Table. S1 Summary of key genetic association studies evaluating SLC30A8, CDKAL1, and HHEX polymorphisms in gestational diabetes mellitus.

Reference (quality)	Population	GDM criteria	Cases/Controls	Gene	Variant	Effect (OR [95% CI], model)	Key covariates
Amin et al., 2022 (case–control; multiple models)	Asian	IASDPG	212 / 256	CDKAL1	rs7754840	Recessive model (CC vs CG+GG): OR=2.09; 95% CI 1.00–4.36. After adjustment OR=2.23; 95% CI 1.04–4.75	Adjusted for gravidity and family history of diabetes
Amin et al., 2022 (case–control; multiple models)	Asian	IASDPG	212 / 256	CDKAL1	rs7756992	Dominant model (AG+GG vs AA): OR=1.59 (95% CI 1.10–2.30), P=0.014; Log-additive: OR=1.42 (1.06–1.90), P=0.019.	Adjusted for gravidity and family history of diabetes
Cho et al., 2009 (case–control)	Asian	Carpenter–Coustan criteria	869/632	CDKAL1	rs7754840	1.55 [1.34–1.79], additive	Not reported / genetic association; cohort comparison
Cho et al., 2009 (case–control)	Asian	Carpenter–Coustan criteria	869/632	CDKAL1	rs7756992	1.39 [1.20–1.61], additive	Not reported / genetic association; cohort comparison
Cho et al., 2009 (case–control)	Asian	Carpenter–Coustan criteria	869/632	HHEX	rs1111875	1.27 [1.09–1.49], additive	Not reported / genetic association; cohort comparison
Cho et al., 2009 (case–control)	Asian	Carpenter–Coustan criteria	869/632	SLC30A8	rs13266634	1.24 [1.07–1.43], additive	Not reported / genetic association; cohort comparison
Gyan et al., 2025 (BMC Endocr Disord) – case-control, meta- analysis	Asian	IADPSG	500/502	CDKAL1	rs7754840 (G>C)	Dominant model OR 1.16 (1.104–1.29); Adjusted codominant model OR 1.715 (1.133–2.595)	Adjusted for age, pre-pregnancy BMI, SBP/DBP, parity
Lauenborg et al.,2009 (Danish prior-GDM cohort)	Caucasian	WHO	283/2446	CDKAL1	rs7756992	Additive model 1.22 [1.00–1.49]	Adjusted: age, BMI
Lauenborg et al.,2009 (Danish prior-GDM cohort)	Caucasian	WHO	283/2446	HHEX	rs1111875	Additive model 1.18 [0.98–1.43]	Adjusted: age, BMI
Lauenborg et al.,2009 (Danish prior-GDM cohort)	Caucasian	WHO	283/2446	SLC30A8	rs13266634	Additive model 1.19 [0.97–1.44],	Adjusted: age, BMI
Noury et al., 2018 (Egyptian cohort)	Middle Eastern/North African	IASDPG	47/51	CDKAL1	rs7754840	Allelic model 1.199 [0.669–2.152],	Not reported / unadjusted
Pervjakova et al., 2022 (multi-ancestry GWAS meta-analysis)	Multi-ancestry	multi-cohort	5485/347856	CDKAL1	rs9348441	Fixed-effects allelic model 1.13 [1.08–1.18]	GWAS standard covariates (study-specific; ancestry PCs etc.)
Pineda-Cortel et al., 2021; (case-control)	Asian	IASDPG	101 / 99	CDKAL1	rs7754840	1.43 [0.82–2.50]	NA
Rosta et al., 2017 ; (case-control)	Caucasian	IASDPG, WHO	IADPSG: 287/533; WHO: 303/517	SLC30A8	rs13266634	Allele T (OR=0.74 (IADPSG) and OR=0.71 (m'99 WHO); p=0.05/0.02 (C/T). CI not reported.	Adjusted for age and BMI (additive model)
Rosta et al., 2017 ; (case-control)	Caucasian	IASDPG, WHO	IADPSG: 287/533; WHO: 303/517	CDKAL1	rs7754840	Allele C : OR=1.51 (IADPSG) and NS under m'99 WHO; p=0.016. CI not reported.	Age-adjusted
Wang et al., 2011; (case-control)	Asian	Carpenter–Coustan criteria	725/1039	CDKAL1	rs7754840	Additive model OR 1.274 (0.957–1.695);	Not reported
Yu et al., 2021 (meta-analysis)	Asian	various	4,819 / 5,873	CDKAL1	rs7754840	CG vs GG: OR 1.36 [1.13–1.65]; CC vs GG: OR 1.76 [1.37–2.26]	Pooled unadjusted genetic models
Yu et al., 2021 (meta-analysis)	Asian	various	2,376 / 4,458	CDKAL1	rs7756992	AG vs AA: OR 1.23 [1.08–1.41]; GG vs AA: OR 1.47 [1.05–2.05]	Pooled unadjusted genetic models
Zeng et al., 2023; (age-stratified analysis)	Asian	IASDPG	500/502	SLC30A8	rs13266634	Recessive moedl 0.615 (0.392–0.966)	Adjusted for age, pre-pregnancy BMI, SBP/DBP, parity

Zeng et al., 2023; (age-stratified analysis)	Asian	IASDPG	500/502	SLC30A8	rs2466293	Adjusted dominant model OR 1.310 (1.005–1.707)	Adjusted for age, pre-pregnancy BMI, SBP/DBP, parity
Zeng et al., 2023; (age-stratified analysis)	Asian	IASDPG	500/502	HHEX	rs5015480	Adjusted dominant model 1.595 (1.034–2.459)	Adjusted for age, pre-pregnancy BMI, SBP/DBP, parity
Zeng et al., 2023; (age-stratified analysis)	Asian	IASDPG	500/502	HHEX	rs1111875	Adjusted heterozygote model 1.370 (1.040–1.805)	Adjusted for age, pre-pregnancy BMI, SBP/DBP, parity
Kwak et al., 2012 (GWAS)	Asian	Carpenter–Coustan criteria	468/1242	CDKAL1	rs7754840	1.707[1-459-1997], (p=<0.0001)	GWAS standard covariates
Xie et al., 2023 (meta-analysis).	Multi-ancestry	Various across included studies (IWCGDM, WHO, ADA, Carpenter–Coustan criteria, etc.)	1,232 / 4,284	HHEX	rs1111875	Allelic/additive (C vs T): OR 1.20 (1.07–1.34); P=0.001; I^2=0%; fixed-effect (3 studies; 4 groups)	Pooled unadjusted genetic models (NOS ≥6 for included studies)
Xie et al., 2023 (meta-analysis).	Multi-ancestry	Various across included studies (IWCGDM, IADPSG, ADA)	1,384 / 1,184	HHEX	rs5015480	Allelic/additive (C vs T): OR 1.29 (1.13–1.47); P<0.001; I^2=0%; fixed-effect (3 studies)	Pooled unadjusted genetic models (NOS ≥6 for included studies)
Xie et al., 2023 (meta-analysis).	Multi-ancestry	Various across included studies (IWCGDM, WHO, ADA, Carpenter–Coustan, EASD, SBD)	2,610 / 5,910	SLC30A8	rs13266634	Allelic/additive (C vs T): OR 1.23 (1.13–1.33); P<0.001; I^2=13.6%; fixed-effect (7 studies; 8 groups)	Pooled unadjusted genetic models (NOS ≥6 for included studies)
Stuebe et al., 2014; prospective cohort	Caucasian/ African-American	Carpenter–Coustan criteria	Caucasian: 56/843; African-American: 24/362	CDKAL1	rs10946398	Caucasian: 1 risk allele vs 0 OR 0.75 [0.41–1.37]; 2 vs 0 OR 0.35 [0.04–1.44]. African-American: 1 vs 0 OR 0.83 [0.23–3.81]; 2 vs 0 OR 0.81 [0.20–3.97].	Adjusted for maternal age and pregravid BMI; among African-American women additionally adjusted for probability of Yoruban ancestry.
Stuebe et al., 2014; prospective cohort	Caucasian/ African-American	Carpenter–Coustan criteria	Caucasian: 56/843; African-American: 24/362	HHEX/IDE	rs1111875	Caucasian: 1 vs 0 OR 1.05 [0.71–1.55]; 2 vs 0 OR 1.10 [0.50–2.40]. African-American: 1 vs 0 OR 1.35 [0.16–64.99]; 2 vs 0 OR 1.45 [0.19–66.21].	Adjusted for maternal age and pregravid BMI; among African-American women additionally adjusted for probability of Yoruban ancestry.
Stuebe et al., 2014; prospective cohort	Caucasian/ African-American	Carpenter–Coustan criteria	Caucasian: 56/843; African-American: 24/362	SLC30A8	rs11558471	Caucasian: 1 vs 0 OR 1.79 [0.52–9.61]; 2 vs 0 OR 1.68 [0.49–9.02]. African-American: 1 vs 0 OR 0.15 [0.02–>999.99]; 2 vs 0 OR 0.29 [0.04–>999.99].	Adjusted for maternal age and pregravid BMI; among African-American women additionally adjusted for probability of Yoruban ancestry.
Stuebe et al., 2014; prospective cohort	Caucasian/ African-American	Carpenter–Coustan criteria	Caucasian: 56/843; African-American: 24/362	SLC30A8	rs13266634	Caucasian: 1 vs 0 OR 1.46 [0.48–5.99]; 2 vs 0 OR 1.48 [0.49–6.08]. African-American: 1 vs 0 OR 0.14 [0.02–>999.99]; 2 vs 0 OR 0.30 [0.04–>999.99].	Adjusted for maternal age and pregravid BMI; among African-American women additionally adjusted for probability of Yoruban ancestry.

Abbreviation: SBP/DBP -Systolic Blood Pressure / Diastolic Blood Pressure, IASDPG-International Association of Diabetes in Pregnancy Study Groups, IWCGDM -The International Workshop-Conference (IWC) on GDM, ADA- American Diabetes Association,

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