

Gluten-Free Diet Consequences

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A gluten-free diet (GFD), in comparison to a gluten-containing diet, is higher on the glycemic scale, promotes several nutrient deficiencies [e.g. protein, folate, iron, thiamine (B1), riboflavin (B2), niacin (B3)], is lower in fiber, increases Body Mass Index (BMI), and promotes the following pathologies: obesity, cardiovascular disease, diabetes, and fatty liver. A GFDs adverse effects are exaggerated in children due to nutrient demands during physical, mental, and sexual developmental periods.

A GFD has shown to have a positive impact on celiac-related symptomatology (including being underweight at the time of diagnosis) and markers, as well as auto-immune thyroid conditions.

Any individual electing to pursue a GFD needs to be aggressive in their attempts to mitigate its adverse effects, similar to other elimination diets (e.g. vegetarian, vegan, paleo). An alternative to a GFD is to emphasize the consumption of traditionally prepared grain foods which results in glycemic reduction, gluten reduction, and the synthesis of beneficial bio-active peptides. A few examples of these traditional methods include fermentation (e.g. sourdough bread), steam-driven emulsification (e.g. pâte à choux), formation of resistant starch (e.g. Rome-style al dente pasta), and carmelization (e.g. toasting).

Below are recent studies on GFD grouped into categories. The studies with an asterisk (*) at the beginning are available for free download.

OBESITY

Increase of BMI

1. Oso O, Fraser NC. A boy with coeliac disease and obesity. *Acta Paediatr.* 2006 May;95(5):618-9. doi: 10.1080/08035250500421576. PMID: 16825144.
2. Reilly NR, Aguilar K, Hassid BG, Cheng J, Defelice AR, Kazlow P, Bhagat G, Green PH. Celiac disease in normal-weight and overweight children: clinical features and growth outcomes following a gluten-free diet. *J Pediatr Gastroenterol Nutr.* 2011 Nov;53(5):528-31.

3. Dickey W, Kearney N. Overweight in celiac disease: prevalence, clinical characteristics, and effect of a gluten-free diet. *Am J Gastroenterol*. 2006 Oct;101(10):2356-9. doi: 10.1111/j.1572-0241.2006.00750.x. PMID: 17032202.
 4. Więch P, Chmiel Z, Bazaliński D, Sałacińska I, Bartosiewicz A, Mazur A, Korczowski B, Binkowska-Bury M, Dąbrowski M. The Relationship between Body Composition and a Gluten Free Diet in Children with Celiac Disease. *Nutrients*. 2018 Nov 21;10(11):1817.
 5. Amirikian K, Sansotta N, Guandalini S, Jericho H. Effects of the Gluten-free Diet on Body Mass Indexes in Pediatric Celiac Patients. *J Pediatr Gastroenterol Nutr*. 2019 Mar;68(3):360-363.
 6. *Dioneda B, Healy M, Paul M, Sheridan C, Mohr AE, Arciero PJ. A Gluten-Free Meal Produces a Lower Postprandial Thermogenic Response Compared to an Iso-Energetic/Macronutrient Whole Food or Processed Food Meal in Young Women: A Single-Blind Randomized Cross-Over Trial. *Nutrients*. 2020 Jul 9;12(7):2035.
 7. Levran N, Wilschanski M, Livovsky J, Shachar E, Moskovitz M, Assaf-Jabrin L, Shteyer E. Obesogenic habits among children and their families in response to initiation of gluten-free diet. *Eur J Pediatr*. 2018 Jun;177(6):859-866.
- Decrease, Normalization, or Unimpactful of BMI (*Note: Celiac Disease patients only, mostly do to increase in fat mass in underweight children*)
1. Cheng J, Brar PS, Lee AR, Green PH. Body mass index in celiac disease: beneficial effect of a gluten-free diet. *J Clin Gastroenterol*. 2010 Apr;44(4):267-71. doi: 10.1097/MCG.0b013e3181b7ed58. PMID: 19779362.
 2. Ukkola A, Mäki M, Kurppa K, Collin P, Huhtala H, Kekkonen L, Kaukinen K. Changes in body mass index on a gluten-free diet in coeliac disease: a nationwide study. *Eur J Intern Med*. 2012 Jun;23(4):384-8. doi: 10.1016/j.ejim.2011.12.012. Epub 2012 Jan 28. PMID: 22560391.
 3. Sansotta N, Guandalini S, Romano S, Amirikian K, Cipolli M, Tridello G, Barzaghi S, Jericho H. The Gluten Free Diet's Impact on Growth in Children with Celiac Disease in Two Different Countries. *Nutrients*. 2020 May 26;12(6):1547. doi: 10.3390/nu12061547. PMID: 32466557; PMCID: PMC7352316.
 4. Anafy A, Cohen S, Ben Tov A, Amir A, Weintraub Y, Moran-Lev H, Dali Levy M, Ankona Bussel M, Yerushalmy Feler A. The effect of gluten-free diet on body mass index in paediatric celiac disease. *Acta Paediatr*. 2021 Jul;110(7):2233-2239. doi: 10.1111/apa.15787. Epub 2021 Feb 11. PMID: 33529351.

5. Xin C, Imanifard R, Jarahzadeh M, Rohani P, Velu P, Sohoul MH. Impact of Gluten-Free Diet on Anthropometric Indicators in Individuals With and Without Celiac Disease: A Systematic Review and Meta-analysis. *Clin Ther*. 2023 Oct 28:S0149-2918(23)00382-X. doi: 10.1016/j.clinthera.2023.09.018. Epub ahead of print. PMID: 37903705.

METABOLIC SYNDROME (Cardiovascular disease, diabetes, obesity, fatty liver)

Worsen

1. *Scaramuzza AE, Mantegazza C, Bosetti A, Zuccotti GV. Type 1 diabetes and celiac disease: The effects of gluten free diet on metabolic control. *World J Diabetes*. 2013 Aug 15;4(4):130-4. doi: 10.4239/wjd.v4.i4.130. PMID: 23961323; PMCID: PMC3746085.
2. Aguilar EC, Fernandes-Braga W, Santos EA, Leocádio PCL, Dos Santos Aggum Capettini L, Orellano LAA, Campos PP, Lemos VS, Soares FLP, Navia-Pelaez JM, Alvarez-Leite JI. Gluten worsens non-alcoholic fatty liver disease by affecting lipogenesis and fatty acid oxidation in diet-induced obese apolipoprotein E-deficient mice. *Mol Cell Biochem*. 2023 Jul 4. doi: 10.1007/s11010-023-04802-3. Epub ahead of print. PMID: 37402020.
3. Norsa L, Shamir R, Zevit N, Verduci E, Hartman C, Ghisleni D, Riva E, Giovannini M. Cardiovascular disease risk factor profiles in children with celiac disease on gluten-free diets. *World J Gastroenterol*. 2013 Sep 14;19(34):5658-64. doi: 10.3748/wjg.v19.i34.5658. PMID: 24039358; PMCID: PMC3769902.
4. *Remes-Troche JM, Cobos-Quevedo OJ, Rivera-Gutiérrez X, Hernández G, de la Cruz-Patiño E, Uscanga-Domínquez LF. Metabolic effects in patients with celiac disease, patients with nonceliac gluten sensitivity, and asymptomatic controls, after six months of a gluten-free diet. *Rev Gastroenterol Mex (Engl Ed)*. 2020 Apr-Jun;85(2):109-117. English, Spanish. doi: 10.1016/j.rgmx.2019.02.002. Epub 2019 Apr 15. PMID: 31000461.
5. *Kabbani TA, Goldberg A, Kelly CP, Pallav K, Tariq S, Peer A, Hansen J, Dennis M, Leffler DA. Body mass index and the risk of obesity in coeliac disease treated with the gluten-free diet. *Aliment Pharmacol Ther*. 2012 Mar;35(6):723-9. doi: 10.1111/j.1365-2036.2012.05001.x. Epub 2012 Feb 8. PMID: 22316503.

6. **"Gluten free products have high levels of lipids, sugar and salt to improve food palatability and consistency, and subjects with CD show an excessive consumption of hypercaloric and hyperlipidic foods to compensate dietetic restriction." Anania C, Pacifico L, Olivero F, Perla FM, Chiesa C. Cardiometabolic risk factors in children with celiac disease on a gluten-free diet. World J Clin Pediatr. 2017 Aug 8;6(3):143-148. doi: 10.5409/wjcp.v6.i3.143. PMID: 28828296; PMCID: PMC5547425.**
7. ***Marciniak M, Szymczak-Tomczak A, Mahadea D, Eder P, Dobrowolska A, Krela-Kaźmierczak I. Multidimensional Disadvantages of a Gluten-Free Diet in Celiac Disease: A Narrative Review. Nutrients. 2021 Feb 16;13(2):643. doi: 10.3390/nu13020643. PMID: 33669442; PMCID: PMC7920475.**
8. **Mønsted MØ, Holm LJ, Buschard K, Haupt-Jorgensen M. Failure to replicate the diabetes alleviating effect of a maternal gluten-free diet in non-obese diabetic mice. PLoS One. 2023 Sep 8;18(9):e0289258. doi: 10.1371/journal.pone.0289258. PMID: 37682921; PMCID: PMC10490983.**

Improve

1. ***Ehteshami M, Shakerhosseini R, Sedaghat F, Hedayati M, Eini-Zinab H, Hekmatdoost A. The Effect of Gluten Free Diet on Components of Metabolic Syndrome: A Randomized Clinical Trial. Asian Pac J Cancer Prev. 2018 Oct 26;19(10):2979-2984. doi: 10.22034/APJCP.2018.19.10.2979. PMID: 30362336; PMCID: PMC6291063.**

No Effect

1. **Kim HS, Demyen MF, Mathew J, Kothari N, Feurdean M, Ahlawat SK. Obesity, Metabolic Syndrome, and Cardiovascular Risk in Gluten-Free Followers Without Celiac Disease in the United States: Results from the National Health and Nutrition Examination Survey 2009-2014. Dig Dis Sci. 2017 Sep;62(9):2440-2448. doi: 10.1007/s10620-017-4583-1. Epub 2017 Apr 27. PMID: 28451915.**
2. **Barone M, Iannone A, Cristofori F, Dargenio VN, Indrio F, Verduci E, Di Leo A, Francavilla R. Risk of obesity during a gluten-free diet in pediatric and adult patients with celiac disease: a systematic review with meta-analysis. Nutr Rev. 2023 Feb 10;81(3):252-266. doi: 10.1093/nutrit/nuac052. PMID: 35947766.**

MALNUTRITION

1. **Mariani P, Viti MG, Montuori M, La Vecchia A, Cipolletta E, Calvani L, Bonamico M. The gluten-free diet: a nutritional risk factor for adolescents with celiac disease? J Pediatr Gastroenterol Nutr. 1998 Nov;27(5):519-23. doi: 10.1097/00005176-199811000-00004. PMID: 9822315.**

2. **Marí-Bauset S, Llopis-González A, Zazpe I, Marí-Sanchis A, Suárez-Varela MM. Nutritional Impact of a Gluten-Free Casein-Free Diet in Children with Autism Spectrum Disorder. *J Autism Dev Disord.* 2016 Feb;46(2):673-84. doi: 10.1007/s10803-015-2582-7. PMID: 26428353.**
3. ***Szaflarska-Popławska A, Dolińska A, Kuśmierk M. Nutritional Imbalances in Polish Children with Coeliac Disease on a Strict Gluten-Free Diet. *Nutrients.* 2022 Sep 24;14(19):3969. doi: 10.3390/nu14193969. PMID: 36235620; PMCID: PMC9572580.**
4. **"Compliance to the GFD may result in certain deficiencies such as fiber, B vitamins, iron, and trace minerals." Theethira TG, Dennis M. Celiac disease and the gluten-free diet: consequences and recommendations for improvement. *Dig Dis.* 2015;33(2):175-182. doi: 10.1159/000369504. Epub 2015 Apr 22. PMID: 25925920.**
5. **Melini V, Melini F. Gluten-Free Diet: Gaps and Needs for a Healthier Diet. *Nutrients.* 2019 Jan 15;11(1):170. doi: 10.3390/nu11010170. PMID: 30650530; PMCID: PMC6357014.**

GENERAL TOPIC

1. **Nash DT, Slutzky AR. Gluten sensitivity: new epidemic or new myth? Every major change in our diet carries with it the possibility of unforeseen risks. *Am J Cardiol.* 2014 Nov 15;114(10):1621-2. doi: 10.1016/j.amjcard.2014.08.024. Epub 2014 Aug 27. PMID: 25261874.**
2. ***Shewry PR, Hey SJ. Do we need to worry about eating wheat? *Nutr Bull.* 2016 Mar;41(1):6-13. doi: 10.1111/nbu.12186. Epub 2016 Feb 16. PMID: 26941586; PMCID: PMC4760426.**
3. ***Littlejohns TJ, Chong AY, Allen NE, Arnold M, Bradbury KE, Mentzer AJ, Soilleux EJ, Carter JL. Genetic, lifestyle, and health-related characteristics of adults without celiac disease who follow a gluten-free diet: a population-based study of 124,447 participants. *Am J Clin Nutr.* 2021 Mar 11;113(3):622-629. doi: 10.1093/ajcn/nqaa291. PMID: 33184625; PMCID: PMC7948866.**