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The health effects of medical nutrition therapy by dietitians in patients with diabetes: A systematic review and meta-analysis

Jalaledin Mirzay Razaza,*Q4 , Jamal Rahmani a, Hamed Kord Varkanehb, Jacqueline Thompsonc, Cain Clarkd, Hebatullah M. Abdulazeeme

a *Department of Community Nutrition, Faculty of Nutrition and Food Technology, National Nutrition and Food Technology Research Institute, Shahid Beheshti University of Medical Sciences, Tehran, Iran*

b *Department of Clinical Nutrition and Dietetics, Faculty of Nutrition and Food Technology, National Nutrition and Food Technology Research Institute, Shahid Beheshti University of Medical Sciences, Tehran, Iran*

c *Nuffield Department of Orthopaedics, Rheumatology & Musculoskeletal Sciences, University of Oxford, Oxford, OX3 7LD, United Kingdom*

d *School of Life Sciences, Coventry University, Coventry, CV1 5FB, United Kingdom*

e *Arab diploma in Family Medicine, AICPD, Egypt*

Abstract

Aims: Intensive lifestyle, dietary interventions and patient education have been recommended as key milestones in to facilitate the management of Diabetes and contain the growing incidence. We performed a systematic review and meta-analysis to assess the health benefits of medical nutrition therapy among patients with diabetes. *Design:* A systematic search was performed in MEDLINE/PubMed, SCOPUS, and Cochrane library from onset up to February 2019 to identify trials investigating the health effect of Medical nutrition (MNT) in patients with diabetes. Random-effects models were used to calculate the effect sizes as weighted mean difference (WMD) and 95% confidence intervals (CI). *Results:* Eleven studies containing 1227 participants were included in the meta-analysis. Pooled results showed a significant reduction in Fasting blood sugar (FBS) (WMD= −8.85 mg/dl, 95% CI: −14.41, −3.28), HbA1c (WMD: −0.43%, 95% CI: −0.69, −0.17),] weight (WMD: −1.54 kg, 95% CI: −2.44, −0.64), Body mass index (BMI) (WMD: −0.34 Kg/m2, 95% CI: −0.52,−0.17),waist circumference (WMD:−2.16 cm, 95% CI:−4.09,−0.23), cholesterol (WMD −4.06 mg/dl, 95% CI: −7.31, −0.81), Systolic blood pressure (SBP) (WMD: 7.90mmHg, 95% CI: −13.03,−2.77). Results of meta-regression analysis based on age of participants and duration of intervention were not significant.

1. Introduction

The global prevalence of diabetes mellitus, defined as fasting blood glucose equal to or higher than 7mmol/L, among adults over 18 years of age has risen from 4.7% in 1980 to 8.5% in 2014 (90–95% of which is Type 1I). Diabetes has been directly linked to 1.6 million deaths globally. High blood glucose alone was the cause of another 2.2 million deaths in 2015, and is an established risk factor for coronary heart disease, ischaemic stroke, and other vascular diseases [1–3]. Higher health care use, economic burden and associated societal costs have been reported among people with diabetes when compared to their normal counterparts [4].

In the US, approximately 20% of the nation's health resource is spent treating peoplewith diabetes [5]. In the UK, diabetes management accounts for around 10% of the National Health Service budget and is projected to rise to around 17% by 2035 [6]. Medical nutrition therapy have been recommended as milestones in the management of type 2 diabetes. There is evidence supporting the effectiveness of patient education and adherence to self management strategies on health out comes [7,8]. National recommendations suggest promoting the role of diabetes educators alongside treating physicians to improve the coordination of care and facilitate better outcomes in diabetes management [9,10]. Currently, studies evaluating the role of multidisciplinary diabetes care teams that include physicians, nurses, pharmacists, and (or) dieti- tians, have shown better patient outcomes such as reduction in weight, BMI, and fasting blood sugars compared to usual care [8,11–14]. However, many of these studies were poorly designed. Methodological flaws such as measurement bias, small sample size, lack of generalizability, short interven- tion and follow-up periods were some of the issues identified [11,15 17]. There is evidence to suggest that engaging other skilled health professionals such as dietitians in primary care improves patient outcomes [12]. Dietitians, both quality care providers and educators have an important role to play within multidisciplinary diabetes care teams. The Diabetes Preven- tion Program (DPP) provides clear indications for integrating dietitians into lifestyle management to help patients change their eating and exercise behaviours and prevent diabetic complications [18]. Nutritional therapy is one of the key components of pre- vention and management strategies for Type 1 and II diabetes mellitus. A number of studies have also demonstrated sus- tained improvements in HbA1c at 12 months [13,14]. These effects were sustained for longer periods when a registered dietitian provided follow-up visits ranging from quarterly to monthly sessions [13,14]. Ongoing medical counselling in nutritional management by a trained dietitian has been shown to lead to better long-term metabolic control [19]. In a clinical trial evaluating a 24-month intervention, weight (−0.7 vs. + 2.1 kg), BMI (+0.3 vs. + 0.7 kg/m2), waist circum ference (–1.3 vs. + 2.4 cm) and overall energy intake (−548 vs. −74 kcal/day) significantly differed between groups, with nutritional therapy demonstrating greater improvement com pared to the control group [20]. Another study by Bhopal, reported significant weight loss in intervention group, vs weight gain in control group following nutritional therapy [21]. Furthermore, Mohammadi and colleagues reported improve ment in anthropometric measures, fasting blood sugar, 2-h postprandial blood sugar, serum total cholesterol, serum ala nine transaminase and increased circulating following diet therapy [22]. However, despite a substantial number of independent studies reporting positive, and sustained, outcomes following nutritional therapy, there is no consensus on its' overarch ing effect. Given the clinical importance of such nutritional management in clinical practice and poor uptake of current guideline recommendations.We sought to conduct a system atic reviewandmeta-analysis of the health benefits ofmedical nutrition therapy among patients with diabetes.

2. Methods

This systematic review and meta-analysis was conducted using recommendations outlined by the Preferred Reporting Items of Systematic Reviews and Meta-Analysis statement guidelines [23].

2.1. Search strategy A systematic search was conducted by combining med ical subject headings (MeSH) and non MeSH terms in PubMed/MEDLINE, Cochrane and SCOPUS with no language or date restrictions. Databases were searched from inception to February 2019 (Supplemental Table1). To avoid missing any relevant studies, reference lists of eligible studies and related reviews were searched manually.

2.2. Eligibility criteria We included studies that met the following inclusion criteria: All studies that evaluated the effect of Medical Nutrition Therapy on diabetes patients were included in this meta analysis. We defined medical nutrition therapy as nutritional consultation provided by a registered dietitian. We included studies that met the following inclusion criteria: (1) studies, irrespective of design that had control groups receiving usual care; (2) studies that evaluated the effectiveness of prescribing Medical Nutrition Therapy by a Registered Dietitians; and (3) reported sufficient information onmetabolic variables both in control and intervention groups. Prospective studies without a suitable control group were excluded. We excluded studies that did not report outcomemeasures (or changes in outcome measures) at baseline to the end of intervention or follow-up.

2.3. Data extraction and quality assessment Two independent researchers (H.K.V and J.R) screened and extracted relevant data for all studies identified by the search strategy. Discrepancies were resolved by consensus agree- ment. When, consensus was not achieved, a senior author (S.J.M.R.) involved in the study helped to resolve disagree- ments. We extracted data on the following items from each study: name of the first author, year of publication, type of study population, number of participants in the interven- tion and control groups, gender, participants mean age, study location, study design, intervention components, intervention duration, and type of diabetes. For the results, we extracted information on the anthropometric, nutritional and biochem- ical variables. Means and standard deviations of metabolic variables at baseline, end of study and/or changes between baseline and period of intervention delivery). When this data was unavailable, we emailed the corresponding author to obtain information missing in the published study report.

2.4. Quality assessment of studies We evaluated the quality of included trials using the Cochrane quality assessment tool which comprises of the following domains: random sequence generation, allocation conceal- ment, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data, selective reporting and other probable sources of biases. To assess the quality of studies, each study was assigned a label (yes, no or unclear). This information was used to classify the study as having a low risk, high risk or unknown risk of bias, respec- tively [24]. Studies were judged to be of high risk of bias when the randomization, allocation concealment and blinding was not reported or not performed. Studies were judged to be of low risk of bias when all critical items or more items on the assessment domains were reported [24].

2.5. Quantitative data synthesis Mean change and standard deviation (SD) of the outcome measures were used to estimate the overall effect size. If the SD of the mean difference was not reported in the studies, we derived this value using the following formula: $SD_{change} = \text{square root}\ [(SD_{baseline}^2 + SD_{final}^2) - (2 \times r \times SD_{baseline} \times SD_{final})]$ [25]. The random-effects model (using Der- Simonian Laird method) was used to estimate the weighted mean difference (WMD) and corresponding 95% confidence intervals (95% CI). We carried out predefined subgroup analy- sis for region (location of study) to detect potential sources of heterogeneity among the studies. Meta-regression was used to determine the effect of duration of intervention and par- ticipant age on intervention outcomes. Publication bias was evaluated by means of visual assessment of funnel plots and Egger's tests [26]. When publication bias was detected, it was re-evaluated using the 'trim and fill' approach [27]. Sensitiv- ity analysis was performed to investigate the effect of each study on overall analysis. All statistical analyses were exe- cuted using Stata software (Stata Corp. College Station, Texas, USA).

3. Results

We retrieved 266 studies using our search strategy after remov ing duplicates papers (Supplemental Figure 1). At title and abstract screening, 241 papers were removed using the study selection criteria and 25 articles were retained for full text eligibility assessment. Eleven

articles [28–38] met the review inclusion criteria. Fourteen studies were excluded for the fol lowing reasons: (1) outcome data was presented in unsuitable format and attempts to obtain complete data was unsuccess ful (n= 7), (2) did not include control group comparisons (n= 4), and (3) intervention was designed without including a nutri tionist (n= 3).

3.1. Study characteristics Table 1 presents the characteristics of included studies. Stud ieswere conducted in theUS [28,31–33,36], China [30], Iran [29], Canada [34], Taiwan [35], Italy [37], and Finland [38]. Studies were published between 1999–2018 and duration of interven tion was between 10 104 weeks. Mean age of participants was 54 (45–66) years. Ten studies were evaluated among patients with diabetes [28 30,32–38] and one conducted on pre-patients with diabetes [31]. Routine care was the common interven tions evaluated among the control groups. Table 2 shows the risk of bias assessment of studies included in this review. One study in selection bias (Randomsequence generation) [35] and two study in selection bias (allocation concealment) [16,38] had low risk of bias.

3.2. Interventions Most intervention groups in studies included this review received recommendations for physical activity and individ ualized nutrition counselling to promote health and behavior change by a registered dietitian.

3.3. Results of meta-analysis Eight studies providing a total of 612 participants in inter vention group and 588 participants in control group with data reported on levels of Fasting blood sugar as an out come variable [29–32,34,35,37,38]. Results combined using random effects model showed a significant reduction in FBS levels following medical nutrition therapy (MNT) interven tion (Weighted mean difference(WMD): −8.85mg/dl, 95% CI: −14.41, −3.28) (Fig. 1). Significant heterogeneity was identified among studies ($p = 0.001$, $I^2 = 76\%$). We combined results from eight studies [30–37] that reported HBA1C as an outcome measure using a random effects model. This provided a total of 1032 participants (intervention= 522 and control = 510). The results demon strated that MNT intervention significantly reduced HBA1C levels (WMD: −0.43%, 95% CI: −0.69, −0.17) in the intervention group compared to the control group (routine care). How ever, we identified significant heterogeneity among studies ($p = 0.004$, $I^2 = 94\%$). In six studies (seven arms) that reported weight as an outcome variable, there was a total of 556 participants in intervention group and 534 participants in control group [28–30,32,34,38]. Pooled results using random effects model showed a significant reduction in weight in the MNT group compared with the control group (WMD: −1.54 kg, 95% CI: −2.44, −0.64). There was significant heterogeneity among included studies ($p = 0.001$, $I^2 = 77\%$). Six studies (seven arms) containing 240 participants in MNT group and 242 participants in control group reported BMI as an outcome variable [29,30,33–35,37]. Pooled results showed that BMI was reduced in the intervention group compared with the control group (WMD: −0.34 Kg/m2, 95% CI: −0.52, −0.17). There was no significant heterogeneity among studies ($p = 0.39$, $I^2 = 4.5\%$). Five studies reported waist circumstance as an outcome measure [29,32,34,37,38]. In comparison with the control group, the MNT group showed a significant reduction in waist circumstance (WMD: −2.16 cm, 95% CI: −4.09, −0.23). There was significant heterogeneity among included studies ($p = 0.001$, $I^2 = 93$). Eight studies containing a total of 748 participants (382 participants in intervention group and 366 participants in con trol group) reported cholesterol levels as an outcomemeasure [29–31,34–38]. We combined results using a random effects model and demonstrated a significant reduction in cholesterol levels followingMNT intervention (WMD: −4.06mg/dl, 95% CI: −7.31, −0.81) (Fig. 1). There was no significant heterogeneity between studies ($p = 0.29$, $I^2 = 16$). For TG, the combined effect size using a random effects modelwas -8.82 mg/dl (95% CI 20.10, 2.45) [30,31,34,35,37,38]. We identified significant heterogeneity between studies ($p = 0.03$, $I^2 = 57\%$). Four studies reported LDL as outcome variables [29,31,34,35]. MNT group showed significant reduction in LDL levels (WMD: −4.43 mg/dl, 95% CI: −13.66, 4.80) compared with the control group. Therewas no significant

heterogeneity between studies (p = 0.12, I^2 = 47%). Overall, results from six studies [29,31,34,35,37,38] con- ducted among 605 participants were combined using a random-effects model. The results showed that MNT did not have any significant effect on HDL levels (WMD: −0.40 mg/dl, 95% CI: −3.20, 2.40). Significant heterogeneity was found among studies (p = 0.001, I^2 = 89). Seven studies providing 694 participants reported SBP as an outcome variable [29,30,33–35,37,38]. Results pooled using random effects model demonstrated a significant reduction in the MNT group compared with the control group (WMD: −7.90mmHg, 95% CI: −13.03, −2.77). There was significant heterogeneity among studies (p = 0.001, I^2 = 93). Furthermore, using a random-effects model we combined results of stud- ies evaluating the impact of nutritional therapy on DBP [29,30,33–35,37,38]. The results indicated a significant reduc- tion in DBP levels (WMD:−2.60mmHg,95% CI:−4.27, 0.94) with significant heterogeneity among included studies (p = 0.001, I^2 = 72).

3.4. Subgroup analysis and meta-regression Table 3 shows results of the subgroup analyses. Studies were stratified based on continents (North American and Eurasian continents). Subgroup analyses showed that Medical Nutri tional therapy had significantly higher effects on FBS, HBA1C, and weight reduction among participant within Eurasian con tinent compared with their North American counterparts.We did not consider subgroup analysis for BMI, Cholesterol, and LDL because these outcomes showed negligible heterogeneity. Also, we did not consider subgroup analysis for waist circum stance, TG, HDL, SBP, and DBP because there were insufficient studies within these subgroups. We performed meta regression analyses on FBS, HBA1C, weight, BMI, Cholesterol, LDL, waist circumstance, TG, HDL, SBP, and DBP based on age of participants and duration of intervention (Supplemental Figs. 2 and 3) but there is no significant relationship between changes in outcome and par ticipants age or intervention duration. ***3.5. Publication bias and sensitivity analysis*** The Funnel plot (Supplemental Fig. 4), Egger's and Begg's tests did not show any publication bias for FBS (p = 0.39, p = 0.32), HBA1C (p = 0.09, p = 0.45), Weight (p = 0.13, p = 0.17), BMI (p = 0.14, p = 0.29), waist circumstance (p = 0.05, p = 0.32), TG (p = 0.17, p = 0.85), and HDL (p = 0.93, p = 0.85) (Supplemen tal Fig. 4). There was a significant publication bias (Egger's and Begg's tests) for cholesterol (p = 0.02, p = 0.13), LDL (p = 0.01, p = 0.04), SBP (p = 0.04, p = 0.65), and DBP (p = 0.02, p = 0.02). We used 'trim and fill' method for adjusting publication bias but did not detect potentially missing studies that could have biased the results of this meta-analyses. Sensitivity analysis did not show any significant differences beyond the limits of 95% CI between calculated SESs for MNT intervention studies (Supplemental Fig. 5).

4. Discussion

This systematic review evaluated the effectiveness of medical nutrition in developing the treatment plan for patients with diabetes. We found evidence to support the effectiveness of medical nutrition therapy (MNT) on almost all anthropometric and biochemical outcomes, expect high and low density lipo- proteins. However, the clinical relevance of this differences remains unknown as most interventions involved multiple components. Furthermore, the duration of the intervention across included studies suggest thatmultiple encounters may be required to observe desired changes. However, lifestyle interventions such as MNT, which demonstrate small effect may exert large impact at a population level. Results of our sub-group analysis showed higher improve- ment in some biochemical parameters - FBS, HBA1C and weight gain among participants in the Eurasian region compared with their North American counterparts. This dif- ferences in outcomes between participants from different continents might be due to genetic variations and differences in lifestyle. Suggesting that health practitioners may need to tailor their approach when managing different patient groups. Although, we did not observe differences in outcome with a sub-group analysis after meta-

regression for age or duration of intervention, thismay have been masked by the small number of studies evaluating long-term outcomes. Sub-group analysis by intervention duration was limited by the nature of the data retrieved from studies included in this review.

4.1. Comparison with previous findings A previous systematic review by Moller et al. [39] showed sim- ilar results to our study. At short-term (6–12 months). The authors [39] reported improvement in HbA1c 0.55 (95% CI: 0.02–1.1) BMI, 2.1-kg (95% CI: 1.2–2.9-kg) and LDL cholesterol 0.17-mmol/L (95% CI: 0.11–0.23-mmol/L) due to nutrition ther- apy compared to dietary advice.However, the size and number of studies included in that review, as well as the methodolog- ical qualities of studies made it difficult to provide definite conclusions about the effectiveness of nutrition therapy. Cur- rent guidelines for managing diabetes recommend MNT for patients with diabetes. In this study we found evidence to support the multi-faceted impact of MNT shown by previ- ous reports [40,41]. Also, there is evidence to recommend the provision of MNT by qualified health care profession- als (i.e. Dietitians) and incorporate tailored approaches to yield sustainable outcomes. Medical nutrition therapy has also been recommended by American guidelines, documenting evidence of clinical benefits for physiological parameters and disease management [42]. However, the evidence to support the long-term provision of this therapy remains scarce and at best uncertain [41]. Considering the resource intensive nature of MNT, studies evaluating long term clinical benefits and cost-effectiveness of MNT are needed to inform guidelines.

4.2. Limitations Although, the results of this review were generated using evidence from a larger total sample size, there were some lim- itations with the review process. The results of this review are limited by inherent bias in the original studies used to synthesis evidence on MNT. A number of studies included in this review were heterogeneous used short-term follow-up durations and varying assessment techniques. There was sig nificant heterogeneity between most studies used to evaluate these outcomes that remained even after sensitivity anal ysis. Most studies showed high or unclear risk of bias for critical domains of randomization or allocation concealment. This may have inflated the effect size observed, limiting the strength of the evidence and consequently, the recommenda tions generated by this review.We performed a comprehensive search process and assessments for publication bias, poorly or non-indexed papers could still have been missed that could have influenced the results of our study. Also, we were limited by the reporting characteristics nature of the studies included in this review. We were unable to retrieve complete outcome data despite attempts to contact corresponding authors. Lifestyle interventions such as medical nutrition ther apy are mostly delivered as part of a multi-component management strategies. The synergistic effects from other complimentary interventions, cultural and contextual fac tors may have contributed to the weight of the effect sizes observed. In this study, we did not adjust for known or unknown mediating factors that could explain a significant part of the intervention effect we observed. Therefore, we advise caution when interpreting the results of this study as mediating factors such as physical activity levels were not adjusted for and most studies were evaluated at short-term follow-up. Future studies should explore the effectiveness of medical nutrition using robust designs in a clearly defined pre diabetic or diabetic patient group and use longer follow up duration.

5. Conclusions

This systematic review and meta-analysis found evidence to support incorporating medical nutrition therapy as a cen tral component of the management of diabetes mellitus. Improvements were observed in outcome measures of FBS, HBA1C, weight, BMI, waist circumference, cholesterol, and SBP. Sub-group analysis showed difference by continents, but no significant associations were found for the effect of age or intervention duration. Future studies should explore the effect of MNT as an early preventative intervention in pre-diabetic

patient groups, evaluate long term maintenance effects and self-management approaches among diabetic patient groups.

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Conflict of interest

The authors declare no conflict of interest.

References#

[1] E.A. Spencer, K.L. Pirie, R.J. Stevens, et al., Diabetes and modifiable risk factors for cardiovascular disease: the prospective Million Women Study, Eur. J. Epidemiol. 23 (2008) 793.
[2] T. Schramm, G. Glslason, L. Kober, S. Rasmussen, J.N. Rasmussen, S.Z. Abildstrom, et al., Diabetes patients requiring glucose-lowering therapy and nondiabetics with a prior myocardial infarction carry the cardiovascular risk. A population study of 33 million people, Circulation 117 (2008) 1945–1954.
[3] Organization WH, Global Report on Diabetes, 2016. [4] W. Yang, W. Zhao, J. Xiao, et al., Medical care and payment for diabetes in China: enormous threat and great opportunity, PLoS One 7 (2012), e39513. [5] Association AD, Economic costs of diabetes in the US in 2012, Diabetes Care 36 (2013) 1033–1046.
[6] N. Hex, C. Bartlett, D. Wright, et al., Estimating the current and future costs of Type 1 and Type 2 diabetes in the UK, including direct health costs and indirect societal and productivity costs, Diabet. Med. 29 (2012) 855–862.
[7] M.G. Albano, C. Crozet, J. d'Ivernois, Analysis of the 2004–2007 literature on therapeutic patient education in diabetes: results and trends, Acta Diabetol. 45 (2008) 211–219. [8] M.J. Davies, S. Heller, T. Skinner, et al., Effectiveness of the diabetes education and self management for ongoing and newly diagnosed (DESMOND) programme for people with newly diagnosed type 2 diabetes: cluster randomised controlled trial, BMJ 336 (2008) 491–495. [9] L. Blonde, J. Dempster, J.M. Gallivan, et al., Reducing cardiovascular disease risk in patients with diabetes: a message from the National Diabetes Education Program, J. Am. Acad. Nurse Pract. 18 (2006) 524–533. [10] Committee CDACPGE, Clinical practice guidelines for the prevention and management of diabetes in Canada. Canadian Diabetes Association, Can. J. Diabetes 27 (2003) S10–S13.
[11] S. Farsaei, A.M. Sabzghabaee, A.H. Zargarzadeh, et al., Effect of pharmacist-led patient education on glycemic control of type 2 diabetics: a randomized controlled trial, J. Res. Med. Sci. 16 (2011) 43.
[12] M.J. Franz, The role of nutrition therapy and dietitians in the management of the metabolic syndrome, Curr. Diab. Rep. 7 (2007) 60–65. [13] L.M. Gaetke, M.A. Stuart, H. Truszczynska, A single nutrition counseling session with a registered dietitian improves short-term clinical outcomes for rural Kentucky patients with chronic diseases, J. Am. Diet. Assoc. 106 (2006) 109–112. [14] J.D. Goldhaber-Fiebert, S.N. Goldhaber-Fiebert, M.L. Tristán, et al., Randomized controlled community-based nutrition and exercise intervention improves glycemia and cardiovascular risk factors in type 2 diabetic patients in rural Costa rica, Diabetes Care 26 (2003) 24–29.
[15] W.L. Haskell, K. Berra, E. Arias, et al., Multifactor cardiovascular disease risk reduction in medically underserved, high-risk patients, Am. J. Cardiol. 98 (2006) 1472–1479. [16] M. Trento, M. Basile, E. Borgo, et al., A randomised controlled clinical trial of nurse-, dietitian-and pedagogistled Group Care for the management of Type 2 diabetes, J. Endocrinol. Invest. 31 (2008) 1038–1042. [17] J. Ma, K. Berra, W.L. Haskell, et al., Case management to reduce risk of cardiovascular disease in a county health care system, Arch. Intern. Med. 169 (2009) 1988–1995.
[18] J. Wylie-Rosett, L. Delahanty, Group DPPR, An integral role of the dietitian: implications of the Diabetes Prevention Program, J. Am. Diet. Assoc. 102 (2002) 1065. [19] A. Al-Shookri, G. Khor, Y. Chan, et al., Effectiveness of medical nutrition treatment delivered by dietitians on glycaemic outcomes and lipid profiles of Arab, Omani patients with type 2 diabetes, Diabet. Med. 29 (2012) 236–244. [20] M.-C. Battista, M. Labonté, J. Ménard, et al., Dietitian-coached

management in combination with annual endocrinologist follow up improves global metabolic and cardiovascular health in diabetic participants after 24 months, Appl. Physiol. Nutr. Metab. 37 (2012) 610–620. [21] R.S. Bhopal, A. Douglas, S. Wallia, et al., Effect of a lifestyle intervention on weight change in south Asian individuals in the UK at high risk of type 2 diabetes: a family-cluster randomised controlled trial, Lancet Diabetes Endocrinol. 2 (2014) 218–227. [22] S. Mohammadi, S.R. Arefhosseini, M.A. Jafarabadi, et al., Regulation of serum lipid profile, glucose, insulin, and adiponectin in obese diabetic women under diet therapy: a randomized clinical controlled study, Iran. Red Crescent Med. J. 19 (2017). [23] D. Moher, A. Liberati, J. Tetzlaff, et al., Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement, PLoS Med. 6 (2009), e1000097. [24] J.P. Higgins, D.G. Altman, P.C. Gøtzsche, et al., The Cochrane Collaboration's tool for assessing risk of bias in randomised trials, BMJ 343 (2011), d5928. [25] M. Borenstein, L.V. Hedges, J. Higgins, et al., References, Wiley Online Library, 2009. [26] M. Egger, G.D. Smith, M. Schneider, et al., Bias in meta-analysis detected by a simple, graphical test, BMJ 315 (1997) 629–634. [27] T.M. Palmer, J.L. Peters, A.J. Sutton, et al., Contour-enhanced funnel plots for meta-analysis, Stata J. 8 (2008) 242. [28] P.Z. Marincic, M.V. Salazar, A. Hardin, et al., Diabetes self-management education and medical nutrition therapy: a multisite study documenting the efficacy of registered dietitian nutritionist interventions in the management of glycemic control and diabetic dyslipidemia through retrospective chart review, J. Acad. Nutr. Diet. (2018). [29] S. Mohammadi, S.R. Arefhosseini, M.A. Jafarabadi, et al., Regulation of serum lipid profile, glucose, insulin, and adiponectin in obese diabetic women under diet therapy: a randomized clinical controlled study, Iran. Red Crescent Med. J. 19 (2017). [30] H. Liu, M. Zhang, X. Wu, et al., Effectiveness of a public dietitian-led diabetes nutrition intervention on glycemic control in a community setting in China, Asia Pac. J. Clin. Nutr. 24 (2015) 525–532.
[31] A.R. Parker, L. Byham-Gray, R. Denmark, et al., The effect of medical nutrition therapy by a registered dietitian nutritionist in patients with prediabetes participating in a randomized controlled clinical research trial, J. Acad. Nutr. Diet. 114 (2014) 1739–1748. [32] K. Niswender, M. Piletic, H. Andersen, et al., Weight change upon once-daily initiation of insulin detemir with or without dietary intervention in overweight or obese insulin-naïve individuals with type 2 diabetes: results from the DIET trial, Diabetes Obes. Metab. 16 (2014) 186–192.
[33] S.T. Miller, V.J. Oates, M.A. Brooks, et al., Preliminary efficacy of group medical nutrition therapy and motivational interviewing among obese African American women with type 2 diabetes: a pilot study, J. Obes. 2014 (2014) 345941. [34] M.C. Battista, M. Labonté, J. Ménard, et al., Dietitian-coached **Q1 0** management in combination with annual endocrinologist follow up improves global metabolic and cardiovascular health in diabetic participants after 24 months, Appl. Physiol. Nutr. Metab. 37 (2012) 610–620.
[35] M.C. Huang, C.C. Hsu, H.S. Wang, et al., Prospective randomized controlled trial to evaluate effectiveness of registered dietitian-led diabetes management on glycemic and diet control in a primary care setting in Taiwan, Diabetes Care 33 (2010) 233–239.
[36] B.D. Timmerberg, J. Wurst, J. Patterson, et al., Feasibility of using videoconferencing to provide diabetes education: a pilot study, J. Telemed. Telecare 15 (2009) 95–97.
[37] M. Trento, M. Basile, E. Borgo, et al., A randomised controlled clinical trial of nurse-, dietitian- and pedagogist-led Group Care for the management of Type 2 diabetes, J. Endocrinol. Invest. 31 (2008) 1038–1042.
[38] J. Eriksson, J. Lindström, T. Valle, et al., Prevention of Type II diabetes in subjects with impaired glucose tolerance: the Diabetes Prevention Study (DPS) in Finland. Study design and 1-year interim report on the feasibility of the lifestyle intervention programme, Diabetologia 42 (1999) 793–801.
[39] G. Moller, H.K. Andersen, O. Snorgaard, A systematic review and meta-analysis of nutrition therapy compared with dietary advice in patients with type 2 diabetes, Am. J. Clin. Nutr. 106 (2017) 1394–1400. [40] E.B. Lynch, R. Liebman, J. Ventrelle, et al., Peer reviewed: a self-management intervention for African Americans with comorbid diabetes and hypertension: a pilot

randomized controlled trial, Prev. Chronic Dis. 11 (2014). [41] E.B. Lynch, R. Liebman, J. Ventrelle, et al., Design of the Lifestyle Improvement through Food and Exercise (LIFE) study: a randomized controlled trial of self-management of type 2 diabetes among African American patients from safety net health centers, Contemp. Clin. Trials 39 (2014) 246–255.
[42] M.J. Franz, M.A. Powers, C. Leontos, et al., The evidence for medical nutrition therapy for type 1 and type 2 diabetes in adults, J. Am. Diet. Assoc. 110 (2010) 1852–1889.

Supplemental Table 1. Search strategy.

PubMed/MEDLINE	Cochrane library	Scopus
((("Clinical Trials as Topic"[Mesh] OR "Cross-Over Studies"[Mesh] OR "Double-Blind Method"[Mesh] OR "Single-Blind Method"[Mesh] OR "Random Allocation"[Mesh] OR RCT[Title/Abstract] OR "Intervention Studies"[Title/Abstract] OR "intervention"[Title/Abstract] OR "controlled trial"[Title/Abstract] OR "randomized"[Title/Abstract] OR "randomised"[Title/Abstract] OR "random"[Title/Abstract] OR "randomly"[Title/Abstract] OR "placebo"[Title/Abstract] OR "assignment"[Title/Abstract]) AND ("nutrition therapy"[Mesh] OR "nutrition therapy"[tiab] OR "nutrition counseling"[tiab] OR "nutrition intervention"[tiab] OR "nutrition monitoring"[tiab] OR "Medical Nutrition Therapy"[tiab] OR "nutritional service"[tiab] OR "nutritional services"[tiab] OR "nutrition services"[tiab] OR "nutrition service"[tiab] OR "Dietary service"[tiab] OR "Dietary services"[tiab] OR "food services"[tiab] OR "food service"[tiab] OR "Dietary Services"[Mesh] OR "clinical nutrition service"[tiab] OR "diet therapy"[tiab] OR "nutrition therapy"[tiab] OR "food therapy"[tiab] OR "Diet Therapy"[Mesh])) AND ("dietitian*"[tiab] OR "dietician*"[tiab] OR "nutritionist*"[tiab] OR "Nutritionists"[Mesh])) AND ("Diabetes Mellitus"[Mesh] OR "Diabetes Mellitus, Type 2"[Mesh] OR "Diabetes, Gestational"[Mesh] OR "Diabetes Insipidus"[Mesh] OR "Diabetes Complications"[Mesh] OR "Diabetes Mellitus, Type 1"[Mesh] OR "Diabetes Mellitus"[tiab] OR "Type 2 Diabetes Mellitus"[tiab] OR "Gestational Diabetes"[tiab] OR "Diabetes Insipidus"[tiab] OR "Diabetes Complications"[tiab] OR "Type 1 Diabetes Mellitus"[tiab] OR ("Diabetes Mellitus"[Mesh] OR Diabetes[TIAB]))	("nutrition therapy" OR "nutrition counseling" OR "nutrition intervention" OR "nutrition monitoring" OR "Medical Nutrition Therapy" OR "nutritional service" OR "nutritional services" OR "nutrition services" OR "nutrition service" OR "Dietary service" OR "Dietary services" OR "food services" OR "food service" OR "Dietary Services" OR "clinical nutrition service" OR "diet therapy" OR "nutrition therapy" OR "food therapy") AND (dietitian OR dietician OR nutritionist) AND ("Diabetes Mellitus" OR Diabetes OR "Diabetes Insipidus" OR "Diabetes Complications" OR "Type 2 Diabetes Mellitus" OR "Gestational Diabetes" OR "Diabetes Complications" OR "Type 1 Diabetes Mellitus" OR Diabetes OR diabetic OR diabete)	((TITLE-ABS-KEY ("nutrition therapy") OR TITLE-ABS-KEY ("nutrition counseling") OR TITLE-ABS-KEY ("nutrition intervention") OR TITLE-ABS-KEY ("nutrition monitoring") OR TITLE-ABS-KEY ("Medical Nutrition Therapy") OR TITLE-ABS-KEY ("nutritional service") OR TITLE-ABS-KEY ("nutritional services") OR TITLE-ABS-KEY ("nutrition services") OR TITLE-ABS-KEY ("nutrition service") OR TITLE-ABS-KEY ("Dietary service") OR TITLE-ABS-KEY ("Dietary services") OR TITLE-ABS-KEY ("food services") OR TITLE-ABS-KEY ("food service") OR TITLE-ABS-KEY ("Dietary Services") OR TITLE-ABS-KEY ("clinical nutrition service") OR TITLE-ABS-KEY ("diet therapy") OR TITLE-ABS-KEY ("nutrition therapy") OR TITLE-ABS-KEY ("food therapy") OR TITLE-ABS-KEY ("Diet Therapy"))) AND ((TITLE-ABS-KEY ("dietitian*") OR TITLE-ABS-KEY ("dietician*") OR TITLE-ABS-KEY ("nutritionist*") OR TITLE-ABS-KEY ("Nutritionists"))) AND ((TITLE-ABS-KEY ("Diabetes Mellitus") OR TITLE-ABS-KEY ("Diabetes Mellitus, Type 2") OR TITLE-ABS-KEY ("Diabetes, Gestational") OR TITLE-ABS-KEY ("Diabetes Insipidus") OR TITLE-ABS-KEY ("Diabetes Complications") OR TITLE-ABS-KEY ("Diabetes Mellitus, Type 1") OR TITLE-ABS-KEY ("Diabetes Mellitus") OR TITLE-ABS-KEY ("Type 2 Diabetes Mellitus") OR TITLE-ABS-KEY ("Gestational Diabetes") OR TITLE-ABS-KEY ("Diabetes Insipidus") OR TITLE-ABS-KEY ("Diabetes Complications") OR TITLE-ABS-KEY ("Type 1 Diabetes Mellitus") OR TITLE-ABS-KEY ("Diabetes Mellitus") OR TITLE-ABS-KEY (diabetes))) AND (((((TITLE-ABS-KEY ("Clinical Trials")) OR (TITLE-ABS-KEY ("Clinical Trial")) OR (TITLE-ABS-KEY ("Cross-Over Studies")) OR (TITLE-ABS-KEY ("Double-Blind Method")) OR (TITLE-ABS-KEY ("Single-Blind Method")) OR (TITLE-ABS-KEY ("Random Allocation")) OR (TITLE-ABS-KEY ("RCT"))) OR (TITLE-ABS-KEY ("random")) OR (TITLE-ABS-KEY ("randomly")) OR (TITLE-ABS-KEY ("placebo")) OR (TITLE-ABS-KEY ("assignment"))) OR ((TITLE-ABS-KEY ("Intervention Studies")) OR (TITLE-ABS-KEY ("intervention")) OR (TITLE-ABS-KEY ("controlled trial")) OR (TITLE-ABS-KEY ("randomized")) OR (TITLE-ABS-KEY ("randomised")))))

Table 1

Table 1 – Baseline characteristics of included studies in the meta-analysis.

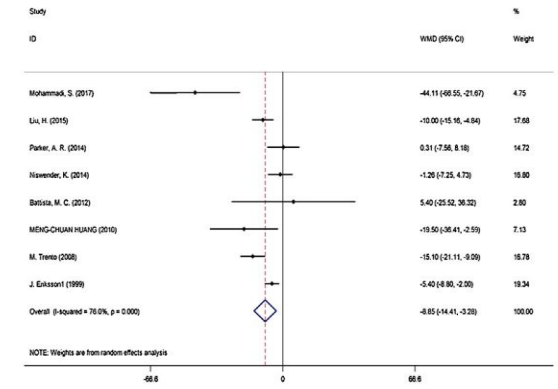
Studies	Author	Country	Study year	Age (years)	Patients, n	Follow up (in weeks)	Type of diabetes	Duration of intervention (week)	Intervention	Control
1	Marincic	US	2018	–	165	12	Type 2 diabetes	12	Medical nutrition therapy	Diabetes self-management education
2	Mohammadi	IRAN	2017	49	30	10	T2DM	10	Diet therapy	Usual care
3	Liu	China	2015	62	117	52	T2DM	52	Dietitian-led intervention	Usual care
4	Parker	US	2014	50	76	12	Prediabetes	12	Medical nutrition therapy	Usual care
5	Niswender	US	2014	57	478	26	T2DM	26	Dietary interven-tion + insulin detemir	Usual care + insulin detemir
6	Miller	US	2014	50	48	18	T2DM	18	Medical nutrition therapy	Self-Care
7	Battista	Canada	2012	59	88	104	T1,2DM	104	Dietitian-coached	Usual care
8	Huang	Taiwan	2010	56	154	52	Type 2 diabetes	52	Registered dietitian-led intervention group	Usual care
9	Timmerberg	US	2009	45	26	16	Type 2 diabetes	16	Group nutrition class + follow up with dietitians	Group nutrition class
10	Trento	Italy	2008	66	45	104	Type 2 diabetes	104	Nurse-, dietitianand pedagogist-led Group Care	Usual care
11	Eriksson	Finland	1999	54	212	52	Type 1I diabetes	52	Medical nutrition therapy	Received general information about the lifestyle changes

Table 2

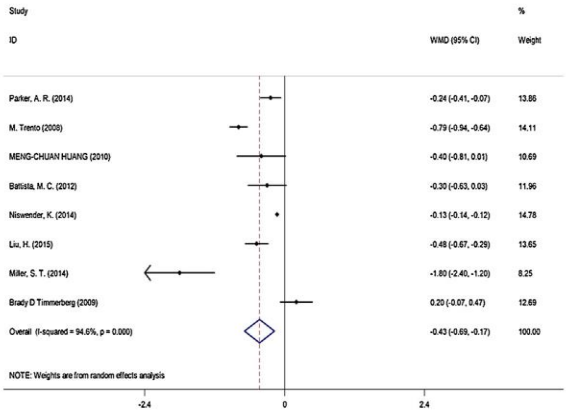
Table 2 – Risk of bias assessment of the studies.

Study name	Year	Selection bias random sequence generation	Selection bias allocation concealment	Performance bias blinding	Detection bias blinding	Attrition bias incomplete outcome data	Reporting bias selective reporting	Other bias other sources of bias
Marincic et al. [28]	2018	Retrospective chart review from the electronic medical records of patients						
Mohammadi et al. [22]	2017	Unclear	Unclear	Low	Low	Low	Low	Low
Liu et al. [30]	2015	Unclear	Unclear	Low	Low	Low	Low	Low
Parker et al. [31]	2014	Unclear	Unclear	Low	Low	Low	Low	Low
Niswender et al. [32]	2014	High	Unclear	Low	Low	Low	Low	Low
Miller et al. [33]	2014	One-arm interrupted time series design, a quasi-experimental research design						
Battista et al. [20]	2012	Unclear	Unclear	Low	Low	Low	Low	Low
Huang et al. [35]	2010	Low	Unclear	Low	Low	Low	Low	Low
Timmerberg et al. [36]	2009	Unclear	Unclear	Low	Low	Low	Low	Low
Trento et al. [37]	2008	Unclear	Low	Low	Low	Low	Low	Low
Eriksson et al. [38]	1999	Unclear	Low	Low	Low	Low	Low	Low

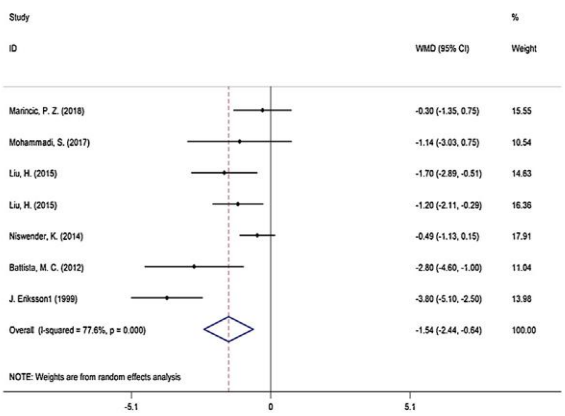
a) Fasting Blood Sugar



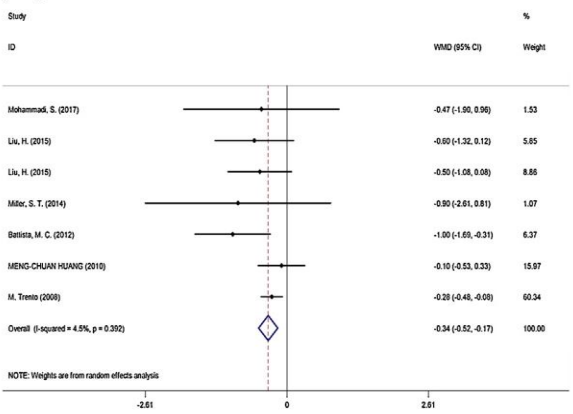
b) HbA1c



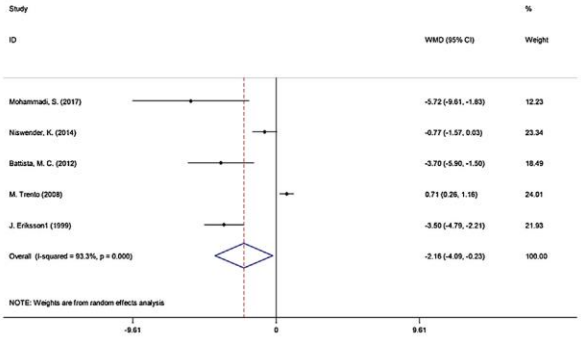
c) Weight



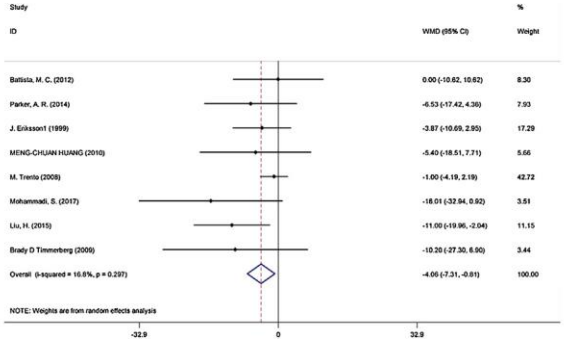
d) Body Mass Index



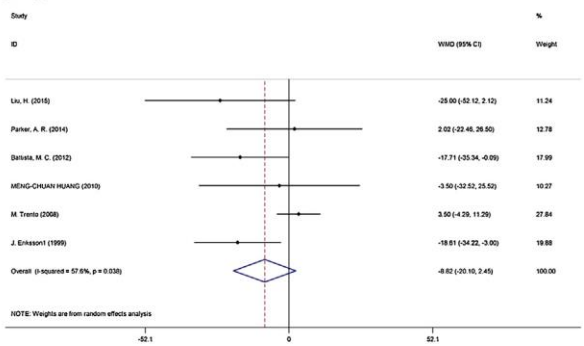
e) Waist circumstance



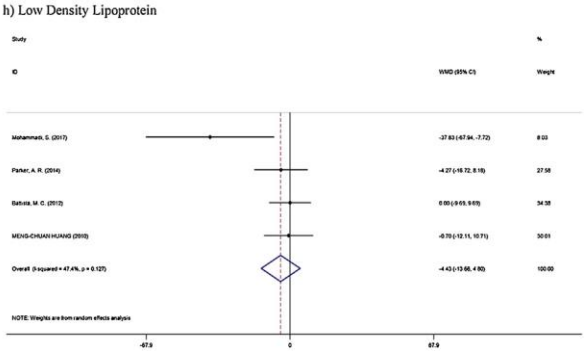
f) Cholesterol



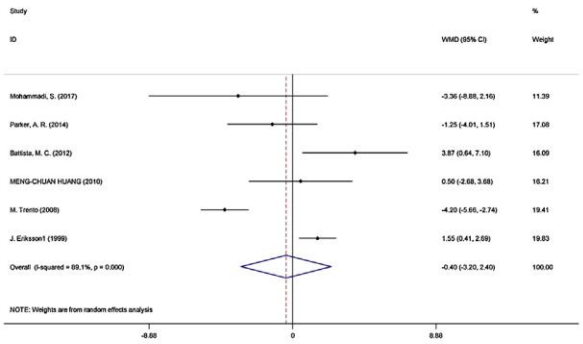
g) Triglyceride



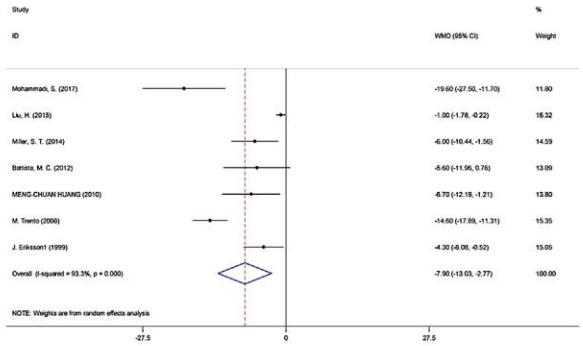
h) Low Density Lipoprotein



i) i) High Density Lipoprotein



j) Systolic blood pressure



k) Dystolic blood pressure

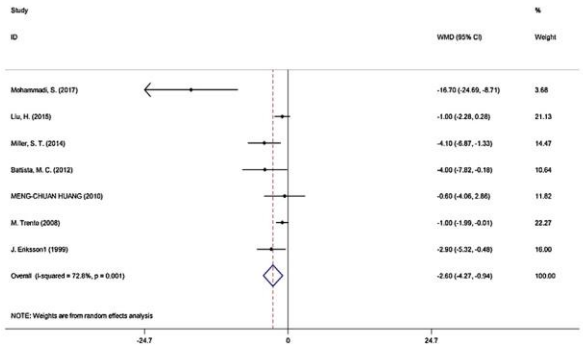
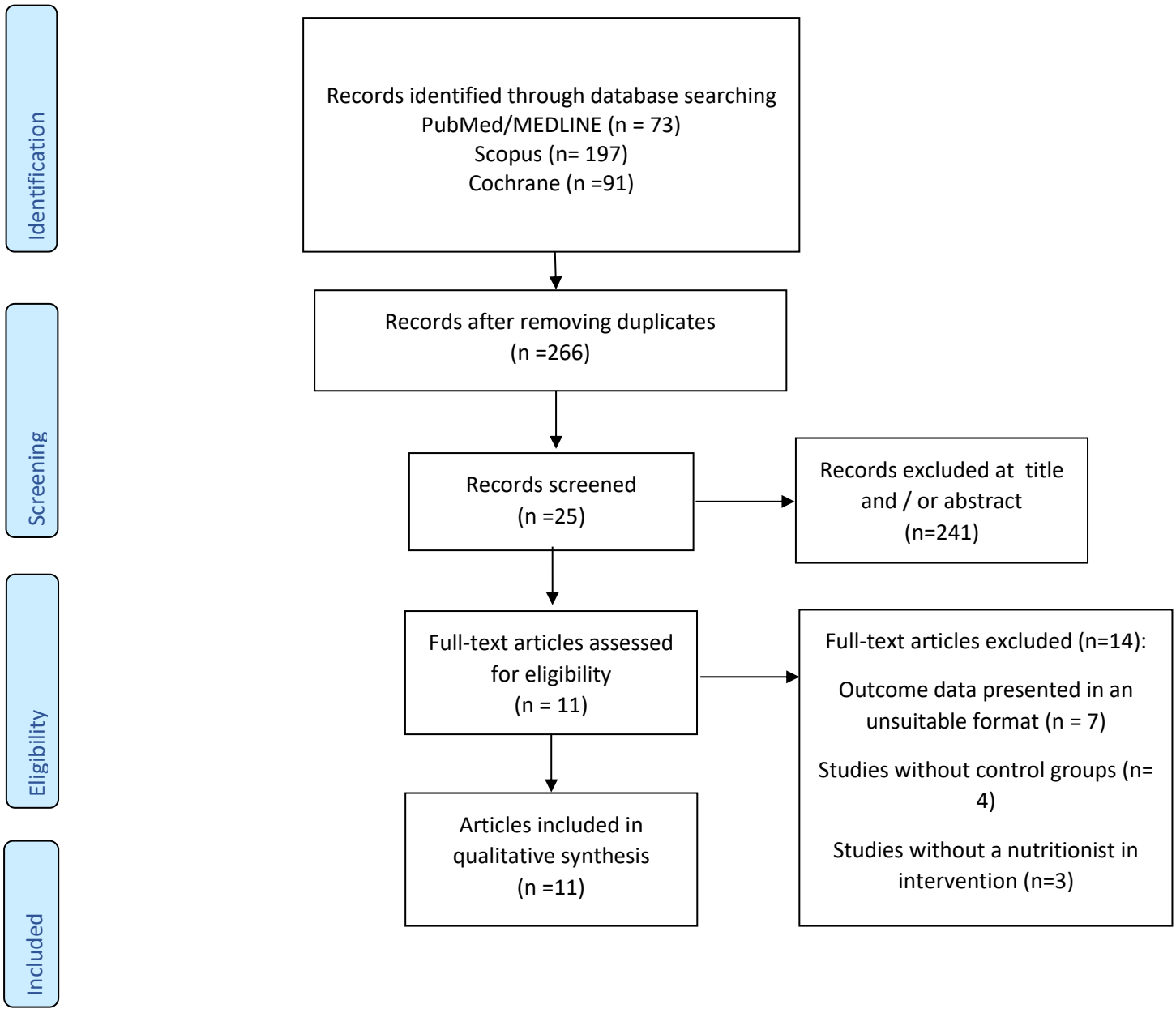


Table 3

Table 3 – Results of subgroup analysis of included randomized controlled trials in meta-analysis.

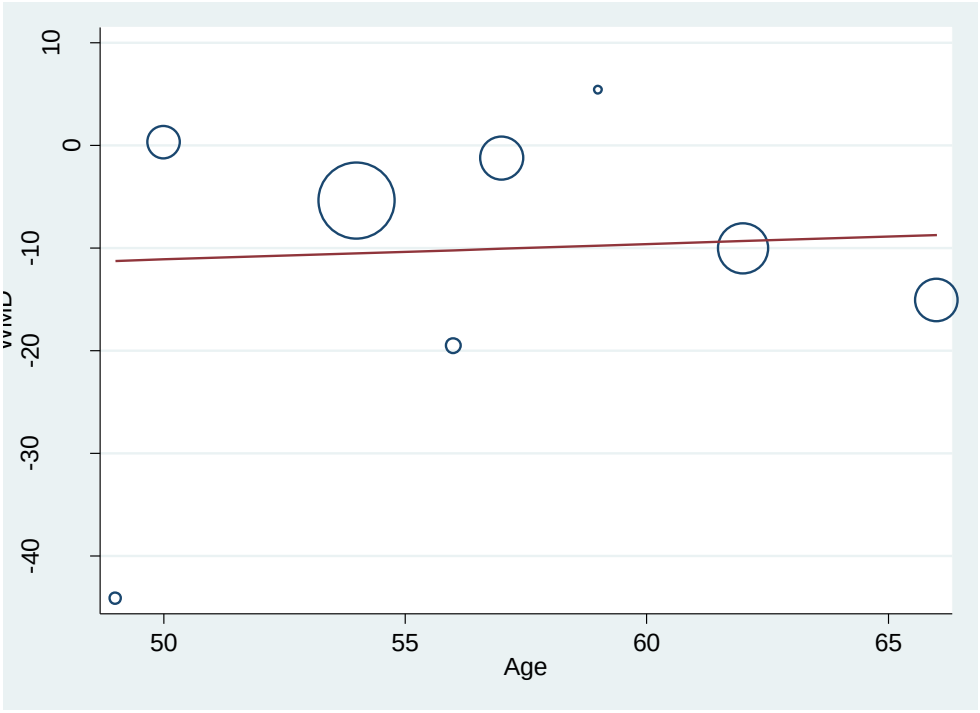
Variables	Region by continent	
	North America	Eurasian continents
FBS		
Number of studies	3	5
Weighted mean difference (WMD)	−0.54	−13.59
95% CI	−5.25, 4.17	−20.65, −6.53
p-heterogeneity	0.88	0.01
HbA1C		
Number of studies	5	3
Weighted mean difference (WMD)	−0.31	−0.59
95% CI	−0.59, 0.04	−0.85, -0.33
p-heterogeneity	0.01	0.01
Weight		
Number of studies	3	4
Weighted mean difference (WMD)	−0.92	−1.98
95% CI	−2.01, 0.17	−3.20, −0.75
p-heterogeneity	0.04	0.01

Supplemental Fig 1. Flow chart of included studies.

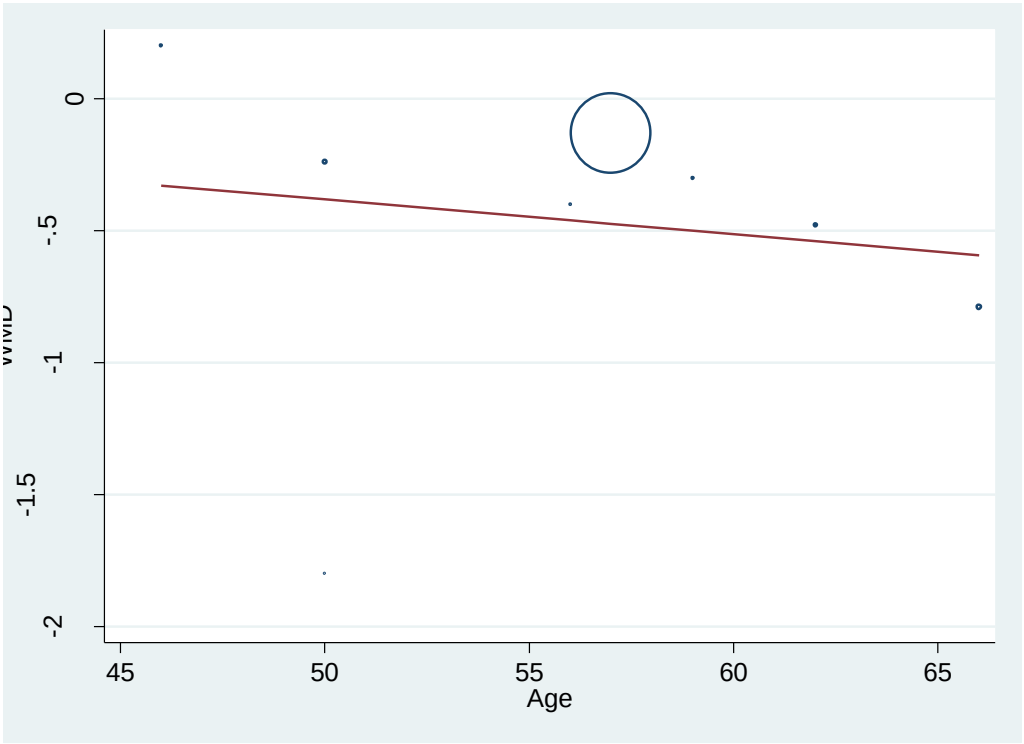


Supplemental Fig 2. Meta regression based on age on:

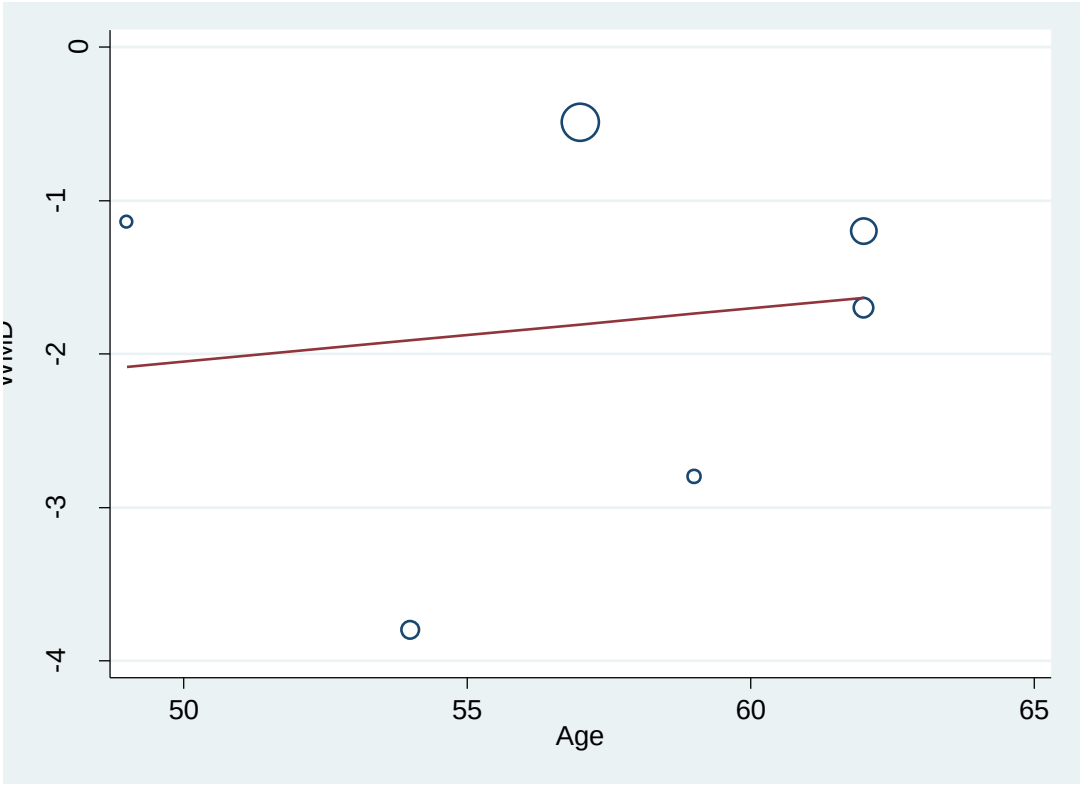
a) Fasting Blood Sugar



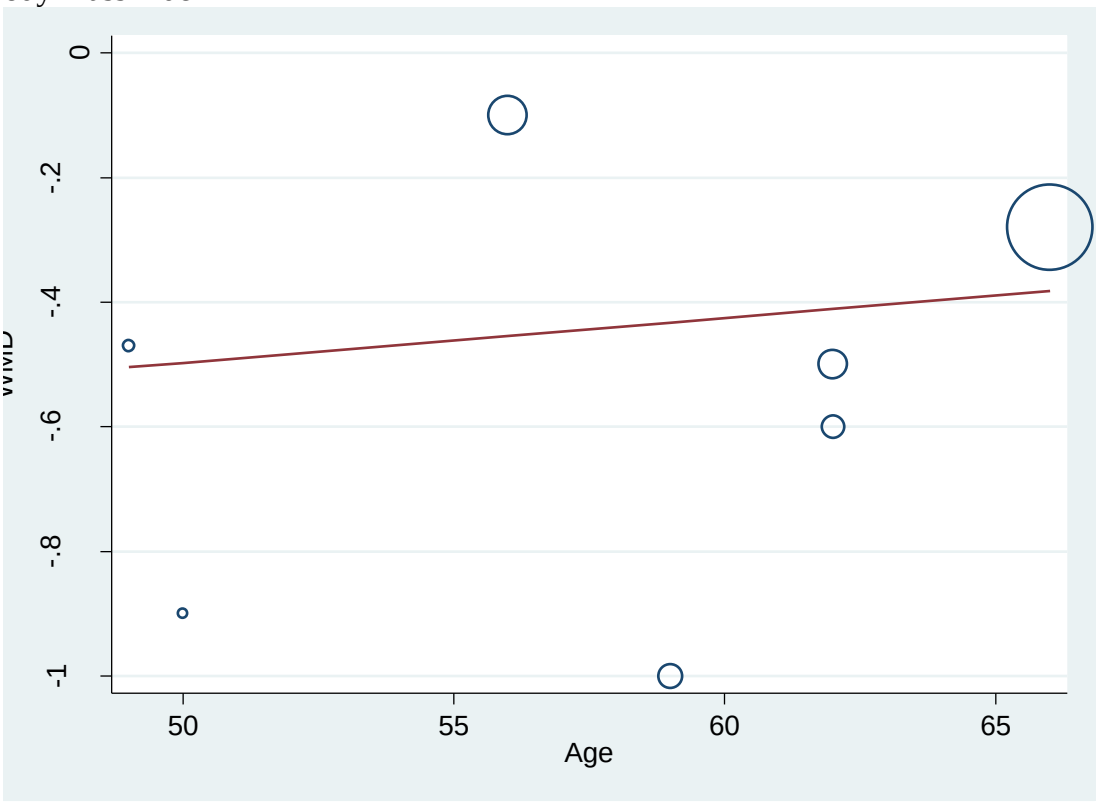
b) HbA1C



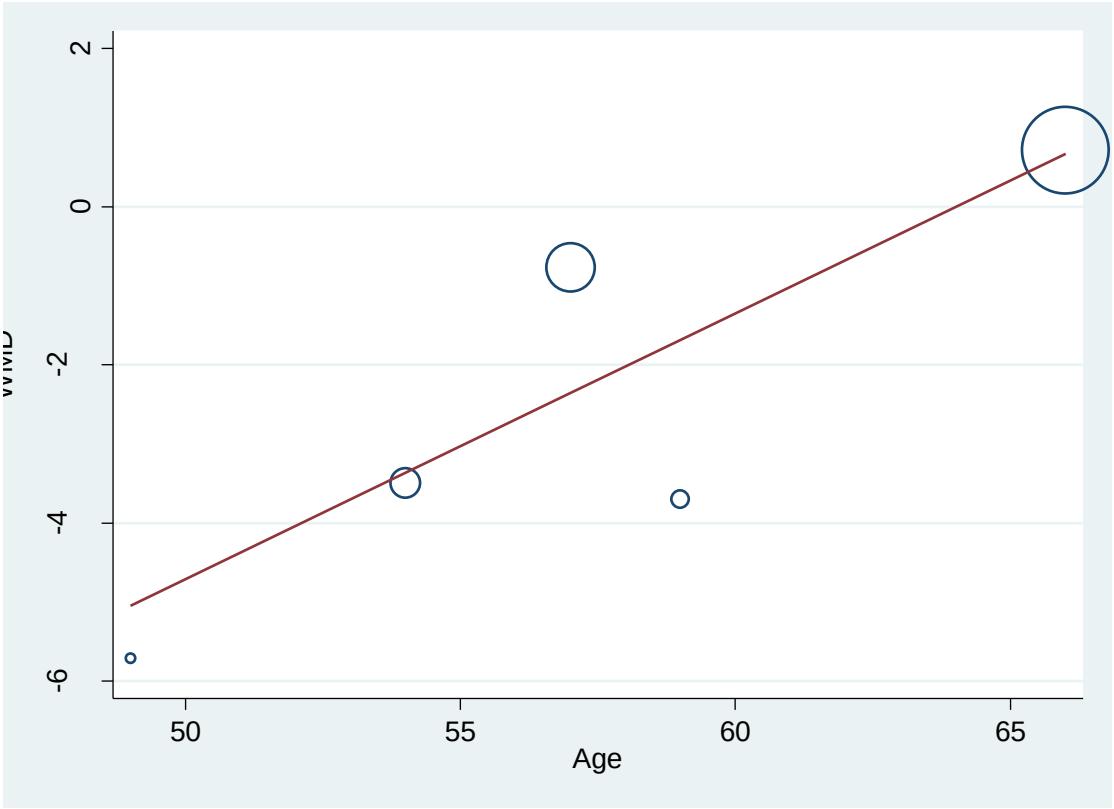
c) Weight



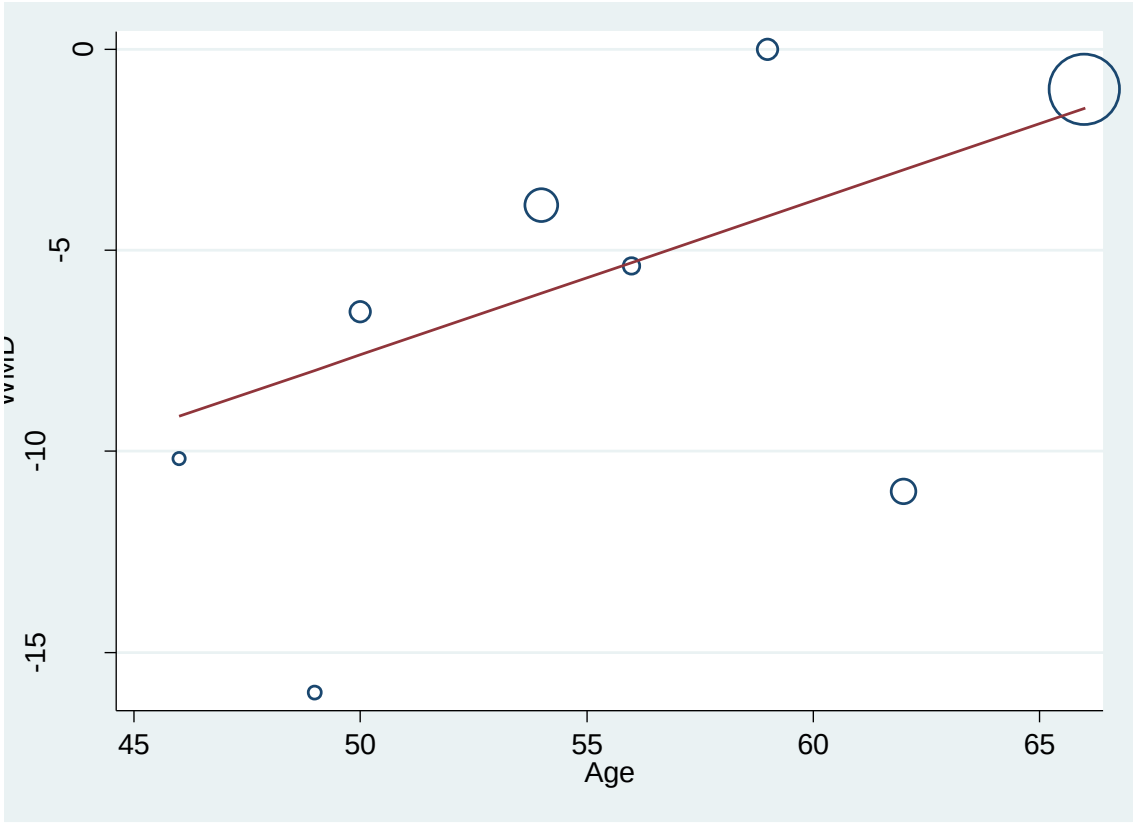
d) Body Mass Index



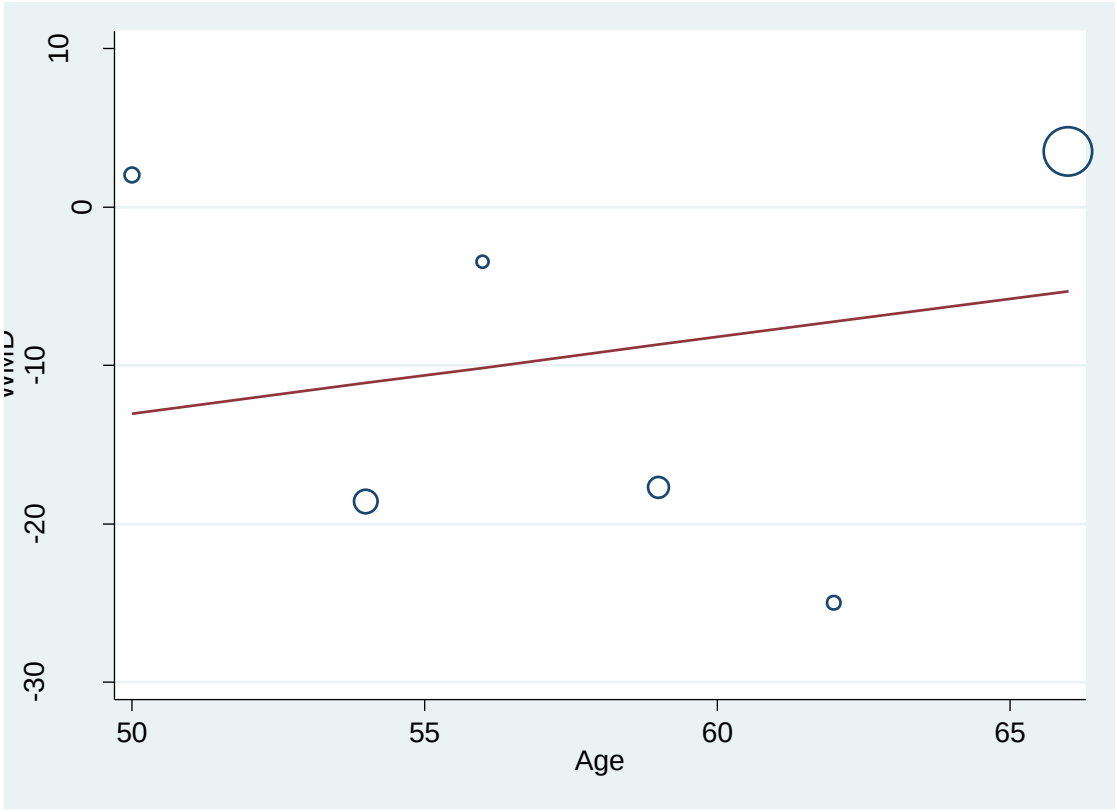
e) Waist circumstance



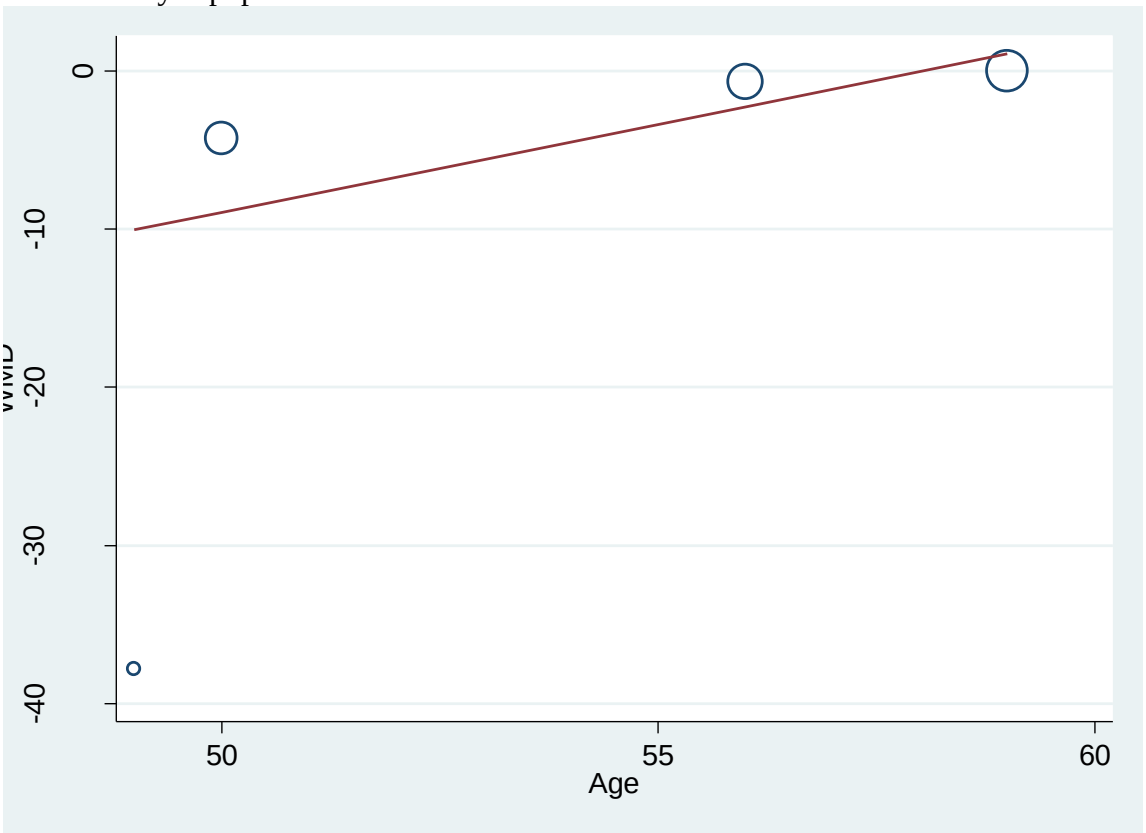
f) Cholesterol



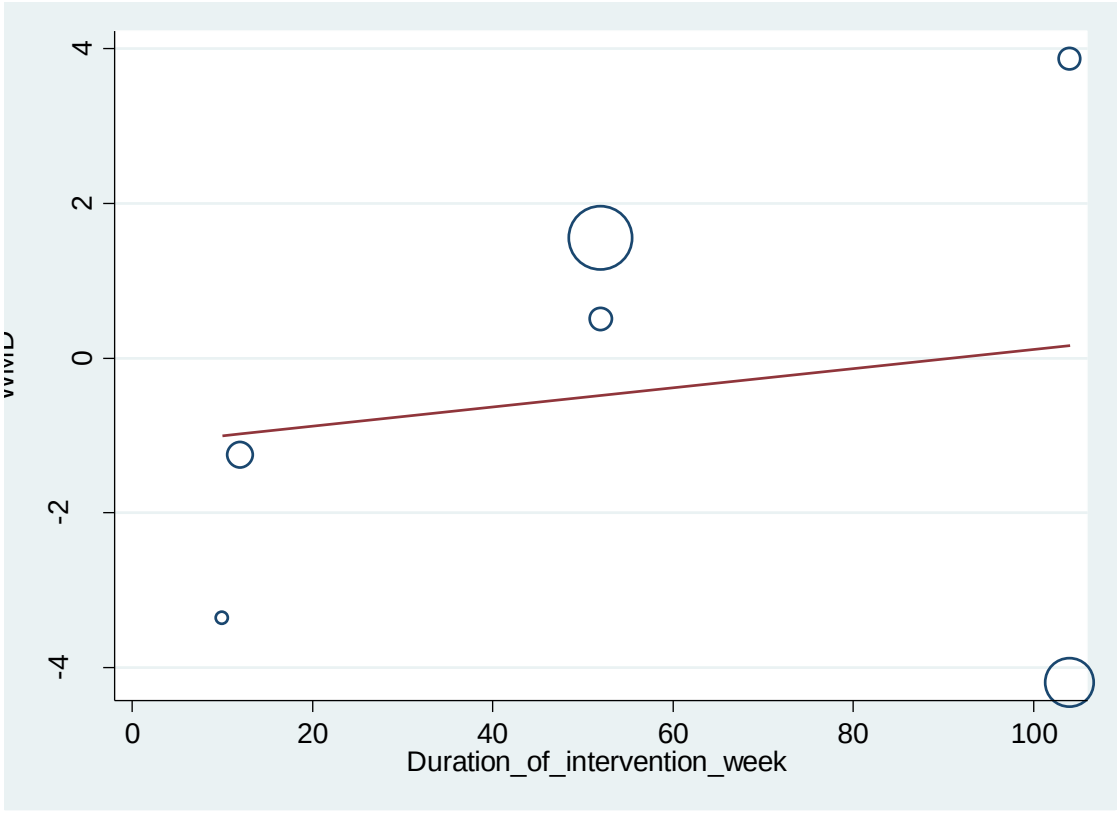
g) T G



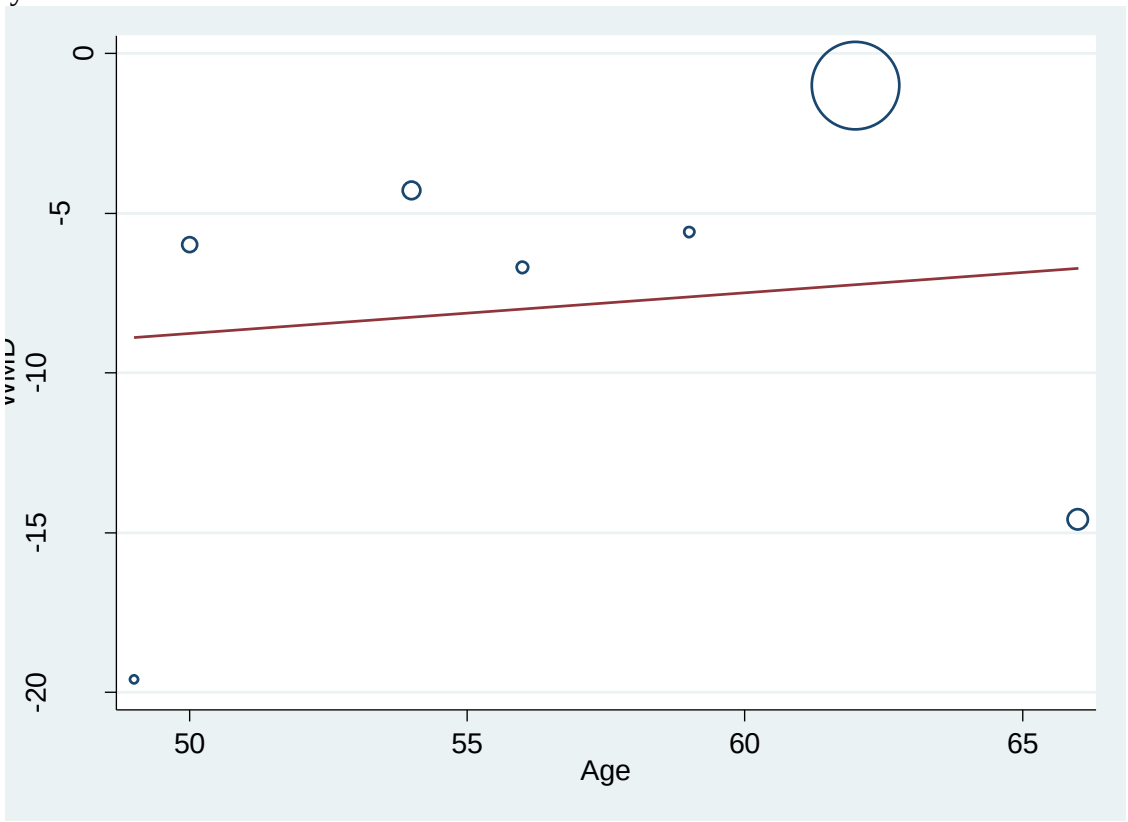
h) Low Density Lipoprotein



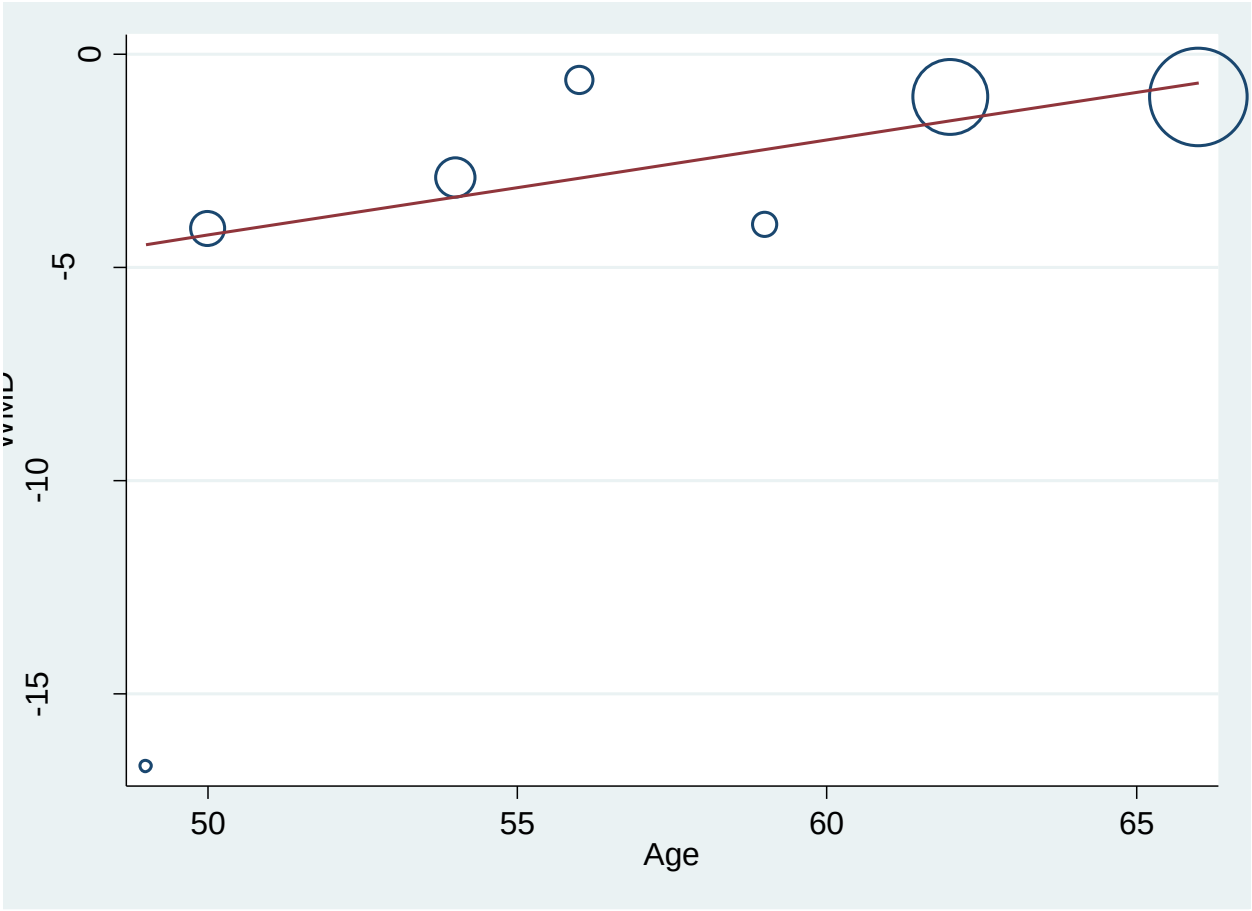
i)High Density Lipoprotein



j) Systolic Blood Pressure

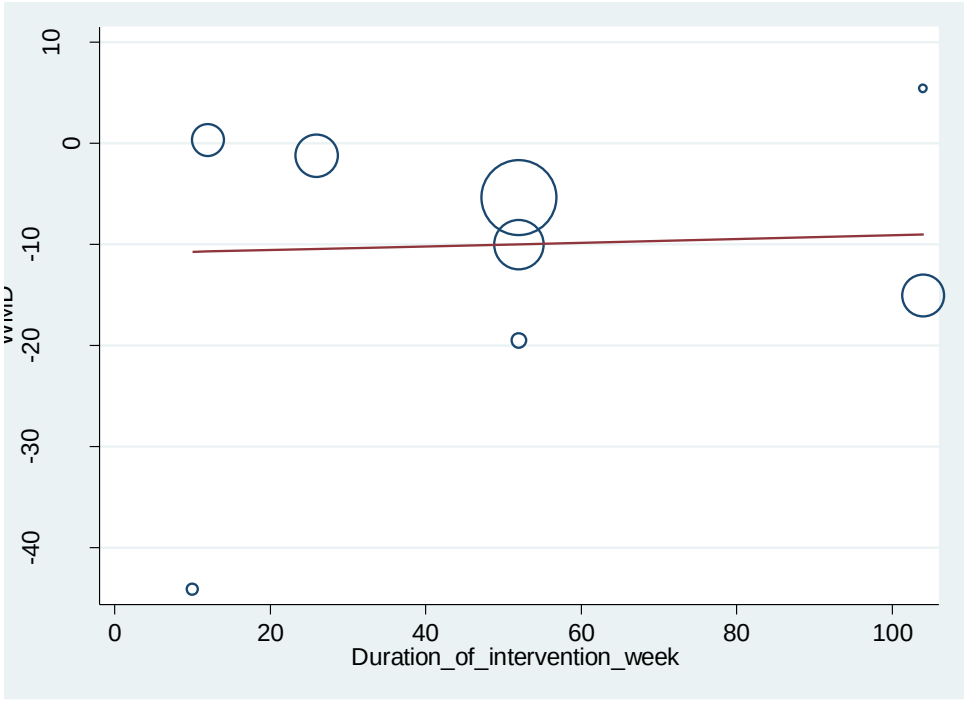


k) Diastolic Blood Pressure

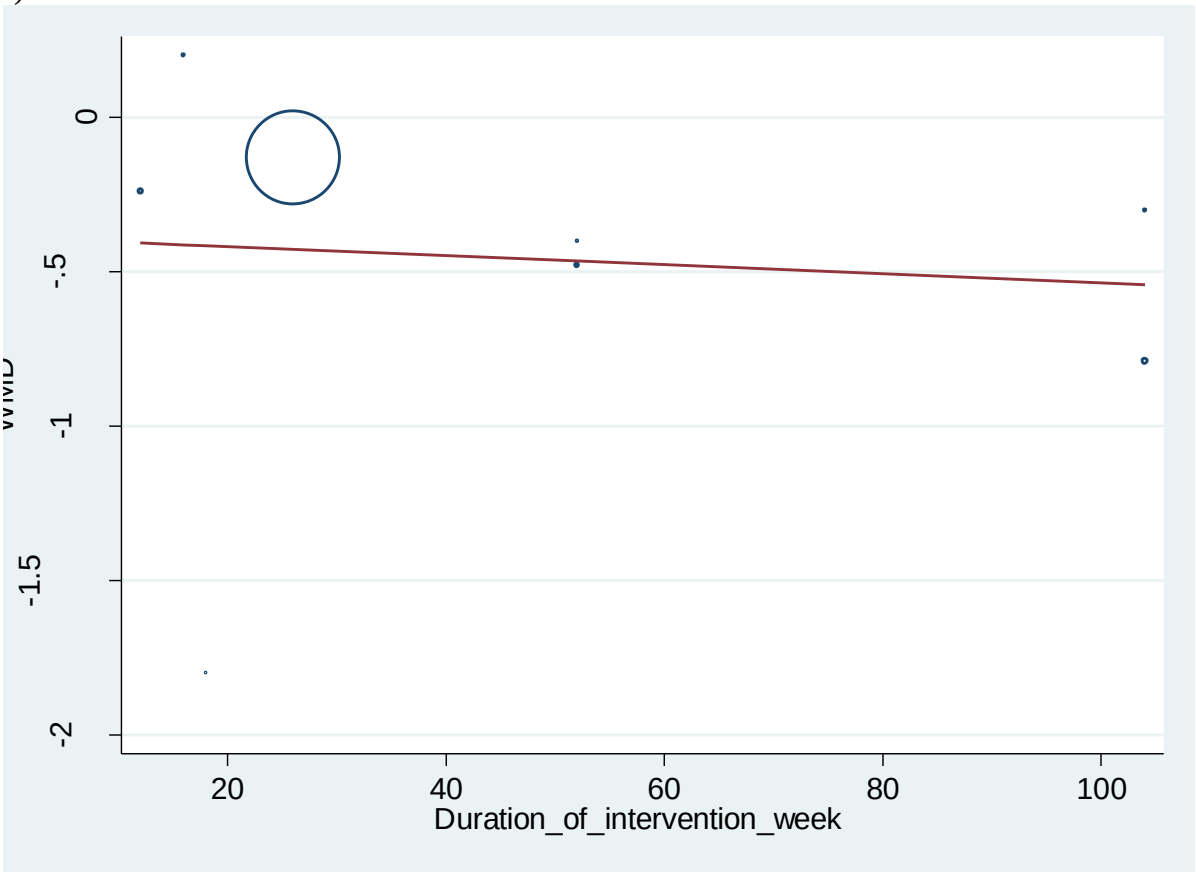


Supplemental Fig 3. Meta regression based on follow-up duration:

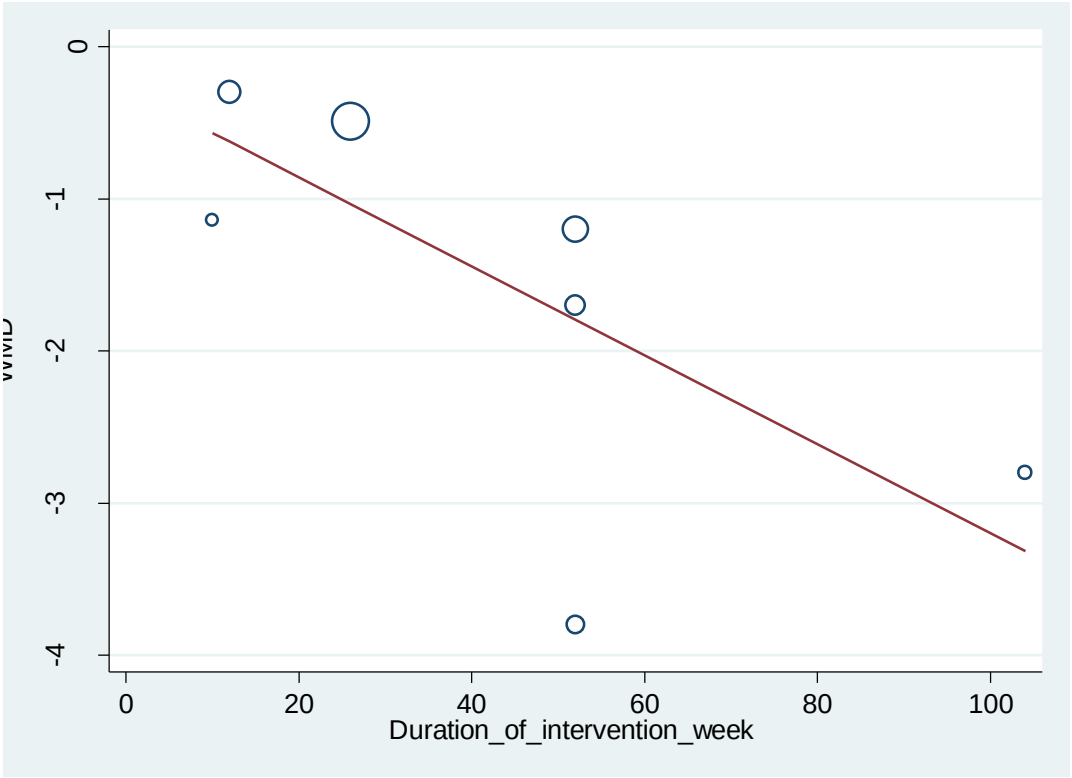
a) Fasting Blood Sugar



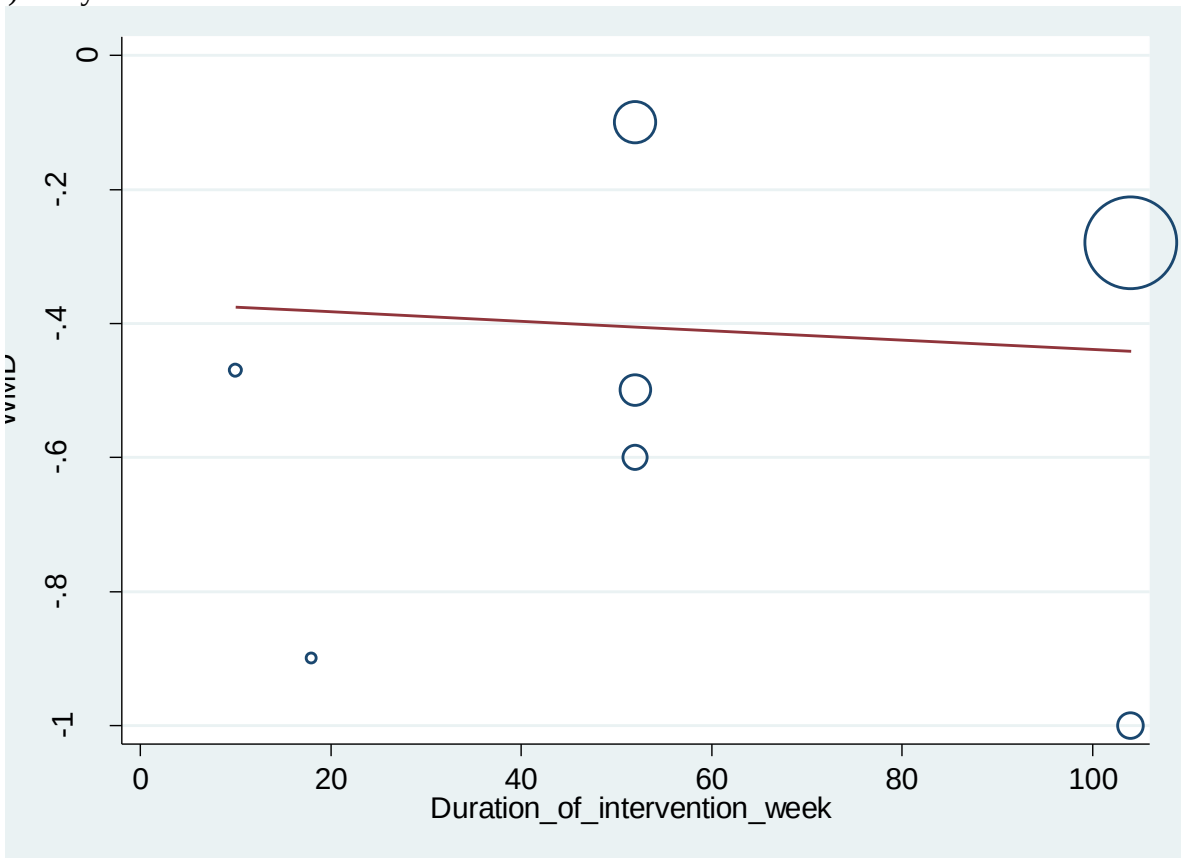
b) HbA1C



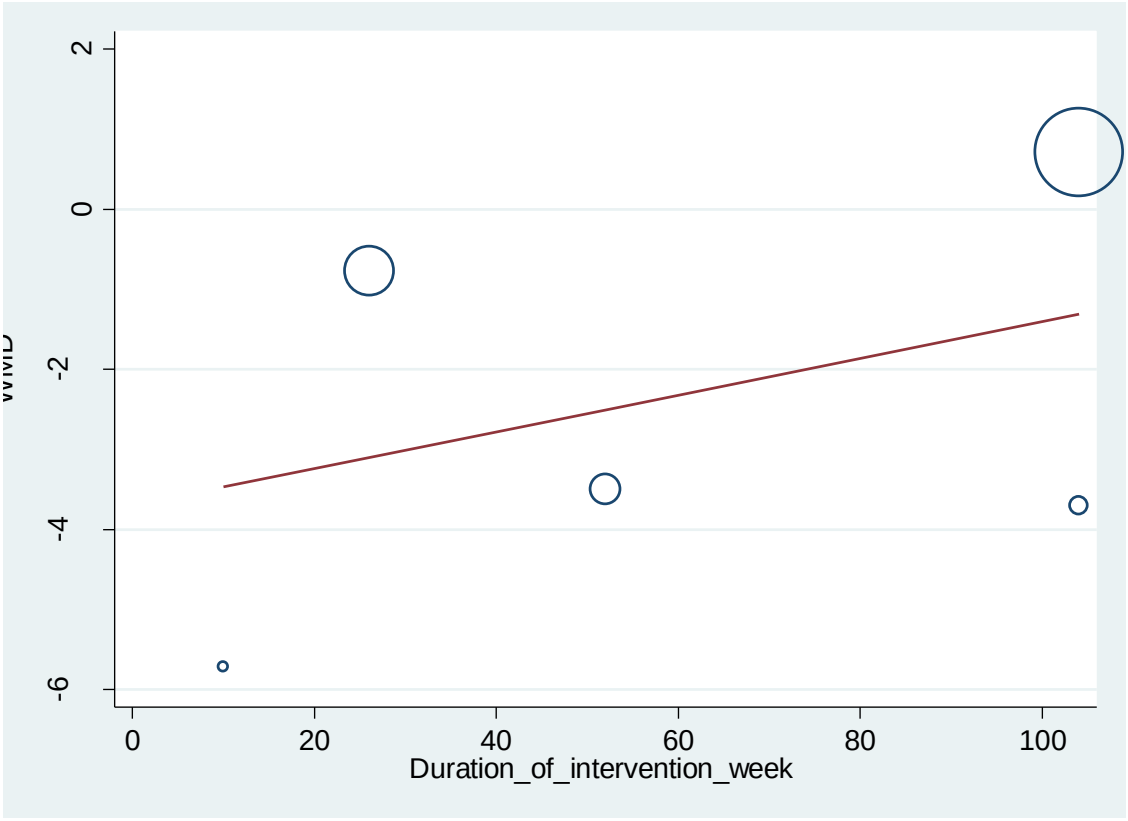
c) Weight



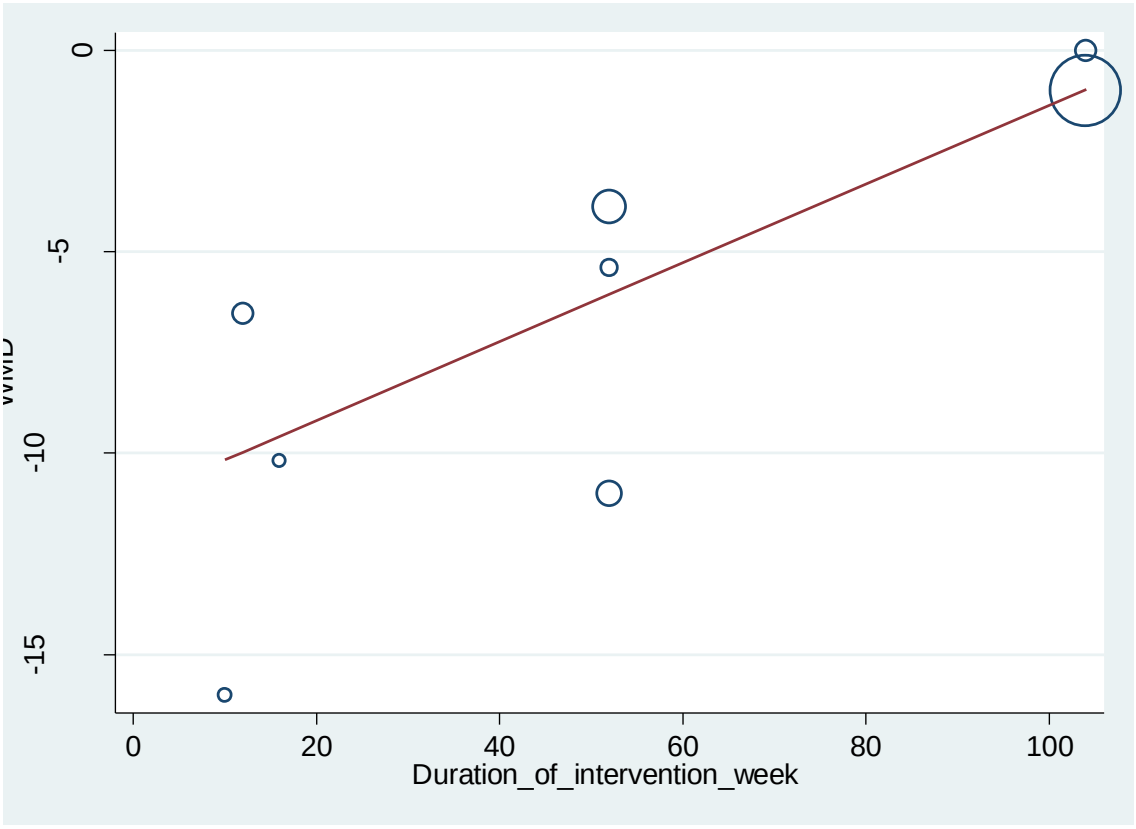
d) Body Mass Index



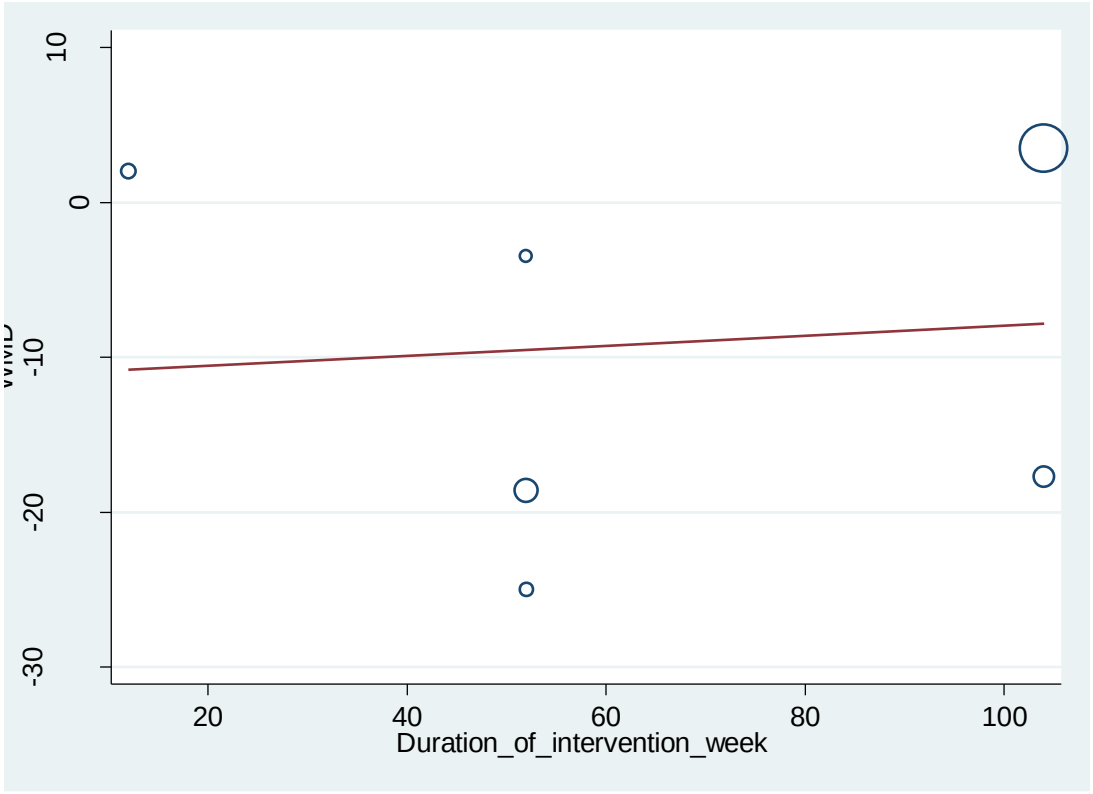
e) Waist circumstance



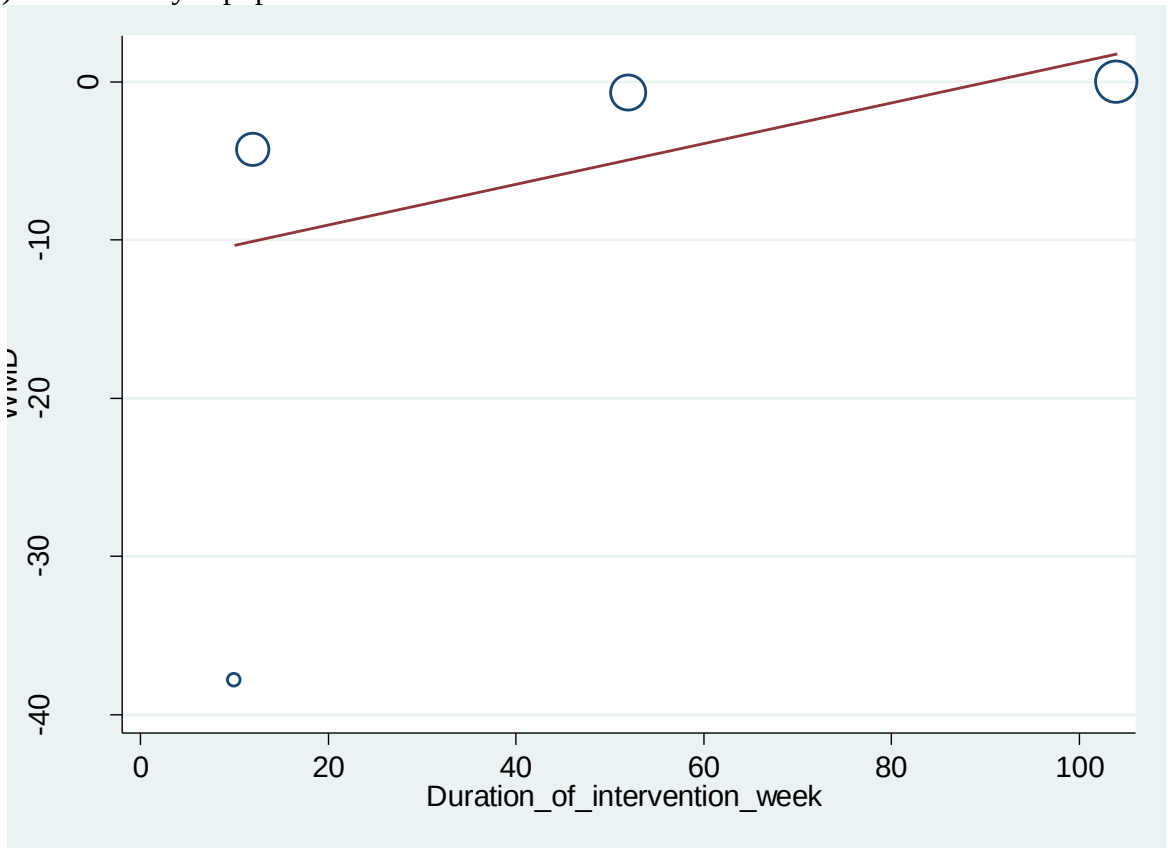
f) Cholesterol



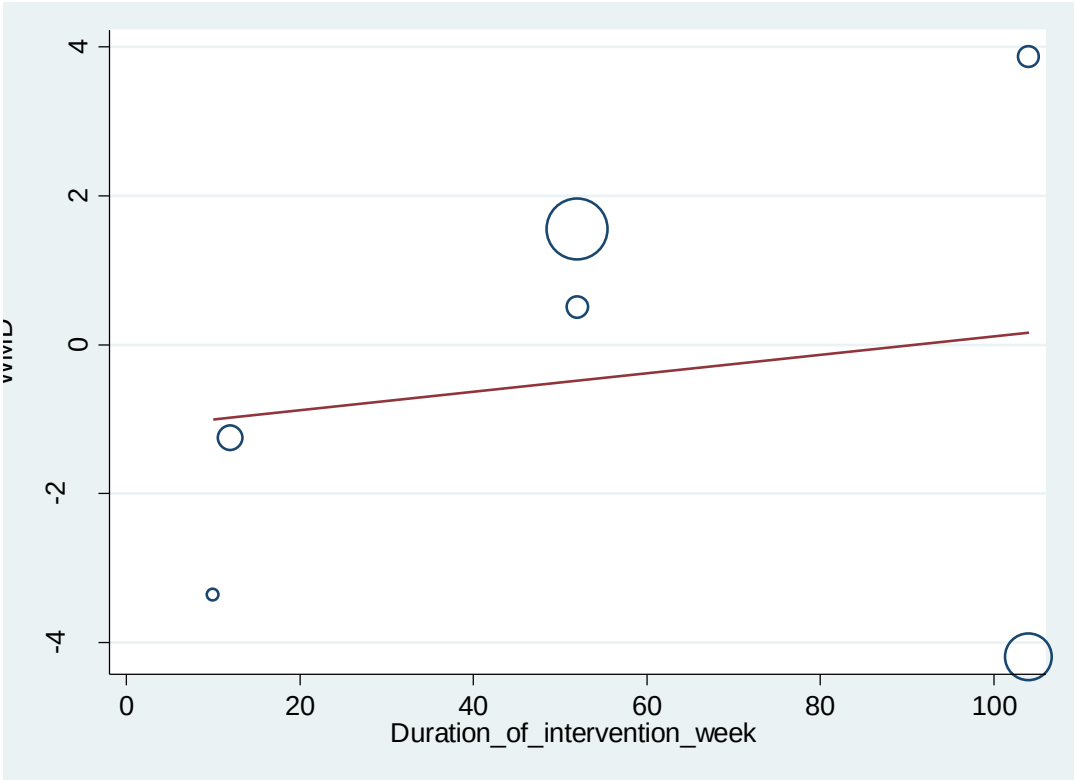
g) Triglyceride



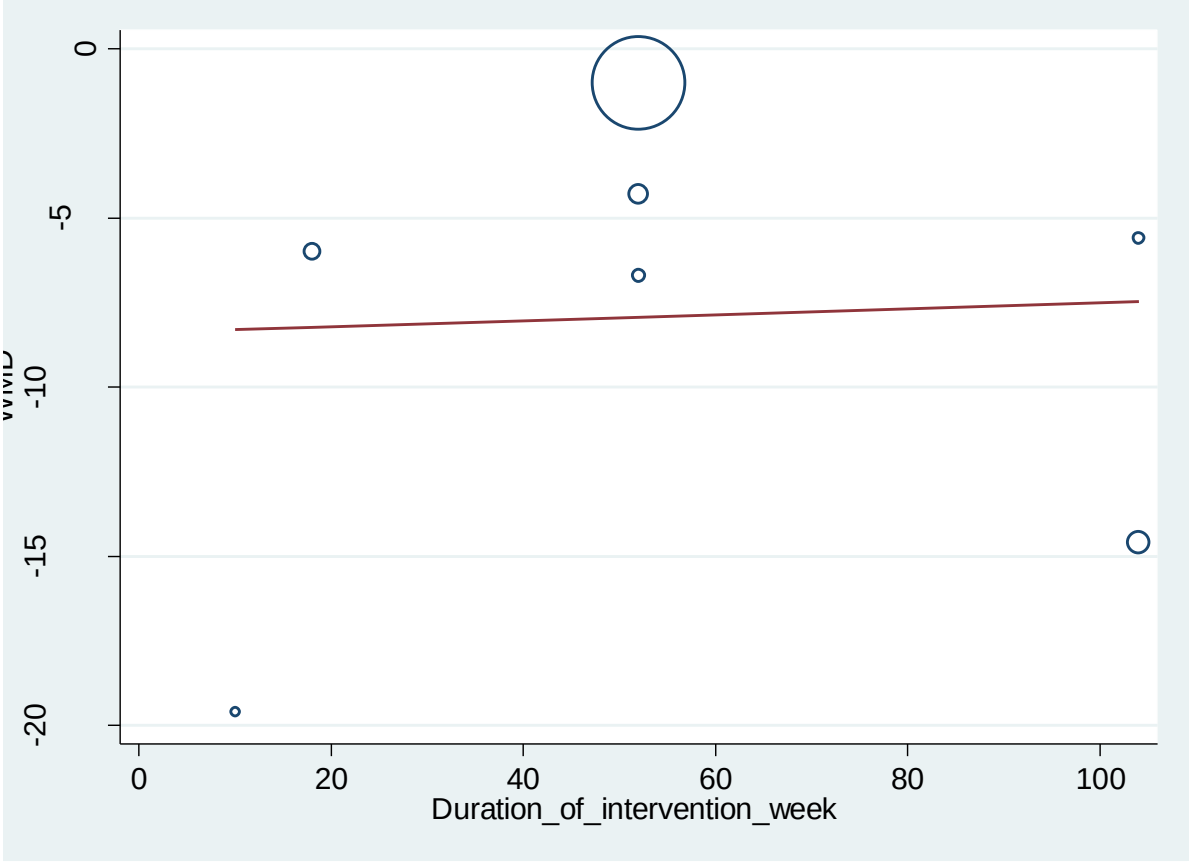
h) Low Density Lipoprotein



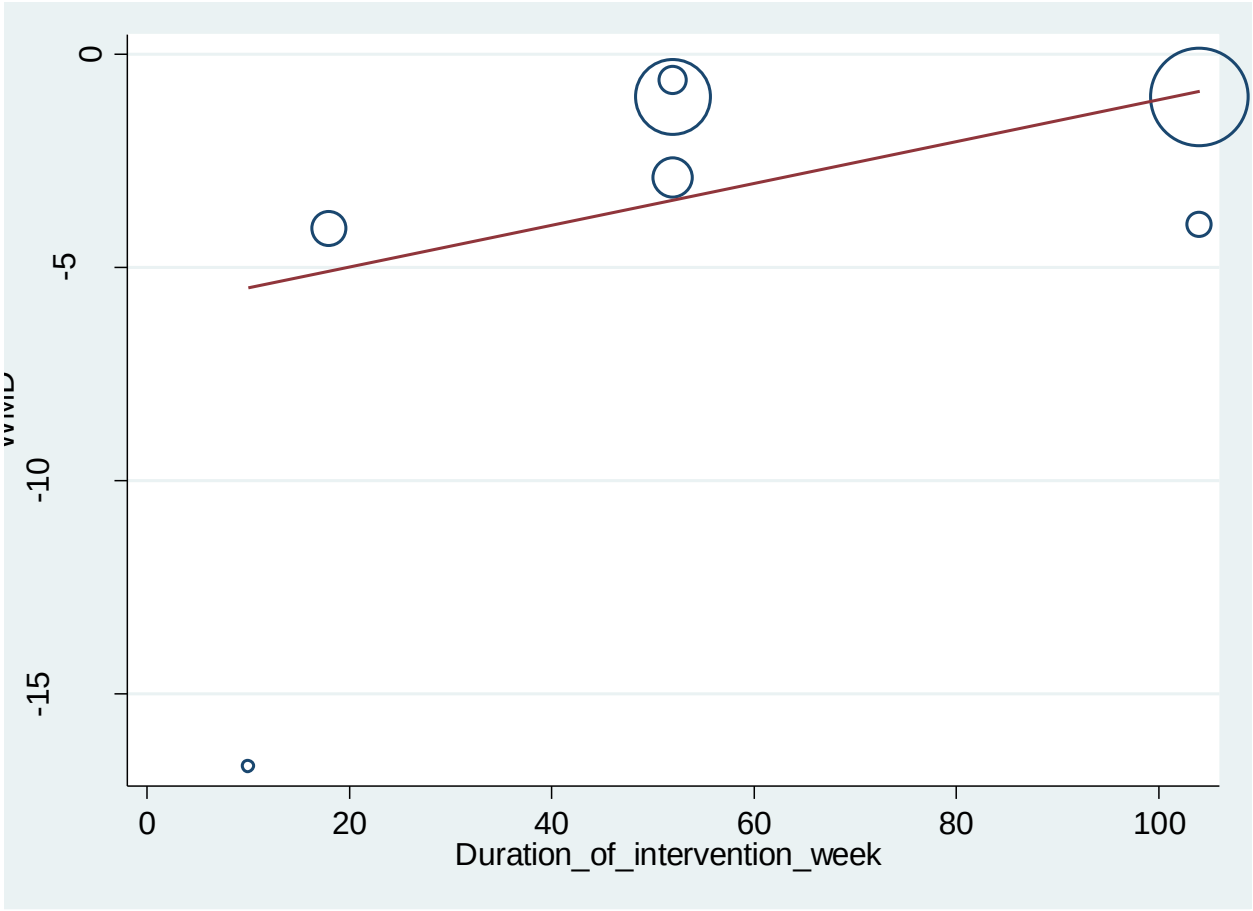
i) High Density Lipoprotein



j) Systolic Blood Pressure

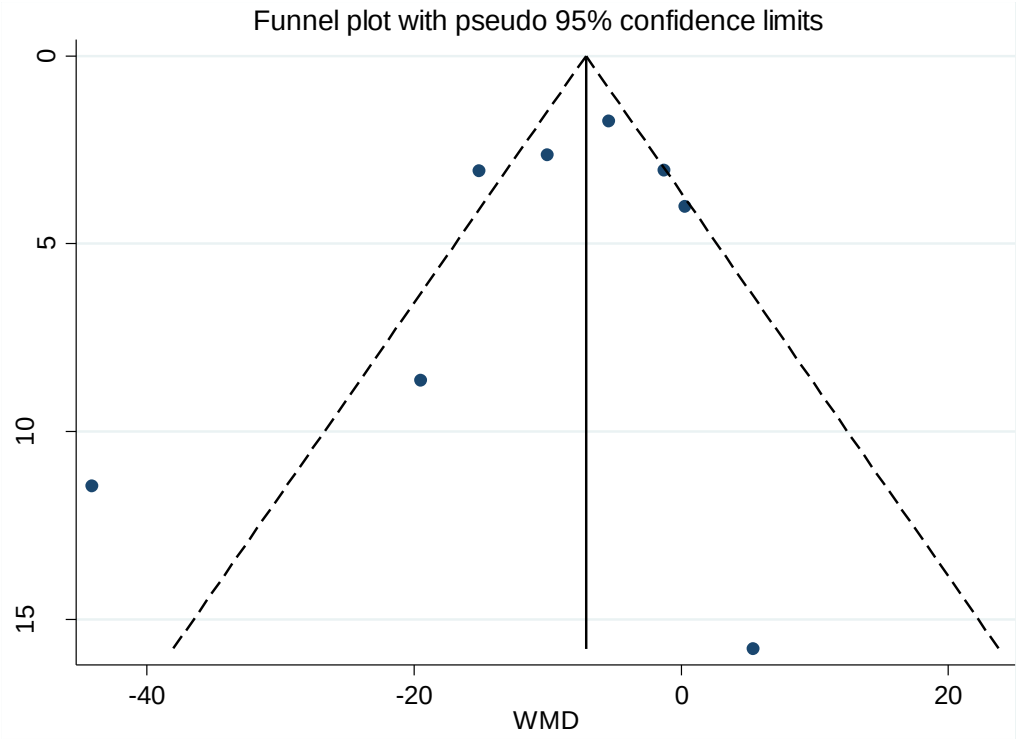


k) Diastolic Blood Pressure

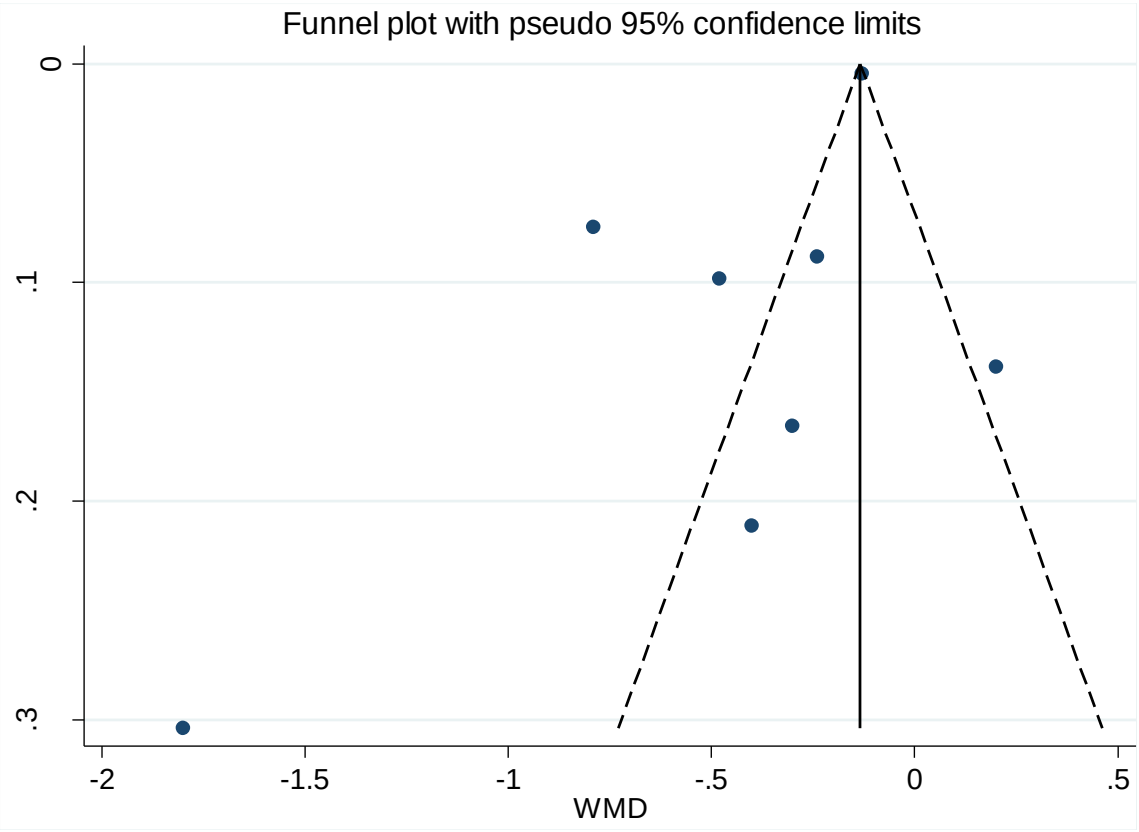


Supplemental Figures 4: Funnel plot to assess publication bias.

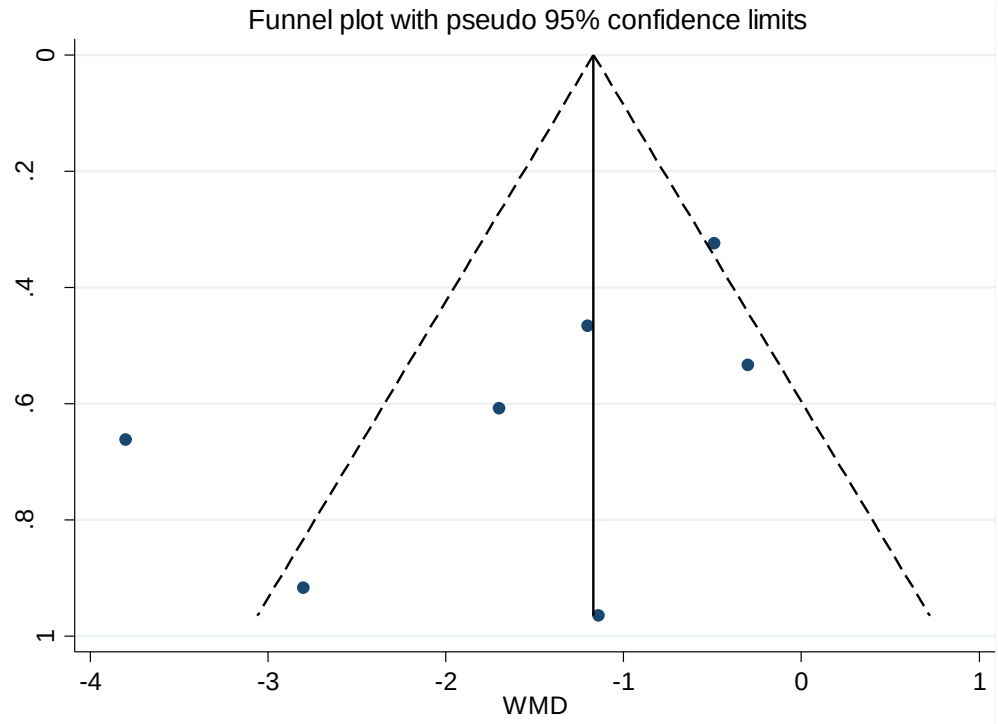
a) Fasting Blood Sugar



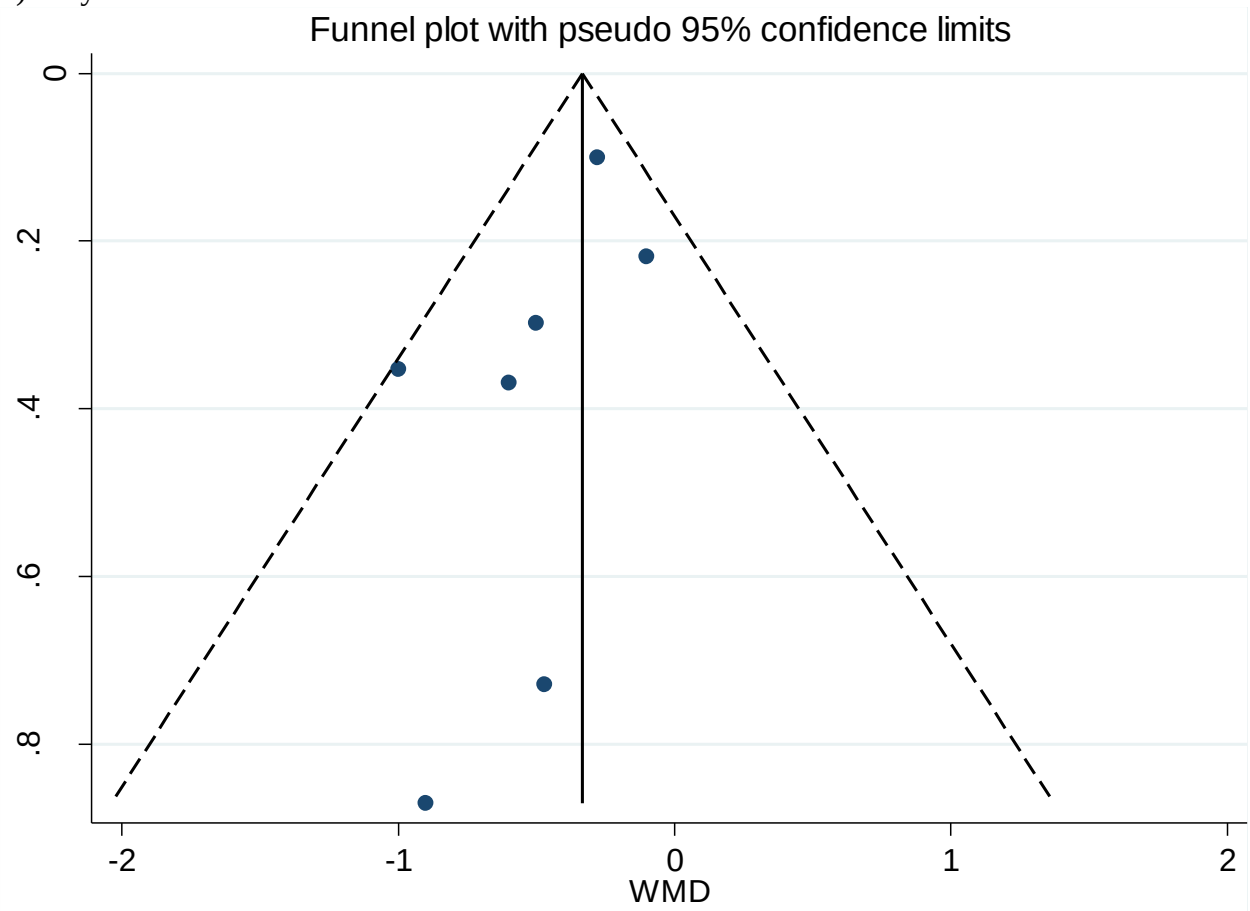
b) HbA1C



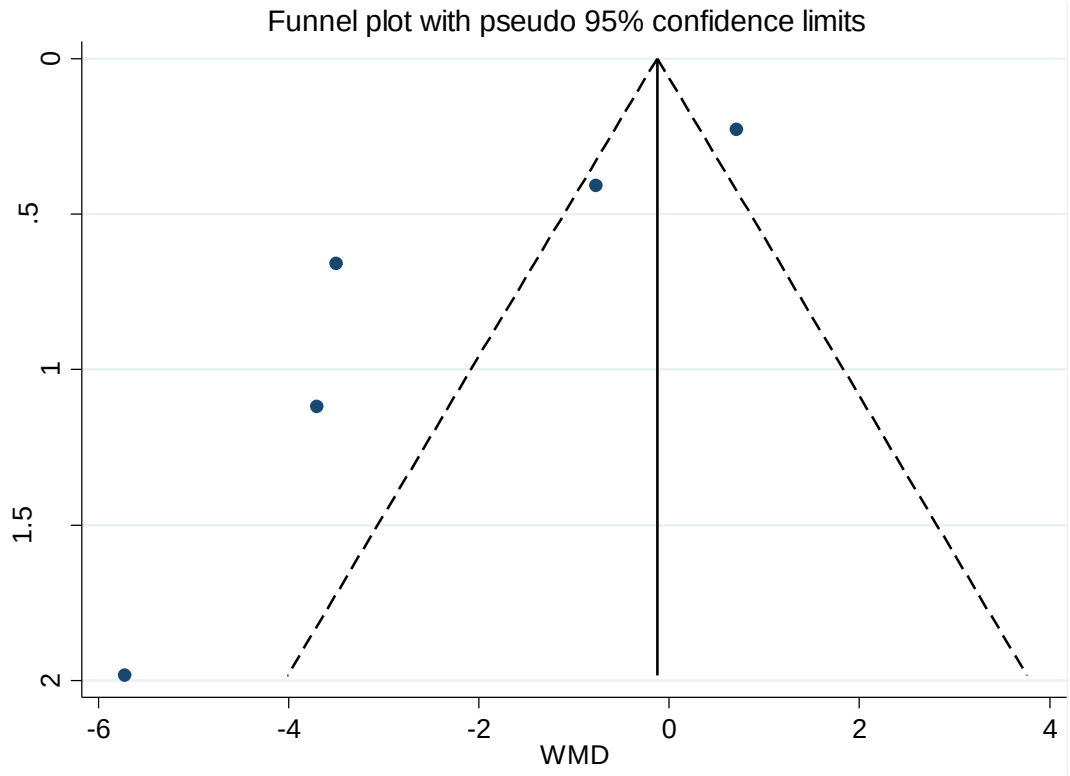
c)Weight



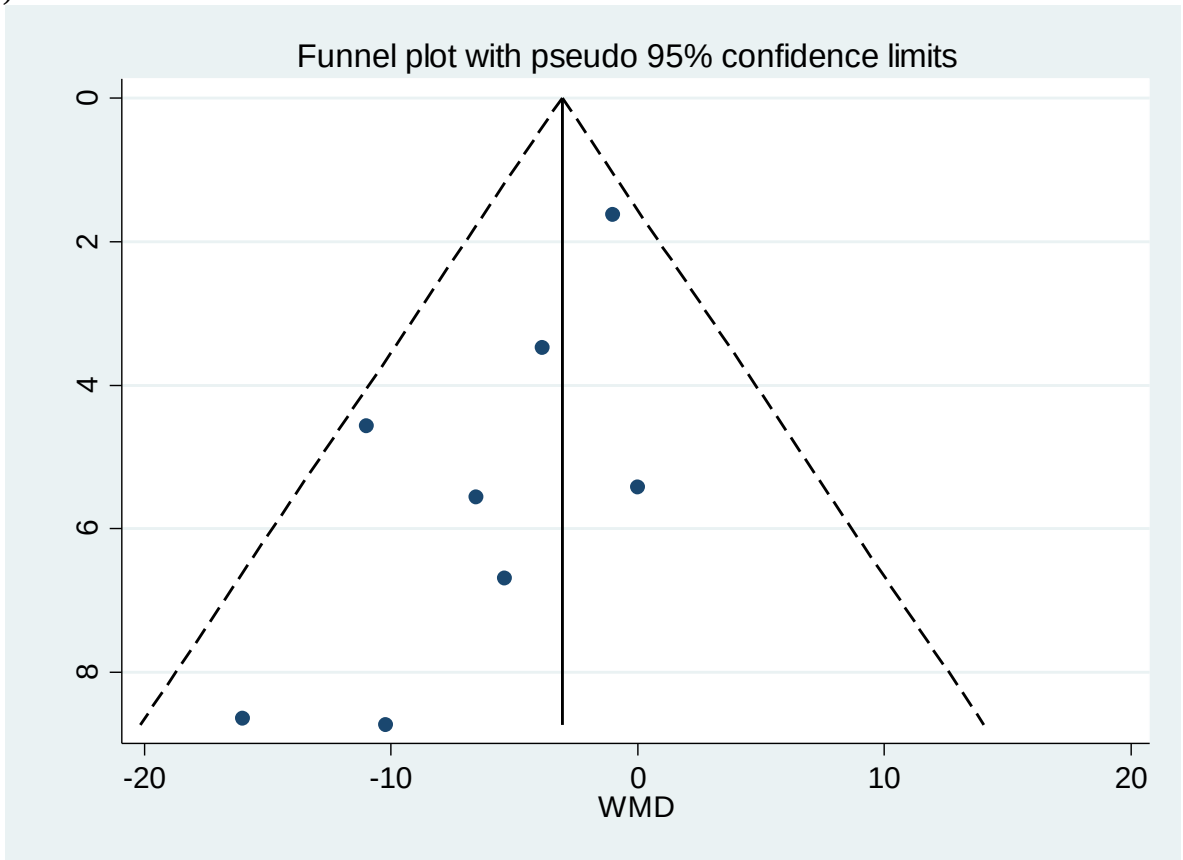
d)Body Mass Index



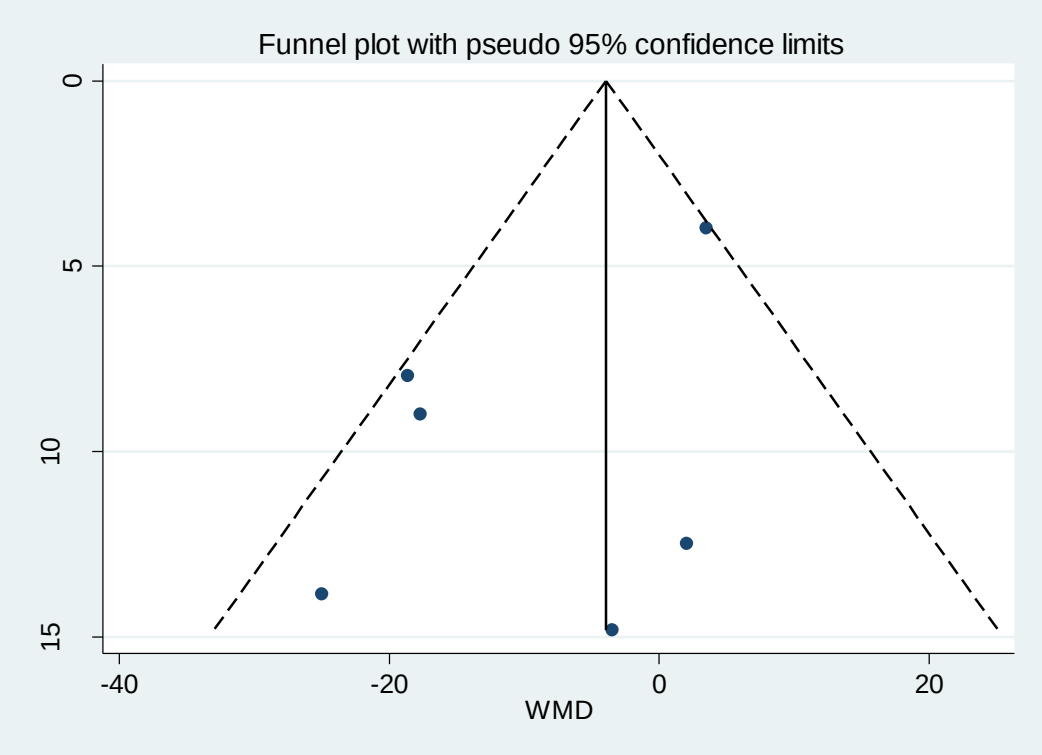
e) Waist circumstance



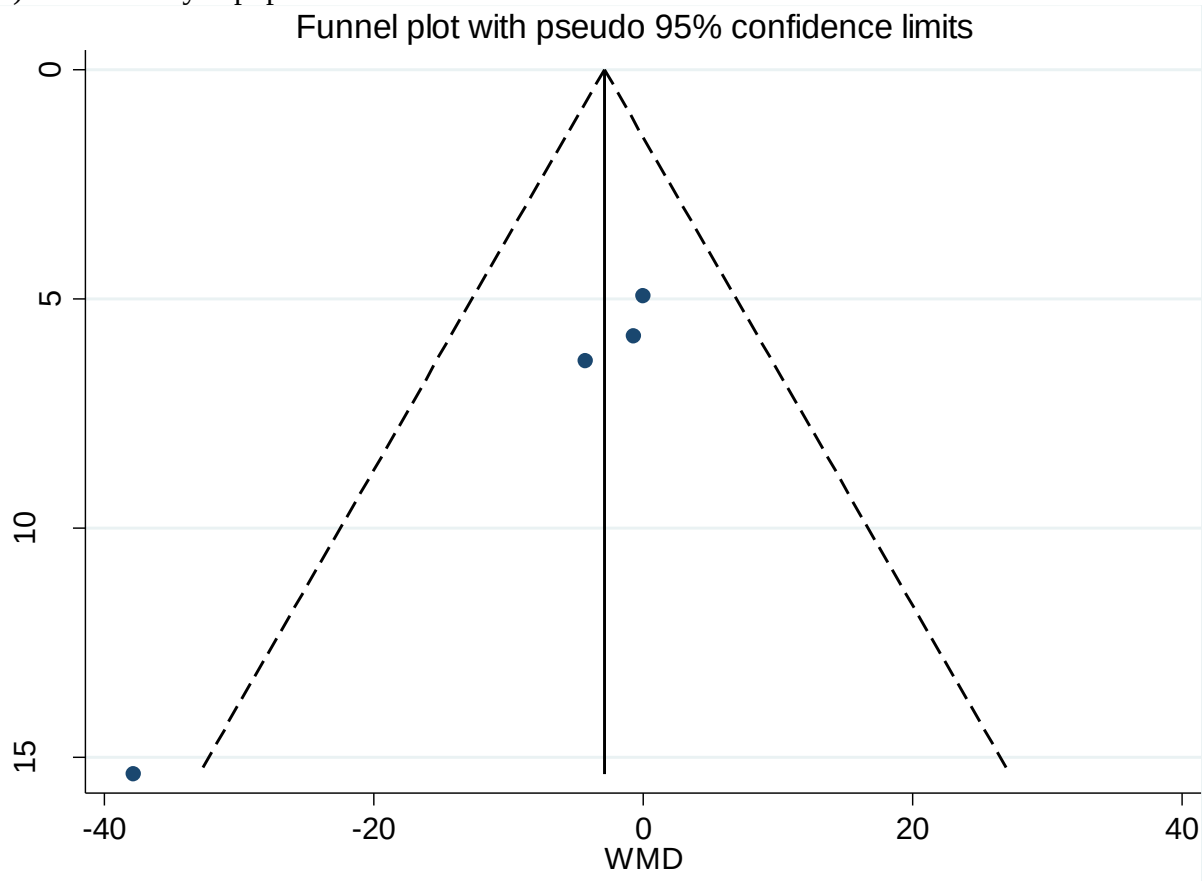
f) Cholesterol



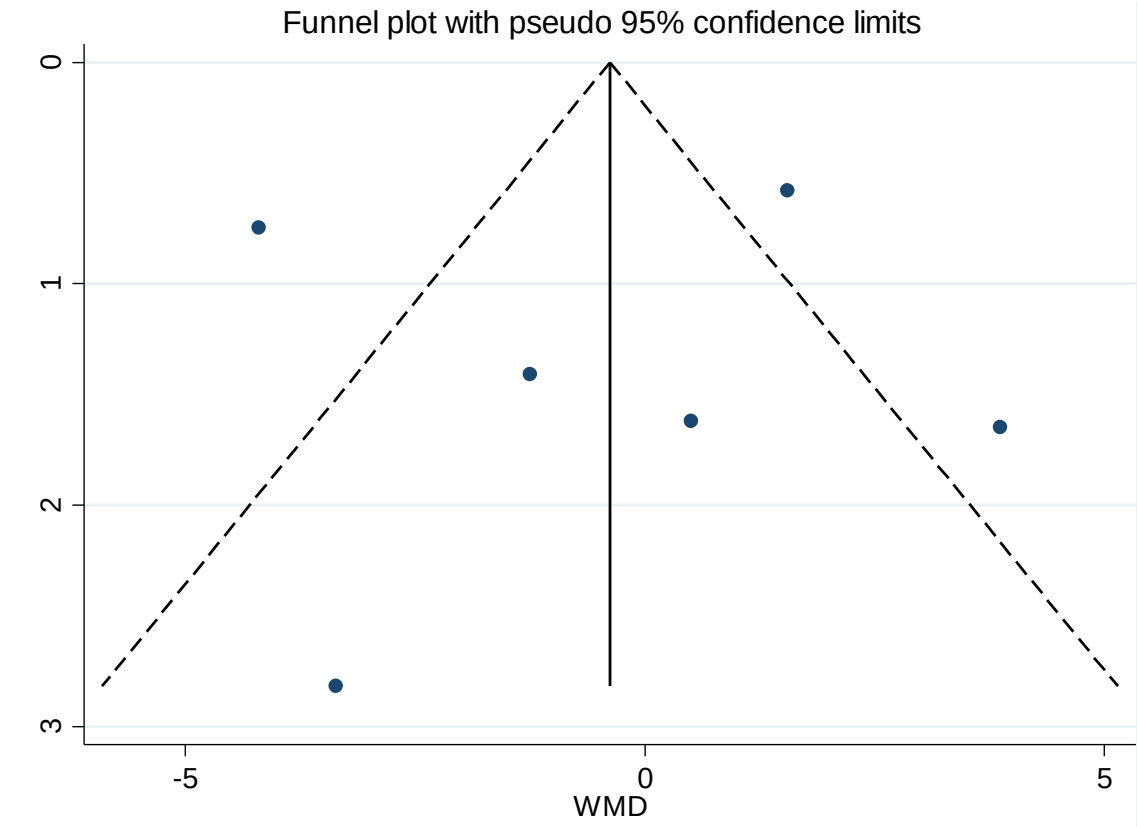
g) Triglyceride



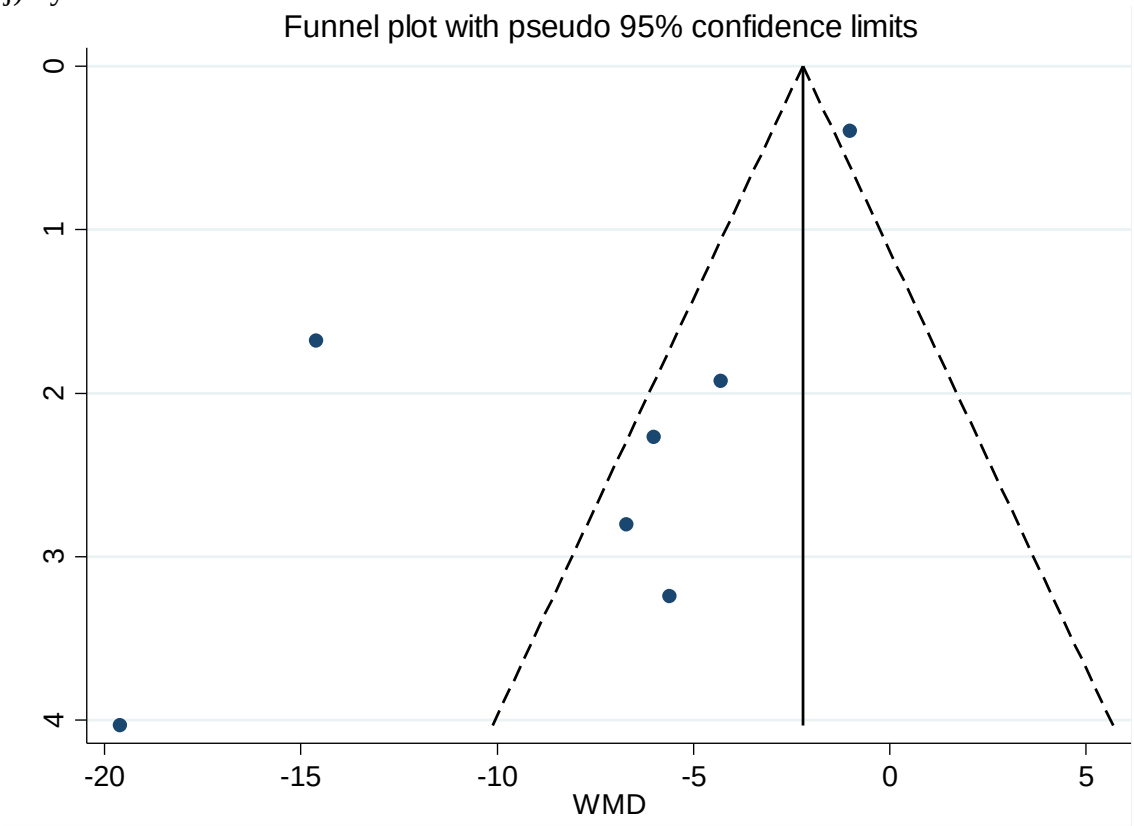
h) Low Density Lipoprotein



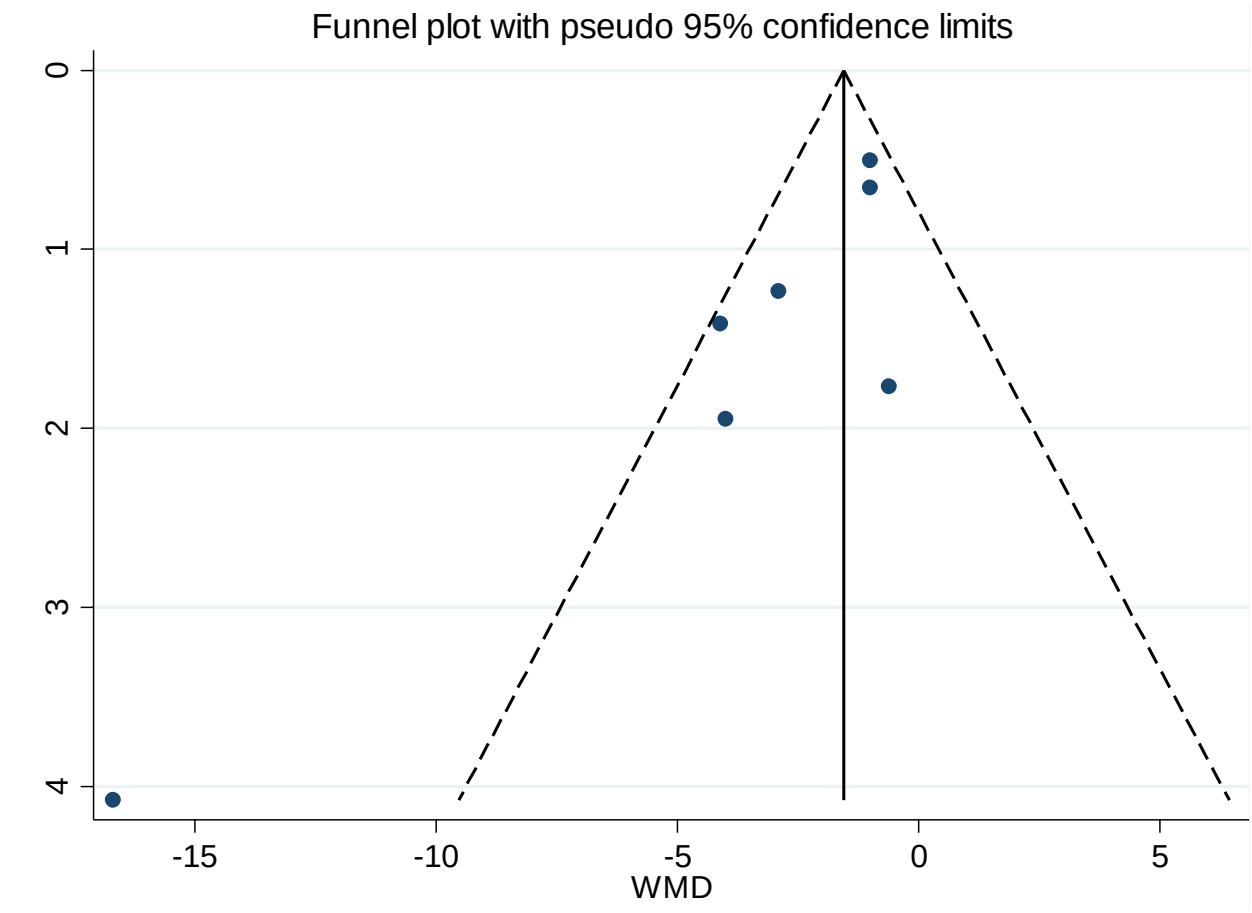
i)High Density Lipoprotein



j) Systolic Blood Pressure

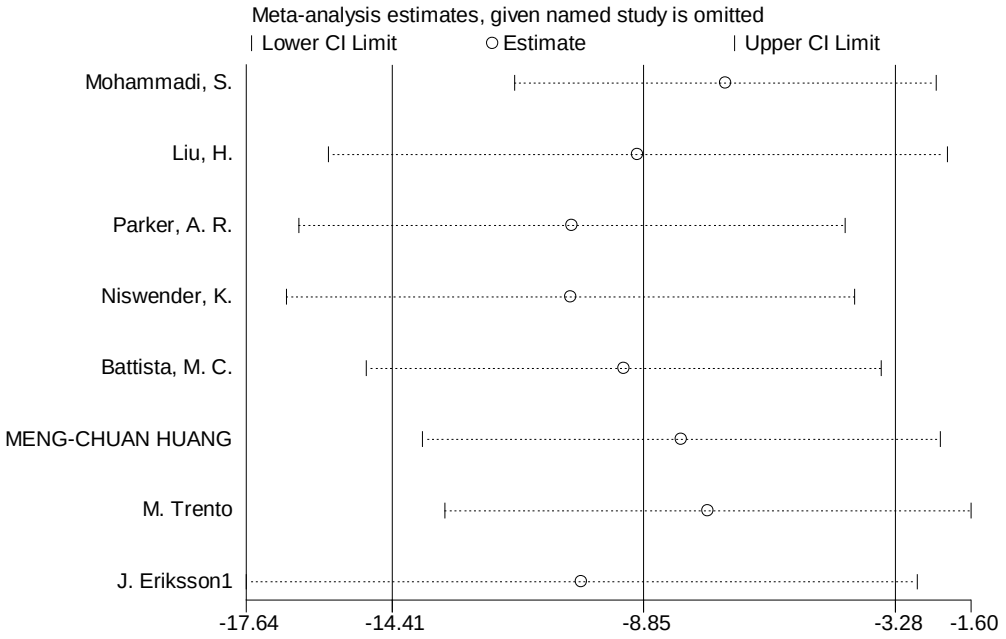


k) Diastolic Blood Pressure

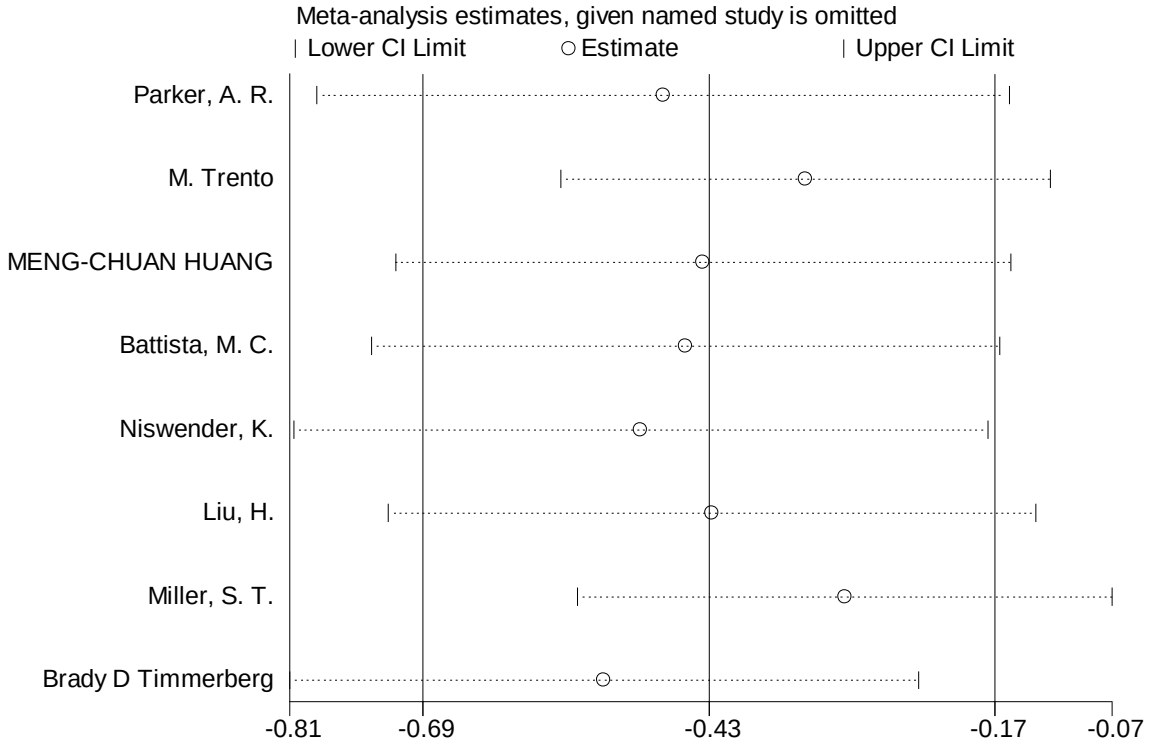


Supplemental Fig 5. Sensitivity analysis on:

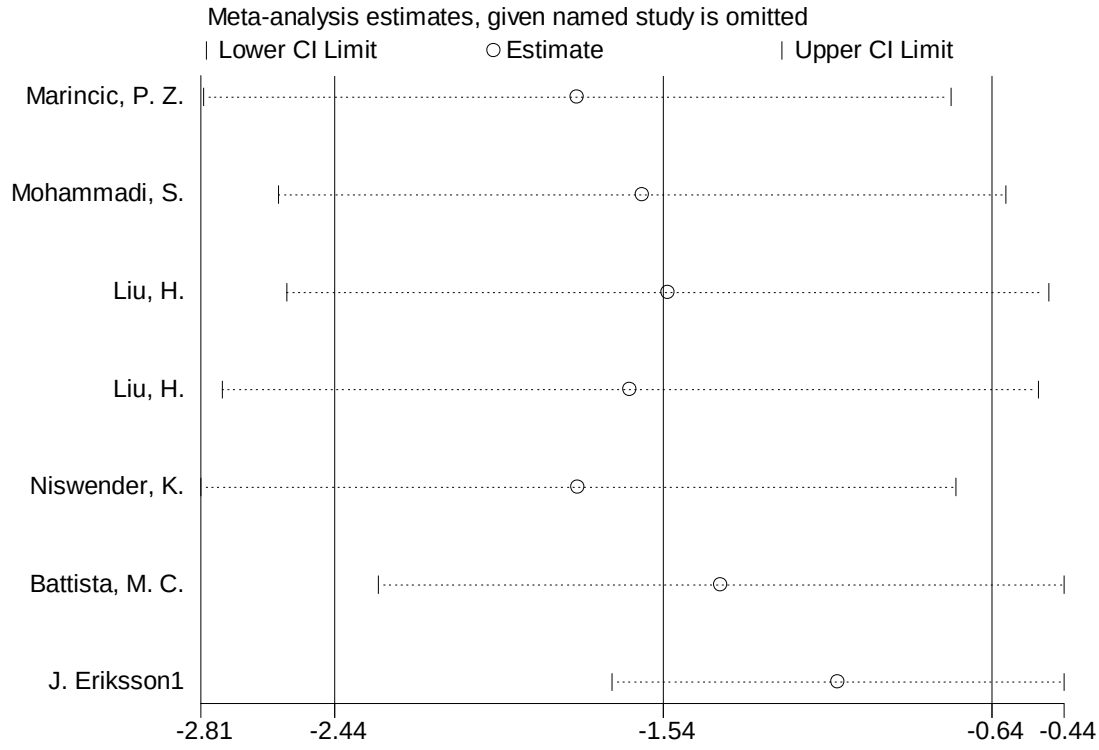
a) Fasting Blood Sugar



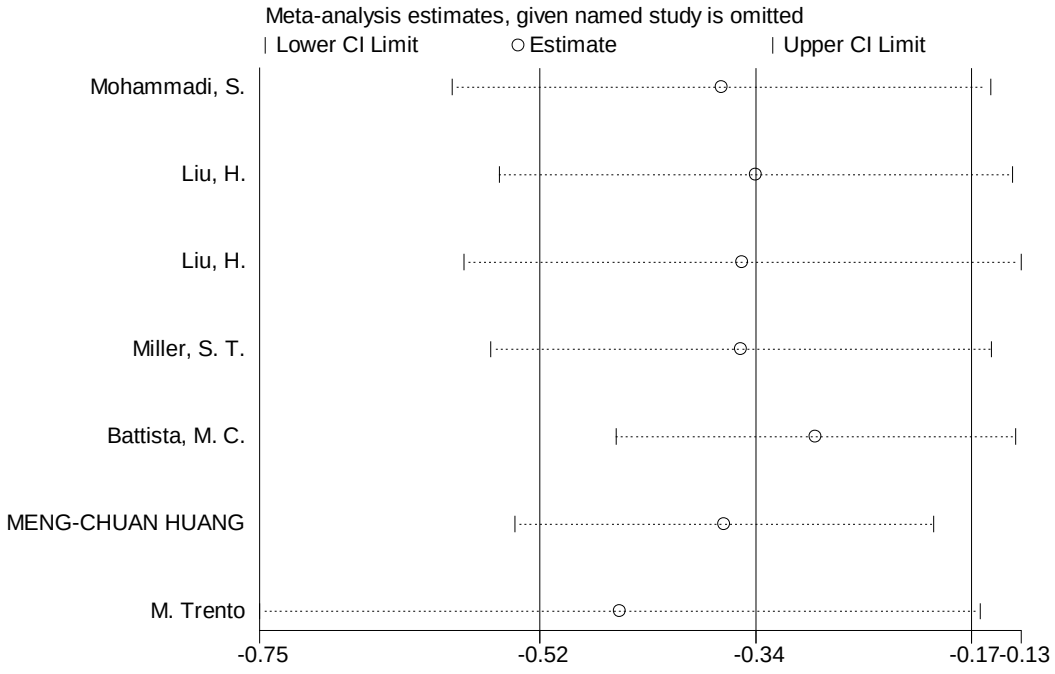
b) HA1C



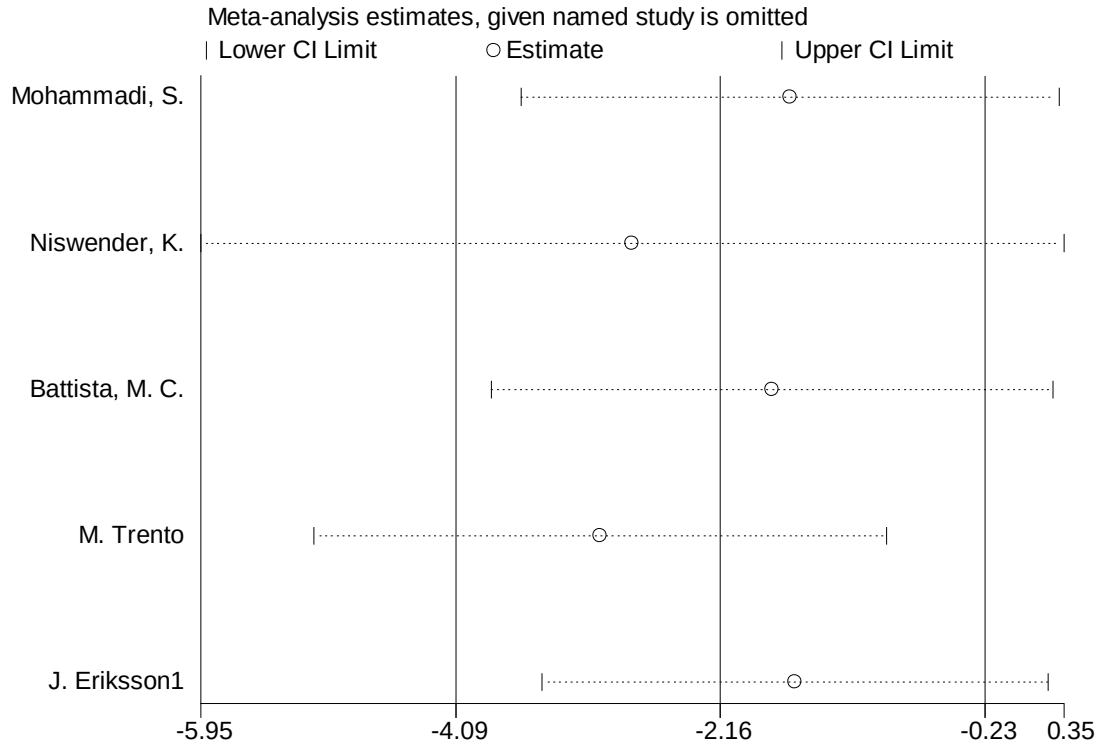
c) Weight



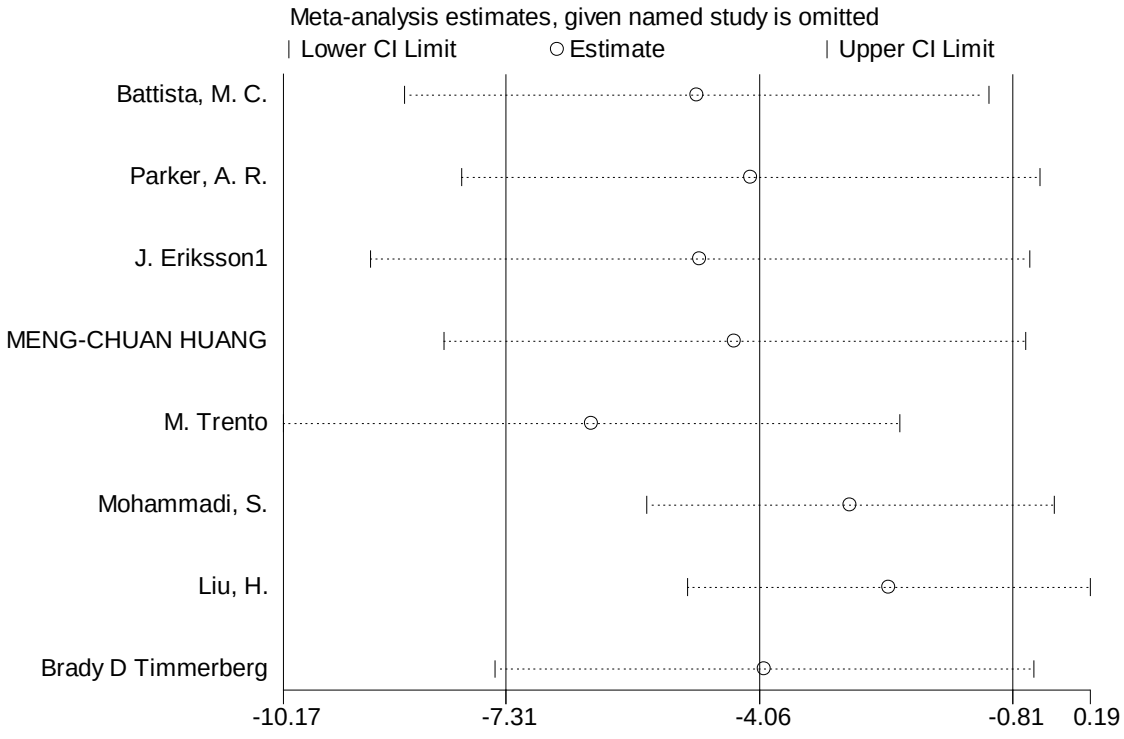
d) Body Mass Index



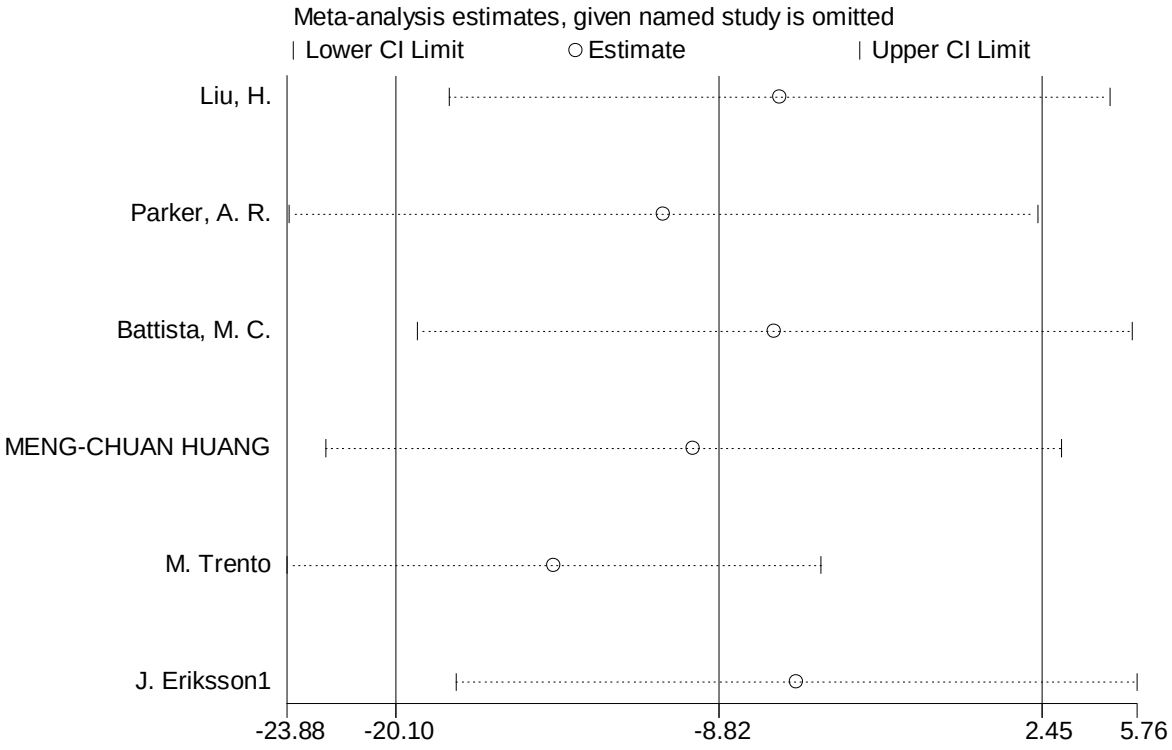
e) Waist circumstance



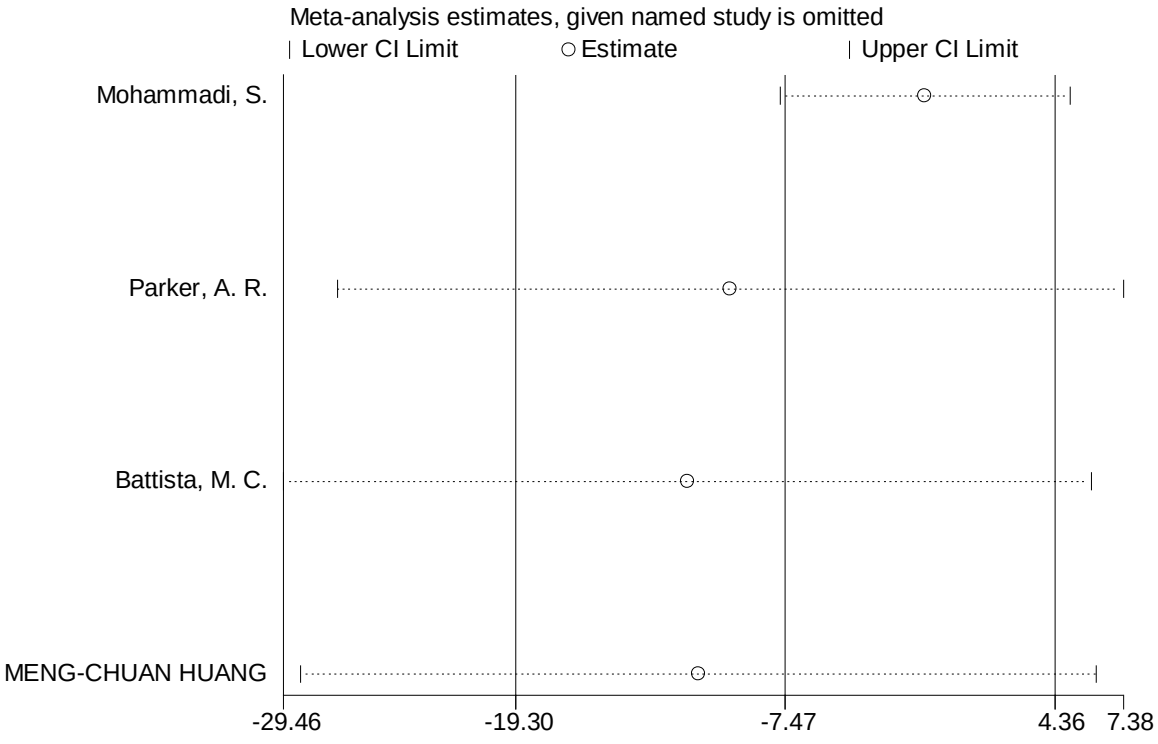
f) Cholesterol



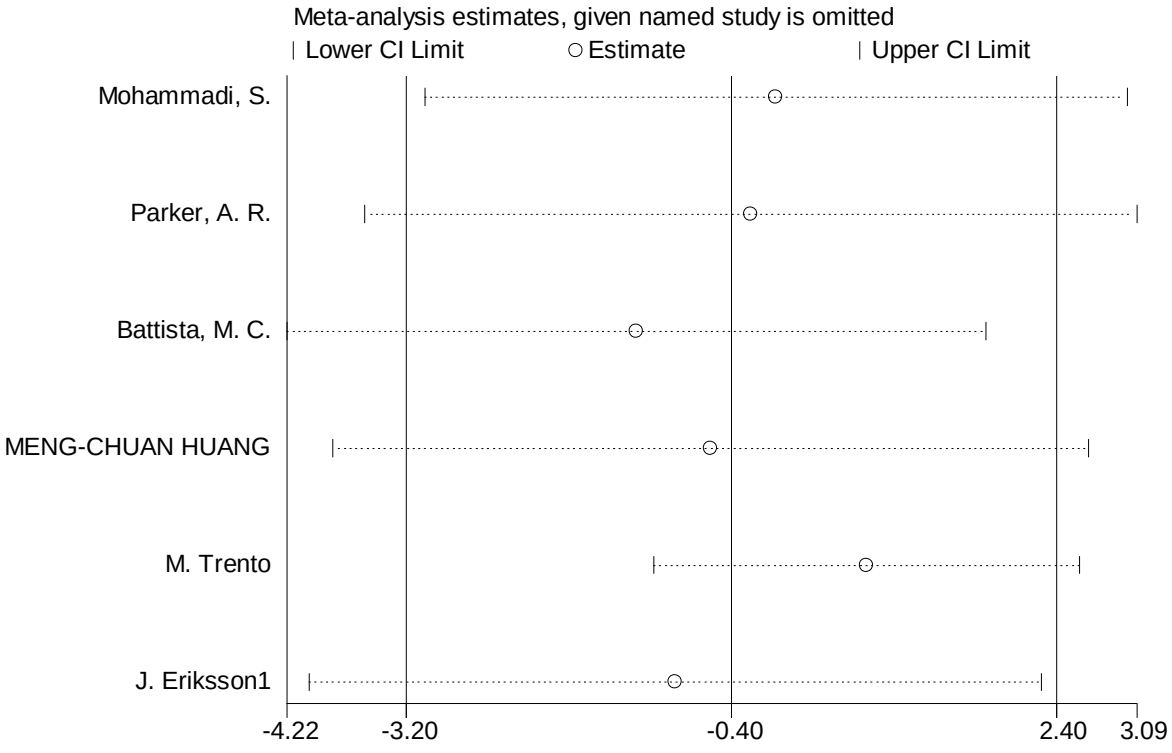
g) Triglyceride



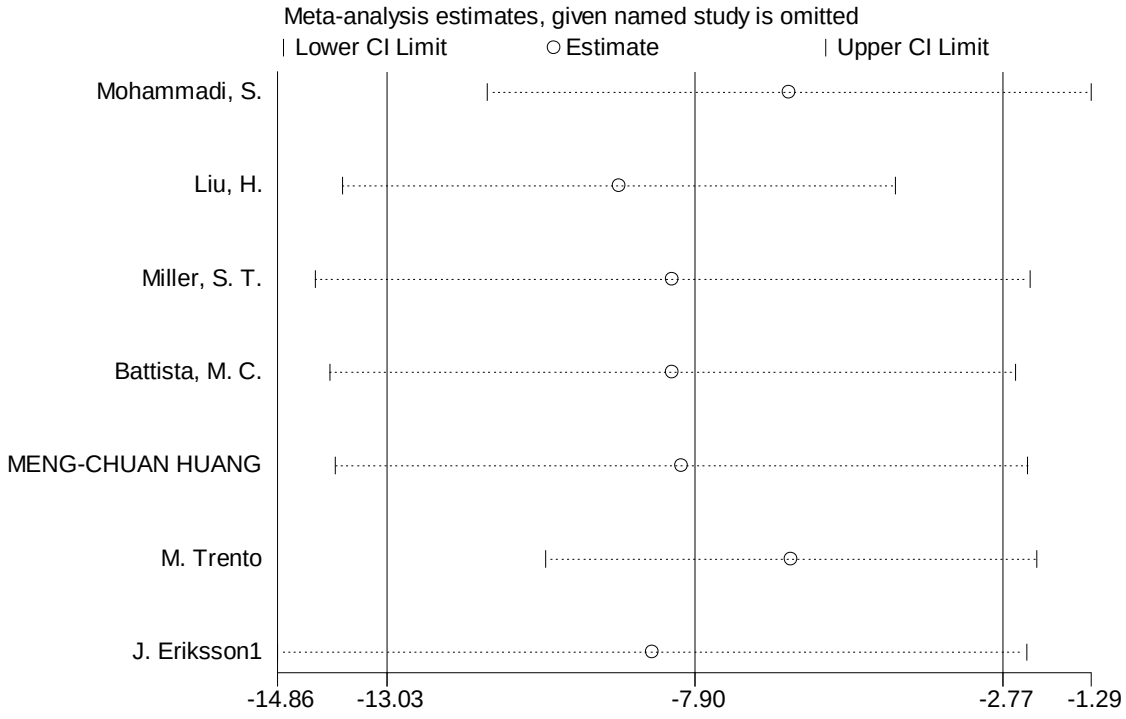
h) Low Density Lipoprotein



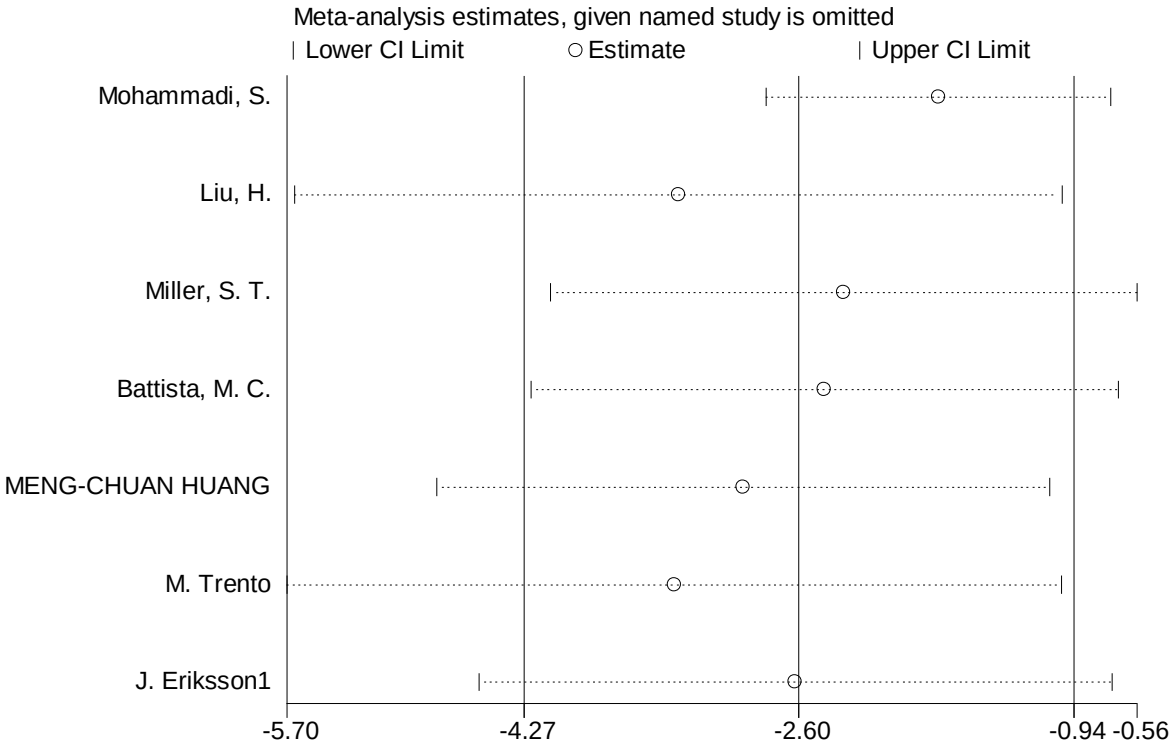
i) High Density Lipoprotein



j) Systolic Blood Pressure



k) Diastolic Blood Pressure


Meta-analysis estimates, given named study is omitted
Lower CI Limit
Estimate
Upper CI Limit
Mohammadi, S.
Liu, H.
Miller, S. T.
Battista, M. C.
MENG-CHUAN HUANG
M. Trento
J. Eriksson1
-5.70
-4.27
-2.60
-0.94
-0.56