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Increasing prevalence of gestational diabetes mellitus when implementing the IADPSG criteria: A systematic review and meta-analysis

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ABSTRACT

Aims: Quantify the proportional increase in gestational diabetes (GDM) prevalence when implementing the new International Association of Diabetes and Pregnancy Study Groups (IADPSG) criteria compared to prior GDM criteria, and to assess risk factors that might affect the change in prevalence.

Methods: A systematic review and meta-analysis was performed of cohort and cross-sectional studies between January 1, 2010 to December 31, 2018 among pregnant women with GDM using IADPSG criteria compared to, and stratified by, old GDM criteria. Web of science, PubMed, EMBASE, Cochrane, Open Grey and Grey literature reports were included. The relative risk for each study was calculated. Subgroup analyses were performed by maternal age, body mass index, study design, country of publication, screening method, sampling method and data stratified according to diagnostic criteria.

Results: Thirty-one cohort and cross-sectional studies with 136 705 women were included. Implementing the IADPSG criteria was associated with a 75% (RR 1.75, 95% CI 1.53–2.01) increase in number of women with GDM with evidence of heterogeneity.

Conclusions: The IADPSG criteria increase the prevalence of GDM, but allow movement towards more homogeneity. More studies are needed of the benefits, harms, psychological effects and health costs of implementing the IADPSG criteria.

1. Introduction

Gestational diabetes mellitus (GDM) was defined by O'Sullivan as "carbohydrate intolerance of varying severity with onset or first recognition during pregnancy" [1]. This first Oral glucose tolerance test (OGTT) based criteria for GDM were chosen to identify women with a high future risk of developing type 2 diabetes mellitus [2]. Since this time, a variety of diagnostic approaches to GDM have been developed across the world.

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GDM is associated with several long- and short-term adverse outcomes for the mother (Shoulder dystocia, pre-eclampsia, cesarean section, type 2 diabetes mellitus, metabolic syndrome, cardiovascular disease) [3–5] and child (macrosomia, birth trauma, neonatal hypoglycemia, impaired glucose tolerance, metabolic syndrome, cardiovascular disease) [5–7]. There is a clinical importance to finding women with GDM, since many short term adverse outcomes can be reduced with GDM treatment (lifestyle and diet, metformin, insulin) [8,9].

Internationally, the prevalence of GDM varies from 1 to 28 %. Even if the same diagnostic criteria and screening method are applied, the prevalence of GDM varies depending on population characteristics such as age, ethnicity, overweight/obesity, lifestyle (physical activity, diet) and type 2 diabetes mellitus prevalence in the background population [10–14].

In 2010, the International Association of Diabetes and Pregnancy Study Groups (IADPSG) consensus panel outlined new diagnostic criteria for GDM, which were for the first time, based on adverse pregnancy outcomes [15]. In 2013 the World Health Organization (WHO) adopted the IADPSG criteria, defined during a 75 g OGTT at an adjusted threshold of 1·75 times odds ratio for adverse pregnancy outcomes with glucose concentration cut-offs of fasting $\geq$ 5·1, 1-hour $\geq$ 10·0 and/or 2-hour $\geq$ 8·5 mmol/l.

As a consequence of the new consensus based criteria with lower fasting cut-off values, added one-hour value, one value sufficient for diagnosis and using a one-step method (diagnostic test only) instead of screening, the GDM prevalence was reported to increase 2–11 fold compared to baseline criteria [10,15–17]. This is in alignment with the increasing prevalence of the pandemic of obesity and associated increase in diabetes in the world, especially in young adults [18–20]. These increases in GDM numbers have raised concerns on the impact on the healthcare system, health outcomes, quality of life and costs.

With ongoing debate about implementing the internationally recommended IADPSG criteria, there is a need for an updated estimation of the increase in prevalence of GDM when implementing the IADPSG criteria. The aim of this comprehensive systematic review and meta-analysis was to quantify the overall increase in GDM prevalence when implementing the new IADPSG criteria compared to old GDM criteria, and to assess any contribution by risk factors that might affect the prevalence.

2. Material and methods

2.1. Search strategy and selection criteria

This systematic review and meta-analysis were conducted based on the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines [21].

A literature search was conducted from January 1st 2010 to December 31th 2018 using Web of science, PubMed, EMBASE, Cochrane, Open Grey and Grey literature report, by librarians and investigators. MeSH terms including “gestational diabetes”, “pregnancy induced diabetes”, “hyperglycemia”, “glucose intolerance”, “insulin resistance“, ”prevalence” and “incidence” were used alone or in combination (Supplementary Table 1).

All original population-based publications involving pregnant women with GDM according to IADPSG (intervention) criteria and at least one other GDM criterion (control) were eligible. The same screening strategy for GDM needed to be used both during the preceding control period and after the introduction of the IADPSG criteria. The time between the old GDM criteria and implementation of the new GDM criteria had to be less than one year. Duplicated data, non-English publications, intervention studies, inadequate methodology description and studies prior to 2010 were excluded.

The outcome studied was the overall increase in GDM according to the IADPSG criteria compared with any older criteria using a 75 g OGTT (Table 1). The WHO 1999 criteria for GDM were used as the control if available. If data for WHO1999 GDM criteria were missing, an alternative older set of GDM criteria was used. The GDM criteria resulting in the highest frequency of GDM was used if several older criteria existed.

The study was registered on PROSPERO (CRD42018088703) [22].

2.2. Data extraction and analysis

Screening of titles and abstracts was performed independently by two investigators (MS and HG) using Rayyan web tool [23]. Disagreements were resolved through discussion with senior investigators (DS and HF). Data on study characteristics as authors name, publication year, study design, sample size, mean age, mean body mass index (BMI), country of study, ethnicity (minority/indigenous), rural/urban, population origin, study period, screening method (early screening, risk factor, two step, universal), prevalence of GDM according to IADPSG criteria and other GDM criteria used were extracted and tabulated. If more than one report related to the same cohort, the report with the most relevant information was included. Control checks for agreement of final data extraction files and studies were made (MS and HG).

The methodological quality of the cohort studies was analyzed independently by two investigators (MS and HG) using the Newcastle Ottawa scale studies [24], which assesses three main domains: selection, comparability, and outcome (Supplementary Tables 2 and 3). Studies were considered high-, medium-, or low quality with a score above six, three to six and less than three respectively (Table 2).

Summary relative risks (RRs) with 95% confidence intervals (CI) were calculated using random-effects models. Forest plots was used to visualize the extent of heterogeneity between studies. Statistical heterogeneity between studies was evaluated with χ^2, τ^2 and I^2.

Potential causes of heterogeneity were explored by carrying out sensitivity analyses. Subgroup analysis was made to further explore potential heterogeneity among studies according to population mean age (<30, $\geq$30 years), mean BMI (<25, $\geq$25 kg/m^2), study design (prospective cohort, retrospective cohort, cross-sectional), country of publication according to the International Diabetes Federation (IDF) atlas [25] (Africa (AFR), Europe (EUR), Middle East and North Amer-

Table 1 – Diagnostic criteria for Gestational Diabetes Mellitus (GDM).

GDM definition					
	OGTT glucose level at time point (mmol/mol)				
GDM criteria	Fasting	1 h	2 h	3 h	Number of values for diagnosis
ADA 2000–2010	5·3	10·0	8·6	–	2
ADIPS 1998	5·5	–	8·0	–	1
CDA 2003	5·3	10·6	8·9	–	2
CDA 2013	5·3	10·6	9·0	–	1
Chinese local[a]	5·6	10·3	8·6	6·7	2
DIPSI	–	–	7·8	–	1
EASD 1996	6·0	–	9·0	–	1
HAPO OR 2·0	5·3	10·6	9·0	–	1
IADPSG/WHO 2013	5·1	10·0	8·5	–	1
JSOG	5·6	10·0	8·3	–	2
Modified IADPSG	5·1	–	8·5	–	1
NICE	5·6	–	7·8		
NZSSD 2004	5·5	–	9·0	–	1
WHO 1999	7·0	–	7·8	–	1
WHO 2006	6·1	–	7·8	–	1

ADA = American Diabetes Association. ADIPS = Australasian Diabetes in Pregnancy Society. CDA = Canadian Diabetes Association. DIPSI = Diabetes in Pregnancy Study Group India. EASD = European Association for the Study of Diabetes. HAPO = Hyperglycemia and Adverse Pregnancy Outcome. IADPSG = International Association of Diabetes and Pregnancy Study Groups. JSOG = Japan Society of Obstetrics and Gynecology. NICE = National Institute for Health and Care Excellence. NZSSD = New Zealand Society for the Study of Diabetes. WHO = World Health Organization.

[a] The Obstetrics and Gynecology Subcommittee of the Chinese Medical Association 2014.

ica (MENA), South and Central America (SACA), South East Asia (SEA), Western Pacific (WP), North America and Caribbean (NAC)), screening method (2 stepped polycose (50 g one-hour glucose test $\geq$ 7.8 mmol/L), risk factors, universal OGTT), early screening (yes/no, if not stated otherwise), use of modified IADPSG criteria (OGTT without one-hour value. Yes/no). In these analyses, we used 99% CIs to reduce the potential for chance differences arising from multiple testing.

The possibility of publication bias was assessed by visual inspection of funnel plot and Egger's test. The nonparametric "trim and fill" method was used to identify and correct any funnel plot asymmetry.

RRs were unadjusted because they were calculated from raw data. All the analyses were performed in Stata 16.0 (StataCorp LLC, College Station, Texas, USA). A two-sided p-value < 0.05 was considered statistically significant.

3. Results

Overall, 4 312 of 6 889 identified records through a database search were screened (Fig. 1). The 31 studies included in the meta-analysis consisted of 136 705 pregnant women of whom 20 127 (14·7%) had GDM according to the IADPSG criteria and 11 577 (8·5%) using the old GDM criteria.

The studies were published 1991–2016 with 20 (64·5%) retrospective cohorts [26–45], seven (22·6%) prospective cohorts [46–52] and four (12·9%) cross-sectional [53–56] studies. Thirteen (41·9%) of the studies were conducted in WP (six Australian, four Chinese, one Japanese, One Thai, one Vietnamese) and seven (22·6%) in EUR (two English, one Croatian, one Norwegian, one Hungarian, one Irish, one Turkish). SEA (three Indian, one Nepali, one Sri Lankan), MENA (two Emirati, one Saudi), AFR (one South African, one Nigerian) , SCA (one Brazilian) accounted for five (16·1%), three (9·7%), two (6·5%) and one (3·2%) study respectively. No studies were included from NAC. The prevalence of GDM was 18·8% in WP, 17.2% in AFR, 41·4% in MENA, 16·7% in SEA, 17·3% EUR, 18·0% SCA with the IADPSG criteria compared to 9·8%, 5·5%, 18·1%, 9·3%, 10·3% and 7·1% with the old criteria respectively.

Twenty-seven (87·1%) studies used universal screening with diagnostic 75 g OGTT compared to three (9·7%) using 2-step polycose test and one (3·2%) risk factor screening. The most widely used old GDM criteria were WHO 1999 in 13 (41·9%), Australasian Diabetes in Pregnancy Society (ADIPS) 1999 in six (19·4%), American Diabetes Association (ADA) 2000–10 in five (16·1%) and National Institute for Health and Care Excellence (NICE) in two (6·5%) studies. Hyperglycemia and Adverse Pregnancy Outcome (HAPO) 2.0, Diabetes in Pregnancy Study Group India (DIPSI), WHO 2006, Japan Society of Obstetrics and Gynecology (JSOG) and Chinese local criteria were used in one study (3·2%) each (Table 2). Fourteen (43·8%) of the studies showed high quality, and 18 (56·3%) moderate. Details of the quality assessment of included studies are presented in Supplementary Tables 2 and 3.

The overall RR for GDM according to the IADPSG criteria compared to old GDM criteria was 1·75 (95% CI 1·53–2·01), with evidence of heterogeneity in the risk estimate (I^2 = 97·3%, χ^2 = 1379·3, df = 30, p < 0·0001) (Fig. 2).

Generally, although no asymmetry was found, there was a high variance in the effect estimates between studies, especially in studies with larger effect size (Fig. 3). There was no substantial publication bias for meta-analyses based on the Egger test (Supplementary Table 4).

Potential sources of heterogeneity in the subgroup analysis by study and participant's characteristics for GDM when

Table 2 – Study characteristics.

	Study type, publication, Country, study year/s	Total women studied	Mean age (years; SD or 95% CI)	Mean BMI (kg/m^2; years; SD or 95% CI)	Screening method	Early screening	Prevalence New criteria/Old criteria (%)	Criteria used in the study	Quality scale (high-low)
Adam et al. (2017) [46]	Prospective cohort, South Africa.	554	27·2	26·6	Universal OGTT[a]	No	25·8/7·2	IADPSG, WHO 99, NICE	Moderate
Agarwal et al. (2015) [26]	Retrospective cohort, United Arab Emirates, 2012	2337	29·8 (5·8)	..	Universal OGTT[a]	No	45·3/24·5	IADPSG, WHO 99, ADA 00–10, ADIPS 98, CDA 13, CDA 03, NZSSD, EASD 96	Moderate
Agarwal et al. (2010) [27]	Retrospective cohort, United Arab Emirates, 2003–2008	10,283	28·3 (6·1)	..	Universal OGTT[a]	No	37·7/12·9	IADPSG, ADA 00-10	Moderate
Alfadhli et al. (2015) [47]	Prospective cohort, Saudi Arabia, 2011–2012	277	30·8 (6·2)	29·5 (6·3)	Universal OGTT[a]	No	41·5/17·0	IADPSG, ADA 00-10	High
Arora et al. (2015) [53]	Cross sectional, India, 2009–2012	5100	21·5 (3·3)	24·2 (4·4)	Universal OGTT[a]	No	34·9/9·0	Modified IADPSG[d], WHO 99	Moderate
Bhavadharini et al. (2016) [28]	Retrospective cohort, India, 2013–2014	1774	25·6 (3·9)	24·2 (4·7)	Universal OGTT[a]	Yes	18·5/14·6	IADPSG, WHO 99	High
Cheung et al. (2017) [29]	Retrospective cohort, Australia, 2014–2016	6175	..	25·1 (5·6)	Universal OGTT[a]	No	17·8/15·0	IADPSG, ADIPS 98	High
Dahanayaka et al. (2012) [54]	Cross sectional, Sri Lanka.	405	27·3 (5·4)	..	Universal OGTT[a]	No	8·9/7·2	IADPSG, WHO 99	High
Djelmis et al. (2016) [30]	Retrospective cohort, Croatia, 2012–2014	4646	30·9 (4·9)	24.2 (4·6)	Universal OGTT[a]	No	23·1/17·8	IADPSG, NICE	Moderate
Fukatsu et al. (2017) [31]	Retrospective cohort, Japan, 2006–2010	452	34·1 (4·5)	24·5 (5·6)	Risk factors[b]	No	29·4/12·4	IADPSG, JSOG	Moderate
Gilder et al. (2014) [48]	Prospective cohort, Thailand, 2011–2012	228	26·3 (6·5)	23·3	Universal OGTT[a]	No	10·1/6·6	IADPSG, WHO 99, HAPO OR 2.0	Moderate
Hanna et al. (2017) [32]	Retrospective cohort, England, 2010–2013	6930	28·5 (5·6)	..	Universal OGTT[a]	No	13·7/9·7	Modified IADPSG[d], WHO 99, NICE	Moderate
Jenum et al. (2012) [33]	Retrospective cohort, Norway, 2008–2010	759	29·9 (4·8)	24·6 (4·8)	Universal OGTT[a]	No	31·5/13·0	Modified[p] IADPSG, WHO 99	High
Kun et al. (2011) [34]	Retrospective cohort, Hungary, 2000	1835	27·5 (4·8)	23·4 (4·5)	Universal OGTT[a]	No	16·6/8·7	Modified IADPSG[d], WHO 99	High
Laafira et al. (2015) [35]	Retrospective cohort, Australia, 2011–2014	3571	30·0 (5·7)	27·5 (7·2)	Universal OGTT[a]	No	15·7/13·0	Modified IADPSG[d], ADIPS 98	Moderate
Leng et al. (2015) [49]	Prospective cohort, China, 2010–2012	17,808	28·5 (2·8)	22·3 (3·4)	2 stepped, polycose[c]	No	7·7/6·8	IADPSG, WHO 99	High
Meek et al. (2015) [36]	Retrospective cohort, England, 2004–2008	25,543	30·7 (30·6-30·8)	24·7 (24·6-24·8)	2 stepped, polycose[c]	Yes	4·6/4·1	IADPSG, NICE	High
Moses et al. (2011) [50]	Prospective cohort, Australia, 2010	1275	29·9	..	Universal OGTT[a]	No	13·0/9·6	IADPSG, ADIPS 98	High
Moses et al. (2016) [37]	Retrospective cohort, Australia, 2012–2014	7180	..	..	Universal OGTT[a]	Yes	12·7/6·6	IADPSG, HAPO OR 2.0	Moderate
O'Sullivan et al. (2011) [38]	Retrospective cohort, Irland, 2006–2009	5500	31·5 (5·5)	26·9 (5·1)	Universal OGTT[a]	No	12·4/9·5	IADPSG, WHO 06	Moderate
Olagbuji et al. (2015) [51]	Prospective cohort, Nigeria, 2012–2014	1059	30·7 (4·4)	28·1 (7·9)	Universal OGTT[a]	No	8·6/3·8	IADPSG, WHO 99	Moderate
Seshiah et al. (2012) [39]	Retrospective cohort, India, 2009–2010	1463	23·6 (3·3)	21·5 (4·1)	Universal OGTT[a]	No	14·6/13·4	IADPSG, DIPSI	Moderate
Shang et al. (2014) [41]	Retrospective cohort, China, 2012–2013	3083	29·1 (3·5)	22·0 (2·9)	Universal OGTT[a]	Yes	19·9/8·0	IADPSG, ADA 00-10	High
Shang et al. (2014) [40]	Retrospective cohort, China, 2008–2011	6201	29·2 (3·3)	..	2 stepped, polycose[c]	No	10·9/5·2	IADPSG, ADA 00-10	Moderate
Sibartie et al. (2015) [52]	Prospective cohort, Australia, 2010–2014	10,277	31·1 (5·5)[e]	BMI range	Universal OGTT[a]	No	3·5/3·4	IADPSG, ADIPS 98	High
Thapa et al. (2015) [55]	Cross sectional, Nepal, 2009–2010	564	23·3 (4·4)	..	Universal OGTT[a]	No	6·6/2·5	IADPSG, WHO 99	High
Tonguc et al. (2018) [42]	Retrospective cohort, Turkey, 2013–2014	320	29· 0 (6·1)	28·0 (5·4)	Universal OGTT[a]	No	19·4/9·1	IADPSG, ADA 00–10	Moderate
Tran et al. (2013) [56]	Cross sectional, Vietnam, 2010–2011	2772	28·2 (4·8)	20·6 (2·7)	Universal OGTT[a]	No	20·4/20·8	IADPSG, ADA 00-10, ADIPS 98	High
Trujillo et al. (2015) [43]	Retrospective cohort, Brazil, 1991–1995	4926	27·8 (5·4)	26·0 (4·0)	Universal OGTT[a]	No	18·0/7·1	IADPSG, WHO 99, HAPO OR 2.0, ADA 00-10	High
Wong et al. (2017) [44]	Retrospective cohort, Australia, 2015	1725	Age range	BMI range	Universal OGTT[a]	No	29·6/14·8	IADPSG, ADIPS 98	Moderate
Yan et al. (2017) [45]	Retrospective cohort, China, 2009–2011	1683	28·6 (7·3)	20·6 (5·1)	Universal OGTT[a]	No	12·4/5·5	IADPSG, Local Chinese	Moderate

OGTT = Oral Glucose Tolerance Test. ADA = American Diabetes Association. ADIPS = Australasian Diabetes in Pregnancy Society. CDA = Canadian Diabetes Association. DIPSI = Diabetes in Pregnancy Study Group India. EASD = European Association for the Study of Diabetes. HAPO = Hyperglycemia and Adverse Pregnancy Outcome. IADPSG = International Association of Diabetes and Pregnancy Study Groups. JSOG = Japan Society of Obstetrics and Gynecology. NICE = National Institute for Health and Care Excellence. NZSSD = New Zealand Society for the Study of Diabetes. WHO = World Health Organization.

[a] Universal OGTT: 2-hour 75 g OGTT.

[b] Risk factors: BMI $\geq$ 25 kg/m^2, maternal weight gain, family history DM, glucosuria, HbA1C $\geq$ 5.9%, RBG $\geq$ 5.5 mmol/L during gestation week 8–12 or 24–28, polyhydramnios, fetal body weight $\geq$ 1.5 SD.

[c] 2-stepped polycose: 1-hour 50 g oral glucose challenge test before OGTT.

[d] Modified IADPSG: OGTT based on only fasting and 2-hour values, no 1-hour value.

[e] Mean age for GDM group only.

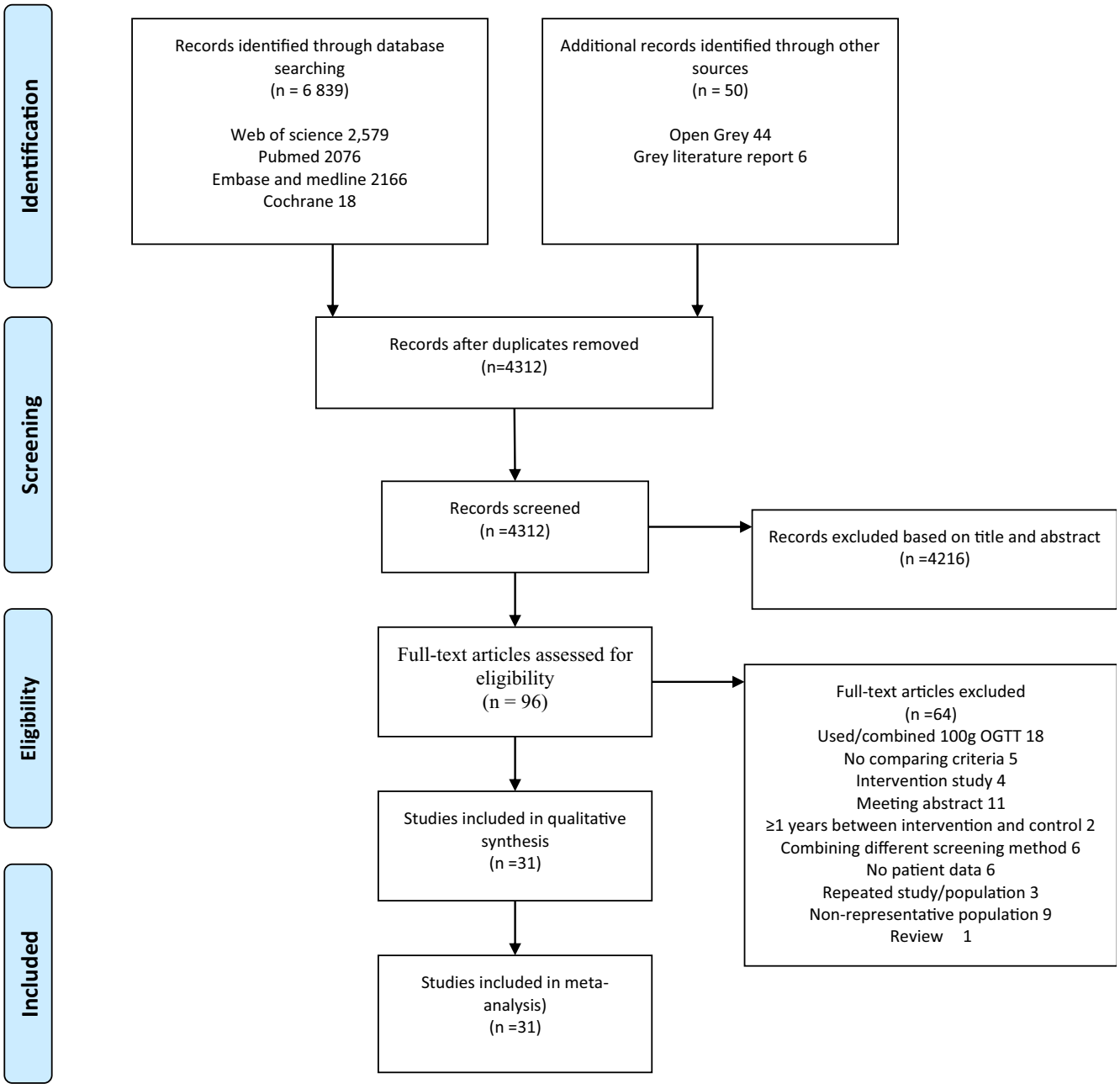

Fig. 1 – PRISMA diagram of the literature search for systematic review and meta-analysis [21].

implementing the IADPSG criteria are shown in Fig. 4. No significant heterogeneity was seen from subgroup analysis of maternal age, BMI, study design, screening method, early screening and use of modified IADPSG criteria. There was some statistically significant heterogeneity in the effect estimates when studies were grouped according to country of publication. Details of statistical heterogeneity in subgroup analysis are presented in the Supplementary Table 4.

Post hoc analysis of European descent (EUR and WP, 19 studies) showed a RR of 1·56 (95% CI 1·35–1·82, χ^2 = 372·78, p < 0·0001, I^2 = 96·02) compared 2·16(95% CI 1·67–2·81, χ^2 = 336·86, p < 0·0001, I^2 = 97·43) with the rest of the population (MENA, AFR, SEA, SCA, 10 studies).

Further analyses on the impact of GDM criteria showed that the CDA 2003 criteria gave rise to the highest RR 4·92 (95% CI 4·12–5·88) with the DIPSI criteria the lowest RR 1·09 (95% CI 0·86–1·38) (Supplementary Fig. 1).

Sensitivity analysis showed no evidence of one single study having excessive influence with an RR variability of 1·70–1·79, which is within the confidence interval of the combined RR 1·53–2·01. The impact of decision-making was explored by excluding and/or including studies based on sample size, methodology and unpublished data. The effect estimate across the analysis was between 1·69 and 2·00. If studies using the 100 g OGTT (Carpenter Coustan criteria) were included the RR was 2·0 (1·71–2·33) (Supplementary Table 5). The heterogeneity was not reduced with the sensitivity analysis.

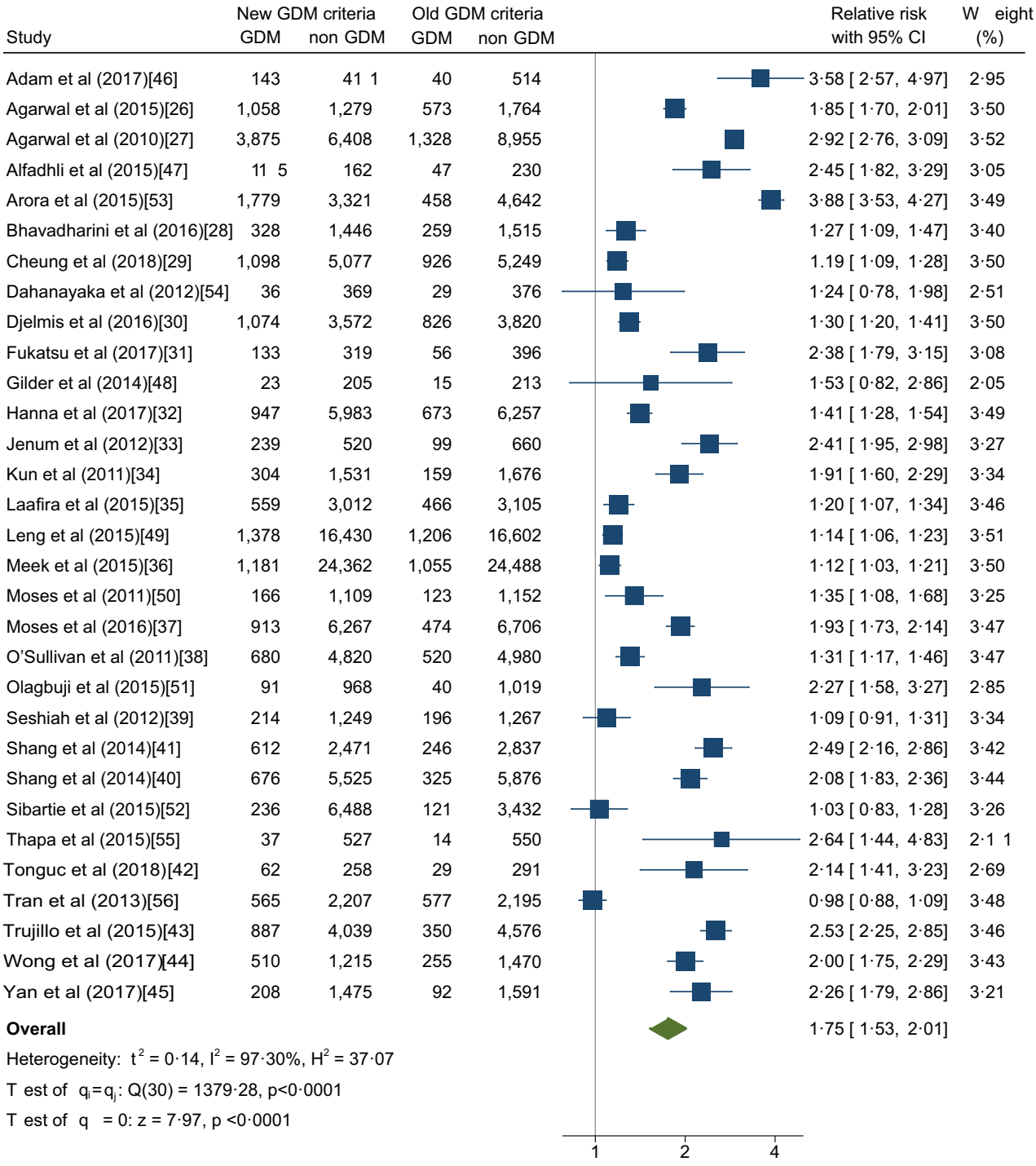

Fig. 2 – Risk of gestational diabetes mellitus (GDM) after implementation of the new GDM criteria compared to old GDM criteria. Bars indicate 95% CIs.

4. Discussion

The prevalence of GDM in this meta-analysis was 14·7% according to the IADPSG criteria and 8·5% when using the old GDM criteria. When implementing the new internationally recommended IADPSG criteria we found that overall, there was a 75% (RR 1·75 (95% CI 1·53–2·01)) increased prevalence of GDM compared to the old GDM criteria. Although the overall increase in prevalence was generally similar throughout sensitivity and subgroup analyses, a larger variation was seen when data was stratified according to different old GDM criteria.

The strength of this large meta-analysis is that it included a large number of pregnant women (136 705) and that the

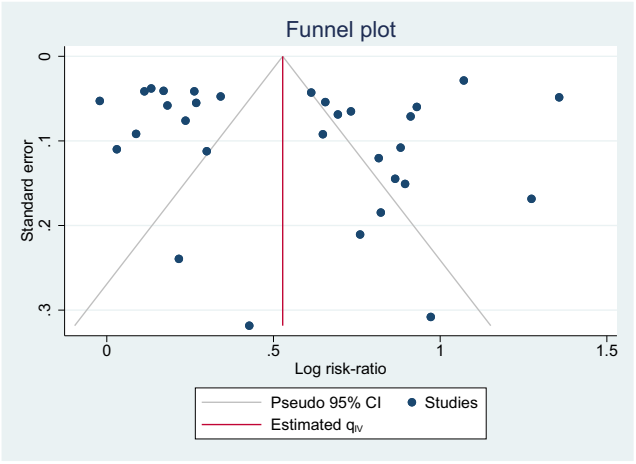

Fig. 3 – Funnel plot of 31 studies included in meta-analysis.

intervention and control occurred in the same population in 31 different studies. Potential biases for the outcome, such as involving only high-risk populations, different screening methodologies before and after the intervention, having more than a gap of one year between intervention and control period, were excluded to reduce clinical and methodological heterogeneity. Sensitivity analyses revealed a robust effect estimate. There was consistency in quality and method throughout the study.

Limitations included the inability to stratify results according to ethnicity (minority/indigenous) and geography (rural or urban) due to a shortage of studies addressing these populations sufficiently. Two studies [28,53] from India mentioned the proportion of the population that were rural and urban. Ethnicity was reported in a variety of groupings. Two studies [33,35] had satisfactory data on ethnicity. Although such risk factors for GDM were not analyzed, it is unclear whether the higher prevalence of diabetes mellitus in indigenous [57] or rural [58] populations would have had an effect on the relative prevalence of GDM when changing the diagnostic criteria.

A further limitation was the high statistical heterogeneity in the overall effect estimate and subgroup analyses were performed to determine potential sources of heterogeneity. However, the estimates were similar when studies were grouped according to maternal age, BMI, study design, country of publication, screening and sampling method, suggesting that much of the heterogeneity was unexplained. When only using WHO 99 criteria studies, the effect estimate remained unchanged, suggesting that the impact on choosing alternative comparative criteria, when no data on WHO 99 criteria existed, was limited (Supplementary Fig. 1).

No statistically significant publication bias was observed in our study, however, our funnel plot reveals that the precision of the included studies varied. The largest effect estimate was seen in a medium size study with 1779 women with GDM using the IADPSG criteria [53].

There are no prior systematic reviews or meta-analyses quantifying the relative risk for GDM when implementing the IADPSG criteria. One meta-analysis on the prevalence of GDM in India including a subgroup analysis of the diagnostic criteria reported a 1·98 fold increase when comparing IADPSG to WHO 99 criteria [59], which is comparable to our findings. Behboudi-Gandevani et al. reported a 6–11 fold increase in prevalence when using the IADPSG compared to old GDM criteria in a subgroup analysis investigating the impact of different GDM criteria. This study compared a pooled prevalence of GDM between different population groups with variation in the risk factors, screening and diagnostic methods for GDM. The most comparable group to our study used universal screening with WHO 2006 criteria as a control group showing a 4 fold increase, but this was not statistically significant [10].

The prevalence of GDM varies substantially worldwide attributable, at least in part, to the lack of uniformity in screening and diagnostic criteria. Behboudi-Gandevani et al reported a pooled wordwide prevalence of 4·4% (95% CI 4·3–4·4%) regardless of the type of screening threshold categories and 10·6% (95% CI 10·5–10·6%) when using the IADPSG criteria, which is lower than our data (8·5% vs 14·7%) [10]. McIntyre et al present the median prevalence with interquartile for GDM in a literature search from 2005 to 2018 across the WHO regions. The prevalence in WP was 10·3% (4·5–20·3), 10·8%(8·5–31·1) in AFR, 15·0%(9·6–18·3) in SEA, 6·1% (1·8–31·0) in EUR, MENA 15·2% (8·8–20·0) and SCA 11·2 (7·1–16·6) [12] which is comparable to our study. Although our data also showed the highest prevalence in MENA when implementing the IADPSG criteria, the prevalence in our study was higher (41·4%). McIntyre et al presented a median prevalence in NAC of 7·0% (6·5–11·9) [12], but no studies from this area were included in our study partly due to 100 g OGTT being widely used for GDM diagnosis. Although prevalence might vary between studies, the main outcome, relative increase in prevalence should remain unaffected.

Previous publications comparing the polycose test with risk factor screening showed that the polycose test is more predictive of GDM as a screening test [60,61]. However, our analyses included too few studies across each screening methodology to add further to this issue. The IADPSG approach usually does not involve such screening strategies and clearly avoids this sensitivity issue.

The increased prevalence of GDM when implementing the IADPSG criteria and the heterogeneity in our systematic review and meta-analysis provide an insight into the real world and its associated clinical diversity. The increase in GDM prevalence using the IADPSG criteria leads to an expected increase in GDM prevalence overall, but less than previously reported. Implementing the IADPSG criteria will let us move toward homogeneity in reporting GDM prevalence. However, our study did not evaluate whether the implementation of the new GDM criteria led to fewer adverse outcomes for the women and their children, any health economic impact and any psychological effects. Treatment for GDM compared to routine care has previously been shown to improve the quality of life with GDM treatment [8]. Health economic impacts, and workload on frontline teams, are probably able to be reduced by changing the model of care [62].

Data availability

The datasets analysed during the current study are available from the corresponding author on reasonable request.

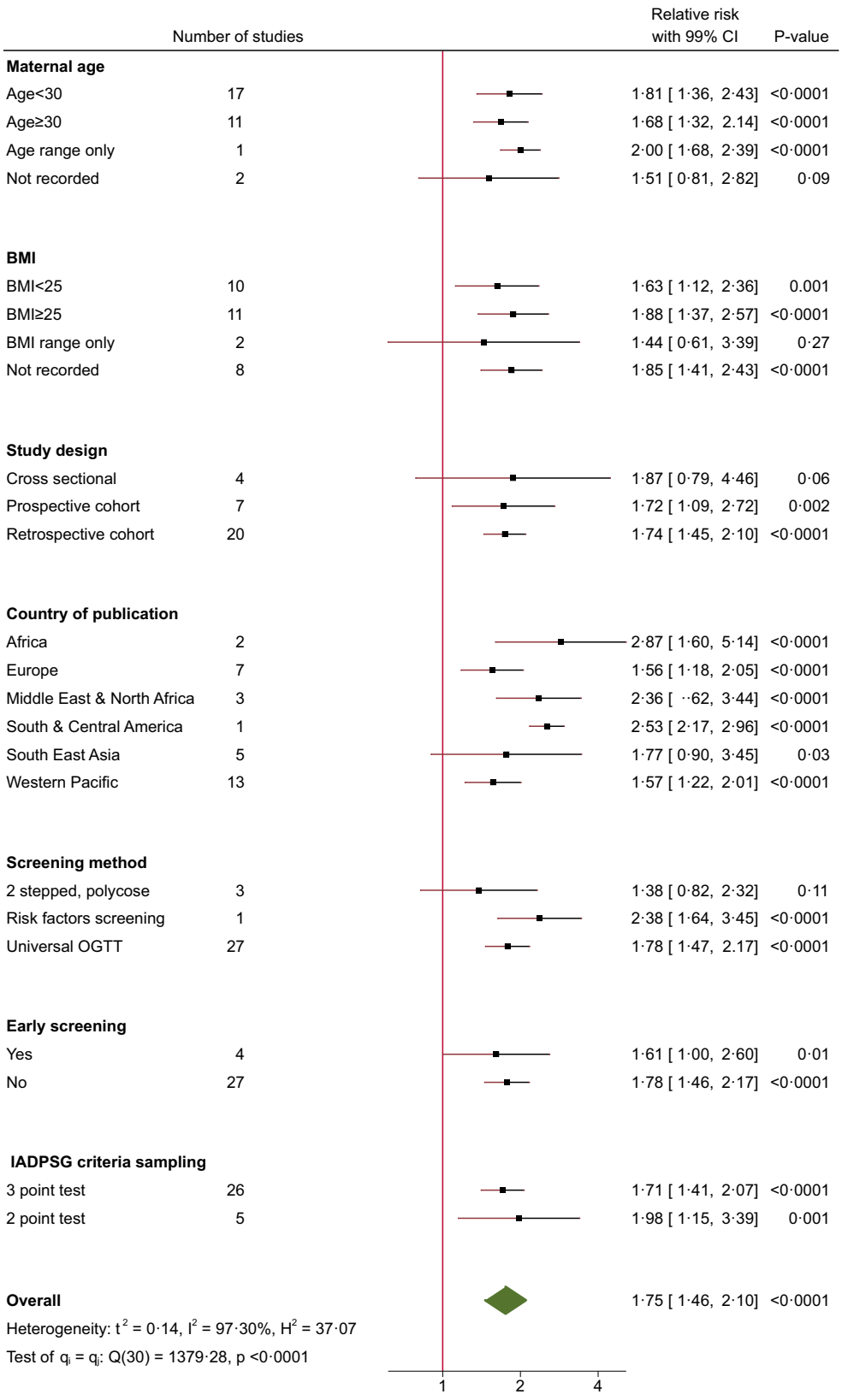

Fig. 4 – Risk of gestational diabetes mellitus (GDM) after implementation of the new GDM criteria grouped by Age (years), BMI (kg/m^2), study design, country of publication, screening method, use of early screening and sampling method.

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Contributors

DS, HF, MS and YC contributed to protocol design. MS and HG did the data extraction. MS did the statistical analysis with help of YC. DS and HF helped with the data interpretation. All authors contributed to the writing and revision of this report, and have seen and approved the final version.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A. Supplementary material

Supplementary data to this article can be found online at https://doi.org/10.1016/j.diabres.2020.108642.

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