Supplementary Material

Supplementary Table ST1- Search strategy terms

Studies were identified from the following databases: Cochrane Central Register of Controlled Trials (CENTRAL) (2000-), the Database of Abstracts of Reviews of Effectiveness (DARE) (1994-), MEDLINE (Ovid) (1946-), EMBASE (Ovid) (1974-), Web of Science (Ovid) (1900-), and CINAHL (1982-) and the gray literature (ex. conferences reports, technical reports, and dissertations) was searched using SIGLE (1982-) up to April 4, 2024. A registered Research Librarian at McMaster University was consulted to help develop appropriate and inclusive search strategy. Conference abstracts were included and recursive bibliography search was conducted where applicable at the discretion of the reviewers. Patients with wheat related disorders and CeD were identified with the medical subject heading and text term "celiac disease" "celiac sprue" "coeliac disease" "gluten sensitive enteropath*" or "CeD patients" and "wheat allergy" "wheat hypersensitiv*" "wheat senstivit*" "non-celiac gluten sensitivit*" "ncgs" and gluten free diet were identified by "gluten free diet" "gluten*" "celiac disease/Th (therapy)". All micronutrient deficiencies were searched with subject headings and within text (outlined in Supplementary Table 2).

Supplementary Table ST2- Search strategy used for EMBASE (Ovid) (1974- 04/2024)

1.	celiac disease/
2.	(celiac disease* or celiac sprue or coeliac disease* or gluten enteropathy* or gluten sensitive enteropath* or CeD patients).mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
3.	wheat allergy/
4.	(wheat allerg* or wheat hypersensitiv* or wheat sensitivit* or non-celiac gluten sensitivit* or non-coeliac gluten sensitivit* or ncgs?ws).mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
5.	or/1-4
6.	gluten free diet/
7.	(gluten-free diet* or gluten*).mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
8.	or/6-7
9.	5 and 8
10.	celiac disease/th [Therapy]
11.	9 or 10
12.	malnutrition/
13.	vitamin b deficiency/ or vitamin deficiency/ or b12 deficiency/ or biotin deficiency/ or folic acid deficiency/ or nicotinic acid deficiency/ or riboflavin deficiency/ or thiamine deficiency/
14.	vitamin deficiency/ or ascorbic acid deficiency/ or retinol deficiency/ or vitamin b deficiency/ or vitamin d deficiency/ or vitamin k deficiency/
15.	choline deficiency/
16.	pyridoxine deficiency/
17.	pernicious anemia/
18.	osteomalacia/
19.	hypophosphatemia/
20.	alpha tocopherol deficiency/
21.	nicotinamide/
22.	nicotinic acid/
23.	calcium/
24.	hypocalcemia/ or calcium deficiency/
25.	magnesium deficiency/ or hypomagnesemia/
26.	folic acid/
27.	(Nutrition* deficienc* or hypophosphatemia or avitaminosis or biotin* or niacin or vitamin B3 or calcium or magnesium or ascorbic acid or vitamin a or retinol or vitamin b or choline or folic acid or riboflavin or thiamine or vitamin b?1 or vitamin b?6 or vitamin b?12 or anemi? or vitamin d or vitamin b?9 or cobalamin or vitamin e or vitamin k).mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
28.	zinc/
29.	iron/
30.	selenium/
31.	selenium deficiency/
32.	zinc deficiency/
33.	iron deficiency/ or hypoferremia/
34.	chromium/
35.	chromium deficiency/
36.	trace element/
37.	nutritional status/
38.	(Zinc or zinc deficiency or iron or iron deficiency or hypoferremia or chromium or chromium deficiency or copper or copper deficiency or micronutrient* or nutritional status or trace element* or selenium or selenium deficiency).mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword, floating subheading word, candidate term word]
39.	copper deficiency/ or hypocupremia/
40.	copper/
41.	or/12-40
42.	11 and 41

Supplementary Table ST3- Equations used to estimate mean ($\overline{X}$) and standard deviation (σ) from Median (m) and either **(A)** minimum (a) and maximum (b) range[18] or **(B)** 1st and 3rd quartiles (q1/q3)[16,17]

(A)

$$\overline{X} = \frac{a + 2m + b}{4} \quad \text{and} \quad \sigma = \frac{b - a}{4}$$

(B)

$$\overline{X} = \frac{q1 + m + q3}{3} \quad \text{and} \quad \sigma = \frac{q3 - q1}{1.35}$$

Supplementary Table ST4- Studies excluded after full text review and primary reason for exclusion

Excluded Study	Year	Reason
Äärelä et al[1]	2016	Not intended outcome
Abdalla et al[2]	2017	Not intended intervention
Abu Daya et al[3]	2013	Not intended intervention
Adam et al[4]	2019	Not intended comparison
Ahlawat et al[5]	2019	Not intended intervention
Aksan et al[6]	2017	Not intended outcome
Al Hussani et al[7]	2024	Not intended intervention
Alzaben et al[8]	2016	Not intended outcome
Alzaben et al[9]	2015	Not intended outcome
Ãnal et al[10]	2012	Data not retrieved- abstract only*
Andrealli et al[11]	2012	Not intended comparison
Abdul-Aziz et al[12]	2017	Not intended intervention
Armagan et al[13]	2005	Not intended intervention
Baccini et al[14]	2006	Not intended intervention
Balaban et al[15]	2016	Not intended comparison
Barone et al[16]	2016	Not intended outcome
Bayrak et al[17]	2018	Conference abstract of included study
Bel'mer et al[18]	2014	Not intended outcome
Borovik et al[19]	2020	Not intended population
Bozbulut et al[20]	2019	Not intended outcome
Campagna et al[21]	2020	Not intended population
Cardigan et al[22]	2019	Not intended intervention
Carroccio et al[23]	1998	Not intended comparison
Carvalho et al[24]	2003	Data not available in article *
Casella et al[25]	2011	Conference Abstract- no poster available*
Chouliaras et al[26]	2011	Conference abstract of Margoni, 2012 (included)
Christhy et al[27]	2017	Not intended intervention
Cikrikcioglu et al[28]	2011	Not intended intervention
Corazza et al [29]	1996	Not intended outcome
Corazza et al[30]	1995	Repeat study
De Marchi et al[31]	2013	Not intended comparison
Delco, et al[32]	1999	Not intended outcome
Deora et al[33]	2017	Not intended comparison
Deora et al[34]	2016	Conference abstract- Repeat study
Dinu et al[35]	2017	Not intended comparison
Drabinska et al[36]	2018	Not intended comparison
Efthymakis et al[37]	2020	Conference abstract- poster not retrieved*
Efthymakis et al[38]	2015	Not intended comparison
El-Hodhod et al[39]	2012	Not intended intervention
El-Shaheed et al[40]	2019	Not intended intervention

Excluded Study	Year	Reason
El-Shaheed et al[41]	2018	Not intended intervention
Elli et al[42]	2018	Not intended comparison
Clinical trial EUCTR2019-003125- 21-FR[43]	2020	Clinical trial with data not available (ongoing)
Fallah et al.[44]	2024	Data not reported in article-not able to retrieve*
Fathi et al[45]	2013	Not intended intervention
Ferretti et al[46]	2003	Not intended comparison
Feurstein et al[47]	2016	Conference abstract- poster not retrieved*
Fickling et al[48]	2001	Not intended comparison
Francavilla et al[49]	2014	Not intended intervention
Geisel et al[50]	2012	Not intended outcome
Gutch et al[51]	2016	Not intended intervention
Haapalahti et al[52]	2005	Not intended intervention
Habel et al[53]	2017	Not intended intervention
Hadithi et al[54]	2010	Not intended intervention
Hallert et al[55]	2002	Not intended comparison
Hallert et al[56]	2009	Not intended comparison or intervention
Harper et al[57]	2007	Not intended intervention
Harper et al[58]	2007	Repeat study
Hassan, et al.[59]	2021	Full article not available- contacted publisher*
Henker & Gabsch[60]	1985	Repeat study
Hinks et al[61]	1984	Data not reported in article-not able to retrieve*
Hjelt & Krasilnikoff[62]	1990	Not intended comparison
Hjelt & Krasilnikoff[63]	1986	Not intended outcome
Hozyasz et al[64]	2003	Repeat
Huratdo[65]	2021	Not intended population
Idris Elzein & Elxein[66]	2019	Not intended intervention
Imam et al[67]	2014	Not intended intervention
Clinical Trial IRCT20170926036426N4[68]	2019	Clinical trial with data not available (ongoing)
Clinical Trial ISRCTN42241118[69]	2006	Not intended intervention
Jamnik et al[70]	2018	Not intended intervention
Jivraq et al[71]	2022	Not intended comparison
Kamal et al[72]	2018	Not intended population or comparison
Kapur et al[73]	2003	Not intended intervention
Kassim & Ross[74]	2018	Conference abstract poster not available*
Kemppainen et al[75]	1999	Not intended comparison
Kemppainen et al[76]	1998	Not intended comparison
Klimov et al[77]	2019	Not intended comparison
Krysiak et al[78]	2019	Not intended population
Kuryaninova et al[79]	2018	Conference abstract- full poster not available*
Lasta et al[80]	2014	Conference abstract- full poster not available*
Lee & Clarke[81]	2017	Not intended comparison
Lerner et al[82]	2012	Not intended intervention
Lheure et al[83]	2017	Not intended comparison
Li et al [84]	2023	Not intended comparison

Excluded Study	Year	Reason
Love et al[85]	2018	Not intended comparison
Lu et al[86]	2021	Systematic Review
Lucendo et al[87]	2011	Not intended comparison
Lucendo et al[88]	2011	Not intended comparison
Mackinder et al[89]	2015	Not intended comparison
Mager, et al[90]	2011	Not intended comparison
Marild et al[91]	2017	Not intended intervention
Martinon-Torres et al[92]	2019	Not intended comparison and intervention
Masood & Shaikh[93]	2014	Not intended intervention
Mazza et al[94]	2019	Not intended population
McFarlane et al[95]	1995	Not intended comparison
Mishra et al[96]	2019	Not intended comparison
Mitchell & Robinson[97]	2002	Not intended comparison
Molteni et al[98]	1995	Not intended comparison
Moreno et al[99]	2018	Not intended comparison
Murray et al[100]	2013	Not intended comparison or intervention
Muzzo et al[101]	2000	Not intended outcome
Clinical Trial NCT03274648[102]	2017	Not intended population
Negi et al[103]	2018	Not intended intervention
O'Leary et al[104]	2004	Not intended comparison
O'Morain et al[105]	2021	Not intended comparison
Packer et al[106]	1978	Not intended comparison
Pham-Short et al[107]	2019	Not intended population
Piatek-Guziewicz et al[108]	2017	Repeat study
Piran Arce et al[109]	2017	Not intended comparison
Piran Arce et al[109]	2017	Repeat study
Quero et al[110]	2015	Not intended comparison
Radzikowski et al[111]	1989	Not intended comparison
Radzikowski et al[111]	1989	Repeat study
Rajalahti et al[112]	2017	Not intended comparison
Rajalahti et al[113]	2016	Conference abstract of study Rajalahti et al[103]
Rajalahti et al[114]	2017	Repeat study
Rawal et al[115]	2010	Repeat study of Negi et al[95]
Rea et al[116]	1998	Not intended comparison
Rea et al[117]	1996	Not intended comparison
Romanczuk et al[118]	2016	Repeat study
Rujner et al[119]	2004	Not intended intervention
Rujner et al[120]	2001	Repeat study
Rujner et al[121]	2001	Repeat study
Saibeni et al[122]	2005	Not intended comparison
Salazar Quero et al[101]	2015	Repeat study of Muzzo et al[101]
Sategna-Guidetti et al[123]	2000	Not intended comparison
Schosler, et al[124]	2016	Not intended comparison
Scott & Losowsky[125]	1976	Data not available in main text*

Excluded Study	Year	Reason
Scricciolo et al[126]	2018	Not intended comparison or population
Sdepanian et al[127]	2003	Data not available in main text*
Sdepanian, et al.[128]	2004	Conference abstract no poster available*
Selby et al[129]	1999	Not intended comparison
Setty-Shah et al[130]	2014	Not intended population
Sgaramella et al[131]	2020	Not intended intervention
Shahriari et al[132]	2018	Not intended population
Sharma et al[133]	2013	Not intended outcome
Shaveta, et al.[134]	2011	Not intended comparison
Shelley, et al.[135]	2016	Not intended comparison
Siddiqui et al. [136]	2023	Not intended outcome
Simmons et al[137]	2011	Not intended population
Soliman et al[138]	2019	Not intended comparison
Soliman et al[139]	2019	Conference abstract of Soliman et al[126]
Solomons, et al.[140]	1976	Not intended outcome
Stahlberg, et al. [141]	1991	Not intended comparison
Stein et al[142]	2015	Not intended intervention
Szathmari et al[143]	1997	Not intended comparison
Taylor et al[144]	2020	Not intended outcome
Tetzlaff et al[145]	2020	Conference abstract- full poster not available*
Thong et al[146]	2018	Not intended population
Tolone et al[147]	2019	Conference abstract-full poster not available*
Tran et al[148]	2011	Not intended comparison
Tuna Kirsaclioglu et al[149]	2016	Not intended comparison
Unalp-Arida et al[150]	2016	Not intended intervention
Van Megen et al[151]	2023	Not intended comparison
Varkonyi et al[152]	1992	Not intended outcome
Ventura et al[153]	2023	Data not available in main text*
Villanueva, et al.[154]	2012	Not intended intervention
Vilppula et al[155]	2011	Not intended comparison
Volkan, et al.[156]	2017	Not intended comparison
Volkan, et al.[157]	2016	Conference abstract of Volkan et al (included)
Volkan et al[158]	2016	Conference abstract of Bayrak et al[31]
Weintraub et al[159]	2017	Not intended intervention
Weir & Hourihane[160]	1974	Not intended comparison
Wierdsma et al[161]	2013	Not intended intervention
Wright et al[162]	2017	Not intended comparison
Yuce et al[163]	2004	Not intended intervention

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Supplementary Table ST5 - Detailed Characteristics of included studies

Study	Year	Language	Methods	Participants	Study Outcomes	Micronutrient Assessed	Notes
DICHOTOMOUS DATA AVAILABLE							
Anand et al.[38] (UK)	1977	English	Assessed absorption of iron by total body counter of radioactive $^{59}Fe^{++}$. CeD confirmed by biopsies. Assessed absorption of iron by Oxford total body counter of radioactive $^{59}Fe^{++}$	27 adults with CeD -Group 1: untreated CeD. n=34; 11 had iron levels measured -Group 2: CeD on GFD from 6 moths to 10 years. n=36; 14 had iron levels -Controls without malabsorptive syndrome however 96 had iron deficiency anaemia. n=131	-To assess the absorption of inorganic $^{59}Fe^{++}$ in untreated and treated CeD and controls in comparison to haemoglobin iron	Iron	-Eligible for analysis: Group 1 and 2 -Data not available to establish the cut off of 2 years
Ballestero-Fernández et al.[30], 2021 (Spain)	2021	English	CeD confirmed by medical diagnosis. Micronutrients were assessed by routine clinical laboratory methods	64 adults with CeD belonging to Coeliac and Gluten Sensitive Association on GFD for over 1 year (n=64) Controls recruited from the general population without diagnosis of chronic disease, no digestive symptoms and not taking nutritional supplements and all controls had screening negative anti-TTG. n=74	1- To assess nutritional status in adults with CeD on long-term GFD compared to healthy controls 2- To assess micronutrient measurements in CeD compared to controls and divided by sex	Calcium Iron Folate Vitamin D	-Only Vitamin D had dichotomous data provided
Bayrak et al.[31] (Turkey)	2020	English	CeD confirmed by biopsies and serology. Micronutrients were assessed by routine clinical laboratory methods	228 children with CeD * -Group 1: CeD on GFD from 3mo to 1 year. n=72 -Group 2: CeD on GFD for 1-3 years. n=53 -Group 3: CeD on GFD for over 3 years. n-103 -Controls were age + sex matched with negative serology for CeD. n=135	1- To assess age of menarche and pubertal development related to GFD in CeD through hormone measurement, Tanner stage and anthropometric measurements.	Ferritin Folate Vitamin B12 Vitamin 25(OH) D	-Eligible for analysis: Group 3 and controls
Choudhary et al.[32] (India)	2017	English	CeD confirmed by biopsies and serology. Micronutrients were assessed by routine clinical laboratory methods	72 children with CeD - Group 1: untreated CeD newly diagnosed. n=36 - Group 2: CeD on GFD for over one year. n=36	1- To assess BMD and biochemical indices in CeD newly diagnosed compared to CeD on GFD for >1year	Calcium	
Ciacci et al.[42] (Italy)	2020	English	CeD confirmed by biopsies and serology. Calcium was measured by Architect assay. Vitamin 25(OH)D and 1-25(OH)D were measured by chemiluminescent assay. Vitamin 25(OH) D had both calibrated and non-calibrated to NIST-SRM972a reported	105 adults with CeD Group1: untreated CeD. n=50 Group 2: CeD on GFD for mean of 10±8.8 years. n=55	1- To assess vitamin D levels in CeD in relationship to BMD and quantitative computed tomography	Calcium Vitamin 25(OH)D Vitamin 1-25(OH)D	-Reported severe and mild Vitamin D deficiency
Elli et al.[47] (Italy)	2015	English	CeD confirmed by medical assessment. Micronutrients were assessed by routine clinical laboratory methods	38 adults with CeD on GFD for mean of 9.0 years (±8.0). 16/39 CeD had iron deficiency anaemia Controls: sex and age matched healthy volunteers. n=76	1- To evaluate the role of *TMPRSS8* variant *rs855791* in treated CeD with iron deficiency anaemia against non-iron deficient anaemia CeD and non CeD controls	Iron Ferritin	-Dichotomous data for iron in CeD only
González et al.[35] (Argentina)	1995	English	CeD confirmed by biopsies and serology Calcium measured by atomic absorption, Vitamin D by protein competition assay of cytosol from rats	32 adult women with CeD Group 1: untreated CeD. n=20 Group 2: CeD on GFD for mean 16 years (range 2-26). n=12 Controls were women who had BMD for another study. n=85	1- To assess extent of alterations in bone mass and body composition in untreated CeD compared to controls 2- To assess if alterations are corrected with GFD	Calcium Vitamin 25(OH)D	-Eligible for analysis: Group 1 and 2
Högberg et al.[19] (Sweden)	2009	English	Serum zinc levels by atomic absorption spectroscopy compared to level of enteropathy on duodenal biopsies. CeD diagnosis confirmed by biopsies	59 children divided into 5 groups Group 1: CeD untreated (Marsh 2-3) n=11 Group 2: CeD not confirmed (Marsh 0-1) n=16 Group 3: CeD on GFD for mean of 12 months (Marsh 0-1) n=14 Group 4: CeD on gluten challenge of mean 3 months (Marsh 2-3) n=12 Group 5: CeD on gluten challenge for mean 4 months (Marsh 0-1) n=6	1- To assess serum zinc profile of children at different stages of investigation for CeD	Zinc	-Eligible for analysis: Group 1 and 3
Hozyasz et al.[20] (Poland)	2003	Polish	Assessed vitamin E in plasma levels and by cholesterol, erythrocytes, and plasma retinol. Vitamin E and retinol levels in erythrocytes determined by liquid chromatography with UC radiation detector. CeD confirmed by biopsies and anti-Endomysium antibodies.	30 Adults and children with CeD were divided into 2 groups Group 1: 18 CeD not on GFD Group 2: 12 CeD on GFD for at least 2 years and negative Anti-Endomysium antibodies	1- To assess vitamin E status in patients with CeD	Vitamin A Vitamin E (three methods; plasma, controlled by plasma cholesterol and in erythrocytes)	
Kavak et al.[49] (Turkey)	2003	English	CeD confirmed by biopsies and serology. Calcium was measured by standard laboratory methods and Vitamin25(OH)D by radioimmunoassay	62 children with CeD Group1: untreated CeD. n=34 Group 2: CeD on GFD for over 1 year. n=28 Controls: age and sex matched healthy children with only BMD. n=64	1- To assess BMD in children with CeD at diagnosis and treated for 1 year	Calcium Vitamin 25(OH)D	-Eligible for analysis: Group 1 and 2
Keaveny et al.[23] (Ireland)	1996	English	CeD confirmed by biopsies. Ionized calcium measured by ion-selective electrode with a Radiometer CAI2 analyzer. Vitamin 25(OH)D measured by radioimmunoassay and Vitamin 1, 25 (OH) D by competitive protein binding assay	51 adults with CeD Group 1: Newly diagnosed CeD. Four participants were on low dose vitamin D supplements. n=19 Group 2: Treated CeD on GFD, mean GFD 6.7 years (1-35). n=16 Group 3: Refractory CeD on GFD on immunosuppressives. n=16	1- To assess bone remodelling indices and secondary hyperparathyroidism in adult CeD patients at different stages	ionized Calcium Vitamin 25(OH)D Vitamin 1-25(OH)D	-Eligible for analysis: Group 1 and 2 -4/19 CeD not on GFD were taking low dose vitamin D (3 <400IU 1>400IU)

Kemppainen et al.[24] (Finland)	1995	English	CeD confirmed by biopsies and unclear diagnosis were excluded. Micronutrients were assessed by routine clinical laboratory methods	82 adults with CeD -Group 1: Untreated CeD n= 40 -Group 2: Treated CeD on GFD >1yr with normalization of villous atrophy. n=42 -Control subjects recruited from two population based surveys (men from osteoporosis study/women from a prior case-control study) for BMD only	1- To assessed nutritional intake and nutritional status of newly diagnosed CeD compared to CeD on GFD 2- To compare anthropometric characteristics of CeD with control	Iron Ferritin Folate Vitamin B12 Calcium Magnesium	-Eligible for analysis: Group 1 and 2 -Calcium and magnesium reported continuous data only**
Klimov et al.[50] (Russia)	2017	English	CeD confirmed by biopsies and serology. Vitamin 25(OH) D levels by enzyme immunoassays	77 children with CeD Group1: untreated CeD. n=22 Group 2: CeD on strict GFD with unclear length of time. n=37 Group 3: CeD non-compliant GFD. n=18 Control: healthy children. n=14	1- To assess Vitamin D status in children with untreated and treated CeD compared to controls	Vitamin 25(OH)D	Conference poster -Eligible for analysis: Group 1 and 2 and control
Margoni et al.[25] (Greece)	2012	English	CeD confirmed by biopsies and Anti-TTG/EMA antibodies. Micronutrients were assessed by routine clinical laboratory methods	81 children with CeD -Group 1: Newly diagnosed CeD. n=45 -Group 2: Ced on GFD >12 months (mean 77.7 ± 54.3). n=36 Prospective repeated bloodwork on 16 patients from Group 1	1- To assess status of bone health in newly diagnosed CeD 2- Effect of strict GFD on evolution of bone health parameters	Calcium Vitamin 25(OH)D	
Mazure et al.[51] (Argentina)	1994	English	CeD confirmed by biopsies and serology. Calcium was measured by atomic absorption and Vitamin 25 (OH) D by protein competition assay	42 adults with CeD Group1: Asymptomatic CeD. n=8, Group 2: Untreated symptomatic CeD, n=20 Group 3: CeD on GFD for mean 16 years (range 2-26 years). n=14 Controls: healthy adults age and sex matched who had BMD only. n=153	1- To assess BMD in asymptomatic CeD patients compared to controls and symptomatic CeD patients	Calcium Vitamin 25(OH)D	-Eligible for analysis: Group 2 and 3
McGrogan et al.[26] (Scotland, UK)	2021	English	CeD confirmed by biopsies and Anti-TTG levels. Vitamin A, B1,B2, B6, E, K by high-performance liquid chromatography (HPLC). Vitamin B2 and B6 in erythrocytes corrected by haemoglobin. Plasma Vitamin E corrected by total cholesterol and Vitamin K by triglycerides. Vitamin C measured by electrochemical detection. Zinc, copper, selenium by mass spectrometry. Ferritin, folate, B12 and magnesium measurement by routine clinical laboratory methods	106 children with CeD Group1: Newly diagnosed untreated CeD. n=25 Group2: CeD on GFD for 6 months or less. n=21 Group3: CeD on GFD for 7-12 months. n=16 Group 4: CeD on GFD for over 12 months. n=44 -Group2 and 3 were combined data from a prospective and cross-sectional cohorts -Not all participants had all the micronutrient measured	1- To asses micronutrient deficiencies in children with CeD 2- To assess changes in micronutrient deficiencies post GFD and if any are persistent despite GFD	Vitamin A, B1,B2, B6, B12, C, K, D, E Folate Magnesium Copper Zinc Selenium Ferritin	-Eligible for analysis: Group 1 and 4
Manseuto et al.[52] (Italy)	2023	English	CeD confirmed by biopsies and serology. NCWS confirmed by absence serology and biopsy in setting of +HLA DQ2/8 Micronutrients were assessed by routine clinical laboratory methods	174 adults with CeD -244 NCWS on GFD for 12 months Controls: Adults with IBS and functional dyspepsia	1- To assess anemia in NCWS compared to CeD and healthy controls	Vitamin B12 Ferritin Iron Folate	
Piatek-Guziewicz et al.[54] (Poland)	May 2017	English	CeD confirmed by biopsies and serology. Vitamin E measured by spectrophotometry. Ferritin and Vitamin D were assessed by routine clinical laboratory methods	145 adults with CeD Group 1: untreated CeD. n=53 Group 2: CeD on GFD for over 2 years. n=92 Controls: Adults with functional GI disorders with negative CeD serology and biopsies. n=52	1- To evaluate oxidative stress imbalance in CeD by concentrations of nitric oxide and anti-oxidant parameters	Ferritin Vitamin D Vitamin E	-Eligible for analysis: Group 1, 2 and controls -Vitamin E deficiency within CeD groups was not available **
Piatek-Guziewicz et al.[55] (Poland)	Nov 2017	English	CeD confirmed by biopsies and serology. Micronutrients were assessed by routine clinical laboratory methods	60 adults with CeD Group 1: untreated CeD. n=29 Group 2: CeD on GFD for over 2 years. n=31 Control: Functional GI disorders with negative CeD serology/biopsies. n=25	1- To determine the involvement of oxidative imbalance and mechanism of mucosal injury in CeD with non-classical symptoms and extraintestinal manifestations	Vitamin D	-Eligible for analysis: Group 1, 2 and controls
Romańczuk et al.[57] (Poland)	2016	English	CeD confirmed by biopsies and serology. Vitamin E levels in erythrocytes determined by high-performance liquid chromatography with ultraviolet detector.	77 adults and children with CeD Group 1: Untreated CeD. n=7 Group 2: CeD with non-compliance to GFD diet. n=22 Group 3: CeD on strict GFD for unclear amount of time. n=48 Controls: were healthy with negative serological markers of CeD (n=20)	1- To assess Vitamin E in erythrocytes in patients with untreated and treated CeD and controls.	Vitamin E	-Eligible for analysis: Group 1, 3 and controls
Selbuz et al.[58] (Turkey)	2021	Turkish	CeD confirmed by biopsies and serology. Micronutrients were assessed by routine clinical laboratory methods.	70 children with CeD Group 1: untreated CeD. n=34 Group 2: CeD on GFD for 3.8 ±3.4 years. n=22 Group 3: CeD not compliant with GFD. n=14 Controls: Healthy children sex and age matched n=57. No bloodwork for controls	1- To assess nutritional and growth status in children with CeD compared to healthy controls	Calcium, Zinc Folic Acid, Iron Vitamin A, B12, E, Vitamin D Magnesium	-Eligible for analysis: Group 1 and 2
Szaflarska-Poplawska et al.[28] (Poland)	2022	English	CeD confirmed by biopsies and serology. folate was measured by chemiluminescence immunoassay, B vitamins by HPLC and others by routine laboratory methods	48 children on GFD for 5.02 ± 3.87 years 50 age matched controls	1- To assess micronutrient dietary intake and serum levels of CeD on GFD compared to controls on regular diet	Biopsies and serology	
Ünal et al.[61] (Turkey)	2012	Polish	CeD confirmed by biopsies and serology	17 Children with CeD on GFD for 11.11±1.98 months Controls: healthy age and sex matched (n=20)	1- To assess selenium levels in children with CeD on GFD compared to controls	Selenium	

			Selenium levels measured by atomic spectrometer				
Uyanikoglu et al.[62] (Turkey)	2021	English	CeD confirmed by biopsies and serology. Vitamin 25(OH)D and Vitamin 1-25(OH)D levels determined by liquid chromatography with tandem mass spectrometry	80 Adults with CeD Group 1: untreated CeD. n=40 Group 2: CeD on GFD for unclear amount of time. n=40 Controls: were healthy adults that were age and sex matched. n=40	1- To assess 25(OH) vitamin D and 1,25(OH) vitamin D levels in untreated and treated adult CeD patients compared to controls	Vitamin 25(OH)D Vitamin 1-25(OH)D	-Eligible for analysis: Group 1, 2 and controls -Able to determine severe and mild Vitamin D deficiency
Continuous Data Only ***							
Ballestero-Fernández et al.[29] (Spain)	2019	English	CeD confirmed by medical diagnosis. Micronutrients were assessed by routine clinical laboratory methods	70 children with CeD belonging to Coeliac and Gluten Sensitive Association on GFD for over 1 year. 67 had bloodwork done Controls recruited from the general population without diagnosis of chronic disease, no digestive symptoms and not taking nutritional supplements. n=67 and 66 had bloodwork done	1- To assess nutritional status in children with CeD on long-term GFD compared to healthy controls 2- To assess micronutrient measurements in CeD compared to controls and divided by sex and age	Calcium Iron Folate Vitamin D	-Calculated mean form median
Björck et al.[39] (Sweden)	2017	English	CeD confirmed by biopsies and serology. Vitamin 25(OH) D was measured using liquid chromatography-mass spectrometry	101 children with CeD Group 1: CeD not on GFD. n=71 Group 2: CeD on GFD of mean or 6.9±1.1 years. n=30 Control 1: age matched controls to group 1. n=142 Control 2: Age matched controls to group 2. n=60, 57 had bloodwork Controls were serological negative children but matched to HLA-DQ allele, sex and age	1- To assess whether bone mass and metabolism are impaired in CeD and genetically at-risk children with screening detected CeD	25 (OH) vitamin D	-Eligible for analysis: Group 2 and Control 2
Boda et al.[40] (Hungary)	1989	Hungarian	CeD confirmed by biopsies. Selenium in erythrocyte concentration measured by fluorimetry	49 children with CeD Group 1: Untreated CeD. n=24 Group 2: CeD on GFD for mean of 17.5 months, n=25 Controls: Age matched with no hematological conditions or CeD. n=15	1- To assess selenium erythrocyte concentration in untreated and treated CeD compared to controls	Selenium	Eligible for analysis: Group 1, 2 and control
Bulut et al.[41] (Turkey)	2023	English	CeD confirmed by biopsies and serology. Micronutrients were assessed by routine clinical laboratory methods	49 Children with CeD Group 1: untreated CeD. n=18 Group 2: CeD on GFD for mean of 6 months. n=31	1- To assess bone structure and integrity between CeD on and off CGF	Vitamin 25(OH)D Calcium	GFD confirmed by TTG levels
Corazza et al.[43] (Italy)	1988	English	CeD confirmed by biopsies. Serum zinc levels were measured by atomic absorption spectrophotometry	48 adults with CeD Group 1: untreated CeD. n=30 Group 2: treated CeD with GFD for 26±15 months. n=18 Controls: healthy volunteers that were age and sex matched. n=30	1- To assess cell-mediated immunity, nutrition status and zinc levels in adult CeD	Zinc Copper	-Eligible for analysis: Group 1, 2 and control -Data for Copper not in text
Corazza et al.[33] (Italy)	1995	English	CeD confirmed by biopsies or positive serology with family history. Serum 25-OH Vitamin D measured by radioimmunoassay.	31 adults with CeD Group 1: untreated CeD. n=17 Group 2: CeD on GFD for median of 2.4 years. n=14 Controls: Healthy adult volunteers. n=24	1- To assess bone metabolism in CeD compared to controls	Calcium Vitamin 25(OH)D Vitamin 1-25(OH)D	
Cortigiani et al.[44] (Italy)	1989	Italian	Assessed serum selenium levels by atomic absorption spectrophotometer in CeD untreated, treated and controls. CeD diagnosed by biopsies	73 children and young adults (up to age 20) with CeD Group 1: untreated CeD. n=37 Group 2: CeD on GFD for at least a year. n=36 -9 subjects were studied on both at diagnosis and on GFD Control: healthy children. n=51	1- To assess selenium levels in untreated and treated CeD compared to controls	Selenium	-Eligible for analysis: Group 1, 2 and control
Dickey et al.[45] (Ireland)	2008	English	CeD confirmed by biopsies and serology. Measurements of Vitamin B6 by pyridoxal 5-phosphate (PLP), Vitamin B2 by erythrocyte glutathione reductase activation coefficient (EGRAC), and Vitamin B12 and folate by microbiological assay	100 adults with CeD Group1: untreated CeD. n=35 Group 2: CeD on GFD for >1year with normalized villous atrophy. n=41 Group 3: CeD on GFD for >1year with persistent villous atrophy. n=24 Controls: age and gender matched who were participating in other B-vitamin studies with no history of gastrointestinal disorders. n=200	1- To assess nutritional status and B vitamin levels between untreated and treated CeD and healthy controls	Folate Vitamin B2 Vitamin B6 Vitamin B12	-Eligible for analysis: Group 1, 2 and control
Efe et al.[46] (Turkey)	2023	English	CeD confirmed by biopsies and serology. Micronutrients were assessed by routine clinical laboratory methods	85 children with CED Group1: poor GFD adherence (n=35) over last 3 months Group 2: good GFD adherence (n=50) (confirmed by diet and serology) Controls: Healthy volunteers with no psychiatric or physical illness (n=72)	1- To assess ADHD traits on CeD patients and associated micronutrients	Vitamin 25 (OH)D, Vitamin B12, Iron, Ferritin	-Eligible for analysis: Group 2 and control
El Amrousy et al. (Eygpt)	2024	English	CeD confirmed by biopsies and serology. Micronutrients were assessed by routine clinical laboratory methods	40 children with CED on GFD Controls: healthy age and sex matched (n=40)	1- To assess cardiac function for CeD patients and associated micronutrients	Ferritin, Vitamin 25 (OH)D	
Henker et al.[18] (Germany)	1985	German	Serum zinc levels at different stages of disease by atomic absorption spectrophotometry. CeD confirmed by biopsies	78 children with CeD divided into 5 groups: Group1: 26 children with active untreated CeD, total villous atrophy on gluten Group 2: 22 children with total villus atrophy with ongoing diet errors with gluten Group 3: 6 children with partial villous atrophy post gluten challenge Group 4: 23 children on GFD for 6 months Group 5: 63 children on GFD for more than 6 months	1- To assess zinc concentrations in patients with coeliac disease compared to different stages of disease 2- To assess relationship of zinc concentrations to albumin, iron, alkaline phosphatase and body length and weight	Zinc	-Eligible for analysis: Group 1/2 and Group 5

Isikay et al.[36] (Turkey)	2018	English	CeD confirmed by intestinal biopsies and/or EMA IgA and anti TTG IgA. Micronutrients were assessed by routine clinical laboratory methods	226 CeD children on GFD for 3 months to 5 years Controls were hospitalized patients with upper airway infection with no chronic diseases n=268	1- To assess the prevalence of restless leg syndrome in CeD compared to non CeD controls 2- To investigate associated factors for restless leg syndrome	Ferritin Folate Vitamin B12 Vitamin 25(OH)D	
Kalayci et al.[48] (Turkey)	2001	English	CeD diagnosed by biopsies and serology. Calcium was measured by a timed-endpoint biuret method corrected for albumin were appropriate	32 children with CeD Group1: untreated CeD. n=16 Group2: CeD on GFD for 3.36 (range 1.6-7) years. n=16. Controls: children with upper respiratory infection, sex-age matched. n=82	1- To assess prevalence of osteopenia and relationship between BMD and metabolites in untreated and treated CeD in children compared to controls	Calcium	-Eligible for analysis: Group 1, 2 and control
Kalita et al.[21] (Poland)	2002	Polish	Concentration of selenium in CeD and healthy controls. CeD confirmed by both intestinal biopsies and anti-EMA. Serum selenium concentration by electrothermal atomic absorption	114 children with CeD at various stages Group 1: New diagnosed of CeD (n=9) Group 2: CeD on GFD with negative anti EMA IgA n=31 Group 3: untreated CeD n=54 Group 4: CeD during gluten challenge. n=20 Control group: non-CeD or other gastrointestinal diseases. n=27	1- To evaluate serum selenium levels in children with CeD	Selenium	-Eligible for analysis: Group 1, 2, and controls -Duration of GFD not reported
Karkoszka et al.[22] (Poland)	2000	Polish	CeD confirmed by duodenal biopsies with atrophy and resolution post GFD. Total plasma calcium determined by flame photometry.	73 children with CeD Group 1: CeD strictly on GFD for mean 11.7±0.6 years (n=33). GFD adherence confirmed by negative anti-EMA antibodies Group 2: untreated CeD (n=40)	1- To assess influence of GFD on bone mineral density (BMD) with BMI and serum bone indices in CeD	Calcium	
Pazianas et al.[53] (England)	2005	English	CeD confirmed by biopsies. calcium measured by standard laboratory method, Vitamin 25(OH)D by radioimmunoassay	24 adult females with CeD on GFD for 4.7±3.1 years Controls: healthy female hospital staff volunteers. n=20	1- To assess calcium absorption and BMD in CeD after long-term GFD	Calcium Vitamin 25(OH)D	
Reinken, et al.[56] (Austria)	1976	English	CeD confirmed by biopsies. Vitamin B6 measured by activity of pyridoxal phosphate (PALP) and pyridoxal-kinase (PALK) through specific assays	20 children with CeD Group 1: untreated CeD. n=15 Group 2: CeD on GFD for 0.5-5 years (n=6) Controls: children with normal biopsies but history of cow's milk allergies, recurring diarrhea, salmonella case and suspected but not confirmed CeD. n=20	1- To assess Vitamin B6 concentrations in adult untreated and treated CeD compared to controls	Vitamin B6	-Eligible for analysis: Group 1, 2 and controls -Data not available to establish the cut-off of 2 years
Sabel'nikova et al.[27] (Russia)	2013	Russian	CeD confirmed by biopsies and serum anti-gliadin and TTG antibodies.	Total 87 adult patients with CeD Group1: Not adhering to GFD. n=24; 33 blood samples Group2: CeD on strict GFD. n= 63; 109 blood samples	- To elaborate recommendations for rehabilitation of patients with CeD on long term follow up based on GFD adherence	Iron Calcium	-Follow up 6 to 31 years
Singhal et al.[59] (India)	2008	English	CeD confirmed by biopsies and serology. Zinc levels determined by atomic absorption spectrophotometry	30 children with CeD Group 1: untreated CeD. n=23 Group 2: CeD on GFD for over 3 months. n=7 Controls: children with chronic diarrhea negative workup for CeD (n=27)	1- To assess zinc levels in untreated and treated CeD	Zinc	-Eligible for analysis: Group 1, 2 and controls
Szymczak et al.[60] (Poland)	2012	English	CeD confirmed by biopsies. Vitamin 25(OH) and 1-25(OH)D were measured by radioimmunoassay (RIA). Calcium was assessed by routine laboratory methods	35 adults with CeD Group 1: untreated CeD. n=16 Group 2: CeD on GFD for over 1 year. n=19 Controls: healthy adults with normal BMI. n=36	1- To assess BMD and calcium deficiencies in adult CeD 2- To assess if GFD sufficient in BMD restoration or if supplementation is required	Calcium Vitamin 25(OH)D Vitamin 1-25(OH)D	-Eligible for analysis: Group 1, 2 and controls
Valente et al.[37] (Brazil)	2015	English	Assessed B vitamins, nutritional status in CeD on GFD with controls. Vitamin B6 by PLP chromatography. CeD diagnosed by biopsies	40 adults with CeD on GFD for at least 6 months Controls were healthy subjects recruited, age and sex matched (n=40)	1- To assess nutritional status and levels of B vitamins in homocysteine metabolism 2- To determine CeD patients have adequate dietary intake of B vitamins	Folate Vitamin B6 Vitamin B12	Data not available to establish the cut off of 2 years
Volkan et al.[63] (Turkey)	2018	English	CeD confirmed by biopsies and serology. Micronutrients were assessed by routine clinical laboratory methods. Vitamin K were assessed by enzyme-linked immunosorbent assay	72 children with CeD Group1: Untreated CeD. n=26 Group 2: CeD on GFD with poor compliance. n=25 Group 3: CeD on GFD for with good compliance. n=21 Controls: healthy age and sex matched children. n=30	1- To investigate BMD in children with CeD 2- To Evaluate association between vitamin K levels and osteoporosis	Calcium Ferritin, folate Vitamin B12, K Magnesium Vitamin 25(OH)D	- Eligible for analysis: Group 1, 3 and controls -Mean follow up time of 2.7 years, unclear cut off for length of GFD

Supplementary Table ST6 - Summary of All Studies Evaluating Micronutrient Levels in CeD on GFD compared to either Control Group

Study, Year	Country	Study design	Age Category	N	GFD length	Vit A	Vit B1	Vit B2	Vit B6	Vit B12	Vit D	Vit 1,25-OH D	Vit E	Vit K	Calcium	Copper	Ferritin	Folate	Iron	Mg	Selenium	Zinc
CED not on GFD compared to GFD																						
Anand 1977	UK	2	NR	25	Short-Term*														**			
Bayrak 2020	Turkey	4	Children	175	Long-Term																	
Boda 1989	Hungary	2	Children	49	Short-Term																	
Bulut 2023	Turkey	2	Children	49	Short-Tem						**				**							
Choudhary 2017	India	4	Children	72	Short-Term*										**							
Ciacci 2020	Italy	2	Adults	105	Long-Term																	
Corazza 1988	Italy	2	Adults	48	Short-Term*																	**
Corazza 1995	Italy	4	Adults	31	Short-Term*						**				**							
Cortigiani 1989	Italy	2	Children	73	Short-Term*																**	
Dickey 2008	Ireland	2	NR	76	Short-Term*													**				
González 1995	Argentina	4	Adults	32	Long-Term																	
Henker 1985	Germany	3	Children	111	Short-Term																	**
Högberg 2009	Sweden	3	Children	25	Short-Term																	**
Hozyasz 2003	Poland	3	Both	30	Long-Term								**									
Kalayci 2001	Turkey	2	Children	32	Long-Term										**							
Kalita 2002	Poland	3	Children	40	NR (Short-																**	
Karkoszka 2000	Poland	3	Children	73	Long-Term										**							
Kavak 2003	Turkey	2	Children	62	Short-Term*										**							
Keaveny 1996	Ireland	3	Adults	35	Long-Term							**										
Kemppainen 1995	Finland	3	Adults	88	Short-Term*					**												
Klimov 2017	Russia	2	Children	59	NR (Short-																	
Margoni 2012	Greece	3	Children	81	Long-Term																	
Mazure 1994	Argentina	2	Adults	34	Long-Term																	
McGrogan 2021	UK	3	Children	69	Short-Term*		**		**				**	**			**			**		
Piatek-Guziewicz 2017 May	Poland	2	Adults	145	Long-Term																	
Piatek-Guziewicz, 2017 Nov	Poland	2	Adults	60	Long-Term																	
Reinken 1976	Austria	2	Children	20	Short-Term*				**													
Romańczuk 2016	Poland	3	Both	55	NR (Short-																	
Sabel'nikova 2013	Russia	3	Adults	142	NR (Short-										**				**			
Selbuz 2021	Turkey	2	Children	56	Short-Term*																	
Singhal 2008	India	2	Children	30	Short-Term																	
Szymczak 2012	Poland	2	Adults	35	Short-Term*						**				**							
Uyanikoglu 2021	Turkey	2	Adults	80	NR (Short-																	
Volkan 2018	Turkey	2	Children	47	Short-Term*					**					**			**				
Non CeD controls compared to CED on GFD																						
Ballestero-Fernández 2019	Spain	4	Children	137	Short-Term*																	
Ballestero-Fernández 2021	Spain	4	Adults	138	Short-Term*																	
Bayrak 2020	Turkey	4	Children	238	Long-Term																	
Björk, 2017	Sweden	2	Children	90	Long-Term																	
Boda, 1989	Hungary	2	Children	40	Short-Term																	
Corazza 1988	Italy	2	Adults	48	Short-Term*																	
Corazza, 1995	Italy	4	Adults	38	Short-Term*																	
Cortigiani, 1989	Italy	2	Children	87	Short-Term*																	
Dickey 2008	Ireland	2	NR	241	Short-Term*																	
Efe, 2023	Turkey	2	Children	122	Short-Term																	
El Amrousy, 2024	Egypt	3	Children	80	Short-Term																	
Elli 2015	Italy	2	Adults	114	Long-Term																	
Isikay 2018	Turkey	4	Children	494	Short-Term*																	
Kalayci, 2001	Turkey	2	Children	98	Long-Term																	
Kalita, 2002	Poland	3	Children	58	NR (Short-																	
Klimov 2017	Russia	2	Children	51	NR (Short-																	
Mansueto, 2023	Italy	2	Adults	298	Short-Term*																	
Pazianas 2005	UK	2	Adults	44	Long-Term																	
Piatek-Guziewicz, 2017 May	Poland	2	Adults	144	Long-Term																	
Piatek-Guziewicz, 2017 Nov	Poland	2	Adults	56	Long-Term																	
Reinken, 1976	Austria	2	Children	16	Short-Term*																	
Romańczuk, 2016	Poland	3	Both	68	NR (Short-																	
Singhal 2008	India	2	Children	34	Short-Term																	
Szaflarska-Poplawska, 2022	Poland	4	Children	98	Long-Term																	
Szymczak, 2012	Poland	2	Adults	55	Short-Term*																	
Ünal 2012	Turkey	2	Children	37	Short-Term																	
Uyanikoglu, 2021	Turkey	2	Adults	80	NR (Short-																	
Valente 2015	Brazil	4	Adults	59	Short-Term																	
Volkan, 2018	Turkey	2	Children	51	Short-Term*																	
Non CeD controls compared to NCWS																						
Mansueto, 2023	Italy	2	Adults	368	Short-Term*					**							**	**	**			

NOTE: 1=RCT; 2=Case control ; 3=Cohort ; 4= Cross-sectional. Green= increased in mean micronutrient levels in patients on GFD compared to control, Red= decreased in mean micronutrient levels in patients on GFD compared to control, Yellow= no change in mean micronutrient levels in patients on GFD compared to control, Grey- only dichotomous data provided or incomplete, blank is not measured within the study. CeD- Celiac Disease GFD= Gluten free diet. Vitamin C was not included as was not compared to controls[29]

*- Determined to be short term due to lack of definitive length of GFD over 2 years in text

**- Statistically significant difference ($p<0.05$)

Supplementary data: Studies evaluating levels of vitamins and minerals reported as continuous outcomes.

Vitamin A

Serum vitamin A levels were available for two cohort studies that showed no significant difference between groups (Supplementary Figure S1B).

Vitamin B1

Serum levels of vitamin B1 was assessed in one study[31]. Serum levels of vitamin B1 was significantly higher in CeD on GFD compared to CeD not on GFD (Mean Difference; MD=265; 95%CI=215,315) (Supplementary Figure S2C, Supplementary Table 6). One study[28] assessed Vitamin B1 in CeD on GFD compared to non CED controls and found as significantly decrease in Vitamin B1 in CeD on GFD (MD= -6.20; 95%CI= -10.88, -1.52) (Supplementary Figure S2D). The quality of data was determined to be low due to high risk of bias (Table 2).

Vitamin B2

A case-control study[47] comparing CeD on GFD with both and CeD not on GFD and non-CeD controls, provided EGRAC activity as a marker of serum vitamin B2 levels and found no significant difference between CeD on GFD and CeD not on GFD (Supplementary Figure S3B) although the CeD on GFD group had significantly lower EGRAC than non-CeD controls (MD=-0.08; 95%CI=-0.12,-0.04; Table 1, Supplementary Figure S3C, and Supplementary Table 6). Another study[28] found significantly higher serum vitamin B2 levels measured by HPLC in CeD on GFD compared to non-CeD controls (MD= 0.67; 95%CI= 0.27, 1.08) (Supplementary Figure S3D).

Vitamin B6

Vitamin B6 levels were measured by 4 studies using different methodology for assessment and therefore the studies were not combined for analysis. One study[31] found significantly lower levels of serum Vitamin B6 measured in hemoglobin (MD=-

1024; 95%CI=-1399.79, -648.21) (Supplementary Figure S4B). The remaining two studies, measuring vitamin B6 in serum pyridoxal phosphate (PALP) (ng/ml)[56] and pyridoxal-5-phosphate (PLP) (pmol/g)[40] showed levels of vitamin B6 were higher in CeD on GFD compared with CeD not on GFD (MD=4.11; 95%CI=0.90,7.32) but were similar to non-CeD controls by all methods, including HPLC by another study (REF) (Supplementary Figure S4C, 4D and Supplementary Table 6)

Vitamin B12

Two studies[47,63] assessing serum vitamin B12 deficiency in CeD on GFD compared to CeD not on GFD, and four studies [39,40,47,63] assessing CeD on GFD compared to non-CeD controls had continuous data only (Table 1, Supplementary Table 6). Serum vitamin B12 levels were significantly higher in CeD on GFD compared to CeD not on GFD in four studies [29,31,47,63] (MD=68.83; 95%CI=32.85,104.80; I2=0%) (Supplementary Figure S5C). Serum vitamin B12 levels were not significantly different in CeD on GFD compared to non-CeD controls in seven studies (MD =-4.18; 95%CI=-25.72, 17.36; I2=81%) (Supplementary Figure S5D). Sub group analysis based on study design, GFD length and population did not resolve heterogeneity (Supplementary Figure S5E-G). However of note, sensitivity analysis with eliminating one study[52] where means were calculated from the median did affect the final result.

Vitamin D

Fourteen studies demonstrated significantly higher serum Vitamin D levels in CeD on GFD compared to CeD not on GFD (MD=2.62; 95%CI=1.68, 3.56; I^2=51%) (Supplementary Figure S6Ei) and the associated funnel plot did not show significant asymmetry (Egger's test intercept =-0.44; 95%CI=-1.40- 0.52; t=-1.03, p=0.33) (Supplementary Figure S6Fii). On subgroup analysis, CeD on Long-Term GFD resolved heterogeneity (Supplementary Figure S6G). Fifteen studies did show a significant decrease in serum levels of Vitamin D in CeD on GFD compared to non-CeD controls (MD=-3.33; 95%CI=-5.72, -0.93; I^2=87%) (Supplementary Figure S6I). Subgroup analyses by study design, GFD duration and age did not resolve heterogeneity (Supplementary Figure S6F-L).

Five studies provided continuous data only for serum levels of 1,25(OH) vitamin D in CeD on GFD compared to CeD not on GFD or non-CeD controls. The characteristics are summarized in both Table 1 and Supplementary Table 6. Four studies showed significantly lower serum levels of 1,25(OH) vitamin D in CeD on GFD compared to CeD not on GFD (MD=-10.07; 95%CI=-19.06,-1.09; I2=87%) (Supplementary Figure S7B). Sensitivity analysis by removing the one study[23] that reported low dose vitamin D supplementation in 4/19 of CeD not on GFD resolved heterogeneity (MD= -5.78; 95% CI= -10.11, 01.45; I2=0%) but did not change overall results (Supplementary Figure S7C). The levels of 1,25(OH) vitamin D were not significantly different when comparing CeD on GFD to non-CeD controls (Supplementary Figure S7D and 7E). The quality of evidence was determined to be very low due to risk of bias (Table 2).

Vitamin E

Two studies assessed proportion of Vitamin E deficiency by erythrocyte level demonstrated a significantly lower risk in CeD on GFD compared to CeD not on GFD (OR = 0.03; 95%CI=0.00-0.41; I2=38%; Supplementary Figure S8B). One study that assessed serum vitamin E levels by chromatography demonstrated a significant higher level in CeD on GFD compared to CeD not on GFD (MD=5.44; 95%CI=0.68,10.20) (Supplementary Figure S8C). The other studies assessing vitamin E levels by different methodology and comparing both CeD on GFD to CeD not on GFD did not show overall significant differences in levels (Supplementary Figure S8D-8G). Both studies comparing CeD on GFD to non-CeD controls demonstrated a significantly lower levels in CeD on GFD (MD=-4.91; 95%CI=-14.3,4.47; I2=80%; Supplementary Figure S8H). Subgroup analysis by methodology or length of GFD did not resolve heterogeneity. The quality of evidence was determined to be very low due to risk of bias (Table 2).

Vitamin K

Levels of Vitamin K was assessed in 2 studies; one measured plasma levels of vitamin K controlled for triglycerides, and the remaining case-control study measured plasma levels of vitamin K not controlled for triglycerides. Pooled data showed significantly higher serum

levels of vitamin K between CeD on GFD compared to either CeD not on GFD or non-CeD controls (MD=0.53; 95%CI=0.37,0.69; Supplementary Figure S9A and 9B).

Calcium

Ten studies that assessed serum levels of calcium in CeD on GFD compared to CeD not on GFD presented continuous data. In addition, all studies comparing serum calcium levels of CeD on GFD to non-CeD controls reported continuous data. The characteristics of these studies are summarized in Table 1 and Supplementary Table 6. Two studies reported median levels of calcium were in the normal range in both CeD on GFD and non-CeD controls, however the interquartile range (IQR) did include levels below the normal range. Authors were contacted to provide dichotomous data. There were significantly higher calcium levels in CeD not on GFD compared with CeD on GFD (MD=0.07;95%=0.04-0.10; I2=94%) in 14 studies (Supplementary Figure S10Fi). Subgroup analysis by study design or length of GFD, or age did not resolve the heterogeneity or changed the results (Supplementary Figure S10G-10I). The asymmetric funnel plot of pooled studies suggested publication bias (Egger's test intercept=-1.466; 95%CI=-3.971,1.04; t=-1.23, p=0.226) (Supplementary Figure S10Fii). Eight studies assessing serum calcium levels between CeD on GFD and non-CeD controls showed similar calcium levels between groups (MD=-0.02; 95%CI=-0.07,0.03; I2=88%), with high heterogeneity that did not resolve with planned subgroup analyses (Supplementary Figures 10J-10M). The quality of evidence was determined to be very low due to risk of bias and inconsistency (Table 2).

Copper

One cohort study assessed serum copper levels in CeD on GFD compared with CED not on GFD in 65 participants. There was no difference in serum copper levels (MD=-0.43; 95%CI=-2.2,1.34) (Supplementary Figure S11B)

Folate

Two studies that assessed folate serum levels in CeD on GFD compared to CeD not on GFD reported only continuous data. An additional six studies comparing serum folate

levels of CeD on GFD to non-CeD controls presented only continuous data. Two studies mentioned that the median levels of folate were in the normal range in both CeD on GFD and non-CeD controls, however the IQR did include levels below the normal range. Authors were contacted to provide more data for dichotomous analysis. The characteristics of these studies are summarized in Table 1 and Supplementary Table 6. One cohort study reported higher erythrocyte folate levels in CeD on GFD compared to CeD not on GFD (MD=174; 95%CI=83, 262). Three studies showed no difference in serum folate levels comparing CeD on GFD to CeD not on GFD (MD=4.82; 95%CI=-1.57,11.21; I2=53%) (Supplementary Figure S12D). All studies were short term GFD. Subgroup analysis by study design and age did not resolve heterogeneity (Supplementary Figure S12E-F). In addition, there was also no significant difference in serum folate levels between CeD on GFD and non-CeD controls in nine pooled studies (MD=-3.63; 95%CI=-8.21,0.94; I2=94%) (Supplementary Figure S12G). Subgroup analysis by study design and population did not resolve heterogeneity (Supplementary Figure S12H-12J). The quality of evidence was determined to be very low due to risk of bias (Table 2).

Ferritin

Two studies that assessed serum ferritin levels in CeD on GFD compared to CeD not on GFD presented continuous data. In addition, the remaining four studies comparing serum ferritin levels of CeD on GFD to non-CeD controls reported continuous data. The characteristics of these studies are summarized in Table 1 and Supplementary Table 6. Four studies demonstrated a significantly higher serum ferritin levels in CeD on GFD compared to CeD not on GFD (MD=10.82, 95%CI= 5.97,15.71; I2=0%) (Supplementary Figure S13B). Eight studies showed a significantly decreased level of ferritin in CeD on GFD compared to non-CeD controls (MD=-13.45; 95%CI=-25.39,-1.50; I2=98%) (Supplementary Figure S13C). The heterogeneity did resolve with both study design and length of GFD, but not population (Supplementary Figure S13D-F). The quality of evidence was determined to be very low due to risk of bias (Table 2).

Iron

One study that assessed serum iron levels in CeD on GFD compared to CeD not on GFD reported only continuous data. For comparison to non-CeD controls, one study[47] suggested 42% (16/38) of patients with CeD on GFD had iron deficiency but did not report the status of the non-CeD control group. The other remaining two studies reported normal median serum iron levels for both CeD on GFD and non-CeD controls, although the IQR did include levels below the normal range. Authors were contacted for clarification but no response was received. The characteristics of these studies are summarized in Table 1 and Supplementary Table 6. Three pooled studies did not find a significant difference in serum iron levels and subgroup analysis with study design, GFD length and population did not resolve heterogeneity between CeD on GFD and not on GFD (Supplementary 14B-14D). Six studies assessing CeD on GFD to non-CeD controls found significant decrease in serum iron levels in CeD on CFD (MD= -11.72, 95%CI= -21.28, -2.17, I2= 90%) (Supplementary Figure S14E). Subgroup analysis by study design, length of GFD and population did not resolve heterogeneity (Supplementary Figure S14F-14H).

Magnesium

Three pooled studies demonstrated no significant difference in serum magnesium levels between CeD on GFD compared to CeD not on GFD (MD=0.02, 95%CI=-0.02,0.06, I2=79%) (Supplementary Figure S15B). All studies were on short-term GFD. Subgroup analysis by study design and population did not improve heterogeneity or change the results (Supplementary Figure S15C, 15D). Two studies demonstrated no significant differences in the levels of serum magnesium in CeD on GFD compared to non-CeD controls (MD= -0.02; 95%CI=-0.27,0.22, I2=96%) (Supplementary Figure S15E). Heterogeneity did not resolve with subgroup analysis for study design or length of GFD (data not shown). The quality of evidence was determined to be very low due to risk of bias and imprecision (Table 2).

Selenium

Three studies assessing serum selenium levels in comparing CeD on GFD to both CeD not on GFD and non-CeD controls provided continuous data only. There was no difference in serum selenium levels between CeD on GFD compared to CeD not on GFD

(MD=1.61; 95%CI=-0.39,3.61; I2=97%) (Supplementary Figure S16C). Subgroup analysis by study design only, as all studies were in children on short-term GFD, did not resolve heterogeneity (Supplementary Figure S16D). In comparing CeD on GFD to non-CeD controls, there was no significant difference in serum selenium levels (MD=0.38; 95%CI=-1.95,2.71; I2=95%) (Supplementary Figure S16E). Subgroup analysis by study design and GFD length did not resolve heterogeneity (Supplementary Figure S16F, 16G). In comparing levels of selenium in erythrocyte data in one study; there was no difference in selenium levels between CeD on GFD compared to CeD not on GFD (Supplementary Figure S16H) but significantly lower levels in CeD on GFD compared to non CeD controls (Supplementary Figure S16I). The quality of evidence was determined to be very low due to risk of bias, inconsistency, and imprecision (Table 2).

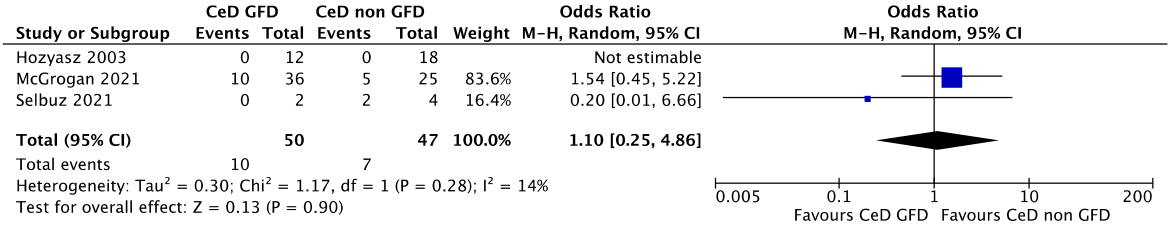
Zinc

Two studies assessing serum zinc levels in CeD on GFD compared to both CeD not on GFD and non-CeD controls provided continuous data only (Summarized in Table 1 and Supplementary Table 5). Five studies demonstrated a significantly increased mean serum zinc level in CeD on GFD compared to CeD not on GFD (MD=3.01; 95%CI=0.38,5.64; I2=94%) (Supplementary Figure S17B). Subgroup analysis by study design resolved the heterogeneity (Supplementary Figure S17C). Zinc levels were significantly lower in CeD on GFD compared to non-CeD controls in two pooled studies (MD=-1.88; 95%CI=-3.06,-0.69; I2=0%) (Supplementary Figure S17D). The quality of evidence was determined to be very low due to risk of bias, inconsistency, and imprecision (Table 2).

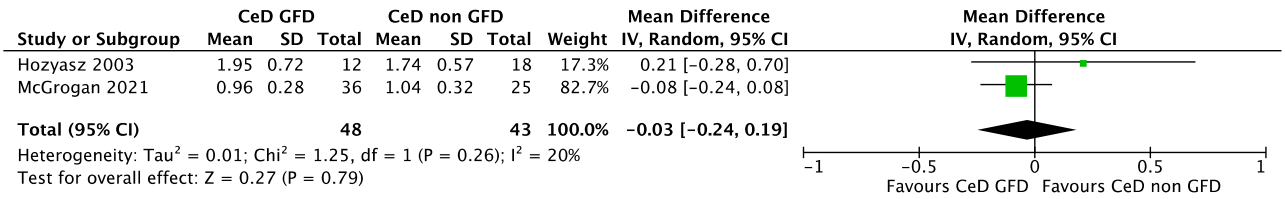
Supplementary Figures

Supplementary Figure S1. Vitamin A

S1A- Forest plot comparison of Vitamin A deficiency between CeD on GFD with CeD not on GFD

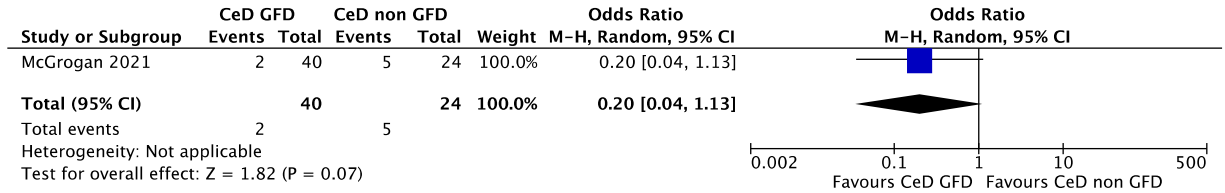


S1B- Forest plot comparison of means of serum Vitamin A levels between CeD on GFD with CeD not on GFD in cohort studies

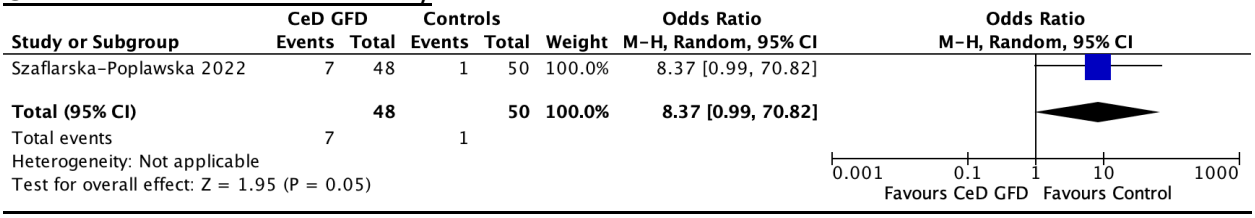


Supplementary Figure S2. Vitamin B1

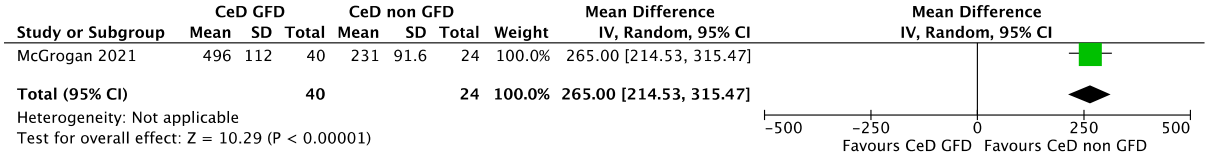
S2A- Forest plot comparison of Vitamin B1 deficiency between CeD on GFD with CeD not on GFD in a cohort study



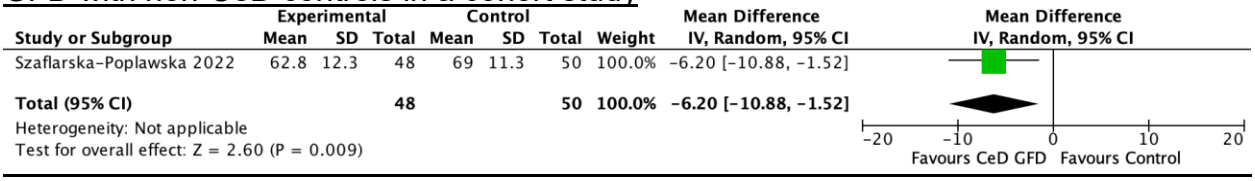
S2B- Forest plot comparison of Vitamin B1 deficiency between CeD on GFD with non-CeD controls in a cohort study



S2C- Forest plot comparison of means of serum Vitamin B1 levels between CeD on GFD with CeD not on GFD in a cohort study

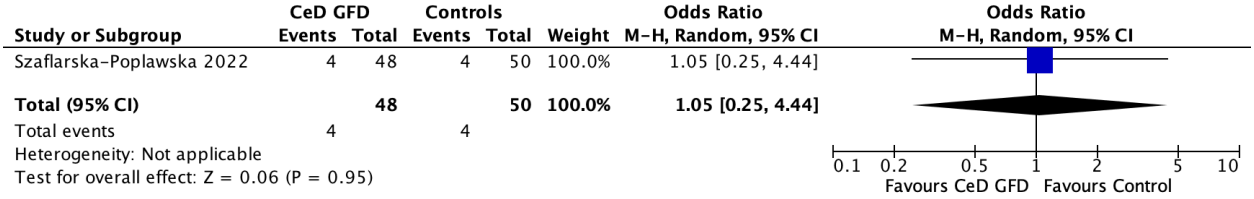


S2D- Forest plot comparison of means of serum Vitamin B1 levels between CeD on GFD with non-CeD controls in a cohort study

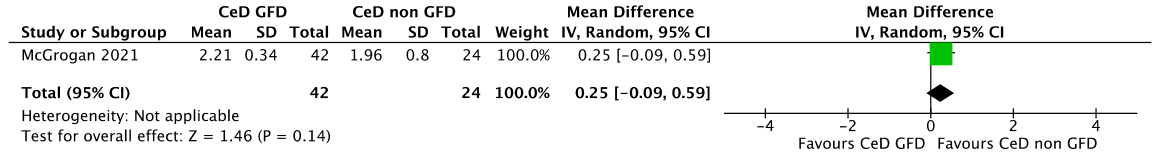


Supplementary Figure S3. Vitamin B2

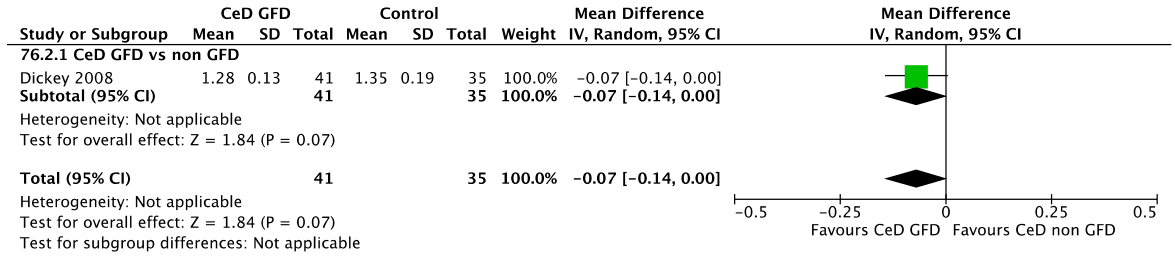
S3A- Forest plot comparison of Vitamin B2 deficiency between CeD on GFD with non-CeD controls in a cohort study



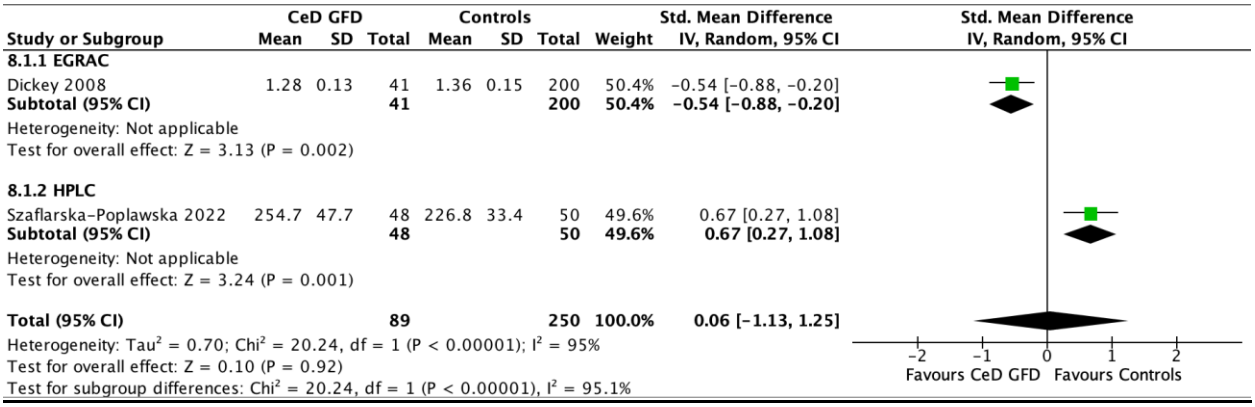
S3B- Forest plot comparison of means of serum Vitamin B2 levels between CeD on GFD with CeD not on GFD in a cohort study



S3C- Forest plot comparison of means of erythrocyte glutathione reductase reactivation coefficient (EGRAC) as a measure of Vitamin B2 levels between CeD on GFD with CeD not on GFD

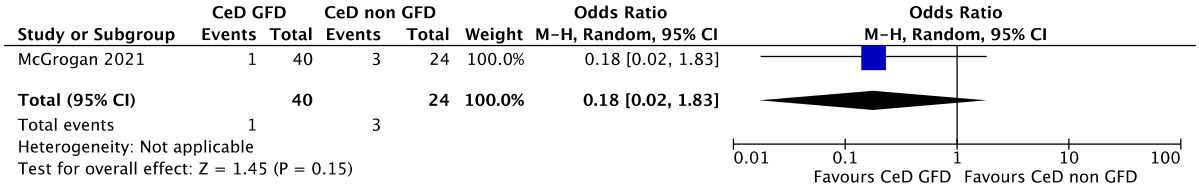


S3D- Forest plot comparison of means of erythrocyte glutathione reductase reactivation coefficient (EGRAC) and HPLC as a measure of Vitamin B2 levels between CeD on GFD with non-CeD controls

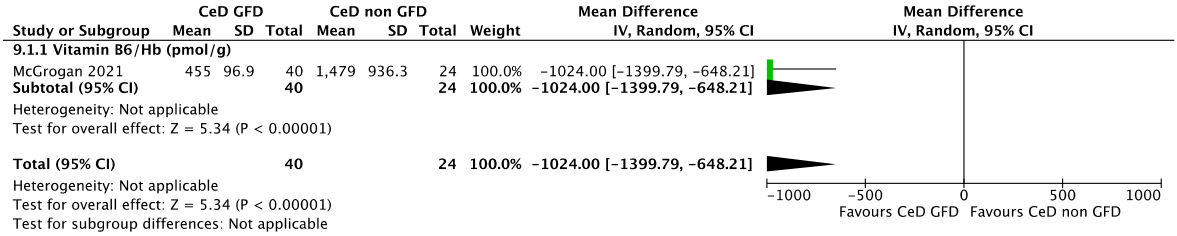


Supplementary Figure S4. Vitamin B6

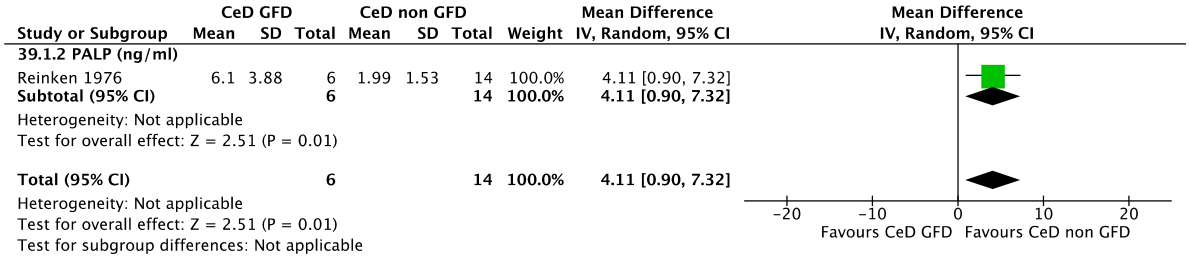
S4A- Forest plot comparison of Vitamin B6 deficiency between CeD on GFD to CeD not on GFD



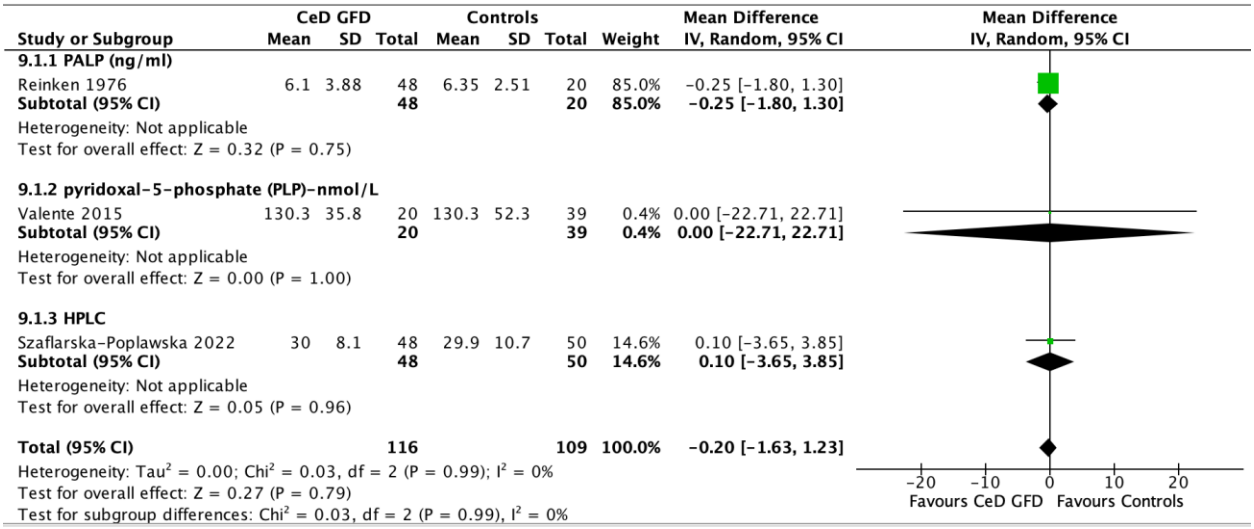
S4B- Forest plot comparison of means of serum Vitamin B6/Hb (pmol/g) between CeD on GFD to CeD not on GFD



S4C- Forest plot comparison of means of serum of pyridoxal phosphate (PALP) as a surrogate of Vitamin B6 levels between CeD on GFD to CeD not on GFD

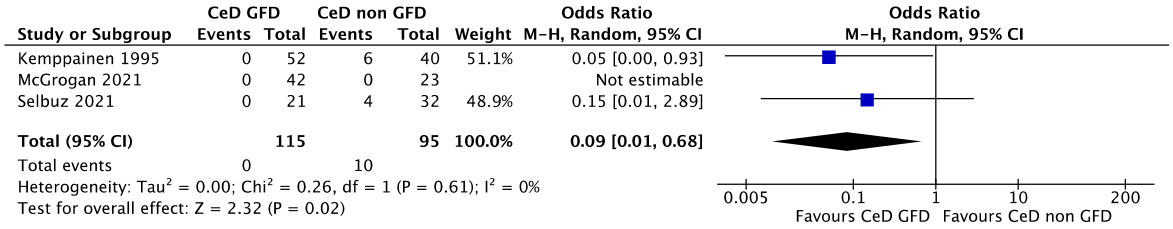


S4D- Forest plot comparison of levels of pyridoxal phosphate (PALP), PLP activity. and HPLC between CeD on GFD and non-CeD controls

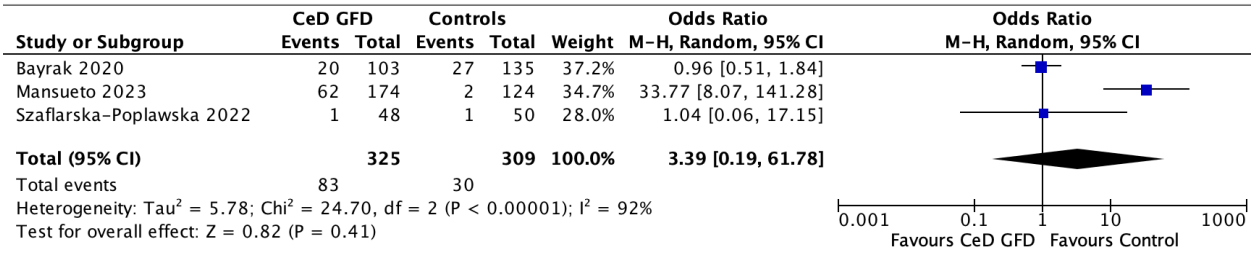


Supplementary Figure S5. Vitamin B12

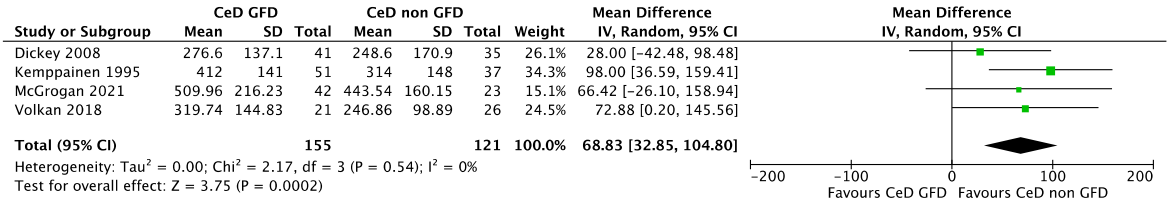
S5A- Forest plot comparison of Vitamin B12 deficiency between CeD on GFD to CeD not on GFD



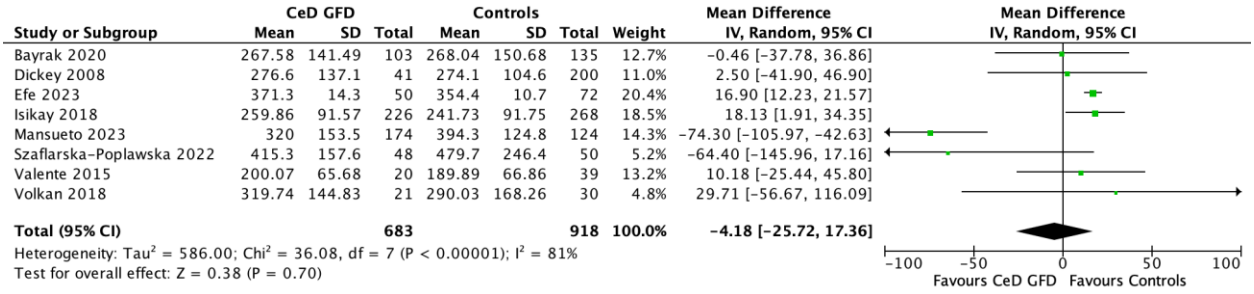
S5B- Forest plot comparison of Vitamin B12 deficiency between CeD on GFD to non-CeD controls



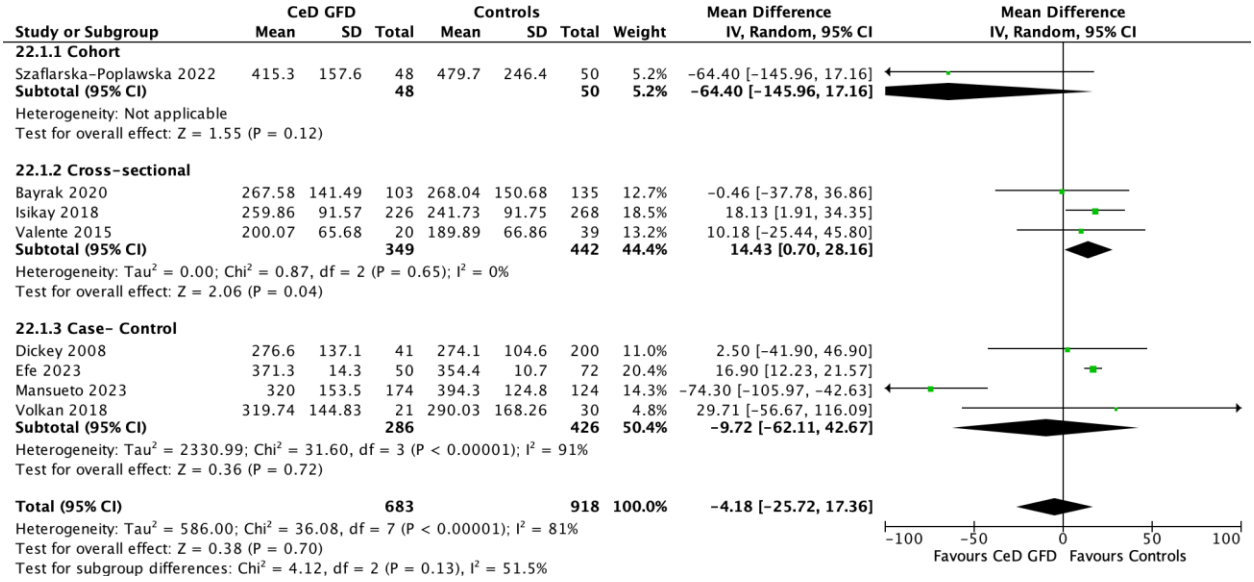
S5C- Forest plot comparison of means of serum Vitamin B12 levels between CeD on GFD to CeD not on GFD. Of note all studies are short term GFD.



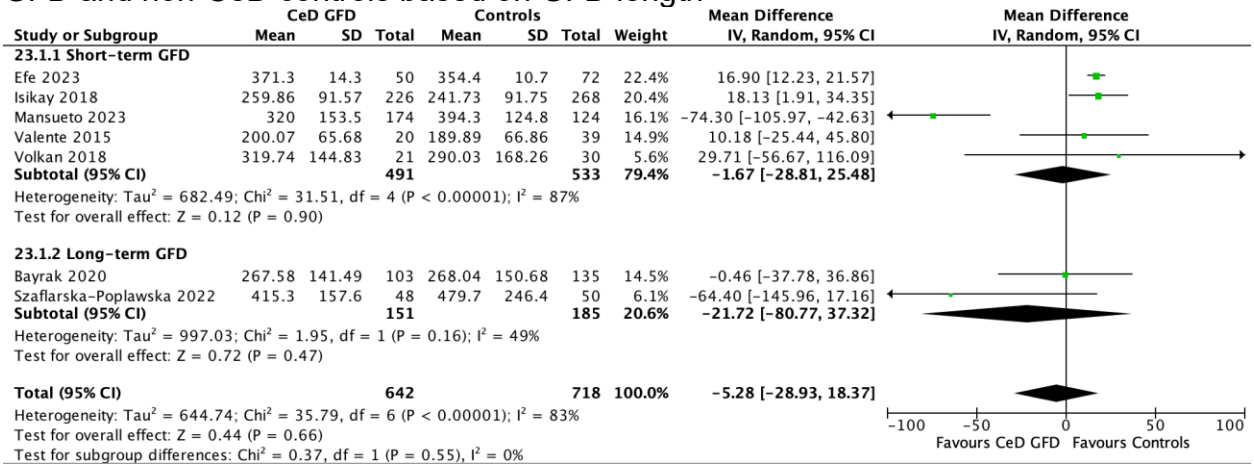
S5D- Forest plot comparison of means of serum Vitamin B12 levels between CeD on GFD and non-CeD controls



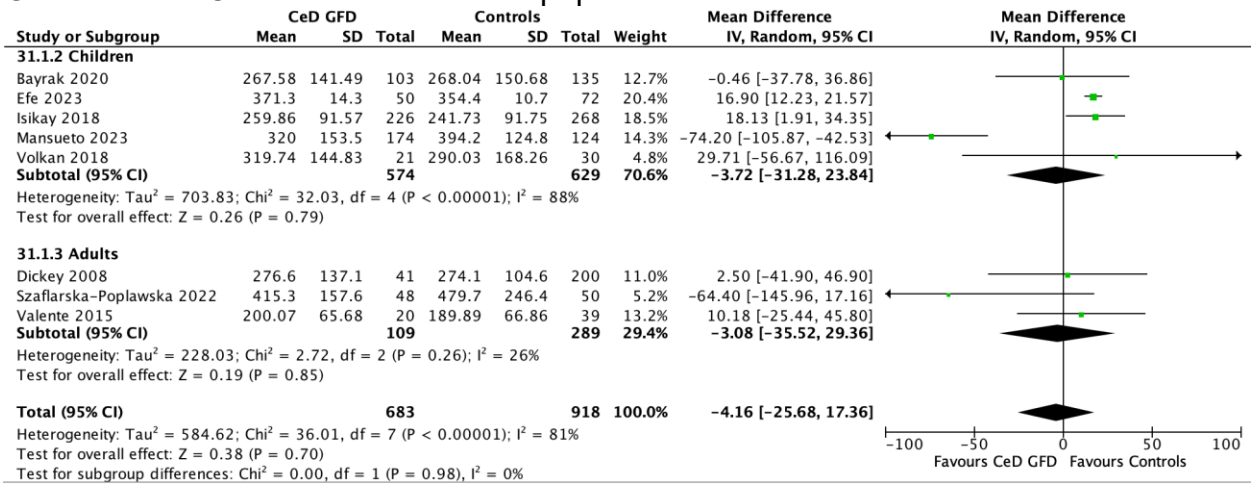
S5E- Forest plot comparison of means of serum Vitamin B12 levels between CeD on GFD and non-CeD controls based on study design



S5F- Forest plot comparison of means of serum Vitamin B12 levels between CeD on GFD and non-CeD controls based on GFD length

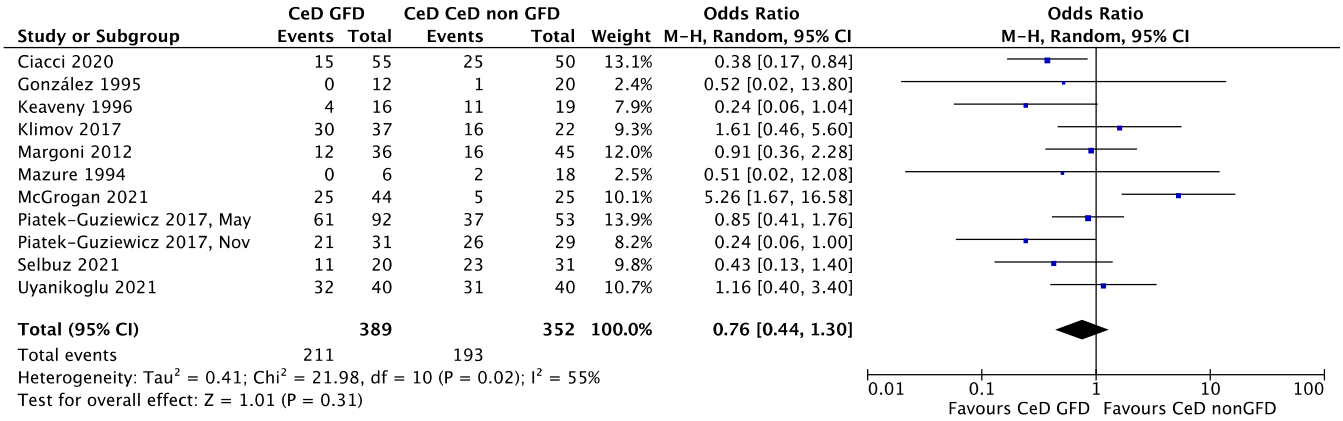


S5G- Forest plot comparison of means of serum Vitamin B12 levels between CeD on GFD and non-CeD controls based on population

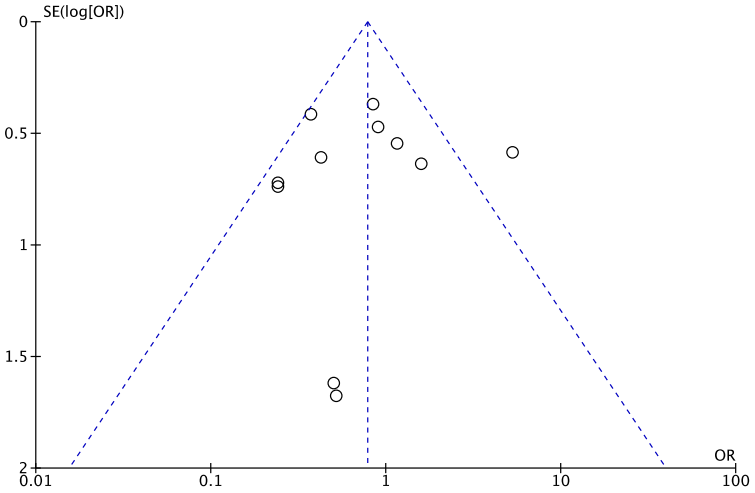


Supplementary Figure S6. Vitamin D

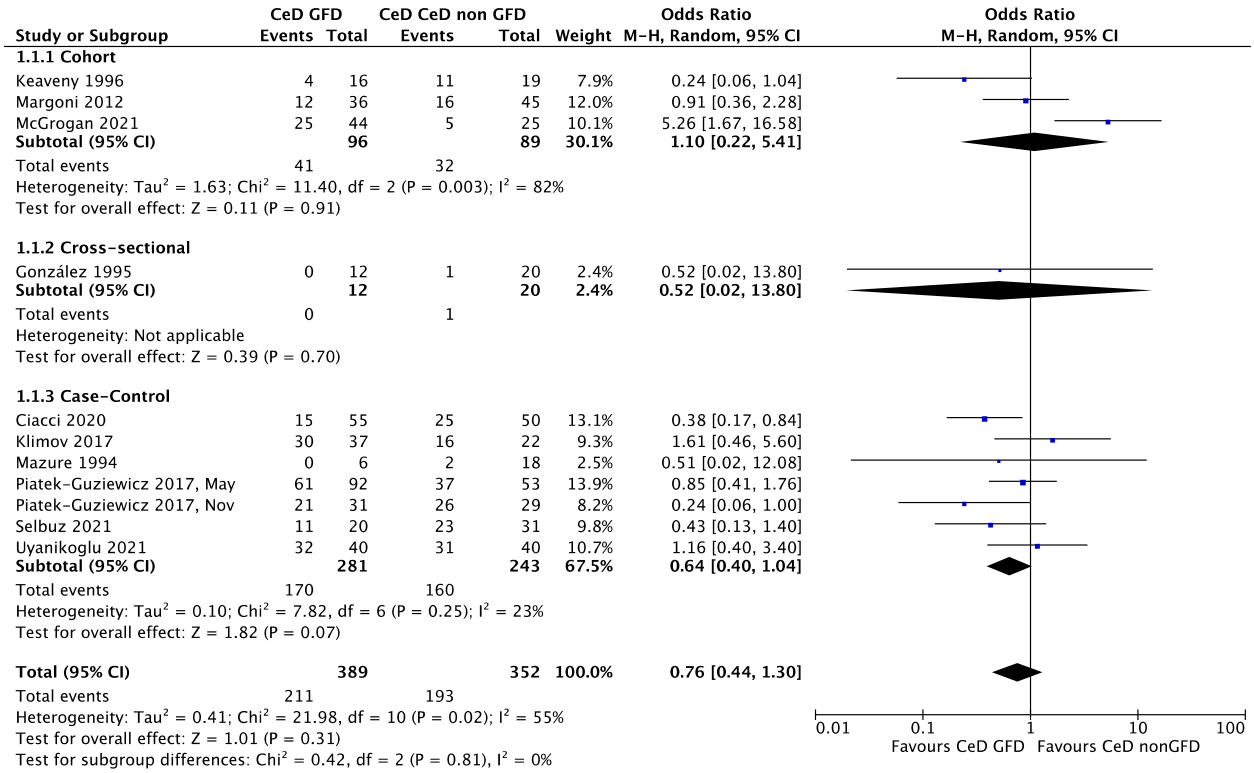
S6Ai- Forest plot comparison of Vitamin D deficiency between CeD on GFD and CeD not on GFD



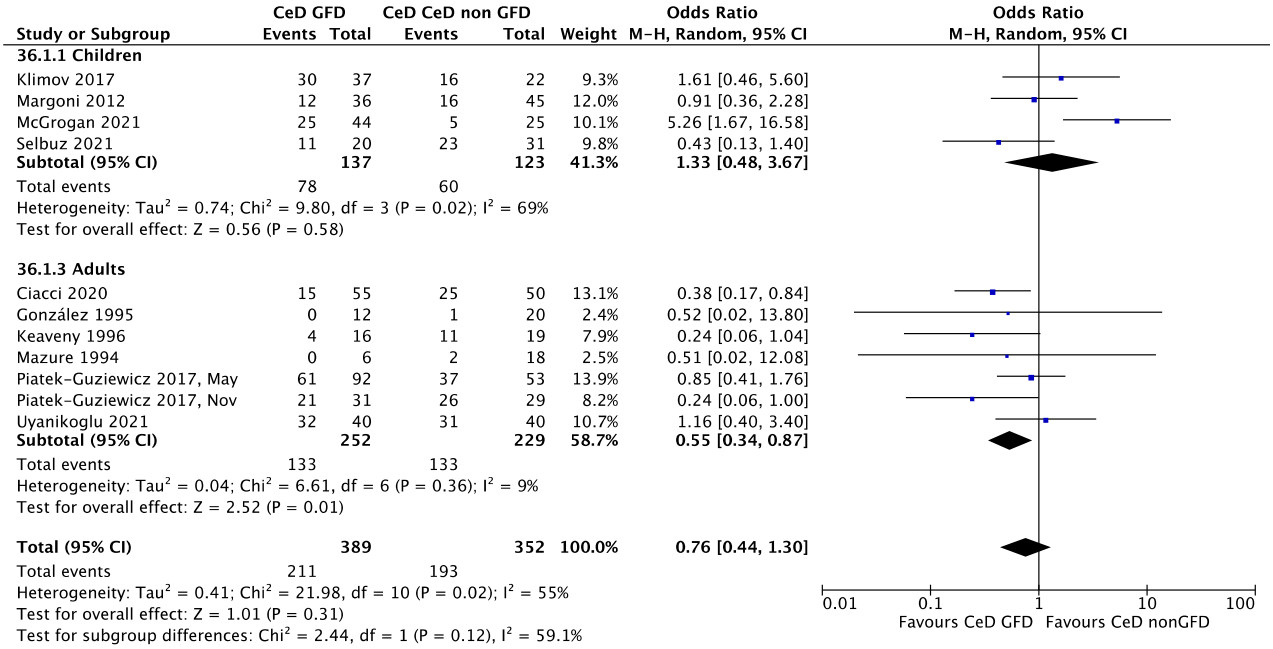
S6Aii- Funnel plot of studies within Ai comparing Vitamin D deficiency between CeD on GFD and CeD not on GFD



S6B- Forest plot comparison of Vitamin D deficiency between CeD on GFD and CeD not on GFD by study design

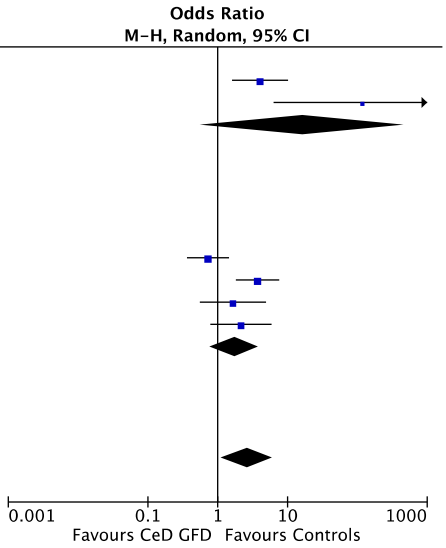


S6C- Forest plot comparison of Vitamin D deficiency between CeD on GFD and CeD not on GFD by population



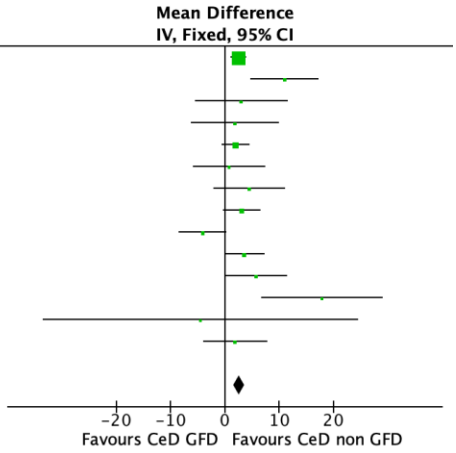
S6D- Forest plot comparison of Vitamin D deficiency between CeD on GFD and non-CeD controls by population

Study or Subgroup	CeD GFD Events	CeD GFD Total	Control Events	Control Total	Weight	Odds Ratio M-H, Random, 95% CI
51.1.1 Children						
Bayrak 2020	97	103	108	135	18.5%	4.04 [1.60, 10.20]
Klimov 2017	30	37	0	14	6.1%	117.93 [6.30, 2209.02]
Subtotal (95% CI)		**140**		**149**	**24.5%**	**16.47 [0.58, 470.17]**
Total events	127		108			
Heterogeneity: $Tau^2 = 4.79$; $Chi^2 = 4.90$, df = 1 (P = 0.03); $I^2 = 80\%$						
Test for overall effect: Z = 1.64 (P = 0.10)						
51.1.2 Adults						
Ballestero-Fernández 2021	22	64	31	74	20.5%	0.73 [0.36, 1.45]
Piatek-Guziewicz 2017, May	61	92	18	52	20.3%	3.72 [1.82, 7.61]
Piatek-Guziewicz 2017, Nov	21	31	14	25	17.0%	1.65 [0.55, 4.91]
Uyanikoglu 2021	32	40	26	40	17.7%	2.15 [0.78, 5.92]
Subtotal (95% CI)		**227**		**191**	**75.5%**	**1.74 [0.78, 3.89]**
Total events	136		89			
Heterogeneity: $Tau^2 = 0.47$; $Chi^2 = 10.58$, df = 3 (P = 0.01); $I^2 = 72\%$						
Test for overall effect: Z = 1.36 (P = 0.18)						
Total (95% CI)		**367**		**340**	**100.0%**	**2.64 [1.14, 6.08]**
Total events	263		197			
Heterogeneity: $Tau^2 = 0.76$; $Chi^2 = 21.29$, df = 5 (P = 0.0007); $I^2 = 77\%$						
Test for overall effect: Z = 2.27 (P = 0.02)						
Test for subgroup differences: $Chi^2 = 1.63$, df = 1 (P = 0.20), $I^2 = 38.7\%$						

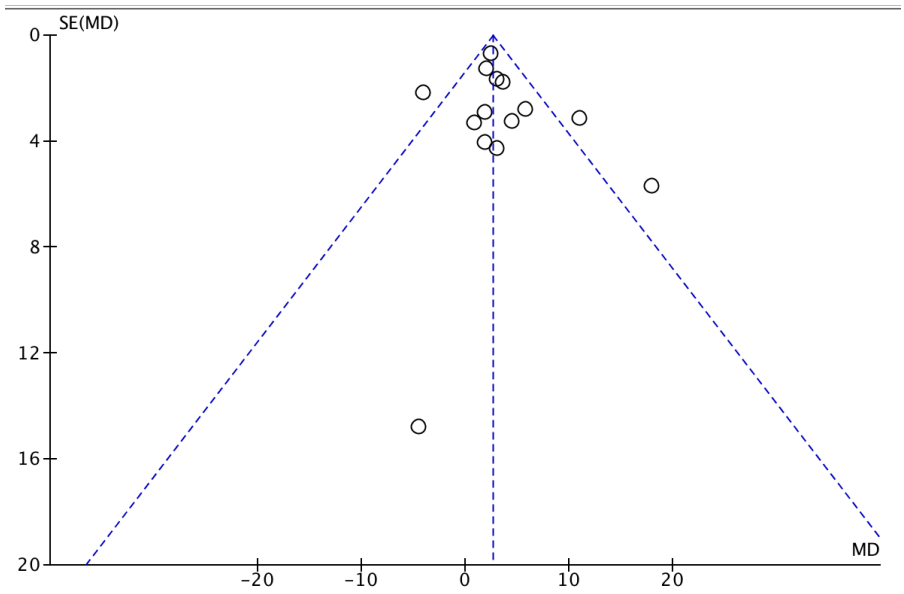


S6Ei- Forest plot comparison of means of serum Vitamin D levels between CeD on GFD and CeD not on GFD

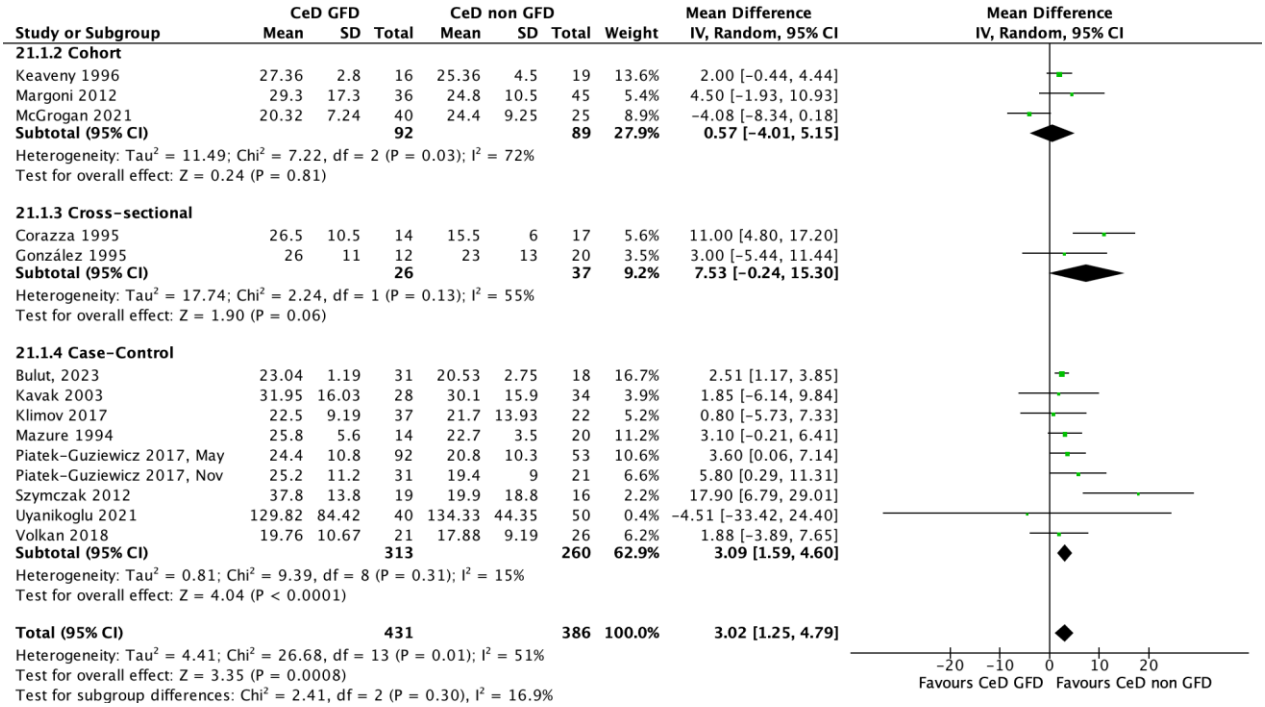
Study or Subgroup	CeD GFD Mean	CeD GFD SD	CeD GFD Total	CeD non GFD Mean	CeD non GFD SD	CeD non GFD Total	Weight	Mean Difference IV, Fixed, 95% CI
Bulut, 2023	23.04	1.19	31	20.53	2.75	18	49.6%	2.51 [1.17, 3.85]
Corazza 1995	26.5	10.5	14	15.5	6	17	2.3%	11.00 [4.80, 17.20]
González 1995	26	11	12	23	13	20	1.2%	3.00 [-5.44, 11.44]
Kavak 2003	31.95	16.03	28	30.1	15.9	34	1.4%	1.85 [-6.14, 9.84]
Keaveny 1996	27.36	2.8	16	25.36	4.5	19	14.8%	2.00 [-0.44, 4.44]
Klimov 2017	22.5	9.19	37	21.7	13.93	22	2.1%	0.80 [-5.73, 7.33]
Margoni 2012	29.3	17.3	36	24.8	10.5	45	2.1%	4.50 [-1.93, 10.93]
Mazure 1994	25.8	5.6	14	22.7	3.5	20	8.1%	3.10 [-0.21, 6.41]
McGrogan 2021	20.32	7.24	40	24.4	9.25	25	4.9%	-4.08 [-8.34, 0.18]
Piatek-Guziewicz 2017, May	24.4	10.8	92	20.8	10.3	53	7.1%	3.60 [0.06, 7.14]
Piatek-Guziewicz 2017, Nov	25.2	11.2	31	19.4	9	21	2.9%	5.80 [0.29, 11.31]
Szymczak 2012	37.8	13.8	19	19.9	18.8	16	0.7%	17.90 [6.79, 29.01]
Uyanikoglu 2021	129.82	84.42	40	134.33	44.35	50	0.1%	-4.51 [-33.42, 24.40]
Volkan 2018	19.76	10.67	21	17.88	9.19	26	2.7%	1.88 [-3.89, 7.65]
Total (95% CI)			**431**			**386**	**100.0%**	**2.62 [1.68, 3.56]**
Heterogeneity: $Chi^2 = 26.68$, df = 13 (P = 0.01); $I^2 = 51\%$								
Test for overall effect: Z = 5.45 (P < 0.00001)								



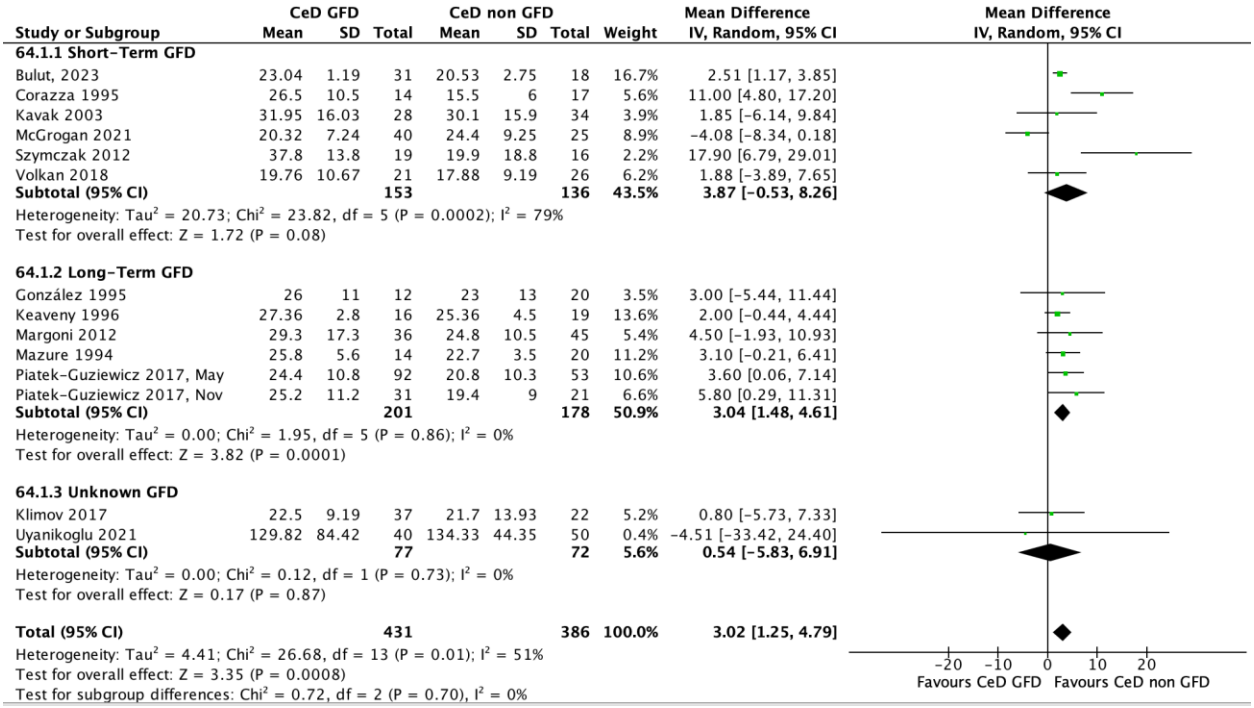
S6Eii- Funnel plot of studies within Fi comparing Vitamin D serum levels between CeD on GFD and CeD not on GFD



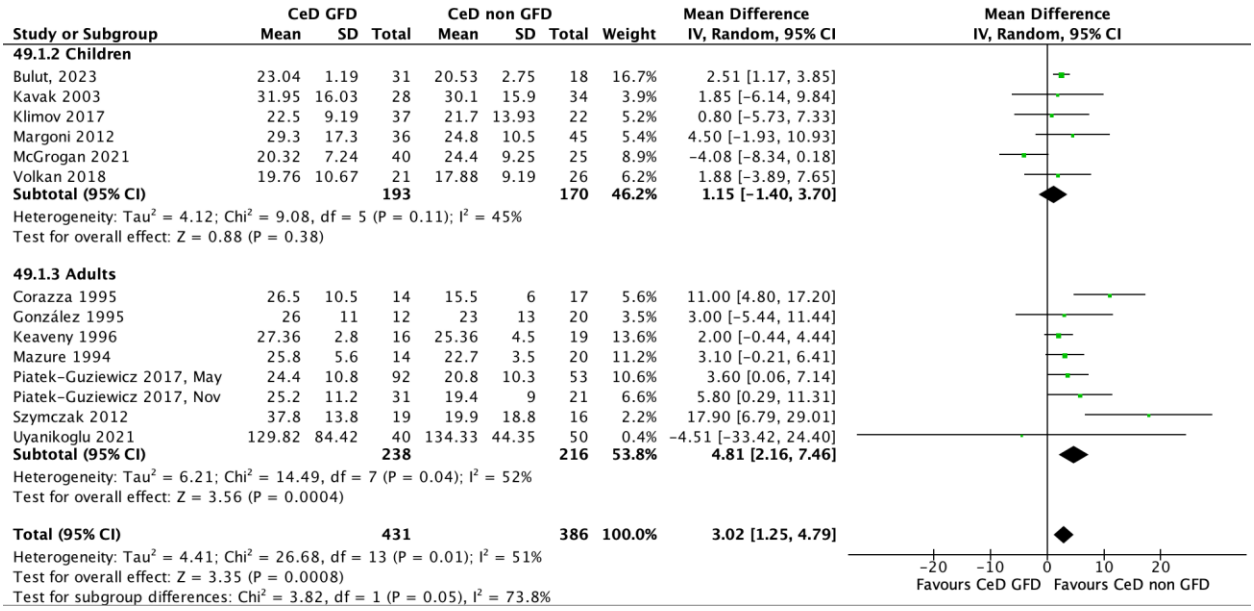
S6F- Forest plot comparison of means of serum Vitamin D levels between CeD on GFD and CeD not on GFD by study design



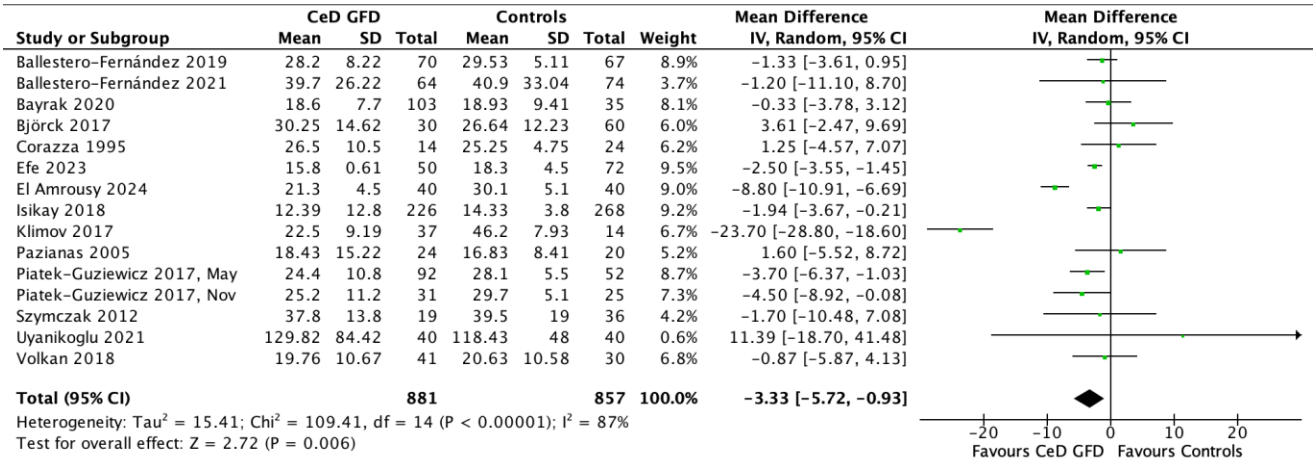
S6G- Forest plot comparison of means of serum Vitamin D levels between CeD on GFD and CeD not on GFD by GFD length



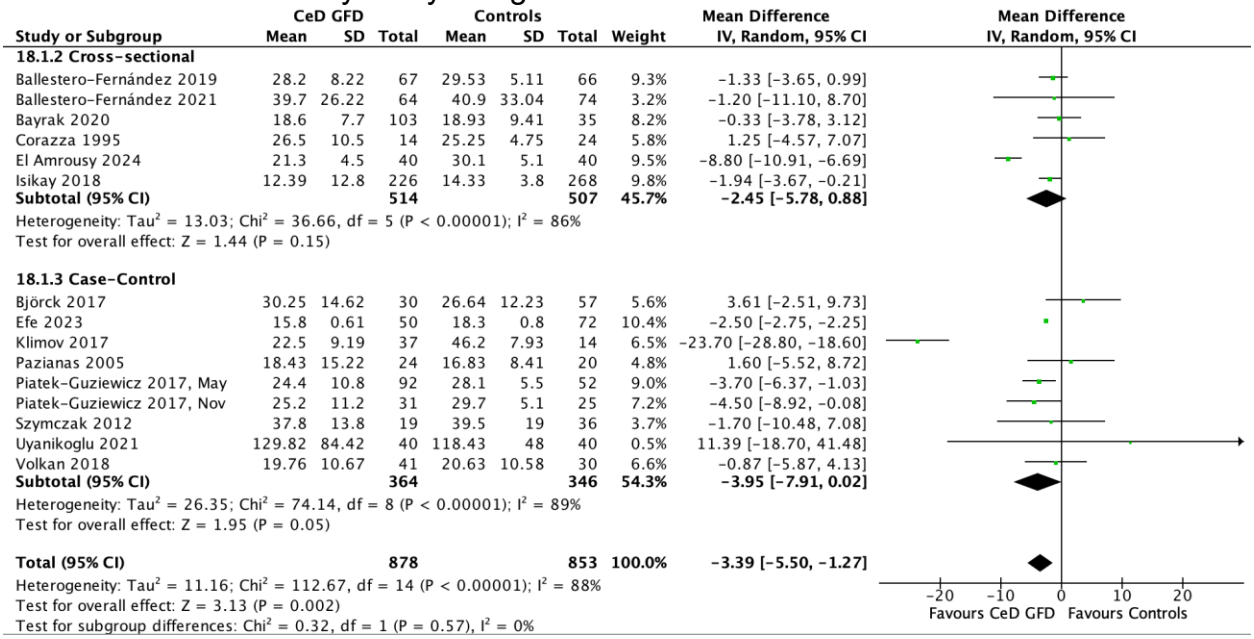
S6H- Forest plot comparison of means of serum Vitamin D levels between CeD on GFD and CeD not on GFD by population



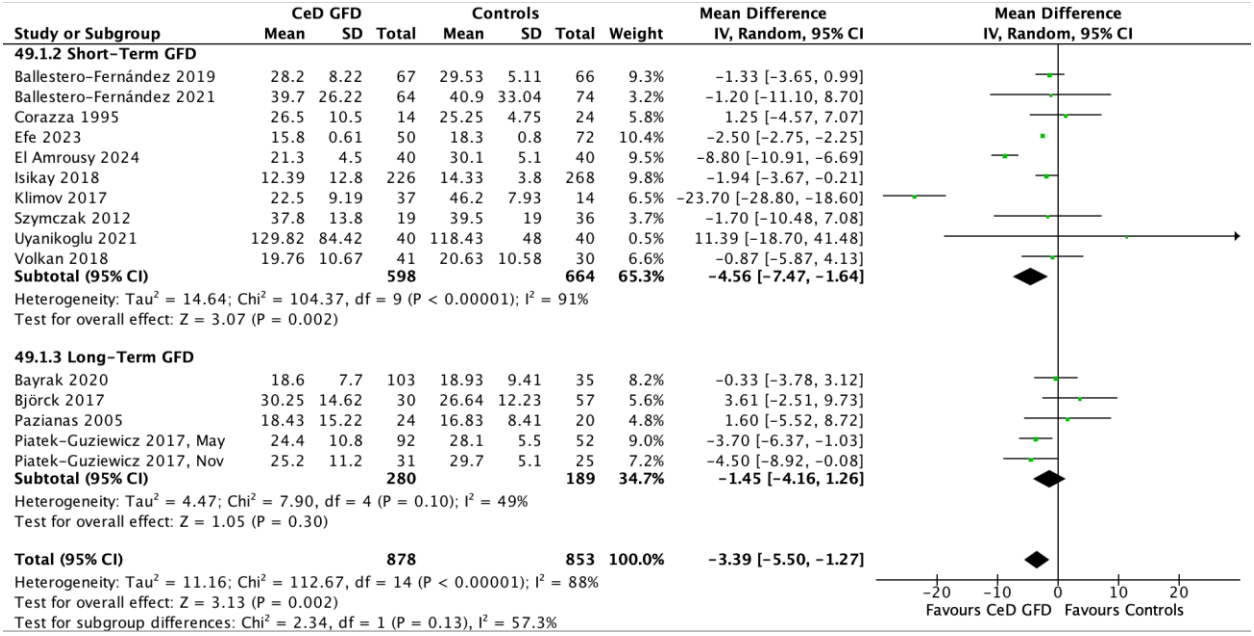
S6I- Forest plot comparison of means of serum Vitamin D levels between CeD on GFD and non-CeD controls



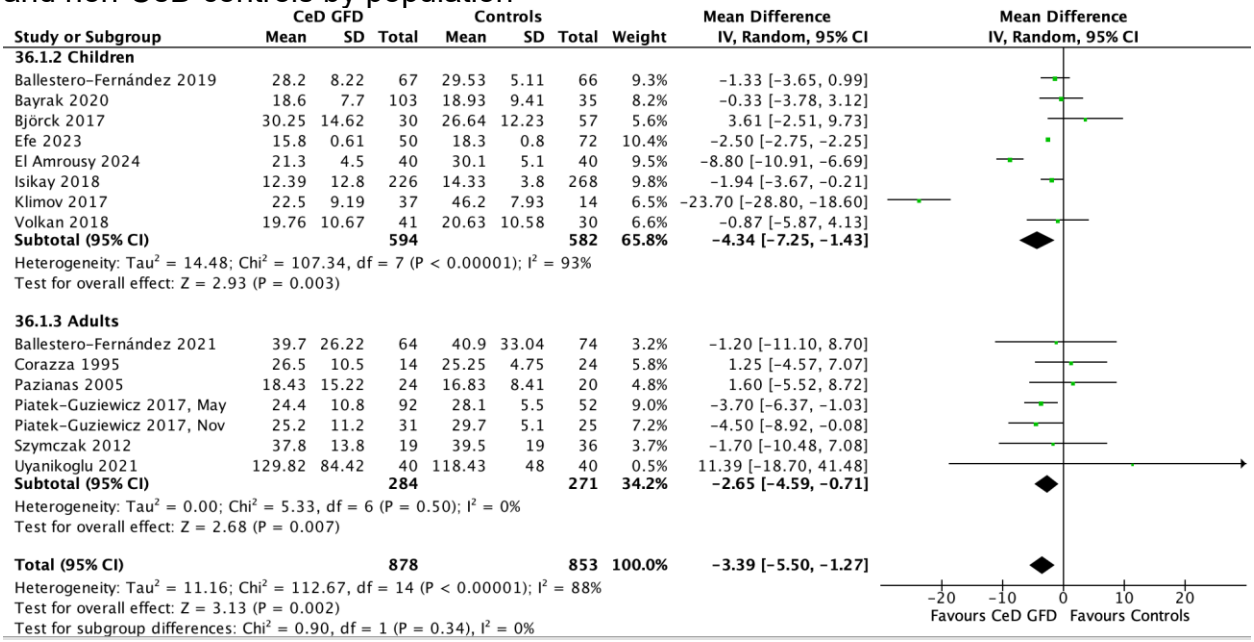
S6J- Forest plot comparison of means of serum Vitamin D levels between CeD on GFD and non-CeD controls by study design



S6K- Forest plot comparison of means of serum Vitamin D levels between CeD on GFD and non-CeD controls by GFD length

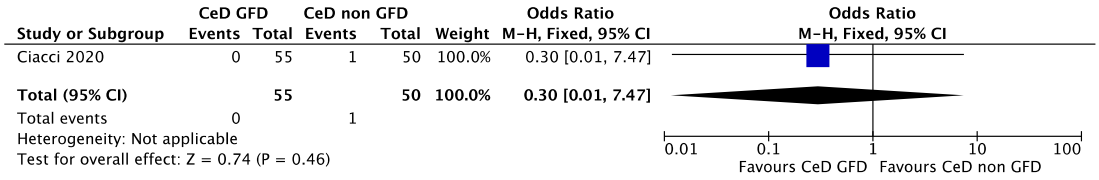


S6L- Forest plot comparison of means of serum Vitamin D levels between CeD on GFD and non-CeD controls by population

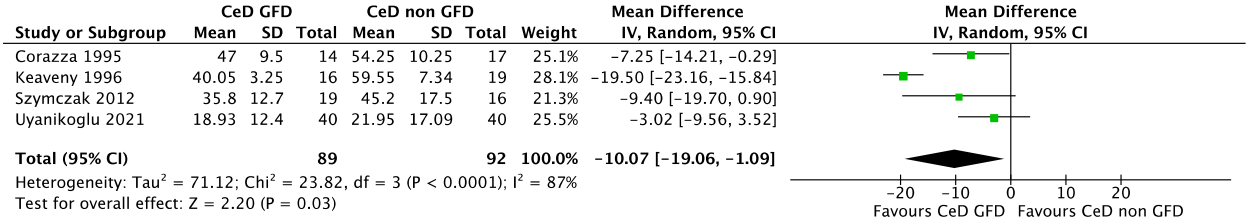


Supplementary Figure S7. 1,25-OH Vitamin D

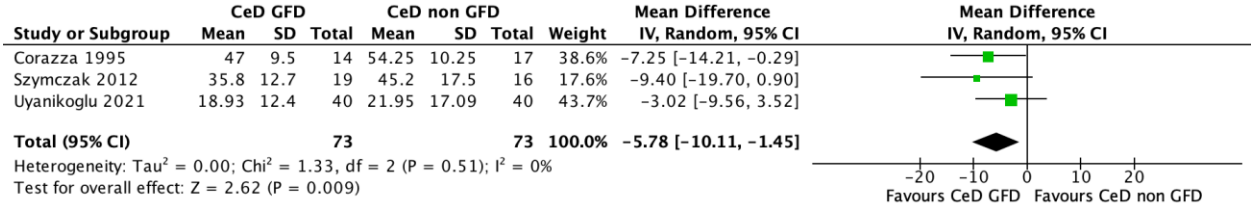
S7A- Forest plot comparison of Vitamin 1,25 OH D deficiency between CeD on GFD and CeD not on GFD



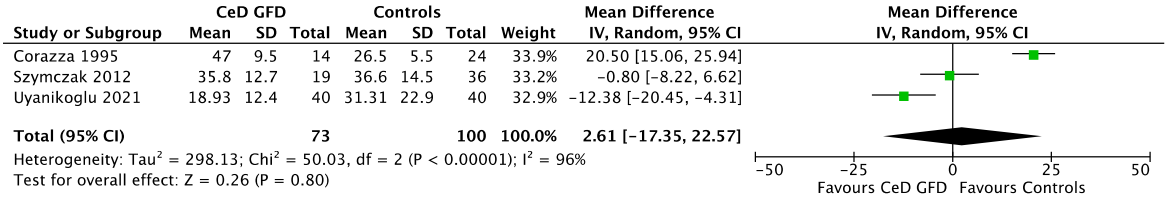
S7B- Forest plot comparison of means of serum 1,25-OH Vitamin D levels between CeD on GFD to CeD not on GFD



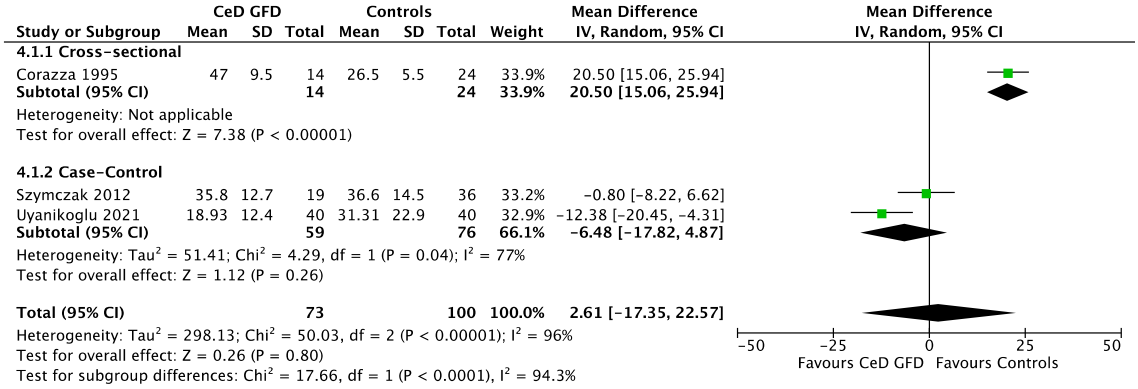
S7C- Forest plot comparison of means of serum 1,25-OH Vitamin D levels between CeD on GFD to CeD not on GFD sensitivity analysis removing Keaveny et al 1996.



S7D- Forest plot comparison of means of serum 1,25-OH Vitamin D levels in patients with CeD on GFD to non-CeD controls

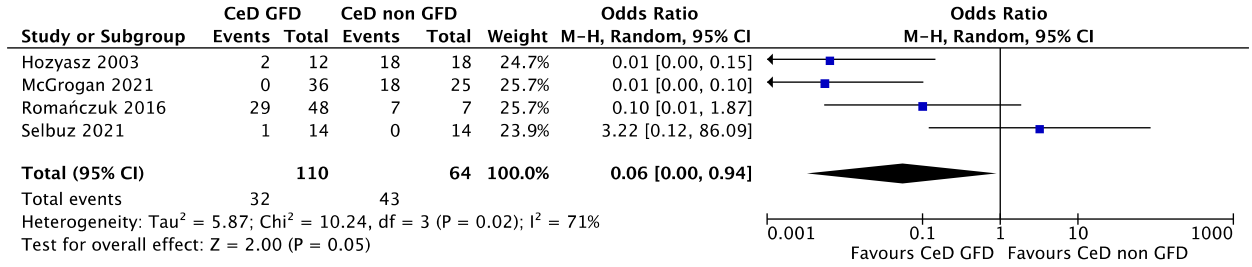


S7E- Forest plot comparison of means of serum 1,25-OH Vitamin D levels in patients with CeD on GFD to non-CeD controls by study design. All studies assessed short term GFD in adults

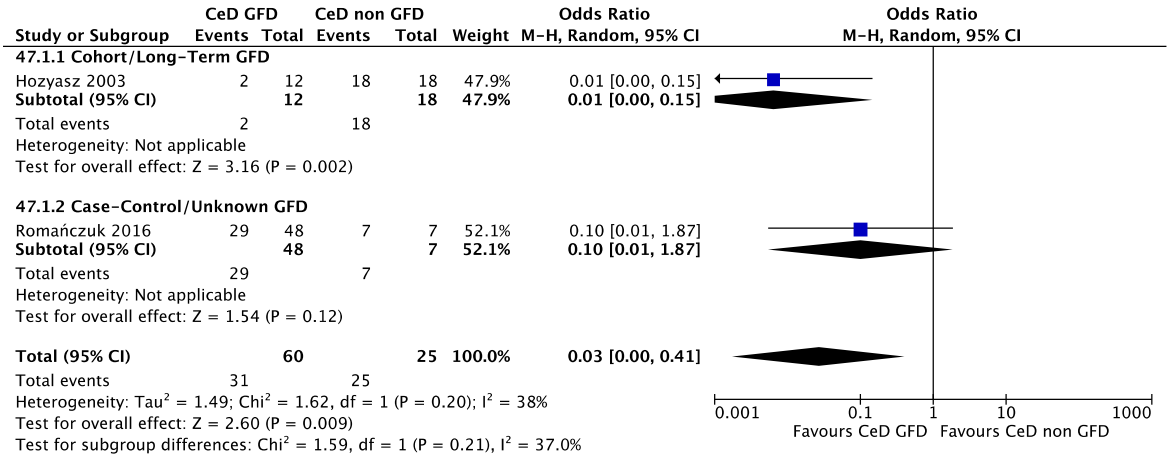


Supplementary Figure S8. Vitamin E

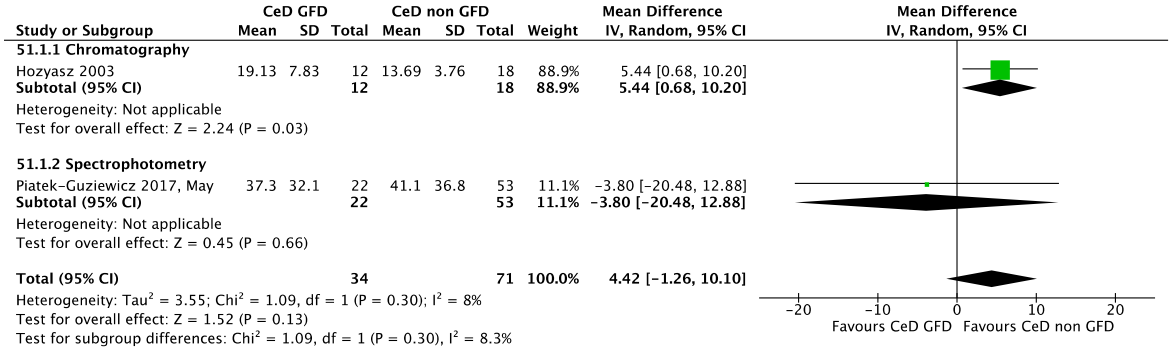
S8A- Forest plot comparison of serum Vitamin E deficiency between CeD on GFD and CeD not on GFD



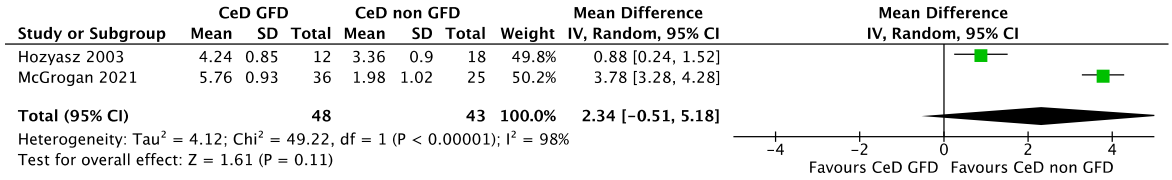
S8B- Forest plot comparison of Vitamin E in erythrocyte deficiency between CeD on GFD and CeD not on GFD by study design and GFD length



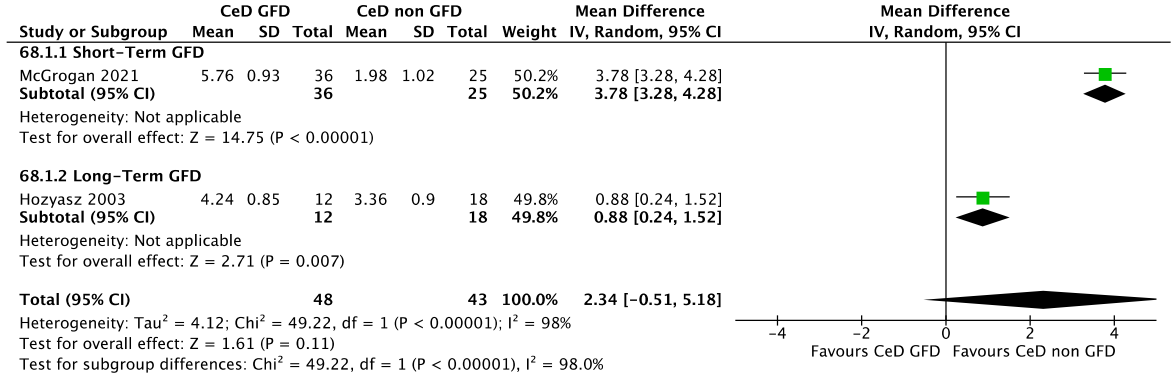
S8C- Forest plot comparison of means of serum Vitamin E levels between CeD on GFD to CeD not on GFD by methodology



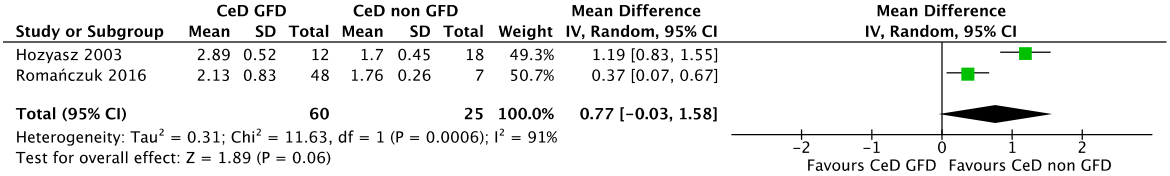
S8D- Forest plot comparison of means of serum Vitamin E levels controlled by serum cholesterol between CeD on GFD and CeD not on GFD



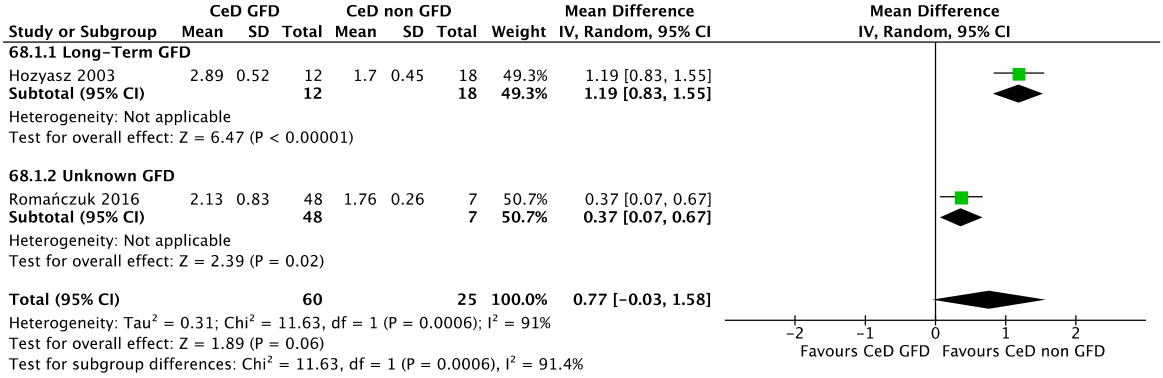
S8E- Forest plot comparison of means of serum Vitamin E levels controlled by serum cholesterol between CeD on GFD and CeD not on GFD by GFD length



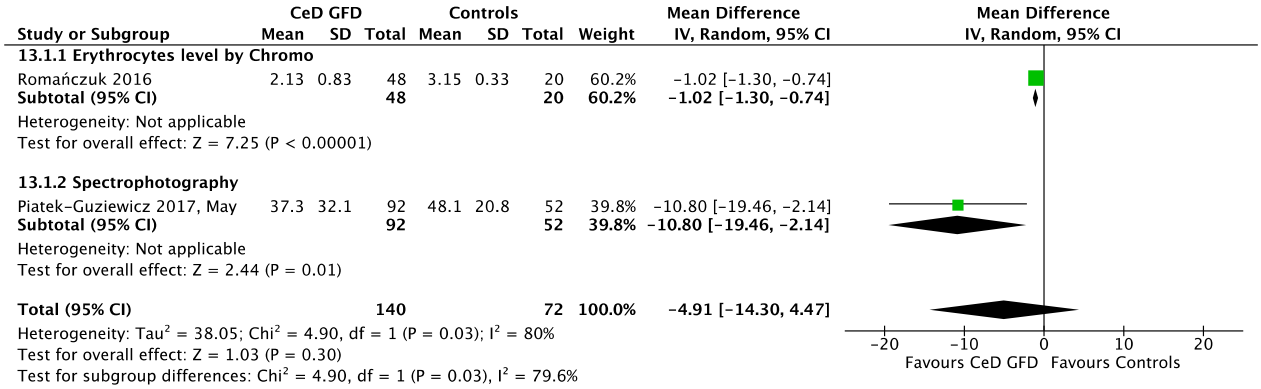
S8F- Forest plot comparison of means of Vitamin E in erythrocytes between CeD on GFD and CeD not on GFD



S8G- Forest plot comparison of means of Vitamin E in erythrocytes between CeD on GFD and CeD not on GFD by GFD length

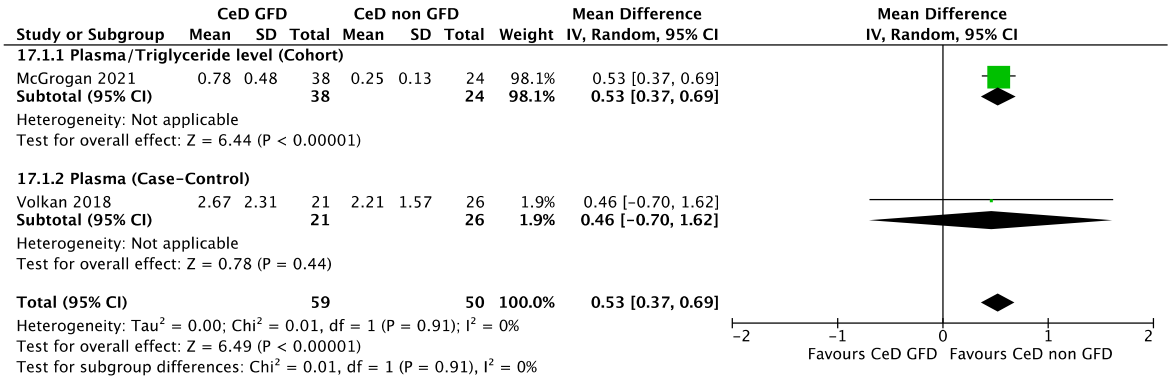


S8H- Forest plot comparison of means of Vitamin E in erythrocytes and plasma between CeD on GFD and non-CeD controls by methodology

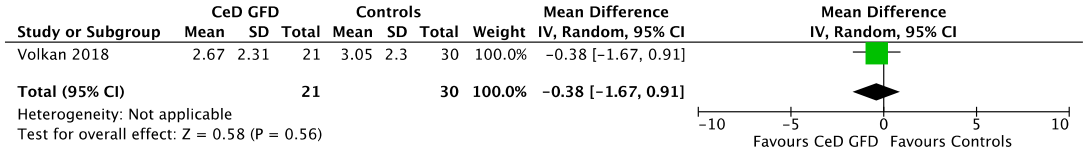


Supplementary Figure S9. Vitamin K

S9A- Forest plot comparison of Vitamin K levels between CeD on GFD and CeD not on GFD by methodology and study design

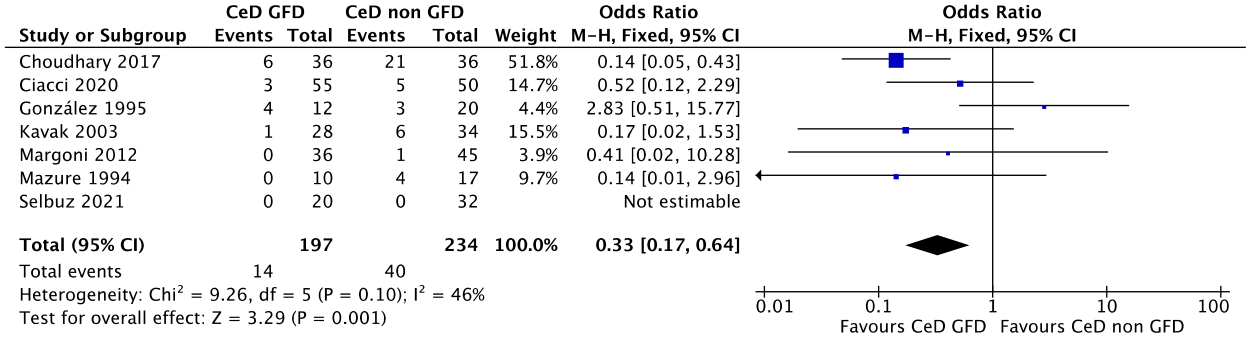


S9B- Forest plot comparison of means of serum Vitamin K levels between CeD on GFD and non-CeD controls

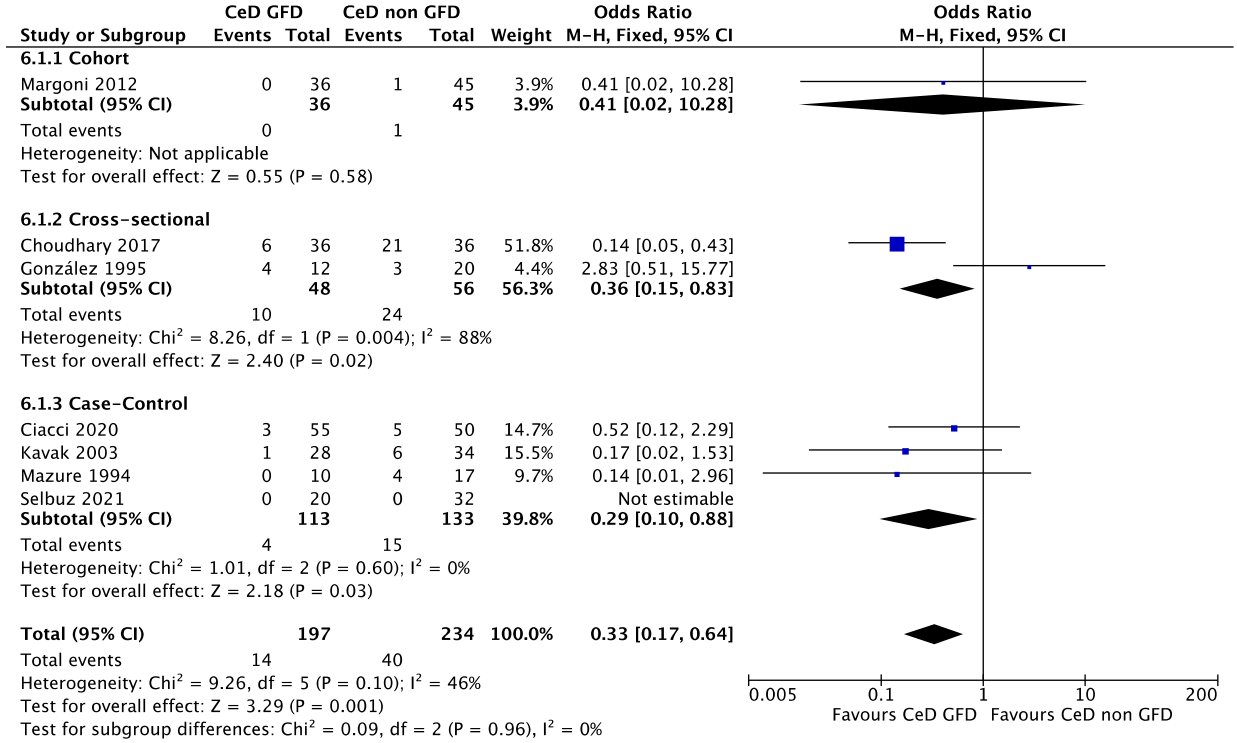


Supplementary Figure S10. Calcium

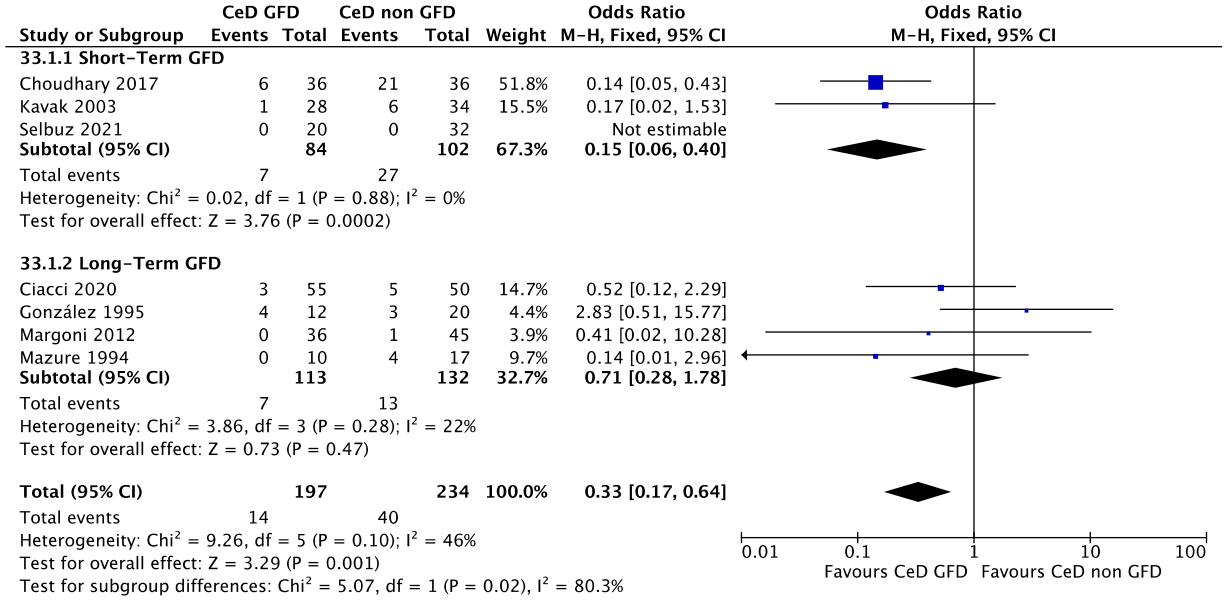
S10A- Forest plot comparison of Calcium deficiency between CeD on GFD and CeD not on GFD



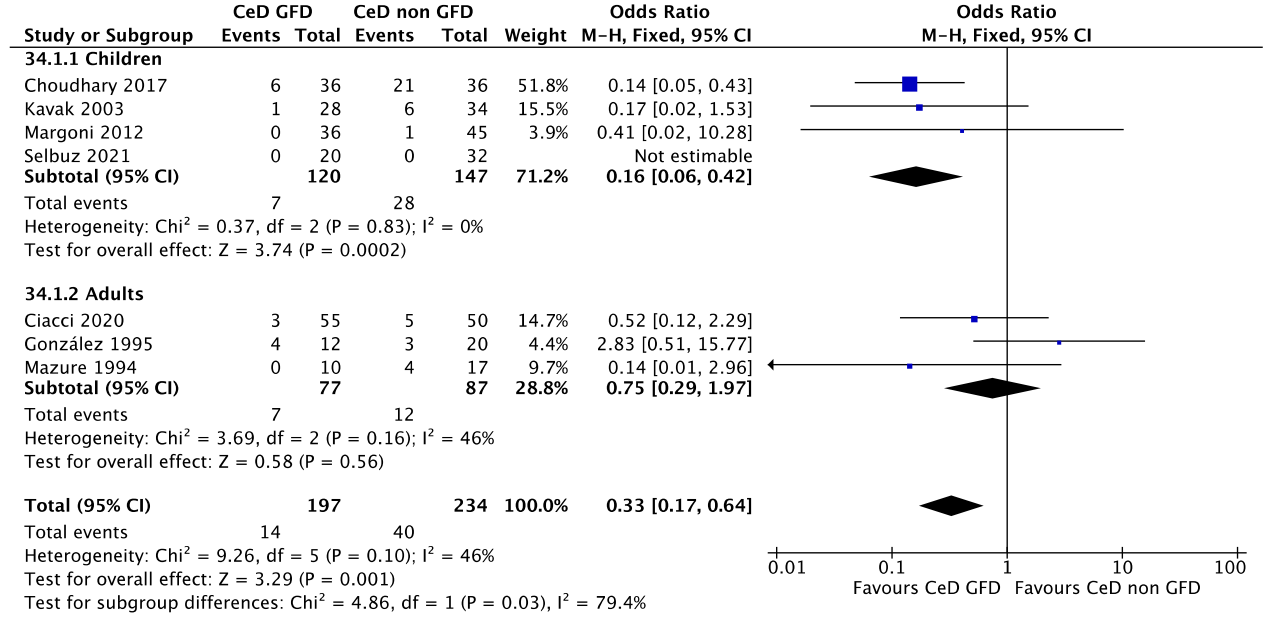
S10B- Forest plot comparison of Calcium deficiency between CeD on GFD and CeD not on GFD by study design



S10C- Forest plot comparison of Calcium deficiency between CeD on GFD and CeD not on GFD by GFD length



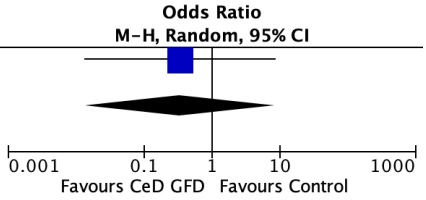
S10D- Forest plot comparison of Calcium deficiency between CeD on GFD and CeD not on GFD by population



S10E- Forest plot comparison of Calcium deficiency between CeD on GFD and non-CeD controls

Study or Subgroup	CeD GFD Events	CeD GFD Total	Controls Events	Controls Total	Weight	Odds Ratio M-H, Random, 95% CI
Szaflarska-Poplawska 2022	0	48	1	50	100.0%	0.34 [0.01, 8.56]
Total (95% CI)		**48**		**50**	**100.0%**	**0.34 [0.01, 8.56]**
Total events	0		1			

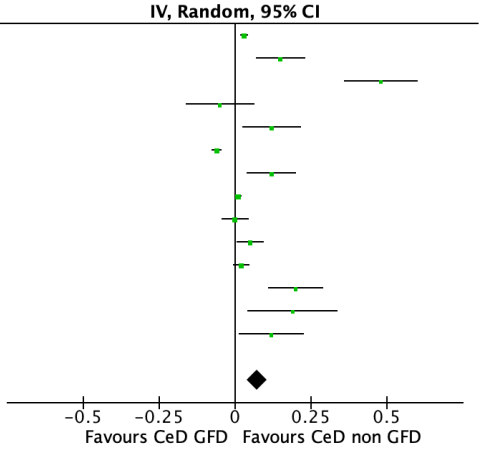
Heterogeneity: Not applicable
Test for overall effect: Z = 0.66 (P = 0.51)



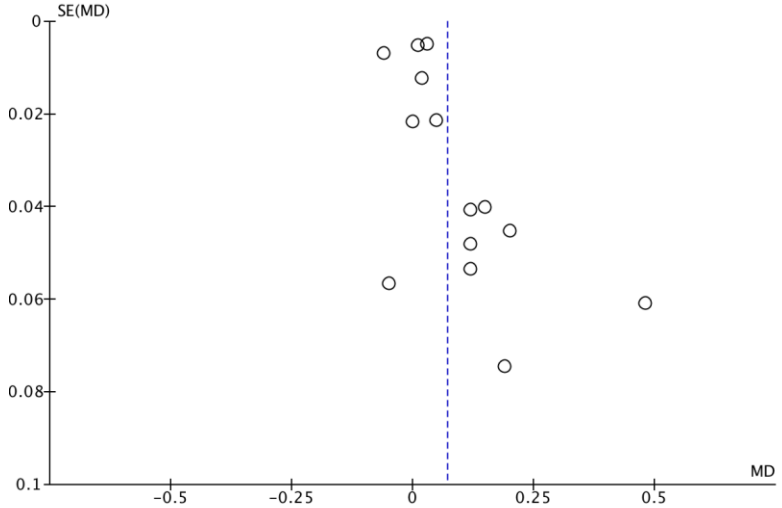
S10Fi- Forest plot comparison of means of serum Calcium levels between CeD on GFD and CeD not on GFD

Study or Subgroup	CeD GFD Mean	CeD GFD SD	CeD GFD Total	CeD non GFD Mean	CeD non GFD SD	CeD non GFD Total	Weight	Mean Difference IV, Random, 95% CI
Bulut, 2023	2.47	0.01	31	2.44	0.02	18	10.2%	0.03 [0.02, 0.04]
Choudhary 2017	2.33	0.16	36	2.18	0.18	36	6.5%	0.15 [0.07, 0.23]
Corazza 1995	2.23	0.09	14	1.75	0.23	17	4.4%	0.48 [0.36, 0.60]
González 1995	2.27	0.12	12	2.32	0.2	20	4.8%	-0.05 [-0.16, 0.06]
Kalayci 2001	2.47	0.12	16	2.35	0.15	16	5.6%	0.12 [0.03, 0.21]
Karkoszka 2000	2.34	0.03	33	2.4	0.03	40	10.1%	-0.06 [-0.07, -0.05]
Kavak 2003	2.47	0.15	28	2.35	0.17	34	6.4%	0.12 [0.04, 0.20]
Keaveny 1996	1.27	0.01	16	1.26	0.02	19	10.2%	0.01 [-0.00, 0.02]
Kemppainen 1995	2.3	0.1	51	2.3	0.1	37	8.8%	0.00 [-0.04, 0.04]
Margoni 2012	2.42	0.07	36	2.37	0.12	45	8.8%	0.05 [0.01, 0.09]
Mazure 1994	2.27	0.02	14	2.25	0.05	20	9.8%	0.02 [-0.00, 0.04]
Sabel'nikova 2013	2.4	0.3	109	2.2	0.2	33	5.9%	0.20 [0.11, 0.29]
Szymczak 2012	2.26	0.11	19	2.07	0.28	16	3.4%	0.19 [0.04, 0.34]
Volkan 2018	2.52	0.22	21	2.4	0.12	26	5.0%	0.12 [0.02, 0.22]
Total (95% CI)			**436**			**377**	**100.0%**	**0.07 [0.04, 0.10]**

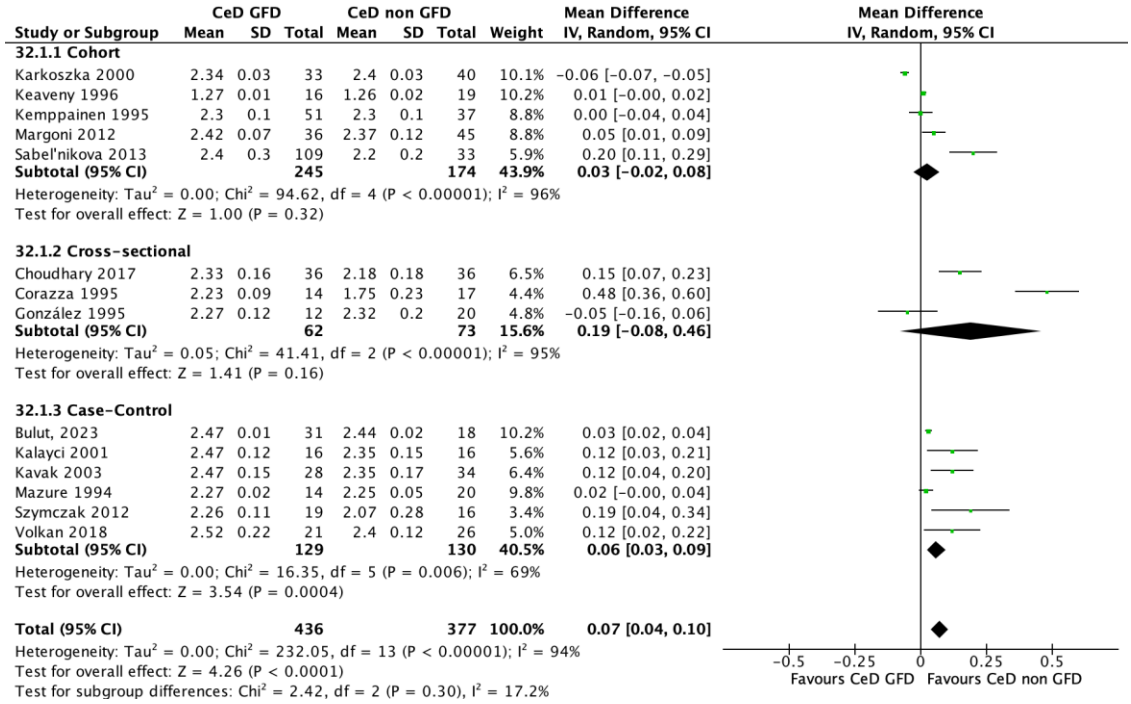
Heterogeneity: $Tau^2 = 0.00$; $Chi^2 = 232.05$, df = 13 (P < 0.00001); $I^2 = 94\%$
Test for overall effect: Z = 4.26 (P < 0.0001)



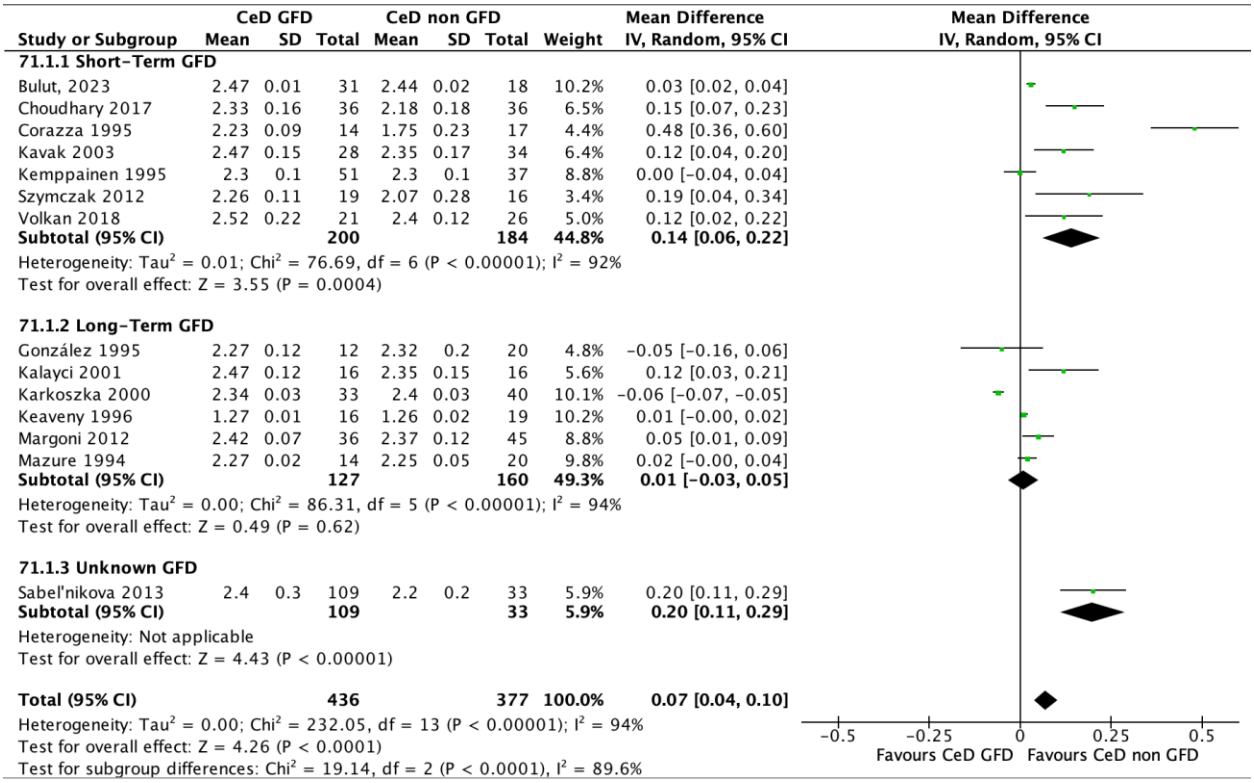
S10Fii- Funnel plot of studies within Fi comparing serum levels of calcium between CeD on GFD and CeD not on GFD



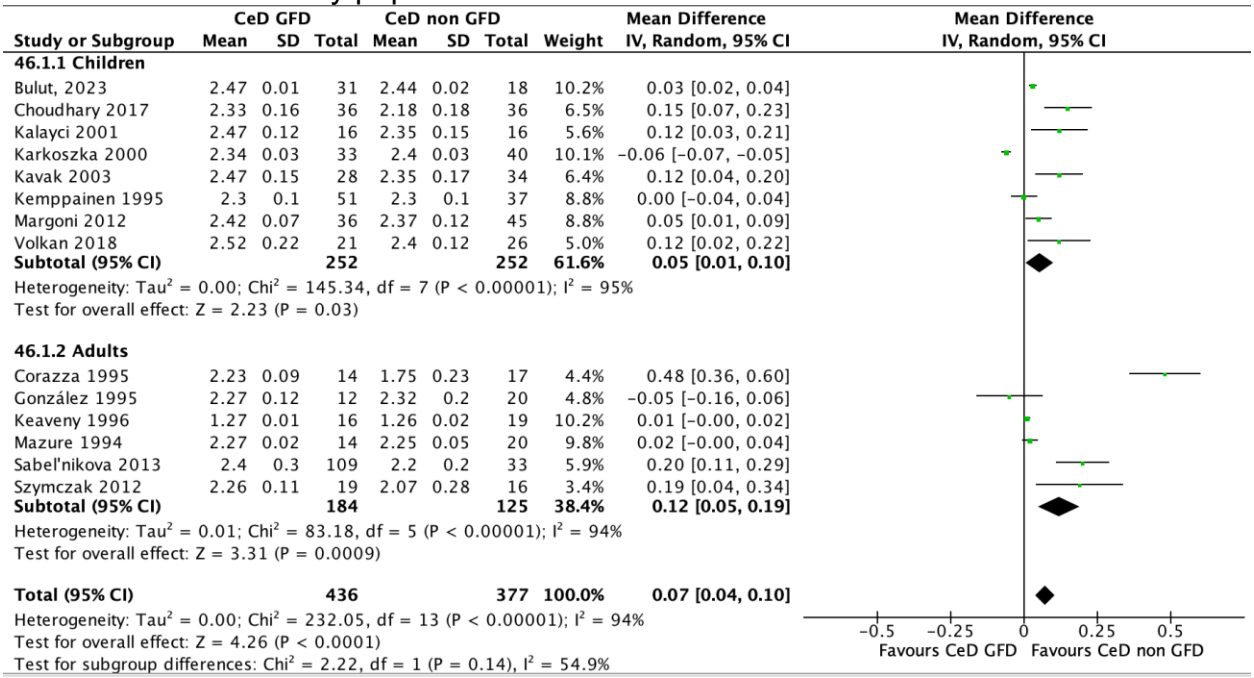
S10G- Forest plot comparison of means of serum Calcium levels between CeD on GFD and CeD not on GFD by study design



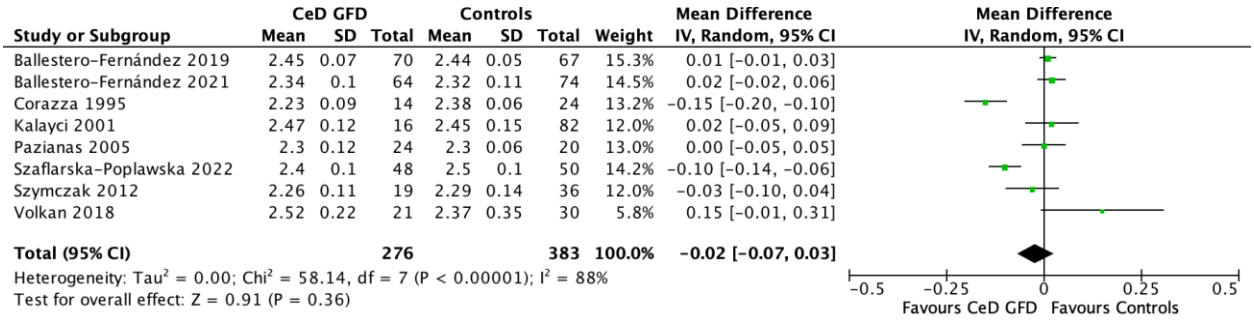
S10H- Forest plot comparison of means of serum Calcium levels between CeD on GFD and CeD not on GFD by GFD length



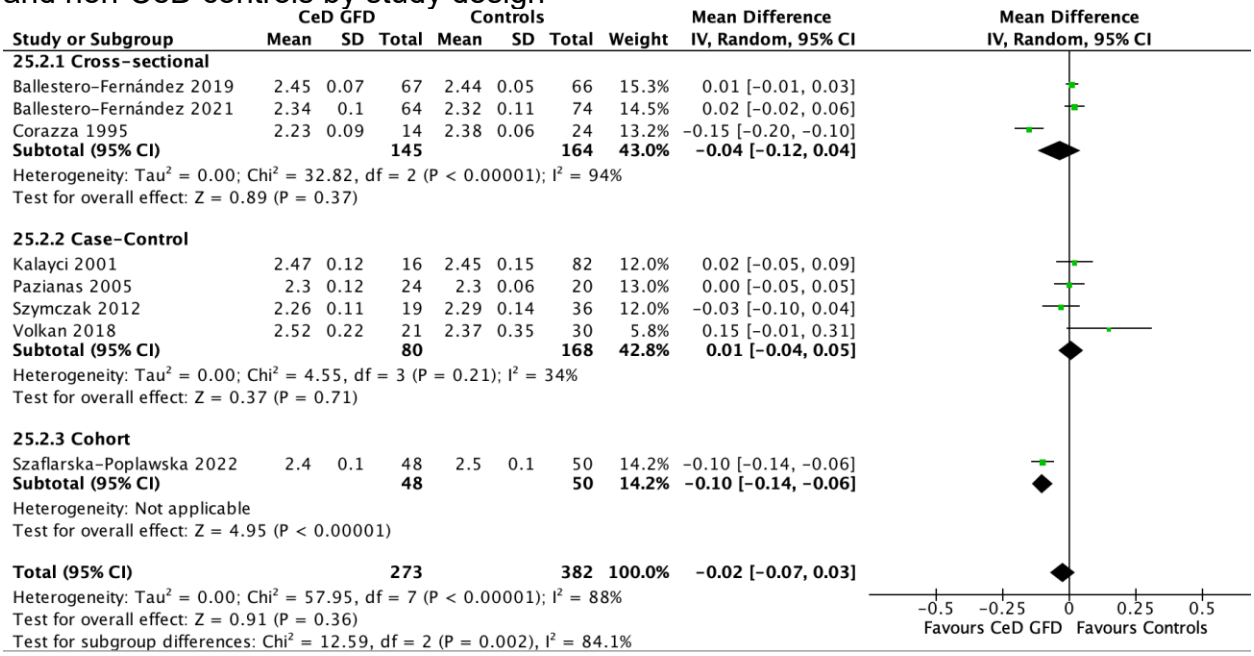
S10I- Forest plot comparison of means of serum Calcium levels between CeD on GFD and CeD not on GFD by population



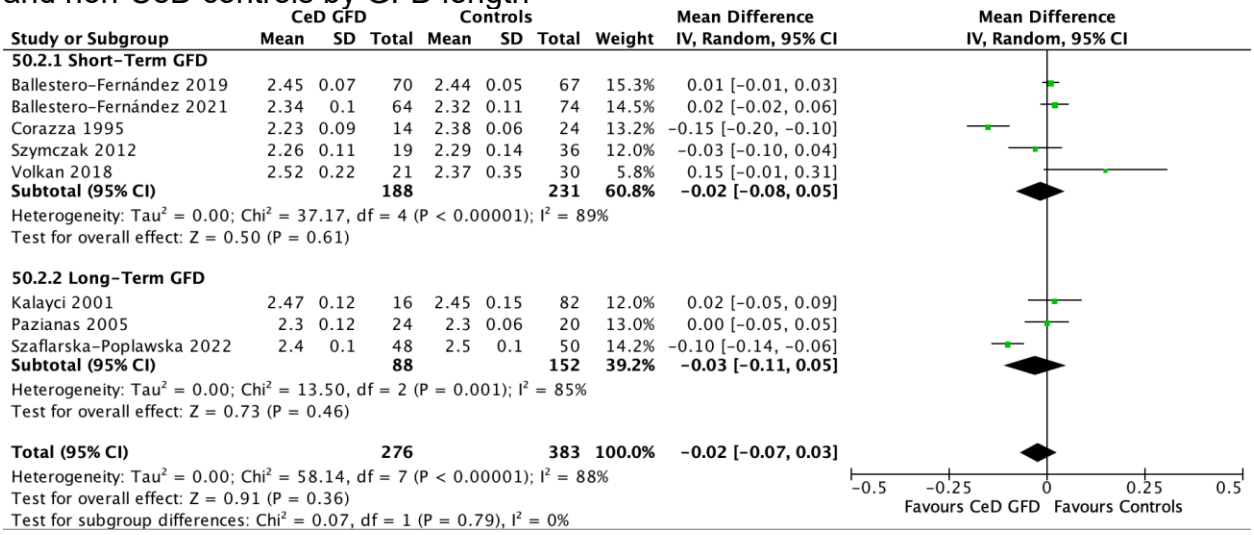
S10J- Forest plot comparison of means of serum calcium levels between CeD on GFD and non-CeD controls



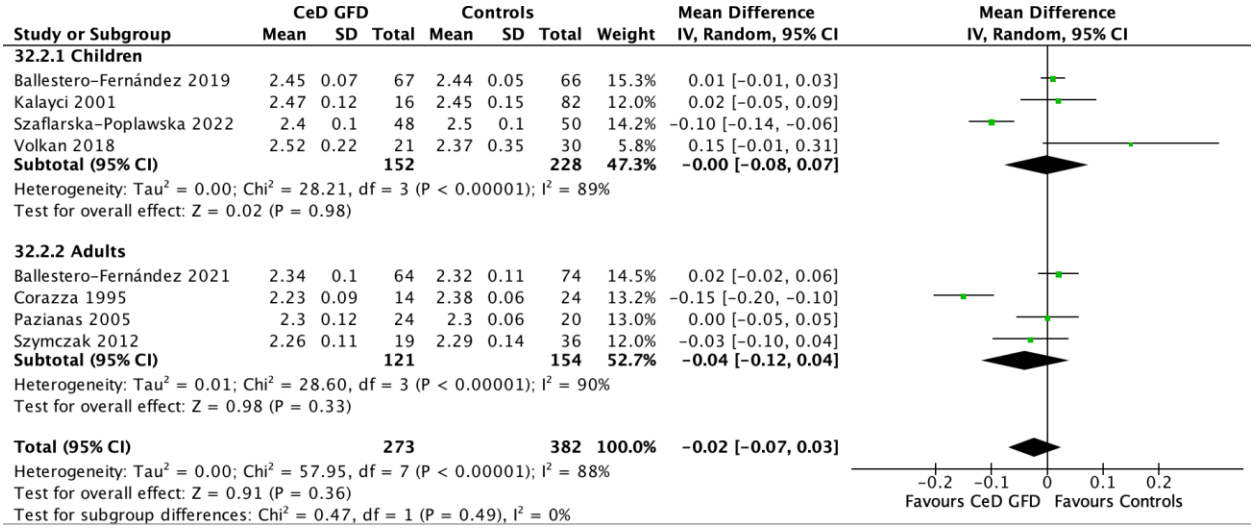
S10K- Forest plot comparison of means of serum calcium levels between CeD on GFD and non-CeD controls by study design



S10L- Forest plot comparison of means of serum calcium levels between CeD on GFD and non-CeD controls by GFD length

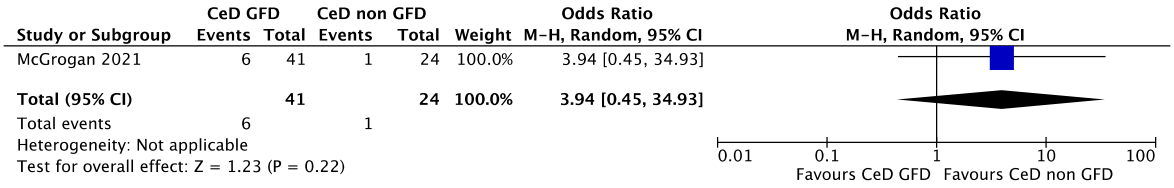


S10M- Forest plot comparison of means of serum calcium levels between CeD on GFD and non-CeD controls by population

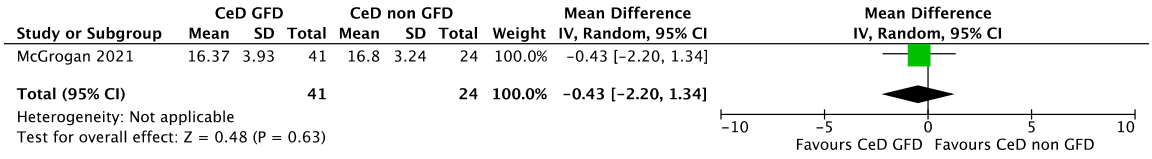


Supplementary Figure S11. Copper

S11A- Forest plot comparison of Copper deficiency between CeD on GFD and CeD not on GFD

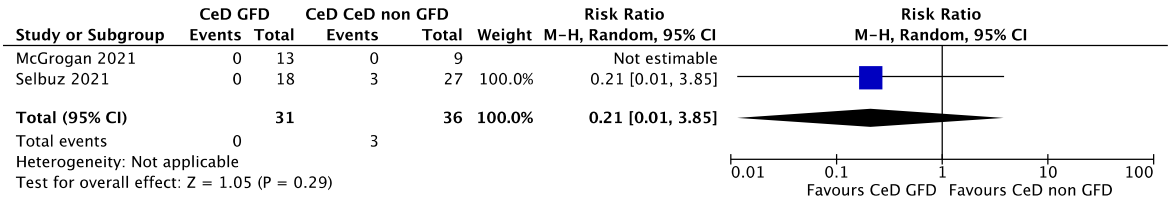


S11B- Forest plot comparison of means of serum copper levels between CeD on GFD and CeD not on GFD

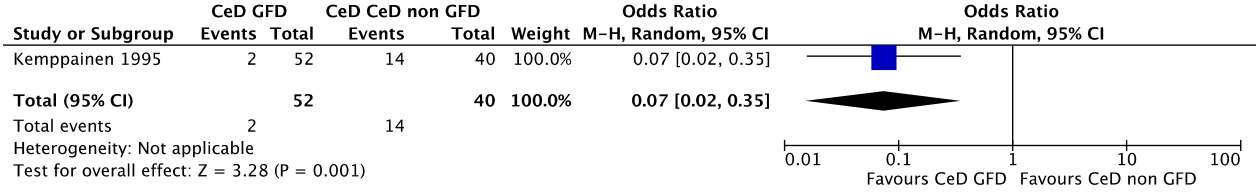


Supplementary Figure S12. Folate

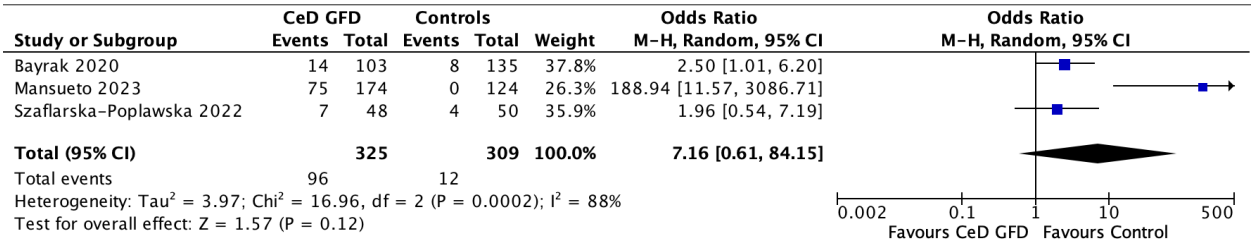
S12A- Forest plot comparison of serum Folate deficiency between CeD on GFD and CeD not on GFD



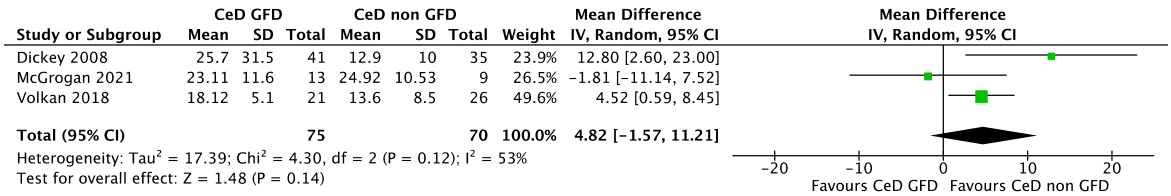
S12B- Forest plot comparison of Folate deficiency in erythrocytes between CeD on GFD and CeD not on GFD



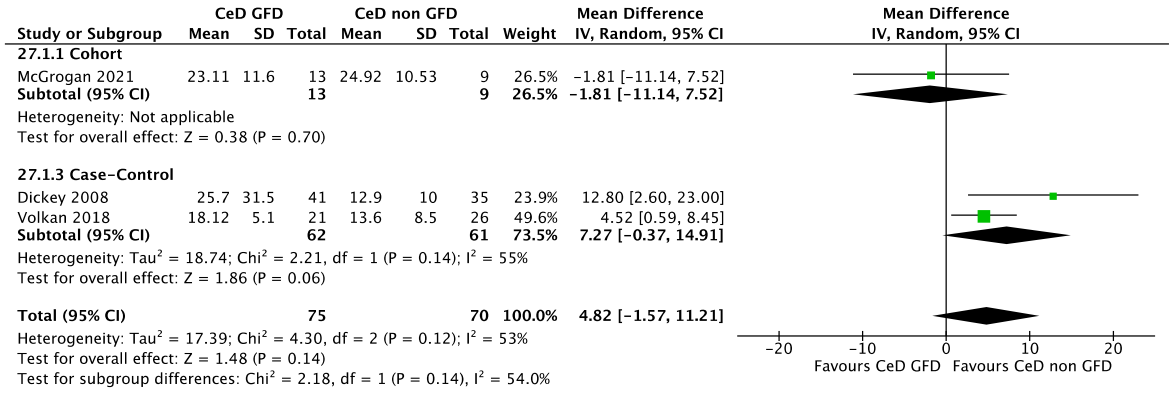
S12C- Forest plot comparison of serum Folate deficiency between CeD on GFD and non-CeD controls



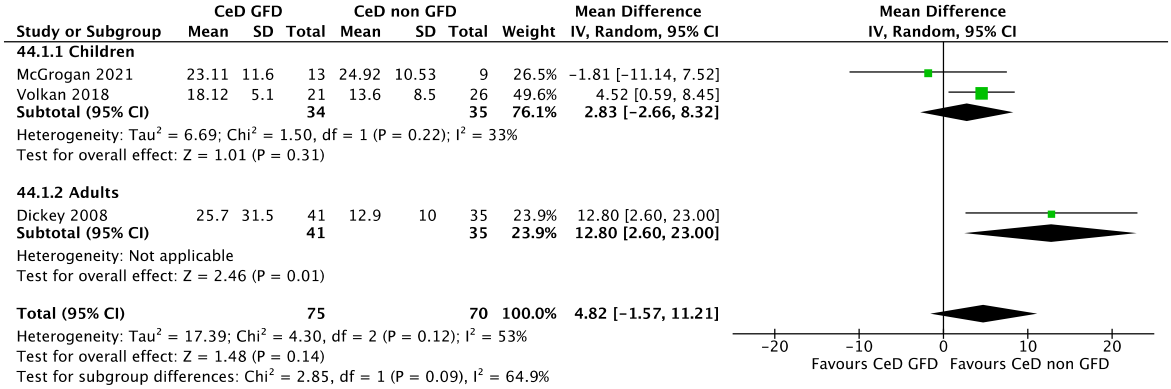
S12D- Forest plot comparison of means of serum Folate levels between CeD on GFD and CeD not on GFD



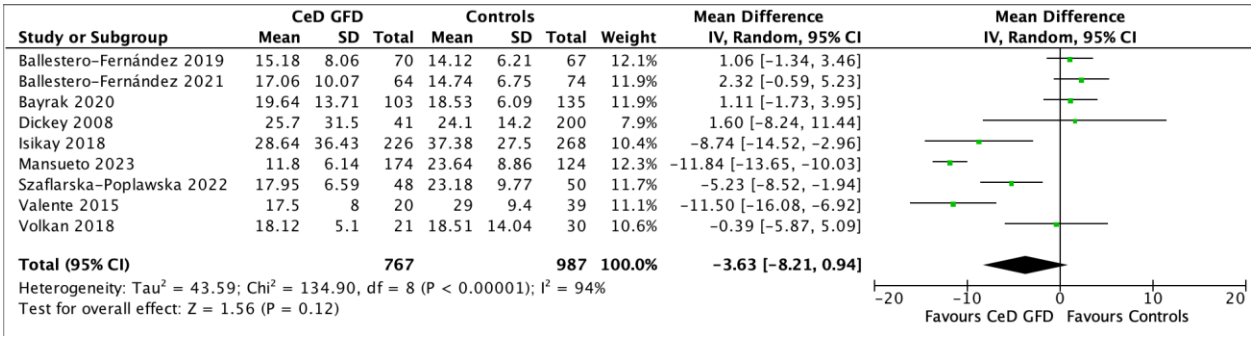
S12E- Forest plot comparison of means of serum Folate levels between CeD on GFD and CeD not on GFD by study design



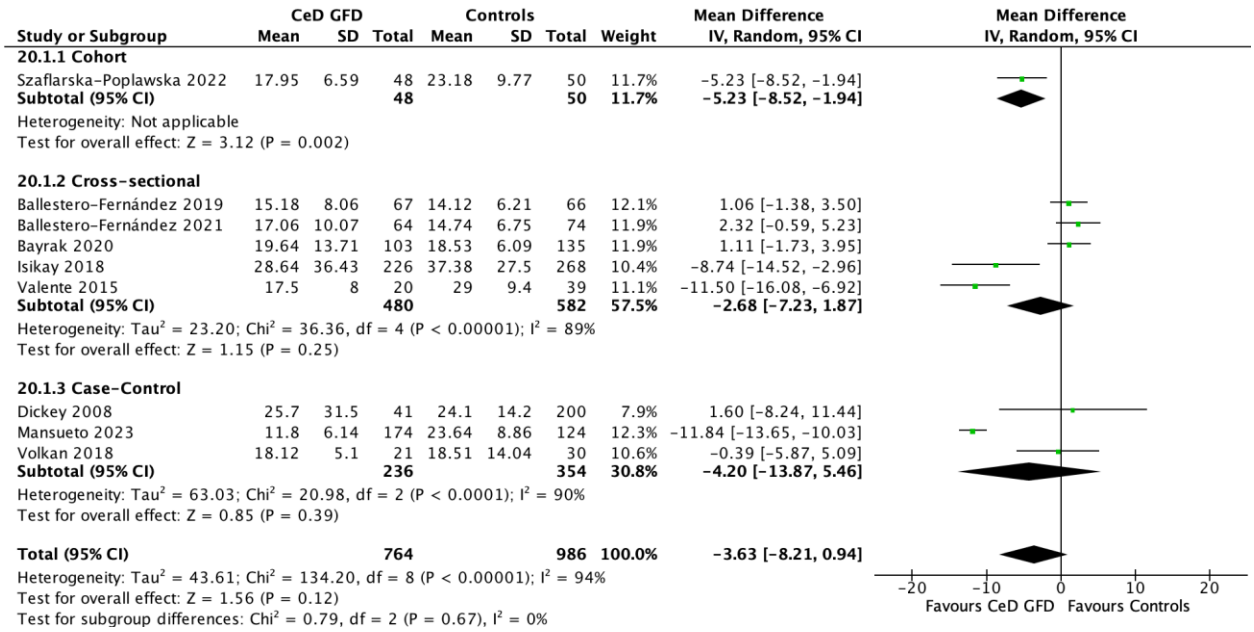
S12F- Forest plot comparison of means of serum Folate levels between CeD on GFD and CeD not on GFD by population



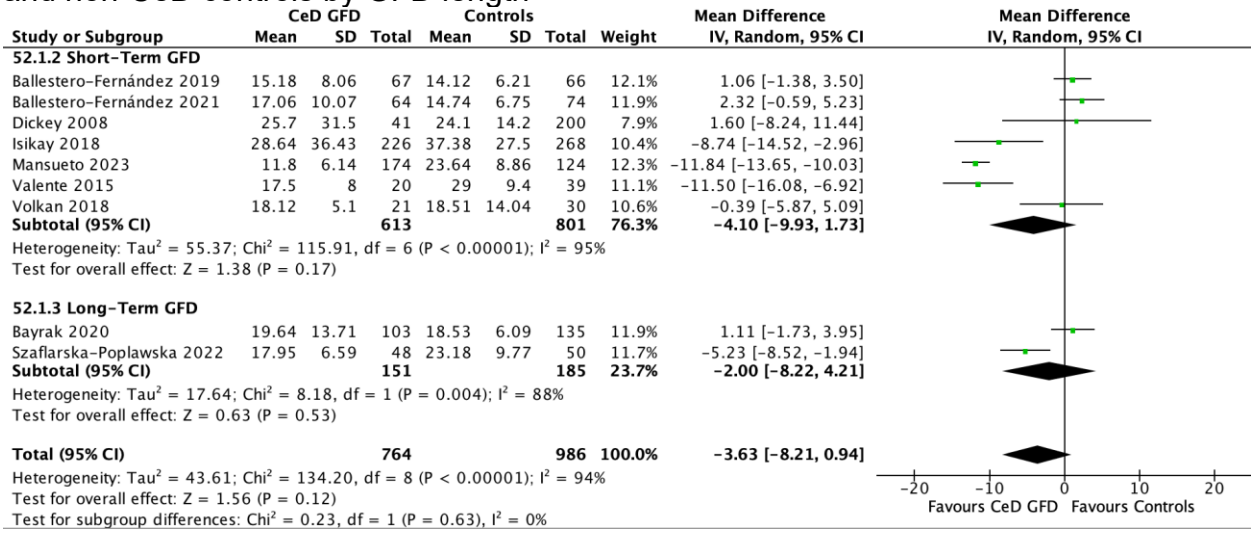
S12G- Forest plot comparison of means of serum Folate levels between CeD on GFD and non-CeD controls



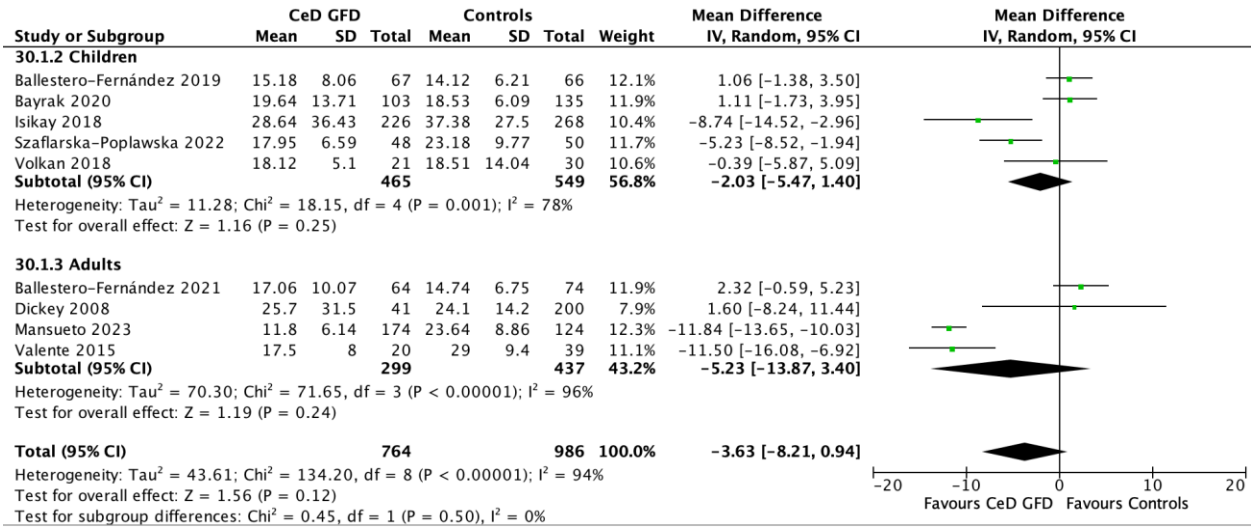
S12H- Forest plot comparison of means of serum Folate levels between CeD on GFD and non-CeD controls by study design



S12I- Forest plot comparison of means of serum Folate levels between CeD on GFD and non-CeD controls by GFD length

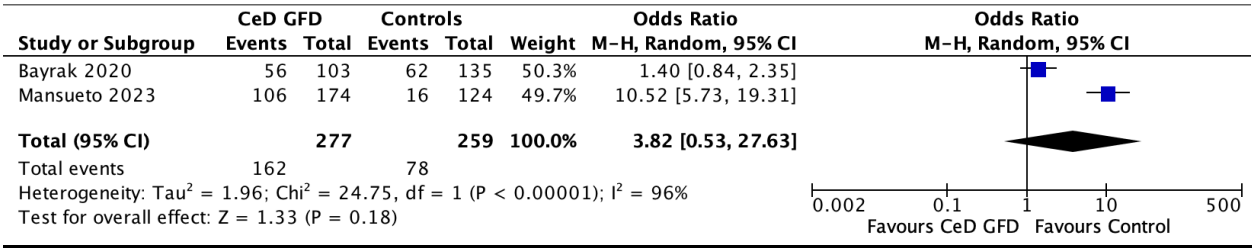


S12J- Forest plot comparison of means of serum Folate levels between CeD on GFD and non-CeD controls by population

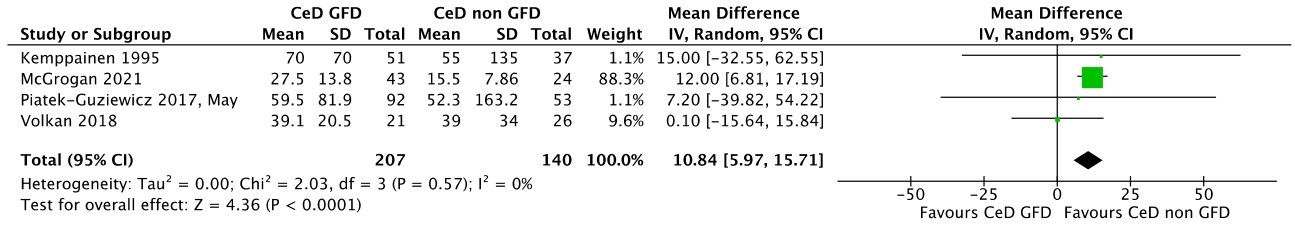


Supplementary Figure S13. Iron studies- Ferritin

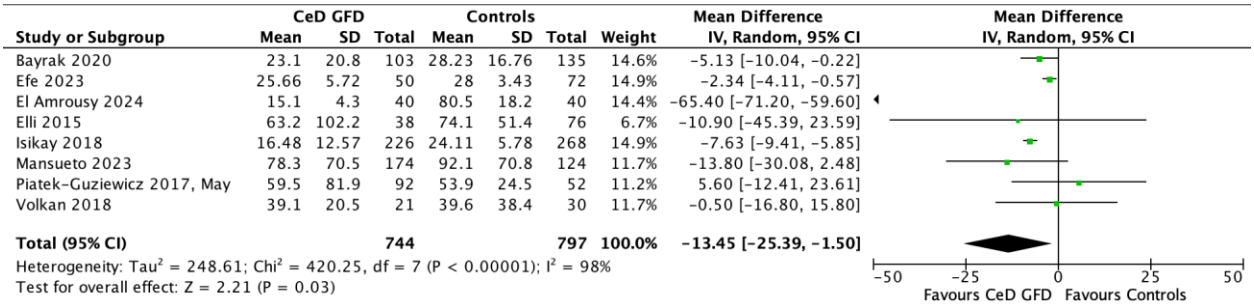
S13A- Forest plot comparison of low serum ferritin levels between CeD on GFD and non-CeD controls



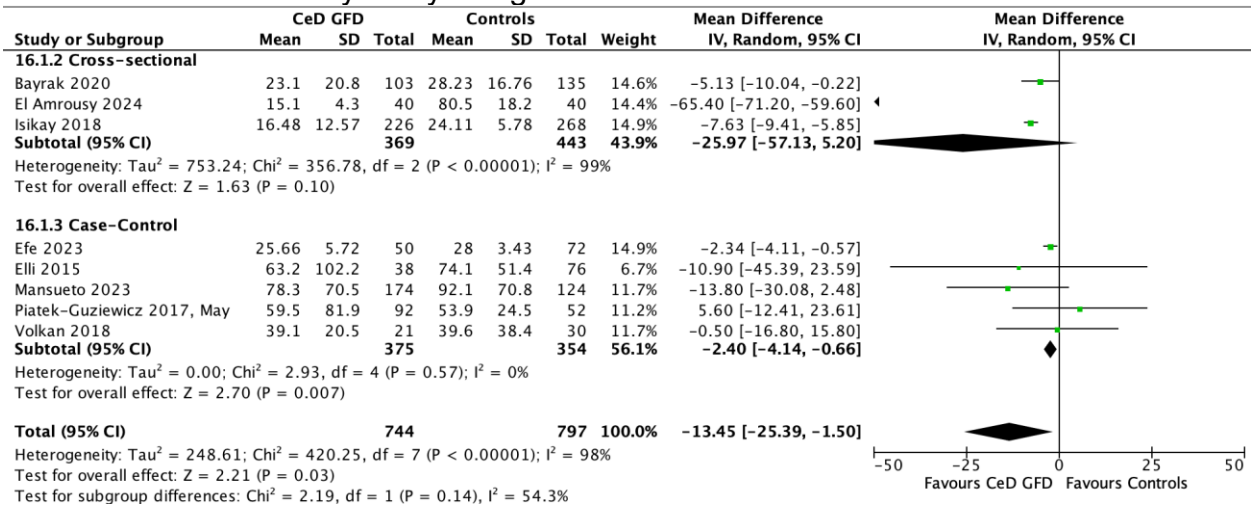
S13B- Forest plot comparison of means of serum Ferritin levels between CeD on GFD and CeD not on GFD



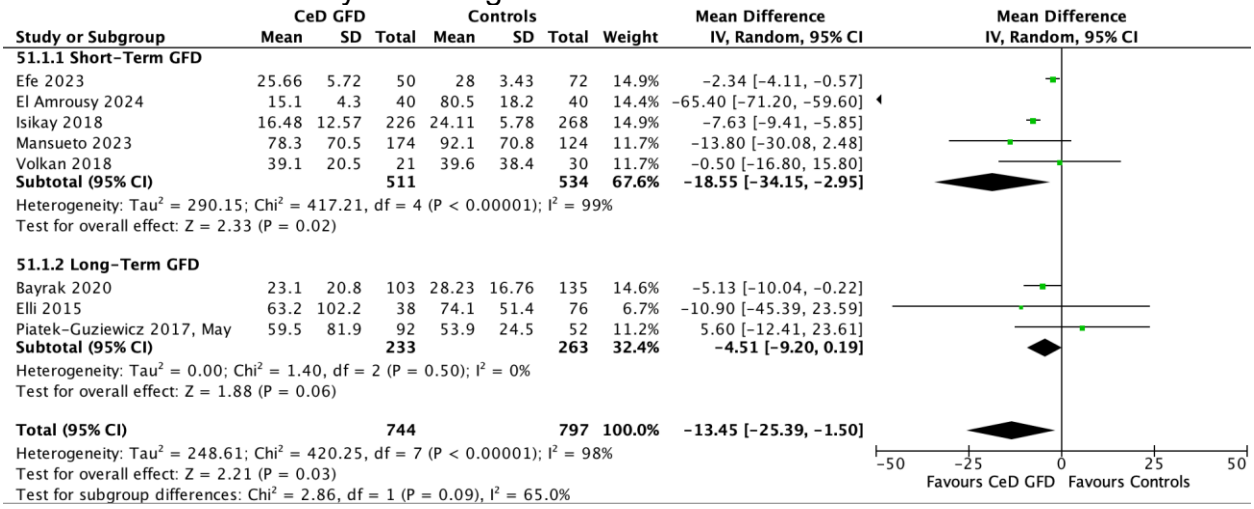
S13C- Forest plot comparison of means of serum ferritin levels between CeD on GFD and non-CeD controls



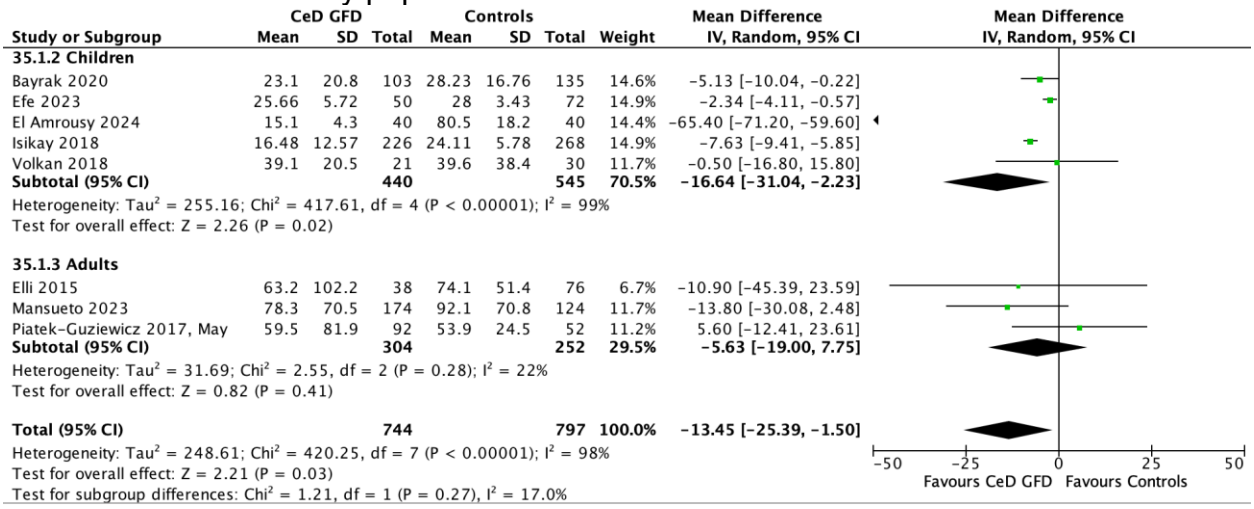
S13D- Forest plot comparison of means of serum ferritin levels between CeD on GFD and non-CeD controls by study design



S13E- Forest plot comparison of means of serum ferritin levels between CeD on GFD and non-CeD controls by GFD length

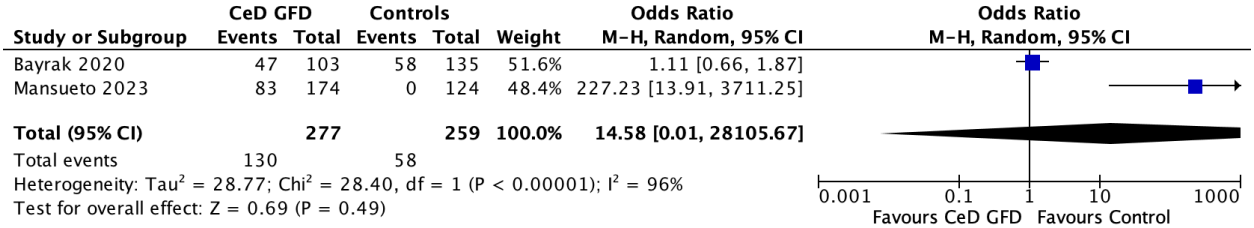


S13F- Forest plot comparison of means of serum ferritin levels between CeD on GFD and non-CeD controls by population

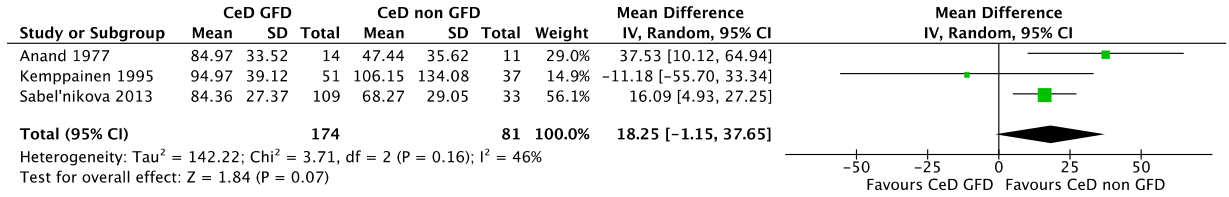


Supplementary Figure S14. Iron

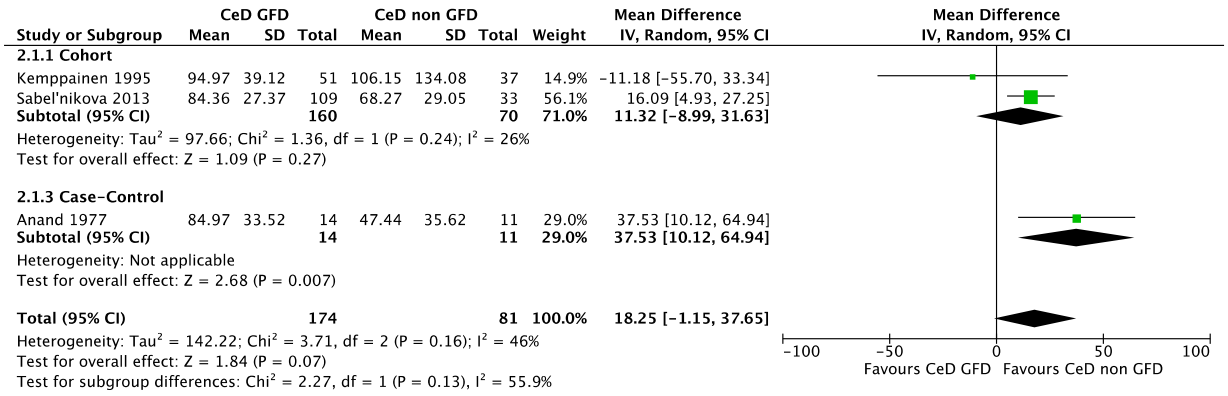
S14A- Forest plot comparison of serum iron deficiency between CeD on GFD and non-CeD controls



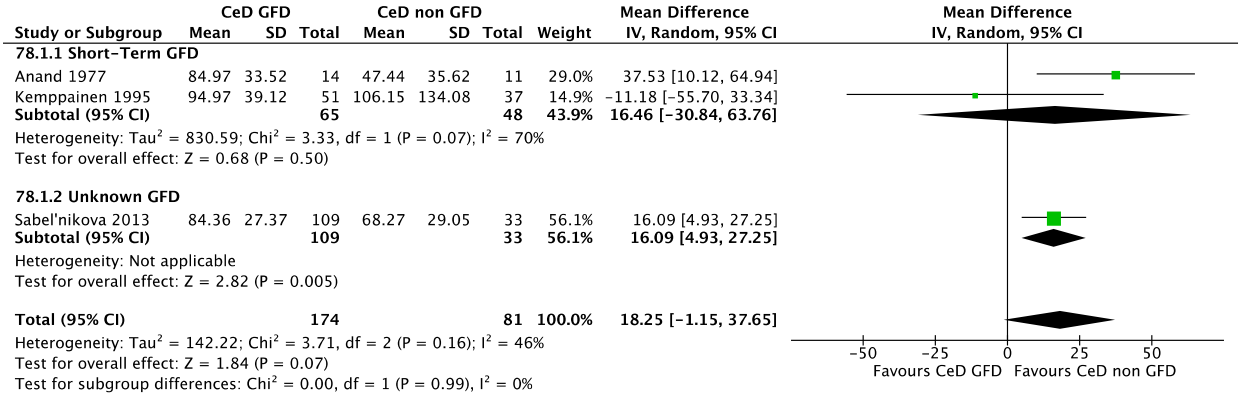
S14B- Forest plot comparison of means of serum iron levels between CeD on GFD and CeD not on GFD



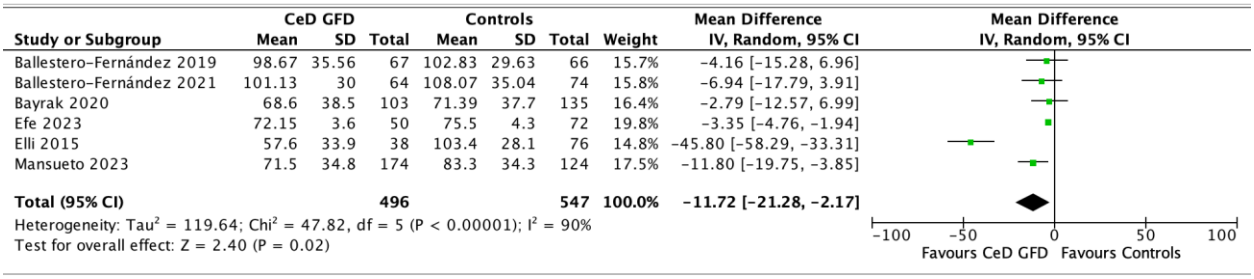
S14C- Forest plot comparison of means of serum iron levels between CeD on GFD and CeD not on GFD by study design



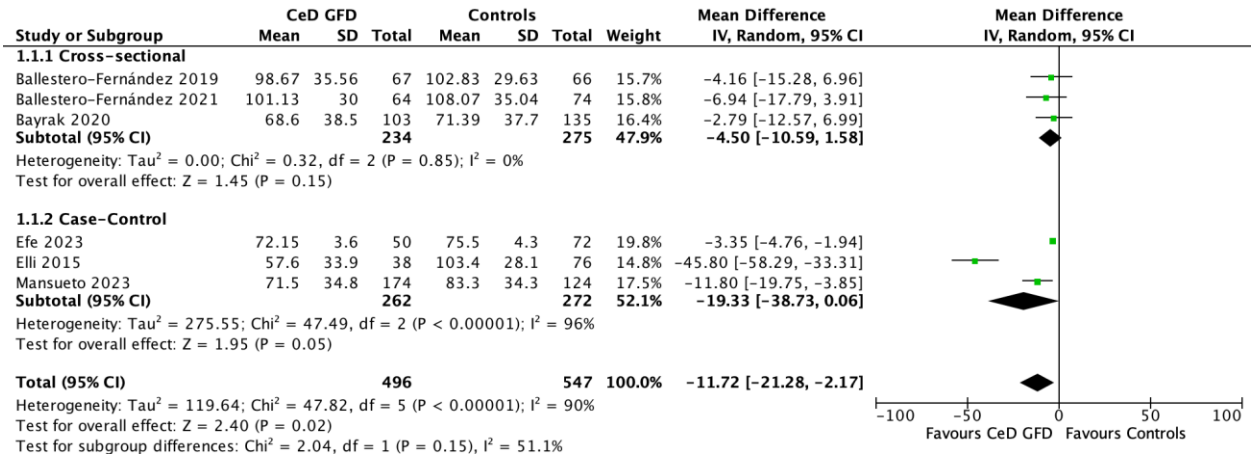
S14D- Forest plot comparison of means of serum iron levels between CeD on GFD and CeD not on GFD by GFD length



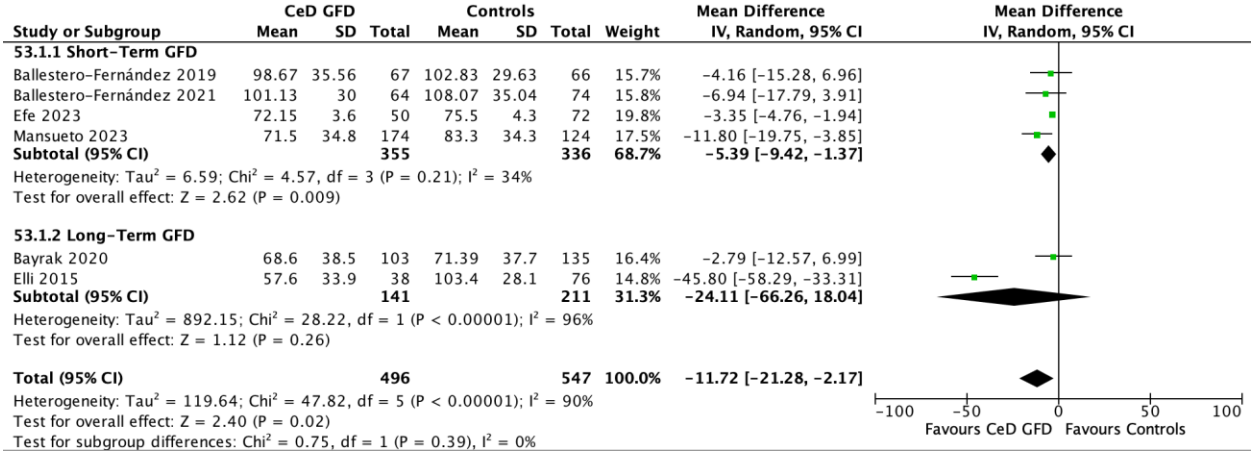
S14E- Forest plot comparison of means of serum iron levels between CeD on GFD and non-CeD controls



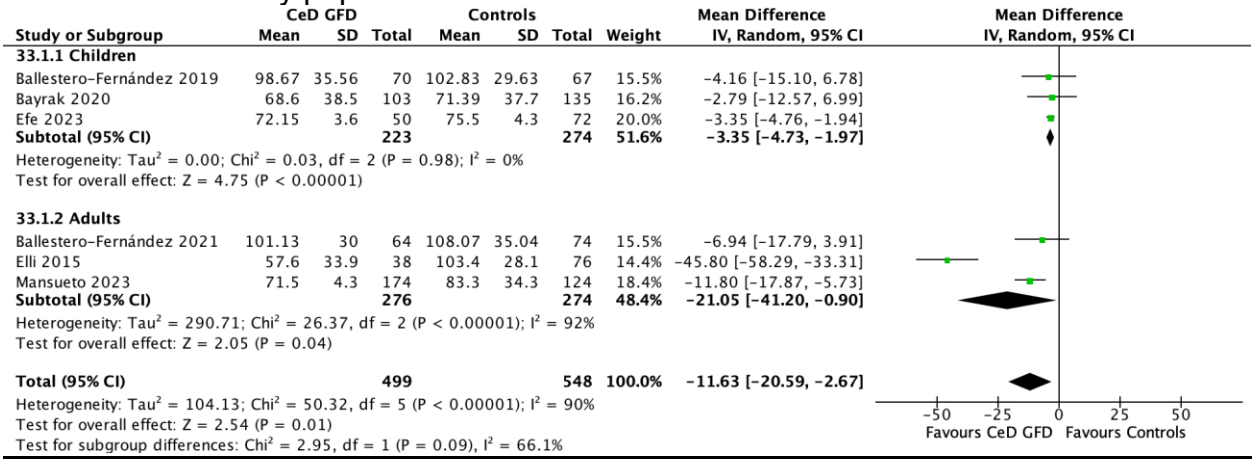
S14F- Forest plot comparison of means of serum iron levels between CeD on GFD and non-CeD controls by study design



S14G- Forest plot comparison of means of serum iron levels between CeD on GFD and non-CeD controls by GFD Length

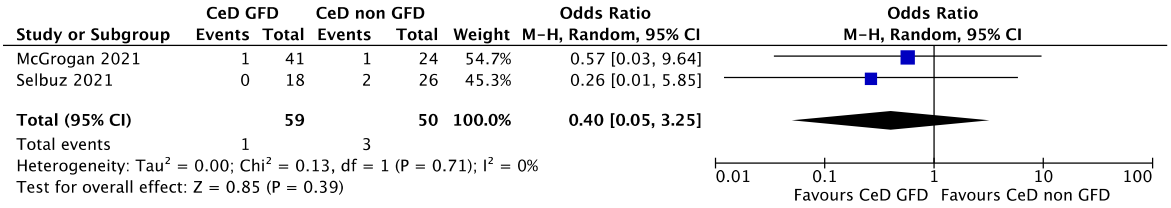


S14H- Forest plot comparison of means of serum iron levels between CeD on GFD and non-CeD controls by population

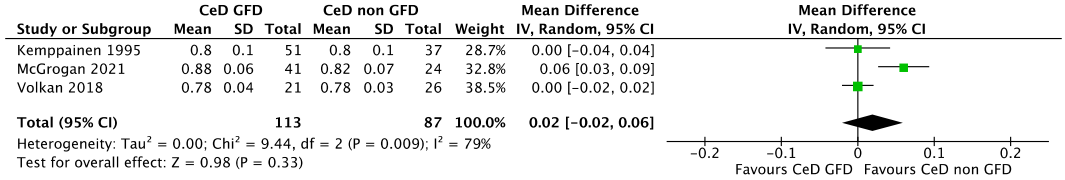


Supplementary Figure 15. Magnesium

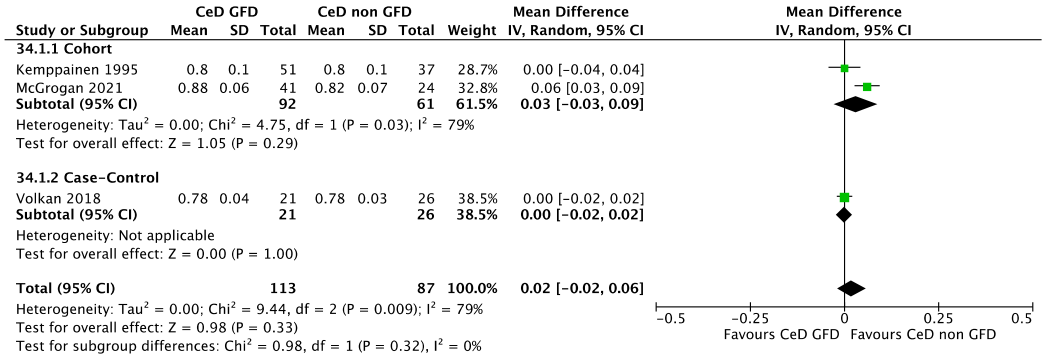
S15A- Forest plot comparison of Magnesium deficiency between CeD on GFD and CeD not on GFD



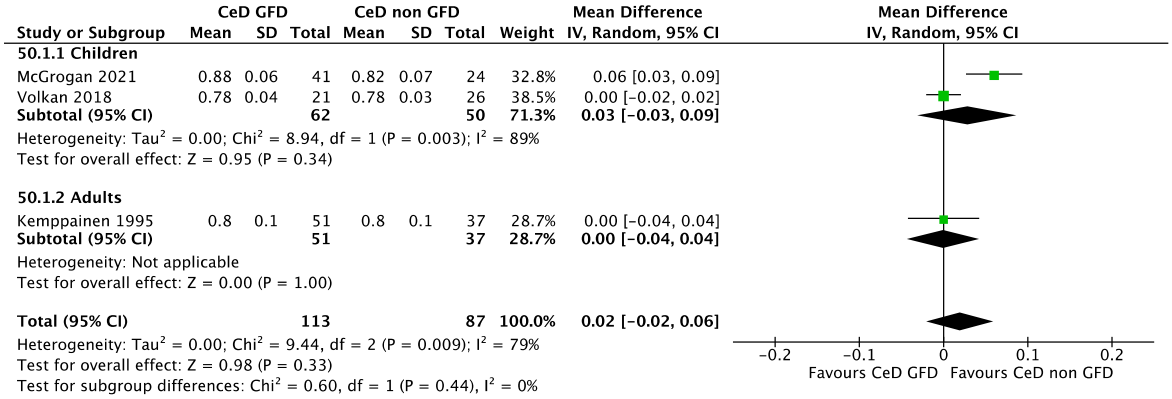
S15B- Forest plot comparison of means of serum Magnesium levels between CeD on GFD and CeD not on GFD



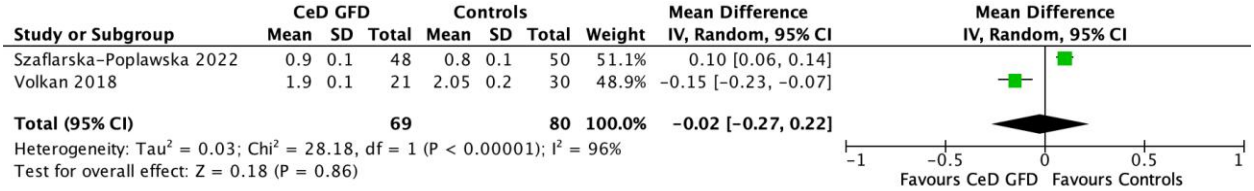
S15C- Forest plot comparison of means of serum Magnesium levels between CeD on GFD and CeD not on GFD by study design



S15D- Forest plot comparison of means of serum Magnesium levels between CeD on GFD and CeD not on GFD by population

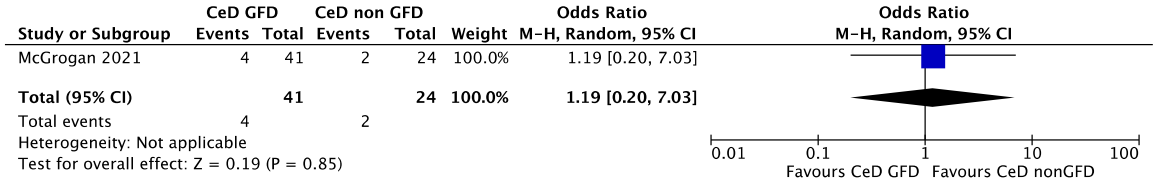


S15E- Forest plot comparison of means of serum Magnesium levels between CeD on GFD and non-CeD controls

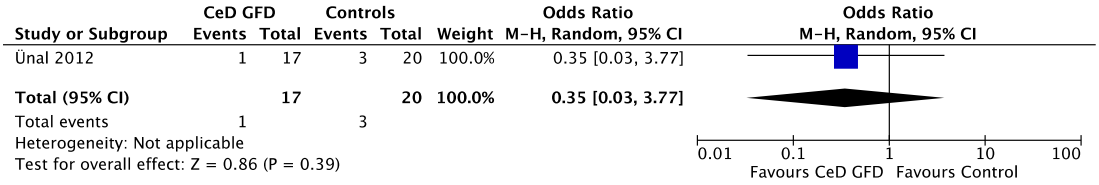


Supplementary Figure S16. Selenium

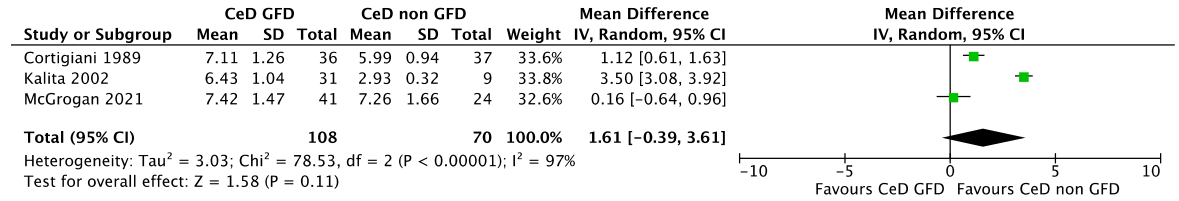
S16A- Forest plot comparison of Selenium deficiency between CeD on GFD and CeD not on GFD



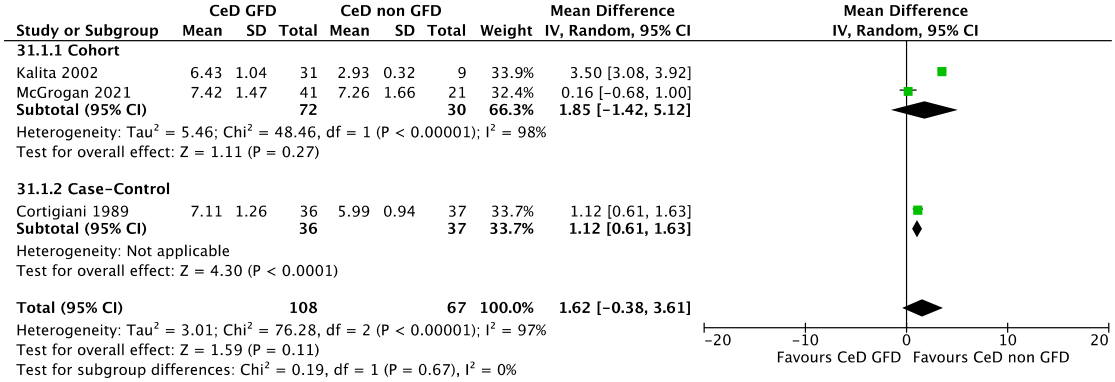
S16B- Forest plot comparison of Selenium deficiency between CeD on GFD and non-CeD controls



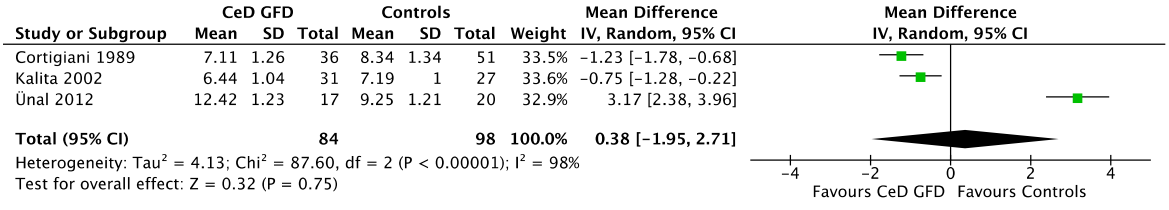
S16C- Forest plot comparison of means of serum Selenium levels between CeD on GFD and CeD not on GFD



S16D- Forest plot comparison of means of serum Selenium levels between CeD on GFD and CeD not on GFD by study design

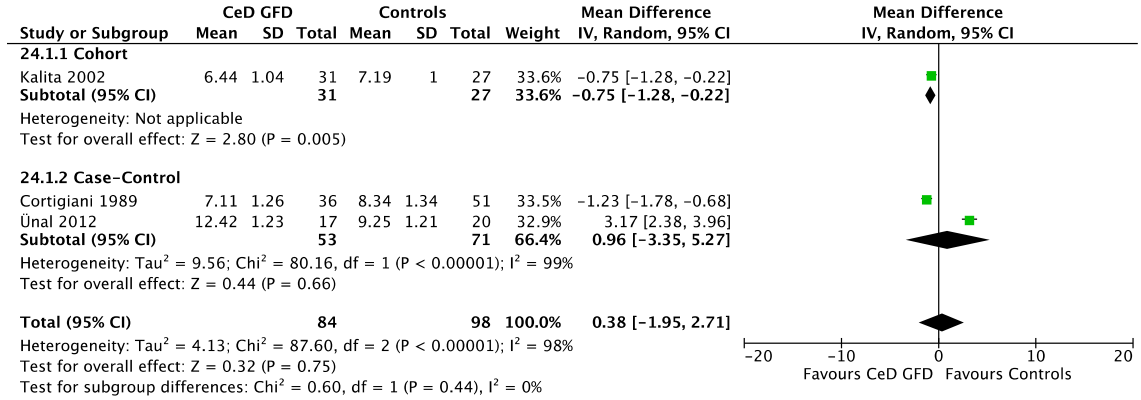


S16E- Forest plot comparison of means of serum Selenium levels between CeD on GFD and non-CeD controls

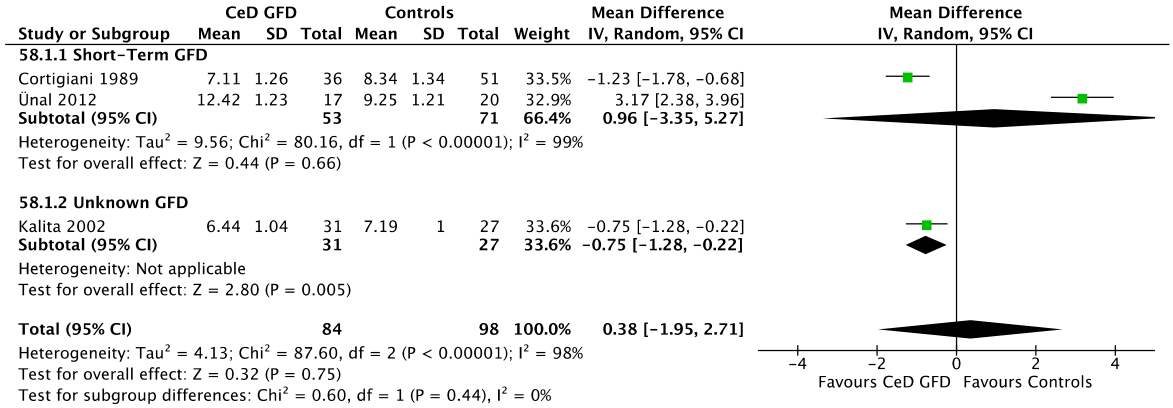


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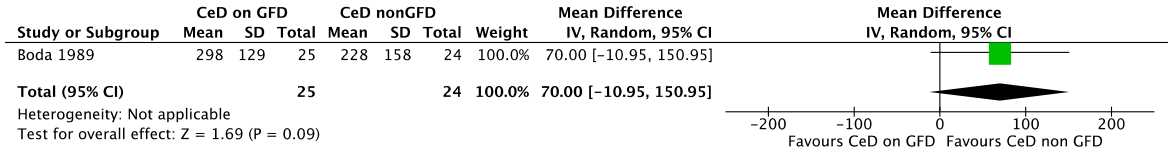
S16F- Forest plot comparison of means of serum Selenium levels between CeD on GFD and non-CeD controls by study design



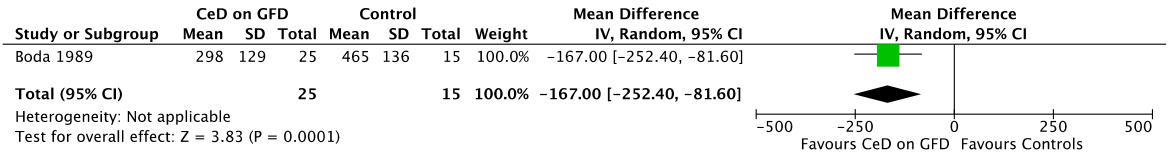
S16G- Forest plot comparison of means of serum Selenium levels between CeD on GFD and non-CeD controls by GFD length



S16H- Forest plot comparison of means of erythrocyte Selenium levels between CeD on GFD and CeD not on GFD

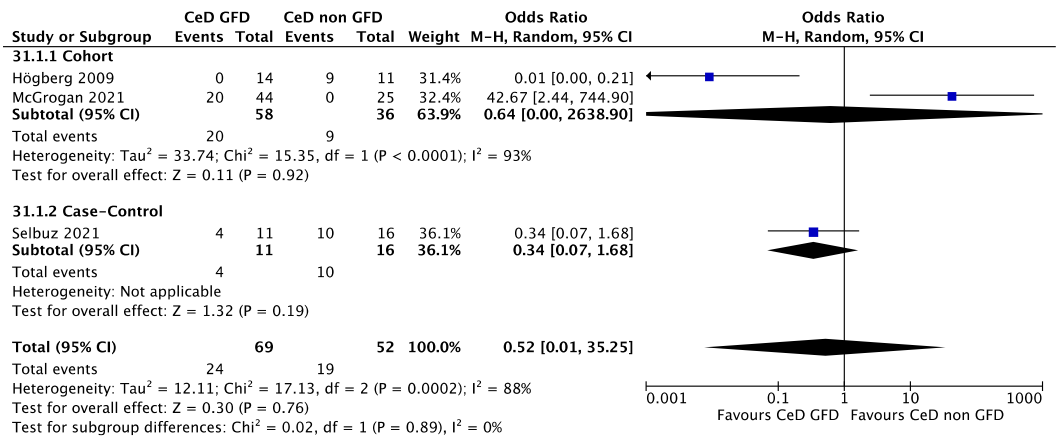


S16I- Forest plot comparison of means of erythrocyte Selenium levels between CeD on GFD and non-CeD controls

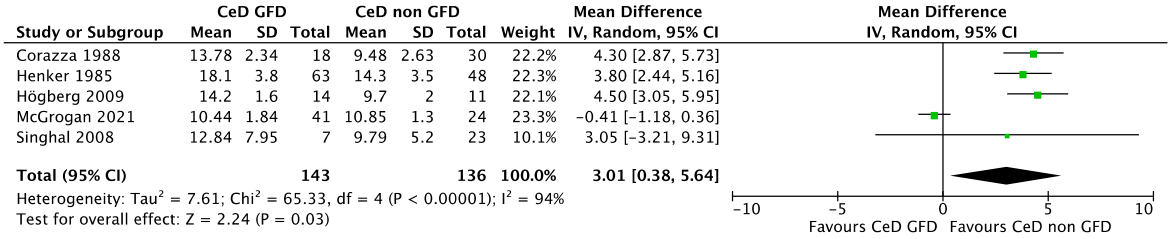


Supplementary Figure S17. Zinc

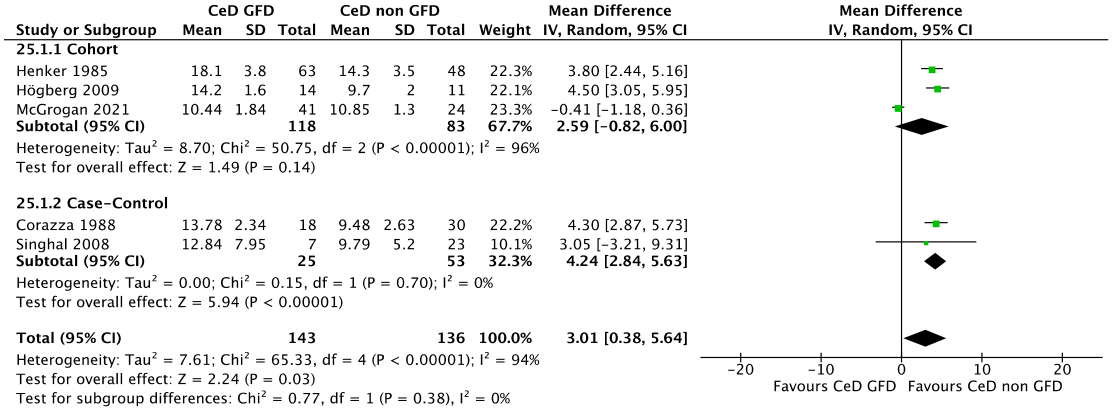
S17A- Forest plot comparison of Zinc deficiency between CeD on GFD and CeD not on GFD by study design



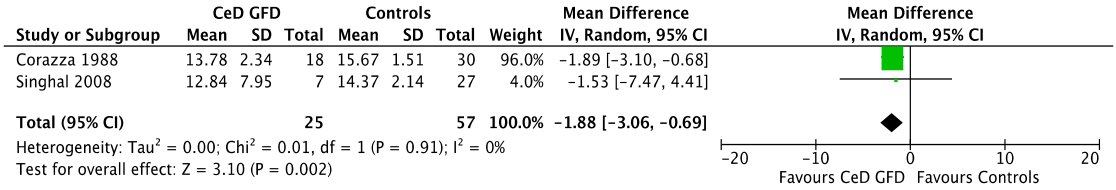
S17B- Forest plot comparison of means of serum zinc levels between CeD on GFD and CeD not on GFD



S17C- Forest plot comparison of means of serum zinc levels between CeD on GFD and CeD not on GFD by study design

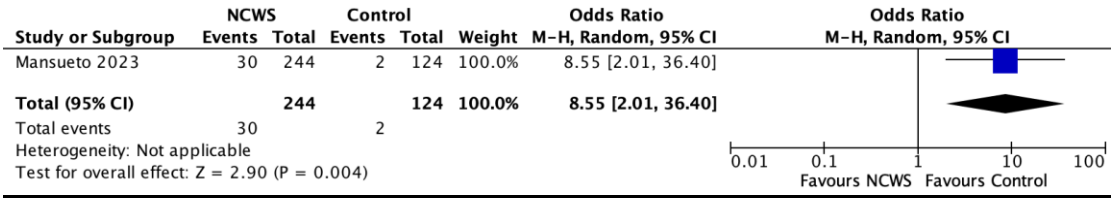


S17D- Forest plot comparison of means of serum zinc levels between CeD on GFD and non-CeD controls

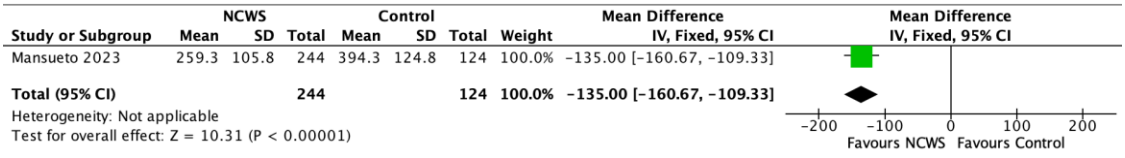


Supplementary Figure S18. NCWS data

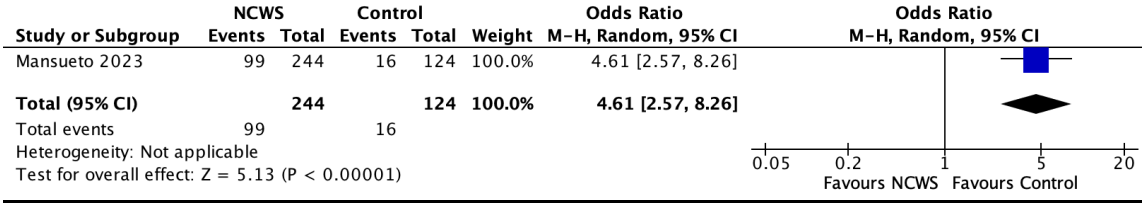
S18A- Forest plot comparison of Vitamin B12 deficiency between NCWS and controls



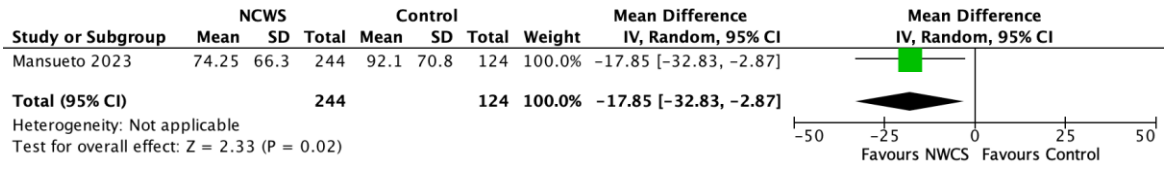
S18B- Forest plot comparison of Vitamin B12 serum levels between NCWS and controls



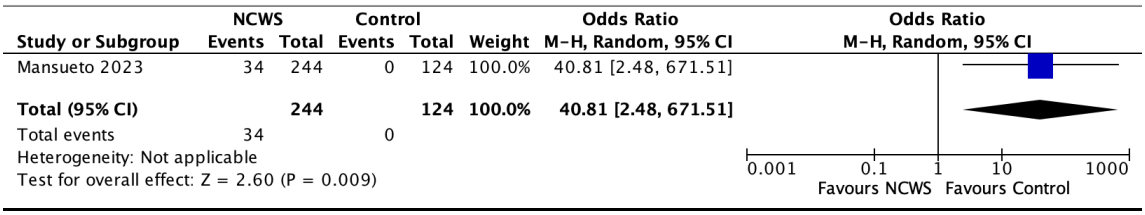
S18C- Forest plot comparison of Ferritin deficiency between NCWS and controls



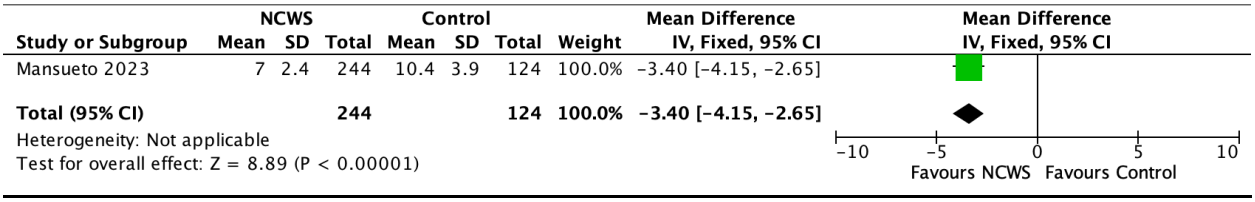
S18D- Forest plot comparison of Ferritin serum levels between NCWS and controls



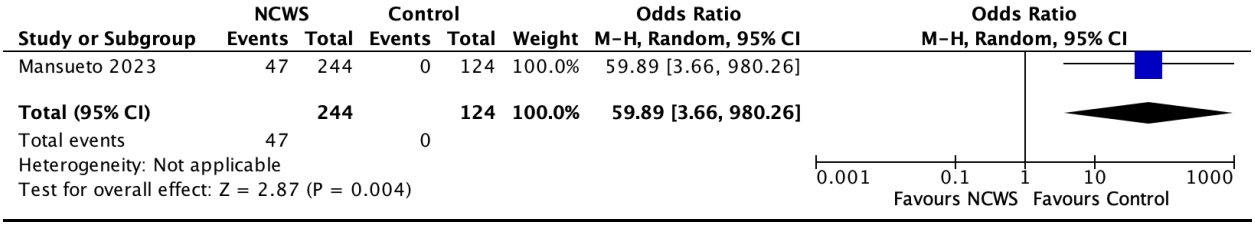
S18E- Forest plot comparison of Folate deficiency between NCWS and controls



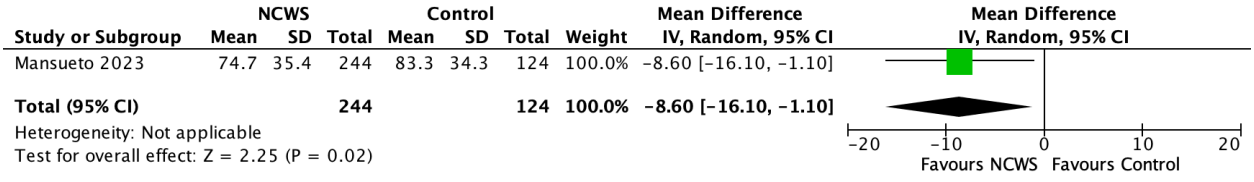
S18F- Forest plot comparison of Folate serum levels between NCWS and controls



S18G- Forest plot comparison of Iron deficiency between NCWS and controls

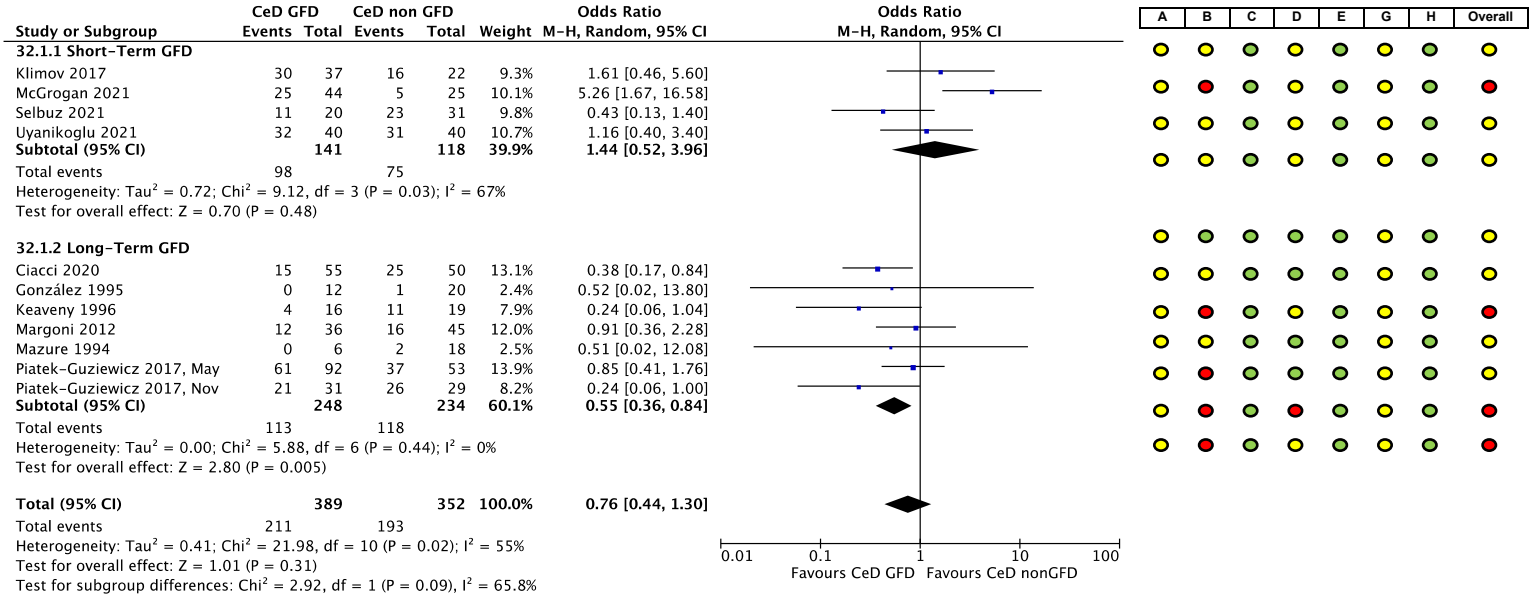


S18H- Forest plot comparison of Iron serum levels between NCWS and controls

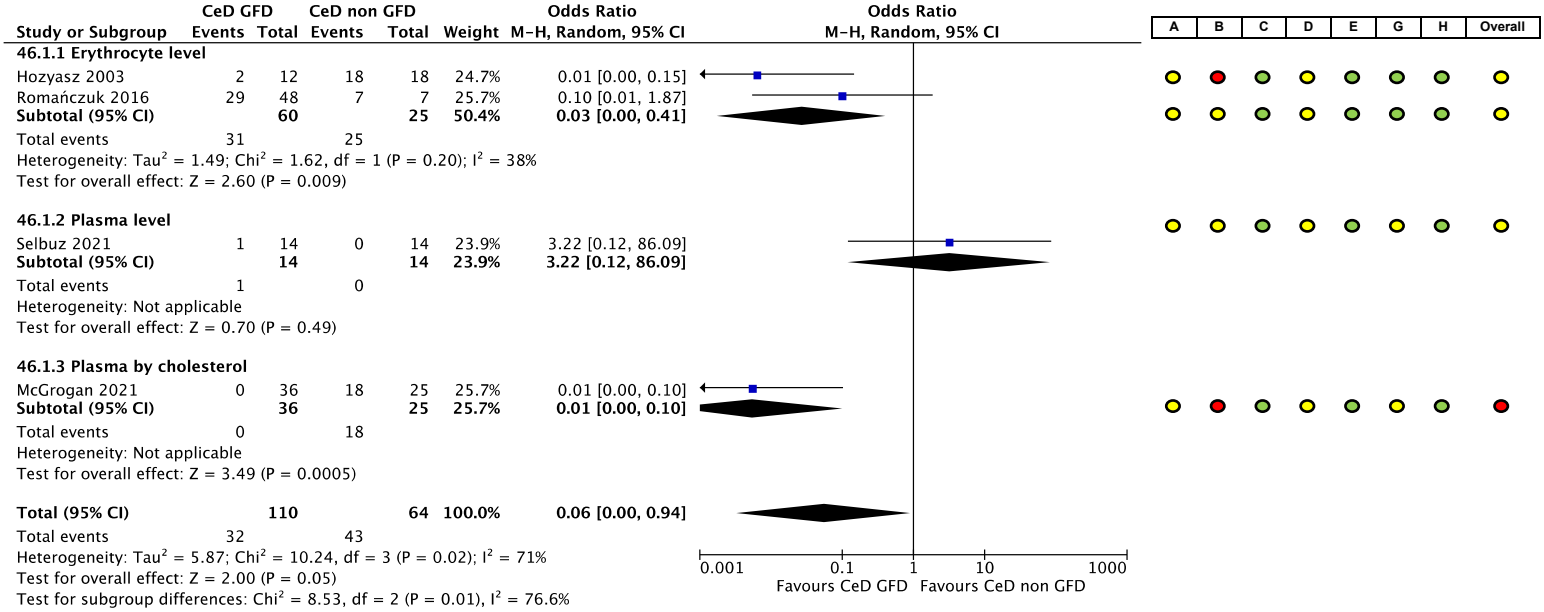


Supplementary Figure S19. - Forest plot of micronutrient deficiencies in CeD on GFD compared to CeD not on GFD with corresponding risk of Bias. **A-** Vitamin 25 (OH) deficiency sub-grouped by duration of GFD **B-** Vitamin E deficiency sub-grouped by study design **C-** Vitamin K deficiency as controlled by triglycerides **D-** Ferritin deficiency **E-** Iron deficiency **F-** Zinc deficiency

A- Vitamin 25 (OH) D



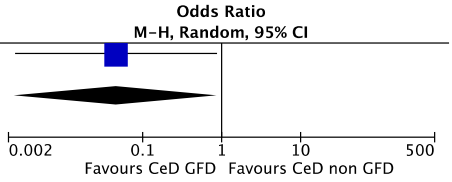
B- Vitamin E

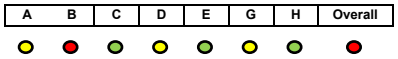


C- Vitamin K

Study or Subgroup	CeD GFD Events	Total	CeD nonGFD Events	Total	Weight	Odds Ratio M-H, Random, 95% CI
McGrogan 2021	0	38	5	24	100.0%	0.05 [0.00, 0.88]
Total (95% CI)		**38**		**24**	**100.0%**	**0.05 [0.00, 0.88]**
Total events	0		5			

Heterogeneity: Not applicable
Test for overall effect: Z = 2.05 (P = 0.04)

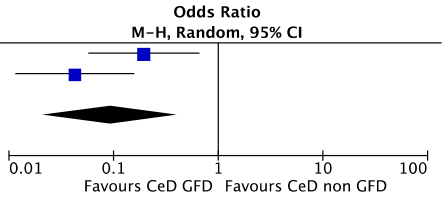


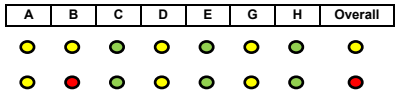


D- Ferritin

Study or Subgroup	CeD GFD Events	Total	CeD non GFD Events	Total	Weight	Odds Ratio M-H, Random, 95% CI
Kemppainen 1995	4	52	12	40	51.2%	0.19 [0.06, 0.66]
McGrogan 2021	6	43	19	24	48.8%	0.04 [0.01, 0.16]
Total (95% CI)		**95**		**64**	**100.0%**	**0.09 [0.02, 0.41]**
Total events	10		31			

Heterogeneity: $Tau^2 = 0.73$; $Chi^2 = 2.76$, df = 1 (P = 0.10); $I^2 = 64\%$
Test for overall effect: Z = 3.13 (P = 0.002)

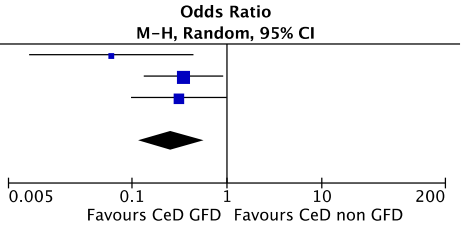


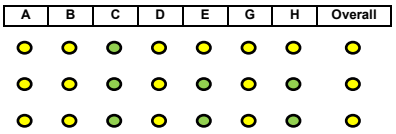


E- Iron

Study or Subgroup	CeD GFD Events	Total	CeD non GFD Events	Total	Weight	Odds Ratio M-H, Random, 95% CI
Anand 1977	3	14	9	11	14.7%	0.06 [0.01, 0.45]
Kemppainen 1995	9	52	15	40	48.5%	0.35 [0.13, 0.91]
Selbuz 2021	6	22	18	33	36.8%	0.31 [0.10, 1.00]
Total (95% CI)		**88**		**84**	**100.0%**	**0.26 [0.12, 0.58]**
Total events	18		42			

Heterogeneity: $Tau^2 = 0.11$; $Chi^2 = 2.49$, df = 2 (P = 0.29); $I^2 = 20\%$
Test for overall effect: Z = 3.30 (P = 0.0010)

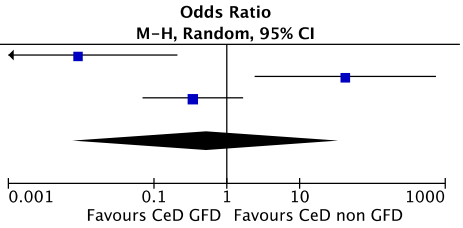


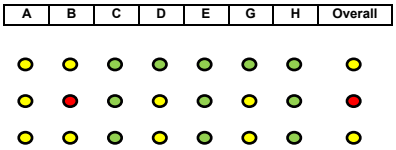


F- Zinc

Study or Subgroup	CeD GFD Events	Total	CeD non GFD Events	Total	Weight	Odds Ratio M-H, Random, 95% CI
Högberg 2009	0	14	9	11	31.4%	0.01 [0.00, 0.21]
McGrogan 2021	19	41	0	24	32.4%	42.47 [2.42, 745.15]
Selbuz 2021	4	11	10	16	36.2%	0.34 [0.07, 1.68]
Total (95% CI)		**66**		**51**	**100.0%**	**0.52 [0.01, 34.68]**
Total events	23		19			

Heterogeneity: $Tau^2 = 12.01$; $Chi^2 = 16.99$, df = 2 (P = 0.0002); $I^2 = 88\%$
Test for overall effect: Z = 0.30 (P = 0.76)

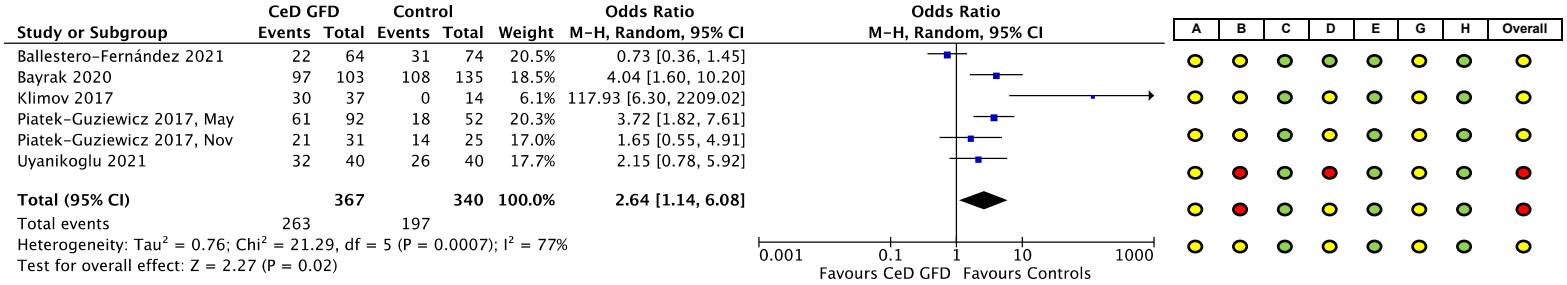




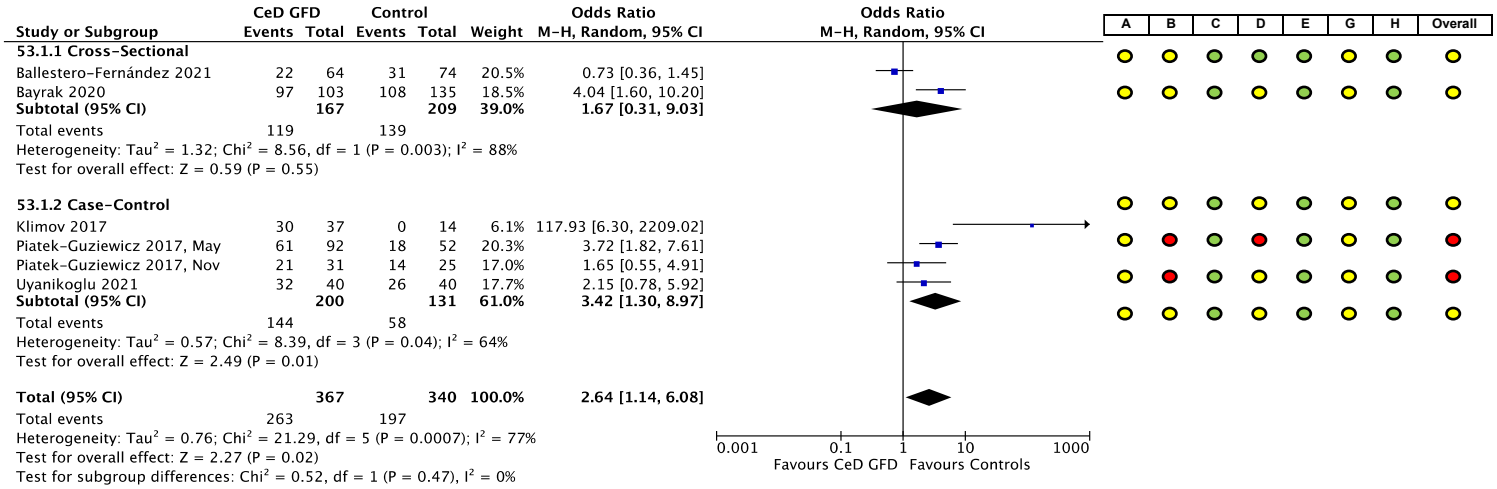
* A- Bias due to confounding, B- Bias due to selection of participants into the study, C- Bias in classification of interventions, D- Bias due to deviation from intervention, E- Bias due to missing data, G- Bias in measurements of outcomes, H- Bias in selection of the reported result, Overall Bias. Green- low risk of bias, yellow- moderate risk of bias, red- severe risk of bias

Supplementary Figure S20. Forest plots comparison of micronutrient deficiencies in CeD on GFD compared to non-CeD controls with corresponding risk of Bias. **A-**Vitamin D deficiency **B-**Vitamin D deficiency stratified by study design **C-**Vitamin D deficiency stratified by duration of GFD length, **D-** Vitamin E deficiency in case-control study

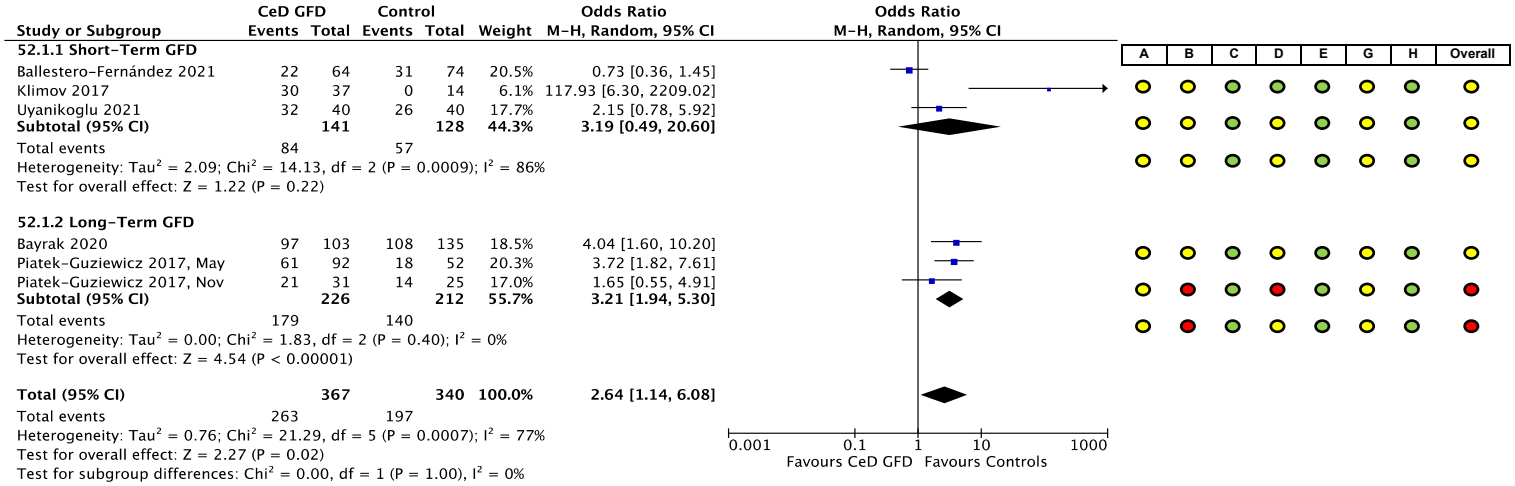
A- Vitamin 25 (OH) D



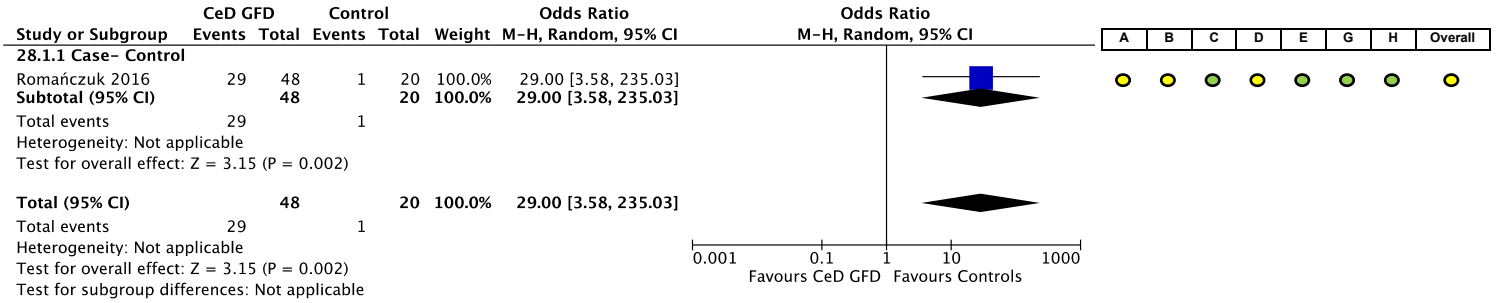
B- Vitamin 25 (OH) D



C- Vitamin 25 (OH) D



D- Vitamin E



***** A- Bias due to confounding, B- Bias due to selection of participants into the study, C- Bias in classification of interventions, D- Bias due to deviation from intervention, E- Bias due to missing data, G- Bias in measurements of outcomes, H- Bias in selection of the reported result, Overall Bias. Green- low risk of bias, yellow- moderate risk of bias, red- severe risk of bias

Supplementary Table ST7. Summary table of nutrient deficiencies in treated CeD compared with untreated CeD or non-celiac controls and NCWS. Number of studies in brackets.

*- statistically significant

Treated vs untreated CeD			
Higher risk	**Lower risk**	**No difference**	**No data**
Vitamin A (3)	Vitamin B1(1), Vitamin B6 (1), Vitamin B12 (3)		Vitamin B2
Selenium (1)	Vitamin E (4)*		Vitamin C
Vitamin D short term GFD (4)	Vitamin D (11) Vitamin D long term GFD (7)*		
Copper (1)	Vitamin K (1)*		
	Calcium short (3)* + long term GFD (3)		
	Vitamin 1,25 OH D (1)		
	Folate (2)		
	Iron (3)*		
	Magnesium (2)		
	Ferritin (2)*		
	Zinc(1)		
Treated CeD vs non-CeD controls			
Higher risk	**Lower risk**	**No difference**	**No data**
Vitamin D (5)	Selenium(1)	Vitamin B1 (1)	Copper, Vitamin A, Vitamin C
Vitamin D long term GFD (2)*	Vitamin B12 (1)	Vitamin B2 (1)	
Vitamin E(1)*		Vitamin B6 (1)	
Folate (1)		Calcium	
Ferritin (1)		Magnesium	
Iron (1)			
NCWS vs non-CeD controls			
Higher risk	**Lower risk**	**No difference**	**No data**
Vitamin B12(1)*			Magnesium. Calcium Copper, Vitamin A, Vitamin C, Vitamin D, Vitamin B1/B2/B6 Selenium, Vitamin E
Ferritin (1)*			
Folate (1)*			
Iron (1)*			

Supplementary Table S8. Summary table of nutrients found in each included study

Micronutrient		CeD Not on GFD		Non CeD Controls		NCWS	
		Study	Characteristics *	Study	Characteristics	Study	Characteristics
Vitamin A	Dichotomous	Hozyasz McGrogan Selbuz	C/ LT/CH C/ ST/CH CC/ST/CH	NA	NA	NA	NA
	Continuous	Hozyasz McGrogan	C/ LT/CH C/ ST/CH	NA	NA	NA	NA
Vitamin B1	Dichotomous	McGrogan	C/ ST/CH	Szaflarska-Poplawska	C/ST/CH	NA	NA
	Continuous	McGrogan	C/ ST/CH	Szaflarska-Poplawska	C/ST/CH	NA	NA
Vitamin B2	Dichotomous	McGrogan	C/ ST/CH	Szaflarska-Poplawska	C/ST/CH	NA	NA
	Continuous	McGrogan Dickey 2008	C/ ST/CH CC/ST/AD	Dickey 2008 Szaflarska-Poplawska	CC/ST/AD C/ST/CH	NA	NA
Vitamin B6	Dichotomous	McGrogan	C/ ST/CH	Szaflarska-Poplawska	C/ST/CH	NA	NA
	Continuous	McGrogan Reinken	C/ ST/CH CC/?/CH	Reinken Szaflarska-Poplawska Valente	CC/?/CH C/ST/CH CS/ST/AD	NA	NA
Vitamin B12	Dichotomous	McGrogan Selbuz Kemppainen	C/ ST/CH CC/ST/CH C/ST/AD	Bayrak Szaflarska-Poplawska Mansueto	CS/LT/CH C/ST/CH CC/ST/AD	Mansueto	CC/ST/AD
	Continuous	McGrogan Kemppainen (RBCs) Dickey Volkan	C/ ST/CH C/ST/AD CC/ST/AD CC/ST/CH	Efe Dickey Bayrak Isikay Szaflarska-Poplawska Valente Volkan Mansueto	CC/ST/CH CC/ST/AD CS/LT/CH CS/ST/CH C/ST/CH CS/ST/AD CC/ST/CH CC/ST/AD	Mansueto	CC/ST/AD
Vitamin C	Dichotomous	McGrogan (No control)	C/ ST/CH (no control)	NA	NA	NA	NA
	Continuous	McGrogan (No control)	C/ ST/CH (no control)	NA	NA	NA	NA
25(OH)Vitamin D	Dichotomous	McGrogan Piatek May Piatek Nov Selbuz Ciacci Gonzalez Keaveny Klimov Margoni Mazure Uyanikoglu	C/ ST/CH CC/LT/AD CC/LT/AD CC/ST/CH CC/LT/AD CS/LT/AD C/LT/AD CC/ST/CH C/LT/CH CC/LT/AD CC/ST/AD	Piatek May Piatek Nov Klimov Uyanikoglu Bayrak Ballestero 2021	CC/LT/AD CC/LT/AD CC/ST/CH CC/ST/AD CS/LT/CH CS/ST/AD	NA	NA
	Continuous	Bulut	CC/ST/CH	Efe	CC/ST/CH	NA	NA

		McGrogan Piatek May Piatek Nov Gonzalez Keaveny Klimov Margoni Mazure Uyanikoglu Corazza 95 Kavak Szymczak Volkan	C/ ST/CH CC/LT/AD CC/LT/AD CS/LT/AD C/LT/AD CC/ST/CH C/LT/CH CC/LT/AD CC/ST/AD CS ST/AD CC/ST/CH CC/ST/AD CC/ST/CH	El Amrousy Piatek May Piatek Nov Klimov Uyanikoglu Bayrak Ballestero 2021 Ballestero 2019 Bjorck Corazza 95 Isikay Pazianas Szymczak Volkan	CS/ST/CH CC/LT/AD CC/LT/AD CC/ST/CH CC/ST/AD CS/LT/CH CS/ST/AD CS/ST/CH CC/LT/CH CS/ST/AD CS/ST/CH CC/LT/AD CC/ST/AD CC/ST/CH		
1-25-OH Vitamin D	Dichotomous	Ciacci	CC/LT/AD	NA	NA	NA	NA
	Continuous	Corazza 95 Szymczak Uyanikoglu Keaveny	CS ST/AD CC/ST/AD CC/ST/AD C/LT/AD	Corazza 95 Szymczak Uyanikoglu	CS ST/AD CC/ST/AD CC/ST/AD	NA	NA
Vitamin E	Dichotomous	Románczuk Hozyasz McGrogan Selbuz	CC/ST/Both C/ LT/CH C/ ST/CH CC/ST/CH	Románczuk	CC/ST/Both	NA	NA
	Continuous	Románczuk Hozyasz McGrogan Piatek May	CC/ST/Both C/ LT/CH C/ ST/CH CC/LT/AD	Románczuk Piatek May	CC/ST/Both CC/LT/AD	NA	NA
Vitamin K	Dichotomous	McGrogan	C/ ST/CH	NA	NA	NA	NA
	Continuous	McGrogan Volkan	C/ ST/CH CC/ST/CH	Volkan	CC/ST/CH	NA	NA
Calcium	Dichotomous	Ciacci Margoni Mazure Kavak Gonzalez Choudhary Selbuz	CC/LT/AD C/LT/CH CC/LT/AD CC/ST/CH CS/LT/AD CS/ST/CH CC/ST/CH	Szaflarska-Poplawska	C/ST/CH	NA	NA
	Continuous	Bulut Ciacci Margoni Mazure Kavak Gonzalez Choudhary Corazza 95 Szymczak Kalayci Karkoszka Keaveny Sabel'nikova Volken Kemppanien	CC/ST/CH CC/LT/AD C/LT/CH CC/LT/AD CC/ST/CH CS/LT/AD CS/ST/CH CS ST/AD CC/ST/AD CC/LT/CH C/LT/CH C/LT/AD C/ST/AD CC/ST/CH C/ST/AD	Ballestero 21 Ballestero19 Corazza 95 Kalayci Pazianas Szaflarska-Poplawska Szymczak Volkan	CS/ST/AD CS/ST/CH CS/ST/AD CC/LT/CH CC/LT/AD C/ST/CH CC/ST/AD CC/ST/CH	NA	NA
Copper	Dichotomous	McGrogan	C/ ST/CH	NA	NA	NA	NA

	Continuous	McGrogan	C/ ST/CH	NA	NA	NA	NA
Ferritin	Dichotomous	McGrogan Kemppanien	C/ ST/CH C/ST/AD	Bayrak Mansueto	CS/LT/CH CC/ST/AD	Mansueto	CC/ST/AD
	Continuous	McGrogan Kemppanien Piatek May Volkan	C/ ST/CH C/ST/AD CC/LT/AD CC/ST/CH	Bayrak Elli Efe El Amrousy Isikay Piatek May Volkan Mansueto	CS/LT/CH CC/LT/AD CC/ST/CH CS/ST/CH CS/ST/CH CC/LT/AD CC/ST/CH CC/ST/AD	Mansueto	CC/ST/AD
Folate	Dichotomous	McGrogan Selbuz	C/ ST/CH CC/ST/CH	Bayrak Szaflarska-Poplawska Mansueto	CS/LT/CH C/ST/CH CC/ST/AD	Mansueto	CC/ST/AD
	Continuous	McGrogan Dickey Volkan Kemppanien (RBCs)	C/ ST/CH CC/ST/AD CC/ST/CH C/ST/AD	Ballestero 2021 Ballestero 2019 Isikay Volkan Valente Bayrak Dickey Szaflarska-Poplawska Mansueto	CS/ST/AD CS/ST/CH CS/ST/CH CC/ST/CH CS/ST/AD CS/LT/CH CC/ST/AD C/ST/CH CC/ST/AD	Mansueto	CC/ST/AD
Iron	Dichotomous	Kemppanien Anand Selbuz	C/ST/AD CC/ST/AD CC/ST/CH	Bayrak Elli (No Control) Mansueto	CS/LT/CH CC/LT/AD CC/ST/AD	Mansueto	CC/ST/AD
	Continuous	Kemppanien Anand Sabel'nikova	C/ST/AD CC/ST/AD C/ST/AD	Ballestero 2021 Ballestero 2019 Bayrak Elli Efe Mansueto	CS/ST/AD CS/ST/CH CS/LT/CH CC/LT/AD CC/ST/CH CC/ST/AD	Mansueto	CC/ST/AD
Magnesium	Dichotomous	McGrogan Selbuz	C/ ST/CH CC/ST/CH	Szaflarska-Poplawska	C/ST/CH	NA	NA
	Continuous	McGrogan Kemppanien Volkan	C/ ST/CH C/ST/AD CC/ST/CH	Volkan Szaflarska-Poplawska	CC/ST/CH C/ST/CH	NA	NA
Selenium	Dichotomous	McGrogan	C/ ST/CH	Unal	CC/ST/CH	NA	NA
	Continuous	McGrogan Kalita Cortigiani Boda	C/ ST/CH C/ST/CH CC/ST/CH CC/LT/CH	Kalita Cortigiani Boda Unal	C/ST/CH CC/ST/CH CC/LT/CH CC/ST/CH	NA	NA
Zinc	Dichotomous	McGrogan Selbuz Högberg	C/ ST/CH CC/ST/CH C/ST/CH	NA	NA	NA	NA
	Continuous	McGrogan Corazza 88 Högberg	C/ ST/CH CC/ST/AD C/ST/CH	Corazza 88 Singhal	CC/ST/AD CC/ST/CH	NA	NA

		Henker Singhal	C/ST/CH CC/ST/CH				

*- C=Cohort, CS= Cross-sectional, CC= case control, LT= long term GFD, ST= short-term GFD, CH-children, AD-Adults, Both=AD+CH, ?=unknown, NA=Not applicable

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	1
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	4
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	4,5
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	4
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	SUP.1
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	SUP 2
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	4,5,6
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	5,6
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	5,6
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	5,6
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	6
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	5,6
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	6
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	6
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	6

Section and Topic	Item #	Checklist item	Location where item is reported
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	4,5,6
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	6
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	6
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	5,6
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	6,7
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	7,8 24-27 SUP Table 5,6
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	SUP pg. 4-17
Study characteristics	17	Cite each included study and present its characteristics.	24-27
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	27
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	7-14 32-35
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Sup P. 63-66
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	7-14 32-35
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	7-14
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	NA
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	32-35
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	32-35

Section and Topic	Item #	Checklist item	Location where item is reported
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	14-17
	23b	Discuss any limitations of the evidence included in the review.	16,17
	23c	Discuss any limitations of the review processes used.	16
	23d	Discuss implications of the results for practice, policy, and future research.	17
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	2, 5
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	5
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	NA
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	22,23
Competing interests	26	Declare any competing interests of review authors.	22,23
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	23

From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

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