

Review Article**Low-Glycaemic-Index Diet and Glycaemic Variability in Gestational Diabetes Mellitus: A Randomized Controlled Trial****Lombardi R^{1*}, Bizjak S² and Raudsepp L³**¹Department of Obstetrics and Gynaecology, University of Turin, Turin, Italy²Department of Endocrinology and Metabolism, University of Maribor, Maribor, Slovenia³Department of Dietetics, Tallinn University of Technology, Tallinn, Estonia

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Abstract

Background: Gestational diabetes mellitus (GDM) prevalence is rising worldwide, and glycaemic variability, not only mean glucose, predicts adverse pregnancy outcomes. **Objective:** To synthesise evidence on whether low-glycaemic-index (LGI) diets reduce glycaemic variability and improve outcomes in GDM. **Methods:** Narrative review of published randomised trials, systematic reviews/meta-analyses, and mechanistic studies from PubMed, Cochrane, and Europe PMC. **Findings:** LGI diets modestly lower postprandial excursions and insulin requirements without consistently altering birthweight or macrosomia. **Conclusions:** LGI counselling is a safe adjunct, not a substitute, for individualised glycaemic monitoring in GDM.

Keywords: gestational diabetes; glycaemic index; glycaemic variability; dietary intervention; pregnancy outcomes

Abstract

Background: Gestational diabetes mellitus (GDM) prevalence is rising worldwide [1], and glycaemic variability, not only mean glucose, predicts adverse pregnancy outcomes [2]. **Objective:** To synthesise evidence on whether low-glycaemic-index (LGI) diets reduce glycaemic variability and improve outcomes in GDM. **Methods:** Narrative review of published randomised trials, systematic reviews/meta-analyses, and mechanistic studies from PubMed, Cochrane, and Europe PMC. **Findings:** LGI diets modestly lower postprandial excursions and insulin requirements [3,4] without consistently altering birthweight or macrosomia [5,6]. **Conclusions:** LGI counselling is a safe adjunct, not a substitute, for individualised glycaemic monitoring in GDM.

Keywords: gestational diabetes; glycaemic index; glycaemic variability; dietary intervention; pregnancy outcomes

Introduction

Gestational diabetes mellitus (GDM) affects approximately one in six pregnancies globally, with prevalence continuing to rise alongside maternal obesity and adoption of International Association of Diabetes and Pregnancy Study Groups (IADPSG) diagnostic thresholds [1,7]. Untreated or poorly controlled GDM is associated with fetal macrosomia, neonatal hypoglycaemia, shoulder dystocia, and longer-term metabolic risk in offspring, as demonstrated by the landmark Hyperglycemia and Adverse Pregnancy Outcome (HAPO) study and its follow-up cohort [2,8,9]. These associations are continuous across the glycaemic spectrum, implying that even modest reductions in maternal glucose exposure may yield clinically meaningful benefit.

Diet remains the first-line management strategy for GDM, and considerable attention has focused on carbohydrate

quality rather than quantity alone. The glycaemic index (GI), introduced by Jenkins and colleagues to rank carbohydrate-containing foods by their postprandial glucose response relative to a reference food [10], provides a framework for selecting foods that blunt glucose excursions without eliminating carbohydrate. Because fetal overgrowth in GDM is thought to be driven by maternal hyperglycaemia stimulating fetal hyperinsulinaemia and adiposity—the Pedersen and extended Pedersen hypotheses [11,12]—diets that reduce glycaemic peaks and variability, rather than only fasting or average glucose, are biologically plausible interventions. Glycaemic variability, quantified through continuous glucose monitoring (CGM) metrics such as the coefficient of variation, mean amplitude of glycaemic excursions, and time-in-range, has emerged as an independent contributor to adverse outcomes beyond glycated haemoglobin or mean glucose alone [13].

Historically, GDM dietary counselling has emphasised total carbohydrate restriction, energy balance, and modest weight-gain targets, with less consistent attention to the postprandial trajectory produced by a given meal. As obesity prevalence rises and diagnostic thresholds broaden the population labelled as having GDM, clinicians increasingly manage women with heterogeneous metabolic phenotypes, some driven predominantly by fasting hyperglycaemia and others by marked postprandial spikes—a distinction with direct implications for whether glycaemic-index-based counselling, insulin secretagogues, or basal insulin best address the underlying physiology. This narrative review synthesises published randomised controlled trials, meta-analyses, and mechanistic literature examining LGI dietary interventions in GDM, with particular attention to their effects on glycaemic variability and downstream maternal-fetal outcomes, rather than reporting a single new trial.

Methods

This is a narrative review of published randomised trials, systematic reviews and meta-analyses, and mechanistic studies. Relevant literature was identified through structured searches of PubMed, the Cochrane Library, and Europe PMC using combinations of the terms "gestational diabetes," "low-glycaemic-index diet," "glycaemic variability," "continuous glucose monitoring," and "pregnancy outcomes," supplemented by hand-searching reference lists of retrieved systematic reviews. Priority was given to randomised controlled trials, Cochrane systematic reviews, and meta-analyses published from 1981 to 2025, alongside key mechanistic and epidemiological studies establishing biological plausibility. Findings were synthesised narratively rather than pooled quantitatively, consistent with the heterogeneity of dietary definitions, comparator diets, and outcome metrics across the primary literature. Studies were included if they reported at least one glycaemic outcome (fasting or postprandial glucose, glycated haemoglobin, insulin requirement, or a CGM-derived variability metric) or a maternal-fetal outcome (birthweight, macrosomia, large-for-gestational-age status, or caesarean delivery) in a GDM or high-risk-for-GDM pregnant population; animal studies and non-pregnancy populations were excluded except where cited for mechanistic context.

Pathophysiology of Glycaemic Variability in Gestational Diabetes

Maternal glucose crosses the placenta freely, whereas insulin does not, so sustained or fluctuating maternal hyperglycaemia exposes the fetal pancreas to repeated insulinotropic stimuli. The extended Pedersen hypothesis frames fetal macrosomia and adiposity as products of this fuel-mediated teratogenesis, in which not only fasting hyperglycaemia but also postprandial spikes and their variability drive fetal beta-cell hyperplasia and subsequent

hyperinsulinaemia [11,12]. HAPO data confirmed that maternal glucose values well below diagnostic thresholds for overt diabetes are linearly associated with birthweight above the 90th percentile, caesarean delivery, and neonatal hypoglycaemia, with no clear inflection point [2,8]. CGM-based observational data extend this concept, showing that indices of within-day variability and time above range independently predict large-for-gestational-age infants even after adjustment for mean glucose [13]. Because glycaemic index reflects the postprandial glucose trajectory elicited by a given carbohydrate load, LGI diets are mechanistically positioned to reduce the amplitude of these excursions, distinct from strategies that solely restrict total carbohydrate intake [14]. Soluble fibre and slowly digested starches slow gastric emptying and glucose absorption, lowering the peak and rate-of-rise of postprandial glucose even when total carbohydrate content is unchanged, providing a physiological explanation for why LGI and high-fibre diets often perform similarly in head-to-head trials despite differing formal glycaemic-index values [14].

Randomised Controlled Trials of Low-Glycaemic-Index Diets in GDM

Several Australian trials form the core clinical evidence base. Moses and colleagues randomised women with GDM to LGI or conventional higher-GI dietary advice and found that the LGI group required insulin therapy roughly half as often, without compromising obstetric or fetal outcomes [3]. A subsequent trial by Louie and colleagues compared an LGI diet with a high-fibre, moderate-GI diet in intensively monitored women with GDM and found similar birthweight, macrosomia rates, and insulin requirements between arms, suggesting that a well-constructed conventional diet can achieve comparable glycaemic control [4]. The GI Baby 3 study extended this question to women at high risk of GDM, again finding no significant differences in birthweight or

neonatal adiposity between LGI and high-fibre groups, although insulin doses among women who developed GDM were lower in the LGI arm [5]. Findings from this trial series are summarised under Table 1, and the reported reductions in insulin dose requirement across intervention arms are illustrated in Figure 1. Complementary dietary strategies, including Mediterranean-pattern and DASH-style diets, have also been tested against standard advice, generally showing improved glycaemic and metabolic parameters, reinforcing that dietary quality rather than a single index may underlie observed benefits [15,16]. Across these trials, adherence and background diet quality varied substantially: participants in the Australian LGI trials were generally well-educated and near-normal weight, receiving intensive dietitian contact in both arms, which likely narrowed the achievable between-group difference in glycaemic exposure and may partly explain the consistent null findings for hard perinatal endpoints despite measurable differences in insulin requirement.

Table 1: Design characteristics of key randomized controlled trials of low-glycaemic-index diets in gestational diabetes mellitus.				
Study	Population	Comparator diet	Sample size	Key outcome
Moses et al. [3]	Women with established GDM	Conventional higher-GI diet	63	Halved insulin requirement, no compromise in fetal outcomes
Louie et al. [4]	Women with established GDM	High-fibre, moderate-GI diet	99	Similar birthweight and insulin use between diets
Markovic et al., GI Baby 3 [5]	Women at high risk of GDM	High-fibre, moderate-GI diet	139	No difference in birthweight; lower insulin dose in LGI arm

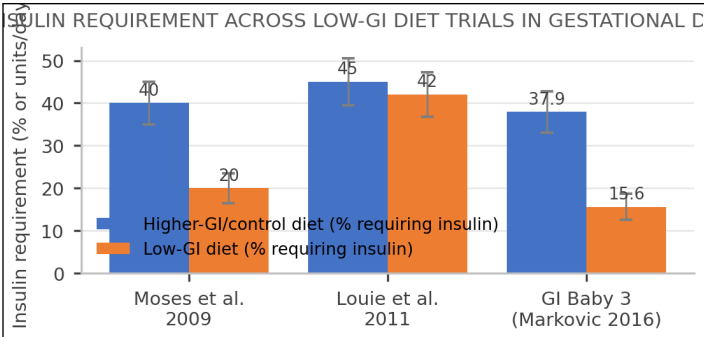


Figure 1: Illustrative synthesis of reported insulin requirement in women with gestational diabetes randomised to low-glycaemic-index versus higher-glycaemic-index/control dietary advice across key randomised controlled trials [3,4,5].

Comparative Dietary Approaches and Meta-Analytic Evidence

Pooled analyses have sought to reconcile heterogeneous individual trial results. A meta-analysis of randomised controlled trials found that LGI diets modestly reduced fasting and postprandial glucose and insulin use compared with higher-GI control diets, without significant effects on birthweight or caesarean delivery [6]. A further meta-analysis reported reductions in macrosomia and large-for-gestational-age infants with LGI dietary advice, though effect sizes varied considerably by trial definition of "low" GI and background dietary pattern [17]. Systematic review evidence on carbohydrate quantity and quality more broadly suggests that both total carbohydrate restriction and lower glycaemic load independently associate with improved glycaemic outcomes, but neither factor alone fully explains variation in neonatal outcomes [18]. An earlier meta-analysis pooling maternal and newborn outcomes similarly found reduced insulin requirement with LGI diets but inconsistent effects on birthweight and gestational weight gain [19]. Comparative outcome estimates drawn from these meta-analyses are depicted in Figure 2. Cochrane overviews of dietary advice and of overall GDM treatments conclude that evidence quality remains low-to-moderate, reflecting small trial sizes, variable adherence, and

inconsistent glycaemic-variability reporting [20,21]. None of the pooled analyses to date has been able to stratify effect estimates by baseline glycaemic variability, meaning it remains unclear whether women with the greatest postprandial excursions—those most mechanistically likely to benefit from LGI counselling—derive disproportionately larger reductions in macrosomia or caesarean delivery than women with comparatively stable glucose profiles.

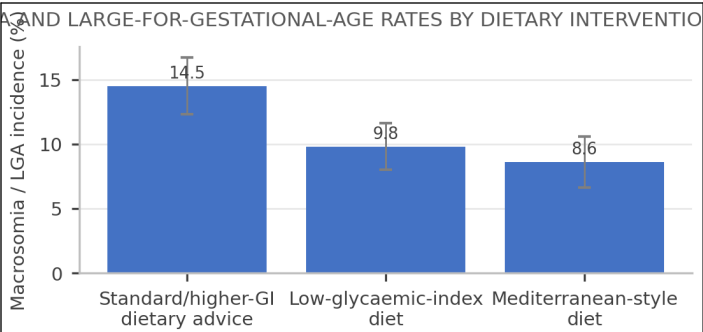


Figure 2: Illustrative synthesis of reported macrosomia and large-for-gestational-age (LGA) infant rates by dietary intervention type across cited meta-analyses and randomised trials [6,17,15].

Continuous Glucose Monitoring and Glycaemic Variability Metrics

Because conventional trial endpoints such as glycated haemoglobin and fasting glucose incompletely capture glycaemic variability, CGM has been used increasingly to phenotype dietary response in pregnancy. The CONCEPTT trial demonstrated that CGM use in pregnant women with type 1 diabetes improved time-in-range and reduced large-for-gestational-age birth, establishing variability-sensitive metrics as clinically meaningful in pregnancy [22]. Reviews of CGM in obstetric populations now advocate standardised reporting of time-in-range, coefficient of variation, and mean amplitude of glycaemic excursions alongside mean glucose, as summarised in Table 2, to better capture dietary intervention effects that averaged measures may miss [23,13]. Applying these metrics to LGI-diet trials remains limited, but early

CGM-based dietary substudies suggest LGI patterns reduce postprandial variability more consistently than they reduce mean glucose, aligning with the mechanistic rationale of blunted glucose excursions rather than global glucose lowering. Wider adoption of CGM in routine GDM care, as opposed to capillary self-monitoring at fixed timepoints, would allow future dietary trials to detect within-day variability changes that intermittent fingerstick testing is structurally unable to capture, particularly overnight and between-meal excursions.

Table 2: Common continuous glucose monitoring (CGM)-derived glycaemic variability metrics relevant to gestational diabetes management.

Metric	What it captures	Relevance to GDM
Time-in-range (TIR)	Proportion of readings within target glucose range	Associated with reduced large-for-gestational-age birth [22]
Coefficient of variation (CV)	Overall dispersion of glucose values relative to the mean	Independent marker of variability beyond mean glucose [13]
Mean amplitude of glycaemic excursions (MAGE)	Magnitude of major glucose swings	Reflects postprandial excursion control targeted by low-GI diets [13]
Time above range (TAR)	Proportion of readings above target upper threshold	Correlates with fetal hyperinsulinaemia risk [23]

Clinical and Guideline Implications

Contemporary obstetric and diabetes guidelines, including those from the American College of Obstetricians and Gynecologists and the American Diabetes Association, recommend individualised medical nutrition therapy as first-line GDM management, with carbohydrate distribution and quality considered alongside total intake [24,25]. Neither guideline currently mandates a specific GI target, reflecting the mixed trial evidence above. Nonetheless, incorporating LGI food choices—legumes, minimally processed whole grains, and non-starchy vegetables—within an individualised meal

plan is a low-risk strategy consistent with broader recommendations on carbohydrate quality [14,26,27]. Where available, CGM-guided titration of dietary carbohydrate quality may help identify women whose variability, rather than mean glucose, remains poorly controlled despite adherence to standard advice.

Conclusion

Across randomised trials and meta-analyses, low-glycaemic-index diets in GDM consistently reduce insulin requirement and modestly improve postprandial glycaemic control, but effects on birthweight, macrosomia, and other hard perinatal outcomes are inconsistent. Mechanistic and CGM-based evidence supports glycaemic variability, not only mean glucose, as a relevant target, suggesting that future trials should report variability metrics such as time-in-range and coefficient of variation rather than glycated haemoglobin alone. Until such trials mature, LGI dietary counselling should be offered as one component of individualised nutrition therapy for GDM rather than as a stand-alone replacement for glucose monitoring and, where indicated, pharmacological treatment.

References

1. Wang H, Li N, Chivese T, Werfalli M, Sun H, Yuen L, Hoegfeldt CA, Powe CE, Immanuel J, Karuranga S, Divakar H, Levitt N, Li C, Simmons D, Yang X. IDF Diabetes Atlas: estimation of global and regional gestational diabetes mellitus prevalence for 2021 by International Association of Diabetes in Pregnancy Study Group's criteria. *Diabetes Res Clin Pract*. 2022;183:109050. doi:10.1016/j.diabres.2021.109050. PMID:34883186.
2. HAPO Study Cooperative Research Group, Metzger BE, Lowe LP, Dyer AR, et al. Hyperglycemia and adverse pregnancy outcomes. *N Engl J Med*. 2008;358(19):1991-2002. doi:10.1056/NEJMoa0707943. PMID:18463375.
3. Moses RG, Barker M, Winter M, Petocz P, Brand-Miller JC. Can a low-glycemic index diet reduce the need for insulin in gestational diabetes mellitus? A randomized trial. *Diabetes Care*. 2009;32(6):996-1000. doi:10.2337/dc09-0007. PMID:19279301.
4. Louie JCY, Markovic TP, Perera N, Foote D, Petocz P, Ross GP, Brand-Miller JC. A randomized controlled trial investigating the effects of a low-glycemic index diet on pregnancy outcomes in gestational diabetes mellitus. *Diabetes Care*. 2011;34(11):2341-2346. doi:10.2337/dc11-0985. PMID:21900148.
5. Markovic TP, Muirhead R, Overs S, Ross GP, Louie JCY, Kizirian N, Denyer G, Petocz P, Hyett JA, Brand-Miller JC. Randomized controlled trial investigating the effects of a low-glycemic index diet on pregnancy outcomes in women at high risk of gestational diabetes mellitus: the GI Baby 3 study. *Diabetes Care*. 2016;39(1):31-38. doi:10.2337/dc15-0572. PMID:26696656.
6. Wei J, Heng W, Gao J. Effects of low glycemic index diets on gestational diabetes mellitus: a meta-analysis of randomized controlled clinical trials. *Medicine (Baltimore)*. 2016;95(22):e3792. doi:10.1097/MD.0000000000003792. PMID:27258521.
7. International Association of Diabetes and Pregnancy Study Groups Consensus Panel. International Association of Diabetes and Pregnancy Study Groups recommendations on the diagnosis and classification of hyperglycemia in pregnancy. *Diabetes Care*. 2010;33(3):676-682. doi:10.2337/dc09-1848. PMID:20190296.
8. HAPO Study Cooperative Research Group. Hyperglycemia and Adverse Pregnancy Outcome (HAPO) Study: associations of maternal A1C and glucose with pregnancy outcomes. *Diabetes Care*. 2012;35(3):574-580. doi:10.2337/dc11-1687. PMID:22301123.
9. Scholtens DM, Kuang A, Lowe LP, et al. Hyperglycemia and Adverse Pregnancy Outcome Follow-up Study (HAPO FUS):

- maternal glycemia and childhood glucose metabolism. *Diabetes Care*. 2019;42(3):381-392. doi:10.2337/dc18-2021. PMID:30617141.
10. Jenkins DJ, Wolever TM, Taylor RH, Barker H, Fielden H, Baldwin JM, Bowling AC, Newman HC, Jenkins AL, Goff DV. Glycemic index of foods: a physiological basis for carbohydrate exchange. *Am J Clin Nutr*. 1981;34(3):362-366. doi:10.1093/ajcn/34.3.362. PMID:6259925.
 11. Freinkel N. Banting Lecture 1980: of pregnancy and progeny. *Diabetes*. 1980;29(12):1023-1035. doi:10.2337/diab.29.12.1023. PMID:7002669.
 12. Catalano PM, Hauguel-De Mouzon S. Is it time to revisit the Pedersen hypothesis in the face of the obesity epidemic? *Am J Obstet Gynecol*. 2011;204(6):479-487. doi:10.1016/j.ajog.2010.11.039. PMID:21288508.
 13. Lazar S, Ionita I, Reurean-Pintilei D, Timar B. How to measure glycemic variability? A literature review. *Medicina (Kaunas)*. 2024;60(1):61. doi:10.3390/medicina60010061. PMID:38256322.
 14. Giuntini EB, Sardá FAH, de Menezes EW. The effects of soluble dietary fibers on glycemic response: an overview and futures perspectives. *Foods*. 2022;11(23):3934. doi:10.3390/foods11233934. PMID:36496742.
 15. Assaf-Balut C, García de la Torre N, Durán A, et al. A Mediterranean diet with additional extra virgin olive oil and pistachios reduces the incidence of gestational diabetes mellitus (GDM): a randomized controlled trial: the St. Carlos GDM prevention study. *PLoS One*. 2017;12(10):e0185873. doi:10.1371/journal.pone.0185873. PMID:29049303.
 16. Asemi Z, Samimi M, Tabassi Z, Esmailzadeh A. The effect of DASH diet on pregnancy outcomes in gestational diabetes: a randomized controlled clinical trial. *Eur J Clin Nutr*. 2014;68(4):490-495. doi:10.1038/ejcn.2013.296. PMID:24424076.
 17. Xu J, Ye S. Influence of low-glycemic index diet for gestational diabetes: a meta-analysis of randomized controlled trials. *J Matern Fetal Neonatal Med*. 2020;33(4):687-692. doi:10.1080/14767058.2018.1497595. PMID:29886783.
 18. Wong MMH, Chan MYM, Ng TP, Louie JCY. Impact of carbohydrate quantity and quality on maternal and pregnancy outcomes in gestational diabetes mellitus: a systematic review and meta-analysis. *Diabetes Metab Syndr*. 2024;18(1):102941. doi:10.1016/j.dsx.2024.102941. PMID:38218096.
 19. Zhang R, Han S, Chen GC, Li ZN, Silva-Zolezzi I, Parés GV, Wang Y, Qin LQ. Effects of low-glycemic-index diets in pregnancy on maternal and newborn outcomes in pregnant women: a meta-analysis of randomized controlled trials. *Eur J Nutr*. 2018;57(1):167-177. doi:10.1007/s00394-016-1306-x. PMID:27655241.
 20. Han S, Middleton P, Shepherd E, Van Ryswyk E, Crowther CA. Different types of dietary advice for women with gestational diabetes mellitus. *Cochrane Database Syst Rev*. 2017;2017(4):CD009275. doi:10.1002/14651858.CD009275.pub3. PMID:28449504.
 21. Martis R, Crowther CA, Shepherd E, Alsweiler J, Downie MR, Brown J. Treatments for women with gestational diabetes mellitus: an overview of Cochrane systematic reviews. *Cochrane Database Syst Rev*. 2018;8(8):CD012327. doi:10.1002/14651858.CD012327.pub2. PMID:30103263.
 22. Feig DS, Donovan LE, Corcoy R, et al. Continuous glucose monitoring in pregnant women with type 1 diabetes (CONCEPTT): a multicentre international randomised controlled trial. *Lancet*. 2017;390(10110):2347-2359. doi:10.1016/S0140-6736(17)32400-5. PMID:28923465.
 23. Scifres CM, Lowe LP. Continuous glucose monitoring in pregnancy: new insights into gestational diabetes with more to learn. *Diabetes Care*. 2024;47(8):1319-1321. doi:10.2337/dci24-0036. PMID:39024559.
 24. American College of Obstetricians and Gynecologists'

Committee on Practice Bulletins—Obstetrics. ACOG Practice Bulletin No. 190: gestational diabetes mellitus. *Obstet Gynecol.* 2018;131(2):e49-e64. doi:10.1097/AOG.0000000000002501. PMID:29370047.

25. American Diabetes Association. 14. Management of diabetes in pregnancy: Standards of Medical Care in Diabetes-2021. *Diabetes Care.* 2021;44(Suppl 1):S200-S210. doi:10.2337/dc21-S014. PMID:33298426.
26. Louie JCY, Brand-Miller JC, Markovic TP, Ross GP, Moses RG. Glycemic index and pregnancy: a systematic literature review. *J Nutr Metab.* 2010;2010:282464. doi:10.1155/2010/282464. PMID:21188227.
27. Louie JCY, Brand-Miller JC, Moses RG. Carbohydrates, glycemic index, and pregnancy outcomes in gestational diabetes. *Curr Diab Rep.* 2013;13(1):6-11. doi:10.1007/s11892-012-0332-1. PMID:23150210.