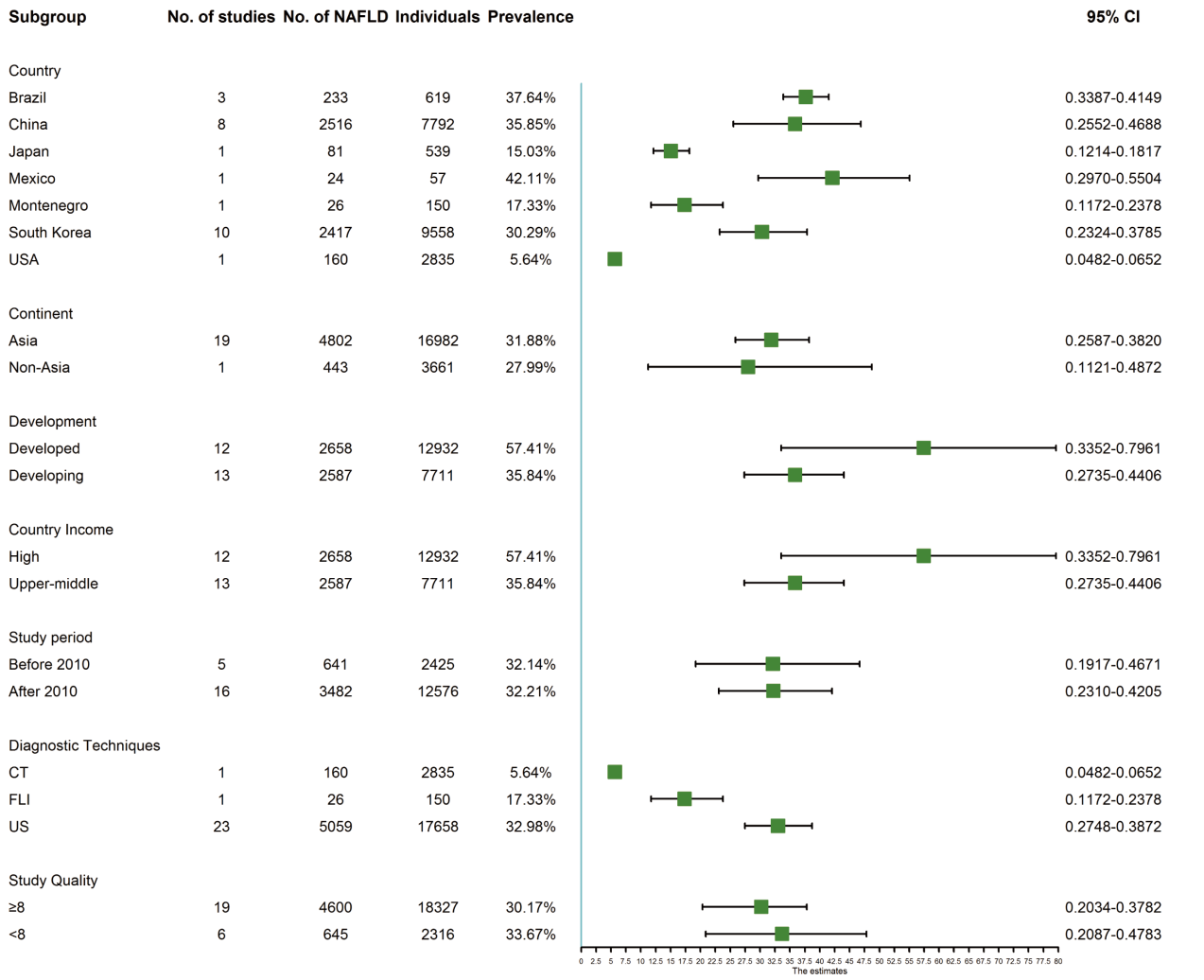

Fig. 3. Subgroup analysis for non-alcoholic fatty liver disease prevalence among postmenopausal women.

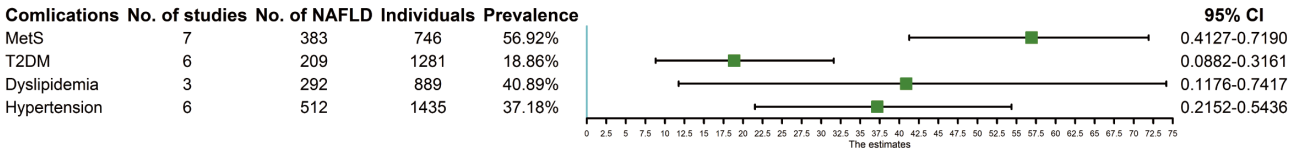

Fig. 4. Pooled estimate of prevalence for complications among postmenopausal women with non-alcoholic fatty liver disease.

odd NAFLD prevalence in USA postmanonesual women diagnosed by CT compared to other diagnostic methodologies. Importantly, the accuracy of diagnosis from CT largely relies on the proficiency of the doctor. Besides, only individuals with good physical condition can be chosen as target populations, as these people were tolerated to long-term body examination under CT, may decrease the pooled estimate NAFLD prevalence diagnosed by CT. All these above resulted in the uncertainty of estimating the accuracy of NAFLD prevalence.

This study has several strengths. This is a comprehensive and up-to-date systematic review and meta-analysis revealing the overall epidemiology of NAFLD in postmenonesaul women. Besides, we also added some new pooled estimation of complications in postmenonesaul women with NAFLD. The limitation for this study including the paucity of information from some continents, like Africa and Oceania which cannot truly reflect the real epidemiology of NAFLD in postmenonesaul women. Besides, unexplained high heterogeneity exists in current study. Although some potential reasons, like diagnostic technique, quality assessment of studies, countries development or countries income could partially explain it. Some other possibilities, like the proficiency and experience of the doctors for diagnosing that cannot take into account in our meta-analysis.

In summary, current meta-analysis indicated a rather high prevalence of NAFLD in postmenonesaul women which calls for the attention of primary care physicians, specialists, and health policy makers.

Author contributions

XX and YL performed the study, acquisition and analysis of data. XX, YL, YW and LH discussed the data; conceive the idea, revising the manuscript and provided technical assistance. XX drafted the manuscript. All authors contributed to editorial changes in the manuscript. All authors read and approve the final manuscript.

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Conflict of interest

The authors declare no conflict of interest.

Supplementary material

Supplementary material associated with this article can be found, in the online version, at https://ceog.imrpress.com/EN/10.31083/j.ceog.2021.01.2208.

References

[1] Li J, Zou B, Yeo YH, Feng Y, Xie X, Lee DH, *et al.* Prevalence, incidence, and outcome of non-alcoholic fatty liver disease in Asia, 1999-2019: a systematic review and meta-analysis. The Lancet Gastroenterology and Hepatology. 2019; 4: 389-398.

[2] Zhou F, Zhou J, Wang W, Zhang XJ, Ji YX, Zhang P, *et al.* Unexpected rapid increase in the burden of NAFLD in China from 2008 to 2018: a systematic review and meta-analysis. Hepatology. 2019; 70: 1119-1133.

[3] Vernon G, Baranova A, Younossi ZM. Systematic review: the epidemiology and natural history of non-alcoholic fatty liver disease and non-alcoholic steatohepatitis in adults. Alimentary Pharmacology and Therapeutics. 2011; 34: 274-285.

[4] Torres DM, Williams CD, Harrison SA. Features, diagnosis, and treatment of nonalcoholic fatty liver disease. Clinical Gastroenterology and Hepatology. 2012; 10: 837-858.

[5] Clark JM, Brancati FL, Diehl AM. Nonalcoholic fatty liver disease. Gastroenterology. 2002; 122: 1649-1657.

[6] Carr MC. The emergence of the metabolic syndrome with menopause. Journal of Clinical Endocrinology and Metabolism. 2003; 88: 2404-2411.

[7] Lovejoy JC, Champagne CM, de Jonge L, Xie H, Smith SR. Increased visceral fat and decreased energy expenditure during the menopausal transition. International Journal of Obesity. 2008; 32: 949-958.

[8] Moher D, Liberati A, Tetzlaff J, Altman DG; PRISMA Group. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLoS Medicine. 2009; 6: e1000097.

[9] Wells GA SB, O'Connell D. The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomized studies in meta-analyses. 2019. Available at: http://www3.med.unipmn.it/dispense_ebm/2009-2010/Corso%20Perfezionamento%20EBM_Faggiano/NOS_oxford.pdf.

[10] Schwarzer G. Metaprop: meta-analysis of single proportions. Available at: https://www.rdocumentation.org/packages/meta/versions/4.9-6/topics/metaprop.

[11] Bruno Ade S, Rodrigues MH, Alvares MC, Nahas-Neto J, Nahas EA. Non-alcoholic fatty liver disease and its associated risk factors in Brazilian postmenopausal women. Climacteric. 2014; 17: 465-471.

[12] Hamaguchi M, Kojima T, Ohbora A, Takeda N, Fukui M, Kato T. Aging is a risk factor of nonalcoholic fatty liver disease in premenopausal women. World Journal of Gastroenterology. 2012; 18: 237-243.

[13] Gutierrez-Grobe Y, Ponciano-Rodríguez G, Ramos MH, Uribe M, Méndez-Sánchez N. Prevalence of non alcoholic fatty liver disease in premenopausal, posmenopausal and polycystic ovary syndrome women. The role of estrogens. Annals of Hepatology. 2010; 9: 402-409.

[14] Moon SS, Lee YS, Kim SW. Association of nonalcoholic fatty liver disease with low bone mass in postmenopausal women. Endocrine. 2012; 42: 423-429.

[15] Kim MK, Ahn CW, Nam JS, Kang S, Park JS, Kim KR. Association between nonalcoholic fatty liver disease and coronary artery calcification in postmenopausal women. Menopause. 2015; 22: 1323-1327.

[16] Florentino GS, Cotrim HP, Vilar CP, Florentino AV, Guimarães GM, Barreto VS. Nonalcoholic fatty liver disease in menopausal women. Arquivos de Gastroenterologia. 2013; 50: 180-185.

[17] Rodrigues MH, Bruno AS, Nahas-Neto J, Sandrim VC, Muniz LG, Nahas EA. Evaluation of clinical and inflammatory markers of nonalcoholic fatty liver disease in postmenopausal women with metabolic syndrome. Metabolic Syndrome and Related Disorders. 2014; 12: 330-338.

[18] Liu PJ, Ma F, Lou HP, Zhu YN, Chen Y. Relationship between serum uric acid levels and hepatic steatosis in non-obese postmenopausal women. Climacteric. 2014; 17: 692-699.

[19] Luo YQ, Ma XJ, Hao YP, Pan XP, Xu YT, Xiong Q, *et al.* Inverse relationship between serum osteocalcin levels and nonalcoholic fatty liver disease in postmenopausal Chinese women with normal blood glucose levels. Acta Pharmacologica Sinica. 2015; 36: 1497-1502.

[20] Wang N, Zhai H, Zhu C, Li Q, Han B, Chen Y, *et al.* Combined association of vitamin d and sex hormone binding globulin with nonalcoholic fatty liver disease in men and postmenopausal women: a cross-sectional study. Medicine. 2016; 95: e2621.

[21] Klisic A, Kavaric N, Jovanovic M, Soldatovic I, Gligorovic-Barhanovic N, Kotur-Stevuljevic J. Bioavailable testosterone is independently associated with Fatty Liver Index in postmenopausal women. Archives of Medical Science. 2017; 13: 1188-1196.

[22] Ryu S, Suh BS, Chang Y, Kwon MJ, Yun KE, Jung HS, *et al.* Menopausal stages and non-alcoholic fatty liver disease in middle-aged women. European Journal of Obstetrics & Gynecology and Reproductive Biology. 2015; 190: 65-70.

[23] Chung GE, Yim JY, Kim D, Lim SH, Yang JI, Kim YS, *et al.* The influence of metabolic factors for nonalcoholic Fatty liver disease in women. BioMed Research International. 2015; 2015: 131528.

[24] Lee DY, Park JK, Hur KY, Um SH. Association between nonalcoholic fatty liver disease and bone mineral density in postmenopausal women. Climacteric. 2018; 21: 498-501.

[25] Cai H, Lu S, Chen Y, Das Mbbs Mrcog S, Niu Z, Zhuo G, *et al.* Serum retinol binding protein 4 and galectin-3 binding protein as novel markers for postmenopausal nonalcoholic fatty liver disease. Clinical Biochemistry. 2018; 56: 95-101.

[26] Li X, Shi H, Wang Z, Chang L, Zhang M, Dong X. Arterial stiffness is increased in nondiabetic, nonhypertensive postmenopausal women with nonalcoholic fatty liver disease. Journal of Hypertension. 2017; 35: 1226-1234.

[27] Park JM, Lee HS, Oh J, Lee YJ. Serum testosterone level within normal range is positively associated with nonalcoholic fatty liver disease in premenopausal but not postmenopausal women. Journal of Women's Health. 2019; 28: 1077-1082.

[28] Kim HB, Lee HS, Lee YJ. Association of serum ferritin levels with non-alcoholic fatty liver disease in postmenopausal women. Climacteric. 2018; 21: 509-514.

[29] Lu Z, Pan X, Hu Y, Hao Y, Luo Y, Hu X, *et al.* Serum vitamin D levels are inversely related with non-alcoholic fatty liver disease independent of visceral obesity in Chinese postmenopausal women. Clinical and Experimental Pharmacology and Physiology. 2015; 42: 139-145.

[30] Shim MJ. Effect of non-alcoholic fatty liver disease on components of metabolic syndrome in post-menopausal women. Journal of Biomedical Science. 2008; 14: 225-231.

[31] Hong SH, Hwang SY, Kim JA, Lee YB, Roh E, Kim NH, *et al.* Comparison of anthropometric indices for the screening of non-alcoholic fatty liver disease in pre- and postmenopausal women. Menopause. 2020; 27: 88-94.
[32] Ryu KJ, Park H, Kim YJ, Yi KW, Shin JH, Hur JY, *et al.* Moderate to severe vasomotor symptoms are risk factors for non-alcoholic fatty liver disease in postmenopausal women. Maturitas. 2018; 117: 22-28.
[33] Chen DZ, Xu QM, Wu XX, Cai C, Zhang LJ, Shi KQ, *et al.* The combined effect of nonalcoholic fatty liver disease and metabolic syndrome on osteoporosis in postmenopausal females in eastern China. International Journal of Endocrinology. 2018; 2018: 2314769.
[34] Wang Z, Xu M, Hu Z, Shrestha UK. Prevalence of nonalcoholic fatty liver disease and its metabolic risk factors in women of different ages and body mass index. Menopause. 2015; 22: 667-673.
[35] Lazo M, Zeb I, Nasir K, Tracy RP, Budoff MJ, Ouyang P, *et al.* Association between endogenous sex hormones and liver fat in a multiethnic study of atherosclerosis. Clinical Gastroenterology and Hepatology. 2015; 13: 1686-1693 e1682.
[36] Cooke PS, Naaz A. Role of estrogens in adipocyte development and function. Experimental Biology and Medicine. 2004; 229: 1127-1135.
[37] Younossi ZM, Koenig AB, Abdelatif D, Fazel Y, Henry L, Wymer M. Global epidemiology of nonalcoholic fatty liver disease-meta-analytic assessment of prevalence, incidence, and outcomes. Hepatology. 2016; 64: 73-84.
[38] Lee SS, Park SH, Kim HJ, Kim SY, Kim MY, Kim DY, *et al.* Non-invasive assessment of hepatic steatosis: prospective comparison of the accuracy of imaging examinations. Journal of Hepatology. 2010; 52: 579-585.
[39] van Werven JR, Marsman HA, Nederveen AJ, Smits NJ, ten Kate FJ, van Gulik TM, *et al.* Assessment of hepatic steatosis in patients undergoing liver resection: comparison of US, CT, T1-weighted dual-echo MR imaging, and point-resolved 1H MR spectroscopy. Radiology. 2010; 256: 159-168.
[40] Yoshimitsu K, Kuroda Y, Nakamuta M, Taketomi A, Irie H, Tajima T, *et al.* Noninvasive estimation of hepatic steatosis using plain CT vs. chemical-shift MR imaging: significance for living donors. Journal of Magnetic Resonance Imaging. 2008; 28: 678-684.
[41] Hernaez R, Lazo M, Bonekamp S, Kamel I, Brancati FL, Guallar E, *et al.* Diagnostic accuracy and reliability of ultrasonography for the detection of fatty liver: a meta-analysis. Hepatology. 2011; 54: 1082-1090.