Received: 28 June 2021 | Revised: 31 August 2021 | Accepted: 27 September 2021

DOI: 10.1111/aogs.14276

AOGS Acta Obstetricia et Gynecologica Scandinavica

ORIGINAL RESEARCH ARTICLE

Changed definition of disease and broader screening criteria had little impact on prevalence of gestational diabetes mellitus

Lina Grønvall | **Finn Egil Skjeldestad**

Research Group Epidemiology of Chronic Diseases, Institute of Community Medicine, UiT the Arctic University of Norway, Tromsø, Norway

Correspondence
Finn Egil Skjeldestad, Department of Community Medicine, Research Group Epidemiology of Chronic Diseases, UiT The Arctic University of Norway, Tromsø N 7037, Norway.
Email: eskjelde@online.no

Abstract

Introduction: There are major controversies in screening for gestational diabetes mellitus (GDM). The present study evaluates the impact of the 2017 revised guidelines for GDM screening and a changed definition of GDM in Norway.

Material and methods: We used a case-series design and included women with no pre-pregnancy diabetes mellitus, who gave birth after gestational week 29 to a singleton fetus at the University Hospital of North Norway, Tromsø, or at a local maternity ward in Troms county, during the first 6 months of 2013 (before group, $n = 676$) and 2018 (after group, $n = 673$). Data were collected from antenatal records, maternal health information sheets, and electronic medical records (Partus). We assessed the screening criteria age, parity, pre-pregnancy BMI, and ethnicity. Primary outcomes were change in size of the population eligible for GDM screening, screening adherence, and prevalence of GDM, and follow up of GDM (treatment and obstetric risk assessment at gestational week 36). Statistical analyses were done using IBM SPSS with chi-squared test. A p value less than 0.05 was considered statistically significant.

Results: The proportion of women eligible for GDM screening increased from 46.4% in the before group to 67.6% in the after group (+45%) ($p < 0.01$). However, screening adherence among eligible women was only 28.3% and 49.2% in the before and after groups, respectively ($p < 0.01$). Among screened women, 16.9% (15/89) and 10.7% (24/224), respectively, were diagnosed with GDM, resulting in an overall estimated prevalence of 2.2% (15/676) and 3.6% (24/673). Among women diagnosed with GDM, 13.3% received no follow up in 2013 and this proportion was 20.8% in 2018. The remaining women underwent obstetric risk assessment at gestational week 36 as advised in the guidelines.

Conclusions: The introduction of broader screening criteria and a more liberal case definition increased the population eligible for GDM screening by 45%. The higher proportion of women screened resulted in an insignificant higher prevalence of GDM.

Abbreviations: BMI, body mass index; CI, confidence interval; GDM, gestational diabetes mellitus; HAPO-study, hyperglycemia and adverse pregnancy outcomes study; IADPSG, International Association of Diabetes and Pregnancy Study Groups; OGTT, oral glucose tolerance test; WHO, World Health Organization.

Screening adherence was poor in both study groups. Stakeholders for obstetric care need to consolidate quality measures and revisit the screening algorithm.

KEYWORDS
gestational diabetes mellitus, morbidity, pregnancy, prenatal care, prevalence, screening, screening adherence

1 | INTRODUCTION

The definition of gestational diabetes mellitus (GDM), whether to offer systematic GDM screening or only test women at risk, and GDM screening criteria and treatment, have been subjects of great controversy since the introduction of the condition more than 50 years ago.[1] There is still insufficient evidence to suggest which thresholds for disease are best for diagnosing GDM.[1–6] This leads to uncertainties in choosing either a universal screening strategy or a more advanced strategy based on risk factors.[2–6] Different strategies for screening and follow up have been investigated in studies of varying quality, which have shown small reduced risks of most negative maternal and perinatal outcomes compared with routine care among women with GDM.[7] Despite these shortcomings, most countries have introduced GDM screening to improve the quality and outcomes of antenatal and obstetric care, as well as strategies for the prevention of metabolic diseases later in life.

The clinical guidelines of the Norwegian Society of Obstetrics and Gynecology recommended screening for GDM in 1998.[8] These recommendations were complemented by national guidelines for screening, treatment, and follow up of GDM from the Norwegian Directorate of Health in 2005,[9] with subsequent revisions in 2008,[10] 2017,[11] and 2020,[12] in agreement with the diagnostic criteria and classification of GDM from the World Health Organization (WHO).[13]

In Norway, pregnant women are screened for GDM in primary health care during gestational weeks 24 through 28. In 2017, the guidelines changed from recommending the screening of all women aged 35 years or more regardless of parity, to recommending the screening of all nulliparous women aged 25 years or more and all multiparous woman aged 40 years or more. Furthermore, the previous recommendation to screen all women with a body mass index (BMI) from 27 kg/m^2 was changed to include all women with a BMI of 25 kg/m^2 or greater, whereas the ethnicity criterion changed from screening all women from "North Africa and the Indian subcontinents" to women from "Asia and Africa". Other changes were also made between 2008[10] and 2017[11] with regard to family history, glucose intolerance, and conditions in the previous and current pregnancy (Table 1). In 2008, the diagnostic criteria for GDM were fasting plasma glucose greater than 5.3 mmol/L and/or 2-hour oral glucose tolerance test (OGTT) of 9.0–11.0 mmol/L, but this changed in the 2017 revision to fasting plasma glucose greater than 7 mmol/L and/or 2-hour OGTT of 7.8–11.0 mmol/L. Opponents of the new guidelines have argued that expanding the screening criteria and changing the diagnostic criteria may lead to over-diagnosis and an increased burden on the healthcare system, and that evidence is lacking on the harms and significant benefits of such wide screening criteria.[3–5]

Key message

Broadening screening criteria for gestational diabetes mellitus increased the number of women eligible for screening by 45%, with little impact on the prevalence of the disease.

In the present study, we evaluate the impact of changes in the screening and diagnostic criteria for GDM on the population eligible for GDM screening, screening adherence, the prevalence of GDM, and follow up of GDM (treatment and obstetric risk assessment at gestational week 36).

2 | MATERIAL AND METHODS

We used a retrospective case-series design to assess the impact of the 2017 revised guidelines for GDM by comparing women who gave birth in the first half of 2013 (before population) with women who gave birth in the first half of 2018 (after population) at the maternity clinic of the University Hospital of North Norway, Tromsø, and the local maternity wards at Finnsnes and Nordreisa. Data were collected from the antenatal fact sheet (*Helsekort for gravide*), maternal health information sheets, and electronic medical records (Partus and hospital record).

A total of 1453 deliveries took place in the first 6 months of 2013 (n = 740) and 2018 (n = 713). We excluded women with pre-pregnancy diabetes mellitus type 1 or 2 (n = 18; 13 in 2013 and 5 in 2018), non-singleton pregnancies (n = 37; 18 in 2013 and 19 in 2018), those who gave birth before gestational week 29 (n = 16; 6 in 2013 and 10 in 2018), and those with incomplete data or missing medical records (n = 33; 27 in 2013 and 6 in 2018). The final analytical sample comprised 676 women in the before group and 673 women in the after group.

Age and BMI were categorized according to the screening criteria (17–24, 25–34, 35–39, and 40–47 years; 14.00–24.99, 25.00–26.99, 27.00–29.99, and 30.0–56.99 kg/m^2). Parity and ethnicity were dichotomized as nulliparous/parous and as high-risk (Asian/African origin)/low-risk ethnicity (all others). We used a hierarchical approach when assigning women to risk groups, in which BMI had priority over age/parity, followed by ethnicity.

TABLE 1 Screening criteria for gestational diabetes mellitus (GDM) in Norway

	Guidelines	
Criteria	**2008**	**2017**
General		
Age and parity	≥35 years regardless of parity	≥25 years and nulliparous ≥40 years and multiparous
Pre-pregnancy BMI	BMI ≥27.0 kg/m^2	BMI ≥25.0 kg/m^2
Ethnicity	From North Africa and the Indian subcontinent	From Asia and Africa
Family history	First-degree relative	First-degree relative
Glucose intolerance	Occasionally detected FPG between 6.1 and 7.0 mmol/L	Impaired glucose tolerance
Previous pregnancy		
Previous GDM	Yes	Yes
Previous macrosomia	Yes	Yes
Preeclampsia	No	Yes
Shoulder dystocia	No	Yes
Current pregnancy		
Glucosuria	Yes	No
Polyhydramnios	Yes	No
Rapid fetal growth	Yes	No

Note: Marked area highlights screening criteria assessed in the study.
Abbreviation: BMI, body mass index; FPG, fasting plasma glucose.

Primary end points were the size of the population eligible for GDM screening according to the considered screening criteria (age, parity, BMI, and ethnicity); screening adherence, defined as having a recorded fasting glucose test and/or a 2-hour OGTT result; and the prevalence of GDM in the study groups. Statistical analyses were performed using IBM SPSS version 26.0 with chi-squared test. A p value less than 0.05 was considered statistically significant.

2.1 | Ethical approval

The Patient Ombudsman at the University Hospital of North Norway, Tromsø, authorized the study as a specific quality assurance study (reference 20197697; project no. 02223). As per current law, institutional review boards do not assess quality assurance studies in Norway.

3 | RESULTS

There were no significant differences in the distribution of age, parity, or ethnicity between the before and after groups (Table 2). The prevalence of women with a BMI of 25.00–26.99 kg/m^2 was far higher in the before group than the after group. Furthermore, there were significantly more women with a BMI above 30.0 kg/m^2 in the before group, whereas there was no difference in the number of women with BMI of 27.0–29.99 kg/m^2 between the groups (Table 2). Overall, the before group had a significantly higher pre-pregnancy BMI than the after group ($p < 0.01$).

The population eligible for GDM screening increased from 46.6% in the before to 67.6% in the after group ($p < 0.01$; Table 3). Nearly 12% of this increase was attributable to changes in the age/age and parity criteria, with the other 10% attributable to the BMI criterion. No change was observed for the ethnicity criterion.

Among women eligible for GDM screening, screening adherence was 28.3% (89/315) and 49.2% (224/455) in the before and after groups, respectively (Table 4; $p < 0.01$). Among screened women, 62.9% of those in the before group were screened during the recommended screening window, i.e. from gestational weeks 24 through 28 (range 20–36), compared with 71.4% (range 13–37) of those in the after group. Most women screened outside the recommended screening window underwent screening at a later gestational week.

In the before and after groups, 16.9% (15/89) and 10.7% (24/224) of women, respectively, were diagnosed with GDM, resulting in an overall prevalence of 2.2% (15/676; 95% CI 1.1–2.7) and 3.6% (24/673; 95% CI 2.2–5.0) ($p = 0.15$).

In the before group, all women were diagnosed based on the 2-hour OGTT, including three women who also had an abnormal fasting glucose test, whereas 41.7% (10/24) of the GDM diagnoses in the after group were based a fasting glucose value alone (normal OGTT). The remaining cases were diagnosed based on the 2-hour OGTT and/or fasting glucose test.

In the before group, two (13.3%) women with GDM received no follow up, eight (53.3%) women were treated with lifestyle interventions, and five (33.3%) were given insulin. No women were treated with metformin. In the after group, five (20.8%) women received no follow up, 13 (54.1%) were treated with lifestyle interventions, three (12.5%) with metformin, and three (12.5%) with insulin. All

TABLE 2 Baseline characteristics

Variables	Time period: Before group 2013 *n* = 676, *n* (%)	Time period: After group 2018 *n* = 673, *n* (%)	*p* value
Maternal age (years)			
17–24	104 (15.4)	78 (11.6)	0.504
25–34	415 (61.4)	445 (66.1)	
35–39	119 (17.6)	114 (16.9)	
40–47	38 (5.6)	36 (5.3)	
Parity			
Nulliparous	300 (44.4)	303 (45.0)	0.83
Parous	376 (55.6)	370 (55.0)	
Pre-pregnancy BMI (kg/m^2)			
14.00–24.99	338 (50.0)	419 (62.3)	0.000
25.00–26.99	122 (18.0)	76 (11.3)	
27.00–29.99	92 (13.6)	87 (12.9)	
30.00–56.99	124 (18.3)	91 (13.5)	
Ethnicity			
Europe	622 (92.0)	604 (89.7)	0.255
Asia	23 (3.4)	36 (5.3)	
Africa	29 (4.3)	28 (4.2)	
Others	2 (0.3)	5 (0.7)	

Abbreviation: BMI, body mass index.

TABLE 3 Screening criteria for gestational diabetes mellitus (%)

Criteria	Time period: Before group 2013 *n* = 676%	Time period: After group 2018 *n* = 673%
None	53.4	32.4
Age	14.5	2.4
Age and parity	0	23.5
Pre-pregnancy BMI	27.5	37.7
Ethnicity	4.6	4.0

Abbreviation: BMI, body mass index.

five women in the after group who did not receive follow up had fasting glucose values just above the threshold and normal OGTT values. One and two GDM cases gave birth before gestational week 36 in the before and after groups, respectively, leaving 12 and 17 women eligible for obstetric risk assessment at gestational week 36. All these women had a specialist consultation, as advised in the guidelines.

The proportion of women having induction of labor increased significantly (chi-squared trend: $p < 0.01$) across status for GDM screening in both the before and after groups (Table 5, upper panel). Regarding mode of delivery there were no differences in outcomes between women having indication for screening, but not screened, compared with women screened, not having GDM (Table 5, lower panel). Women having indication for screening had significantly higher proportions of cesarean delivery, mainly emergency cesarean deliveries, in both the before and after groups, compared with women having no indication for screening. However, the low prevalence of GDM in both the before and after groups made outcomes of mode of delivery in the GDM group insignificant in any comparison across status for screening (low sample size). Mean gestational age was significantly lower in the GDM group in the before group, and borderline significant in the after group, compared with women having no indication for screening (Table 6, upper panel). The overall prevalence of preterm birth was 5.6%, relatively consistent across status for screening and before/after groups. There was no difference in mean birthweight or Apgar score across status for screening and before/after groups (Table 6, middle panel or lower panel). The overall prevalence of shoulder dystocia was 1.01% (95% CI 0.42–1.60), none diagnosed among the GDM cases.

4 | DISCUSSION

By broadening the selection criteria and lowering the threshold for abnormality in the fasting glucose test and/or heightening the criterion for pathological 2-hour OGTT, the proportion of women eligible for GDM screening increased by 45% (from 46.6% to 67.6%) after the introduction of the 2017 revised guidelines. Although adherence to screening increased from 28.6% to 49.2% in the before and after groups, this proportion is still low. Moreover, despite the increased proportion of women eligible for GDM screening and increased screening adherence, we observed only minor changes in the prevalence of GDM (2.2% to 3.6%; not significant).

When the 2017 revised national guidelines on GDM were introduced in Norway, several authors claimed that expanding screening criteria could lead to massive over-screening and over-medicalization of healthy pregnant women.[14] The Norwegian College of General Practice especially criticized the screening of all women aged 25 years and above, pointing out that, because average age at first pregnancy is 29 years, the majority of pregnant women would fulfil at least one screening criterion, and estimating that over 70% of pregnant Norwegian women would be candidates for screening.[15] We found that 67.6% of women fulfilled at least one criterion for screening in 2018, and that the entire increase in screening eligibility from 2013 was attributable to changes in the age/parity and BMI criteria. The proportion of women eligible for GDM screening has been reported to be similar in Portugal (68.2%), where risk factor-based screening is applied (BMI ≥30.0 kg/m^2, history of GDM, macrosomic, i.e. ≥4000 g, newborns in previous pregnancies, or first-degree relatives with type 2 diabetes mellitus).[16]

This study demonstrates that adherence to screening guidelines is unsatisfactorily low. A retrospective case-series of 2432 nulliparous women in the United Kingdom and Ireland showed that 60.8% of women with identifiable risk factors for GDM were appropriately screened,[17] whereas studies from Thailand and France reported

TABLE 4 Adherence to screening and follow up in the before and after group

Before group 2013 ($n = 676$)			After group 2018 ($n = 673$)	
n	*n* (%)	Eligible women	*n* (%)	673
	361 (53.4)	No screening criterion	218 (32.4)	
315	315 (46.6)	Fulfilled at least one screening criterion (age, parity, pre-pregnancy BMI, ethnicity)	455 (67.6)	455
	226 (71.7)	Not screened	231 (50.8)	
89	89 (28.3)	Screened	224 (49.2)	224
	74 (83.3)	No GDM	200 (89.3)	
15	15 (16.7)	GDM	24 (10.7)	24
	2 (13.3)	Did not receive follow up	5 (20.8)	
13	13 (86.7)	Follow up	19 (79.2)	19

Abbreviations: BMI, body mass index; GDM, gestational diabetes mellitus.

TABLE 5 Induction of labor, mode of delivery by study group and screening status (%)

Induction of labor	No indication screening	Indication screening		
		Not screened	Screened, no GDM	Screened, GDM
2013	*n* = 361% 18.0	*n* = 225% 23.1	*n* = 75% 32.0	*n* = 15% 40.0
2018	*n* = 218% 16.5	*n* = 231% 21.6	*n* = 200% 29.5	*n* = 24% 45.5
Mode of delivery				
2013	*n* = 361%	*n* = 225%	*n* = 75%	*n* = 15%
Normal vaginal delivery	81.4	71.6	70.7	80.0
Operative vaginal delivery	6.7	3.1	8.0	0.0
Planned cesarean delivery	3.3	8.0	8.0	0.0
Emergent cesarean delivery	8.6	17.3	13.3	20.0
2018	*n* = 218%	*n* = 231%	*n* = 200%	*n* = 24%
Normal vaginal delivery	83.0	76.6	69.5	37.5
Operative vaginal delivery	4.6	6.5	8.0	20.8
Planned cesarean delivery	5.0	6.5	6.5	8.3
Emergent cesarean delivery	7.3	10.4	16.0	33.3

screening rates of 78% and 80%, respectively.[18,19] The latter studies were conducted in hospital and private clinic settings and had slightly different screening approaches.[18,19] In a study from Sweden, where GDM screening is done similarly to Norway, 31% (257/822) of pregnant women had at least one risk factor for GDM, 31% (79/257) of whom were screened.[20] Barriers to screening may include failure of healthcare workers to identify risk factors either at the first or subsequent antenatal visits. A less likely explanation may be that some pregnant women refuse screening and/or that midwives/general practitioners neglect screening recommendations/borderline positive findings.[21]

A systematic review from 2017 on risk factor-based GDM screening reported that, when used as stand-alone criteria, BMI and high maternal age were as good as more complex prediction models.[5] This is in line with a study from 2019 that demonstrated only a minor additive value (~1%) of expanding the age and BMI criteria to include factors like previous GDM, history of high birthweight, and first-degree family history of diabetes.[22] This information is reassuring for the validity of the present study, in which more general screening criteria were used and family history and risk factors associated with current and past pregnancies were not included (Table 1).

The prevalence of GDM in Norway increased from 3.0% in 2013 to 5.0% in 2018; corresponding numbers for the two most northern counties, of which our study is part, were 2.3% and 2.8%, respectively.[23] Some authors claimed that the revised guidelines would double or triple the prevalence of GDM.[24] In our study, nearly 50% of eligible women were screened in 2018. If we assume that all eligible women were screened, the prevalence would have doubled from 3.6% to 7.2% as a result of complete screening coverage. The

TABLE 6 Mean, standard error of mean, range gestational age, birthweight and 5-minute Apgar score by study group and screening status

		Indication screening		
	No indication screening	Not screened	Screened, no GDM	Screened, GDM
Gestational age (weeks)				
2013	*n* = 361	*n* = 225	*n* = 75	*n* = 15
Mean	39.5*	39.4	39.8	38.2*
Standard error of mean	0.09	0.13	0.17	0.59
Range	33–42	31–42	36–42	31–40
2018	*n* = 218	*n* = 231	*n* = 200	*n* = 24
Mean	39.6**	39.3	39.4	38.7**
Standard error of mean	0.10	0.14	0.13	0.50
Range	33–43	30–43	30–43	32–42
Birthweight (g)				
2013	*n* = 361	*n* = 225	*n* = 75	*n* = 15
Mean	3471	3491	3595	3539
Standard error of mean	27	37	60	182
Range	1571–5030	1520–4655	1901–4600	1913–4484
2018	*n* = 218	*n* = 231	*n* = 200	*n* = 24
Mean	3594	3486	3486	3516
Standard error of mean	35	35	39	157
Range	1944–5130	1354–4612	1206–4875	1540–5228
Apgar scrore at 5 minutes				
2013	*n* = 361	*n* = 224[a]	*n* = 75	*n* = 15
Mean	9.7	9.5	9.6	9.5
Standard error of mean	0.04	0.08	0.09	0.13
Range	4–10	0–10	6–10	9–10
2018	*n* = 218	*n* = 228[b]	*n* = 200	*n* = 24
Mean	9.8	9.7	9.6	9.2
Standard error of mean	0.03	0.06	0.08	0.36
Range	8–10	0–10	0–10	2–10

[a]Missing information, one case.

[b]Missing information, three cases.

*$p < 0.05$; **$p = 0.07$.

non-significant increase in the prevalence of GDM between 2013 (2.2%, 95% CI 1.1–2.7) and 2018 (3.6%, 95% CI 2.2–5.0) is attributable to both an increase the eligible population (46.6% to 67.6%) as a consequence of broader screening criteria, and an increase in screening adherence (28.67% to 49.2%).

In a Finnish study that employed a similar "before/after" design, screening was performed twice as often, and the prevalence of GDM increased from 7.2% to 11.3%, but this comprehensive screening effort did not improve pregnancy or neonatal outcomes.[25] In the present study, there was a similar number of parturients in the first 6 months of 2013 and 2018. The larger population eligible for GDM screening and higher screening adherence in 2018 led to the diagnosis of nine additional GDM cases. The detection rate among women eligible for GDM screening decreased from 16.9% (15/89) in 2013 to 10.7% (24/224) in 2018, indicating less effective case identification, with minimal, if any, impact on overall maternal and neonatal morbidity.

In 2013, all GDM diagnoses were based on the 2-hour OGTT (including three cases with elevated fasting glucose values), whereas in 2018, 42% of cases were based solely on the fasting glucose test. Decisions on diagnostic thresholds are arbitrary and based on risk stratification that is considered sufficient to merit GDM

case ascertainment and treatment.[26] Following the hyperglycemia and adverse pregnancy outcomes (HAPO) study,[27] the GDM threshold values recommended by the International Association of Diabetes and Pregnancy Study Groups (IADPSG) were not in accordance with any previous OGTT diagnostic values. The diagnostic criteria used in Norway are based on glucose values that reach an odds ratio of 2.0 for the adverse outcomes demonstrated in the HAPO study. The reliability of odds ratios derived from observational data is poor, and the fact that only one abnormal test (fasting plasma glucose or 2-hour OGTT) is required for a diagnosis further elucidates this problem.[24] Fasting plasma glucose has low specificity, which limits its usefulness as a screening test.[28] A systematic review of the 2-hour OGTT test concluded that "caution should be exercised when interpreting a single test result".[29] Results from our study show that if GDM diagnosis was defined as positive results for both the fasting plasma glucose and the 2-hour OGTT, only three (3/676) women would have been diagnosed in 2013, and seven (7/673) in 2018; hence the prevalence would have been minimal.

Seven cases (two in 2013 and five in 2018) received no follow up. In all these cases, pathological values were documented in the standard antenatal record, but the mother was not informed nor was she diagnosed with GDM. The "older" diagnostic criteria had a higher threshold for fasting glucose and a lower threshold for the 2-hour OGTT, so healthcare providers may have failed to identify these women because of poor adaptation to the "old" and/or the "revised" diagnostic criteria.

Except for the seven women with no follow up, all diagnosed GDM cases were examined at week 36 in a maternity outpatient clinic, as advised in the guidelines. Few studies have analyzed adherence to follow up in primary or specialist antenatal care following a GDM diagnosis. Most studies have focused on treatment, outcome, and postpartum follow up. A systematic review on the determinants of and barriers to GDM services found that there were serious barriers to satisfying GDM services and management from screening to postpartum follow up, even in high-income countries.[30]

This study demonstrated that adherence to risk-based screening guidelines for GDM in Norway was poor both before and after implementation of the revised guidelines. The new guidelines led to a great increase in the number of women subjected to screening, followed by a small increase in the prevalence of GDM, which corresponds to the assumptions made by detractors of the revised guidelines. The new screening criteria have a major impact on costs and infrastructure capacity, and there is no clear evidence of the benefits of such a broad screening approach.[21] Another consideration is the impact of diagnosing asymptomatic pregnant women at a time when they might be particularly susceptible to stress, guilt, and anxiety.[27]

There is no evidence on whether the different screening alternatives improve outcomes that are important to patients.[10] The revised guidelines led to a significant increase in the proportion of 2-hour OGTTs performed in primary health care. In total, the costs associated with broader GDM screening and consequent follow up/treatment are estimated at 16 million NOK.[10] No cost–benefit analyses have been conducted to determine the cost savings related to preventing and treating the adverse outcomes related to short- and long-term complications; however, two studies have analyzed the cost-effectiveness of implementing broader screening criteria (based on IADPSG recommendations). One concluded that it would be cost-effective only if detection of GDM reduced the rate of type 2 diabetes later in life.[31] However, the long-term risk of developing type 2 diabetes among women with mild hyperglycemia identified with the broader screening criteria is unknown. The second study found that the revised screening algorithm would only be cost-effective if the number of cesarean sections were reduced.[32] This is unlikely, as a diagnosis of GDM is associated with an increase in cesarean section rates, even if birthweight is normalized through treatment.[33] A systematic review (2019) on the cost-effectiveness of controlling GDM concluded that neither screening nor treating mild GDM was convincingly cost-effective.[33]

The strengths of this study include its population-based approach, which reflects how screening is practiced, as well as the few parturients excluded because of missing information ($n = 33/1349$). Our study did not have the power to make any conclusion on clinical variables such as induction of labor, mode of delivery, and maternal/neonatal outcomes due to low numbers of GDM cases relative to non-cases, which is a limitation of the study. Another possible limitation is that not all risk factors for screening in the guidelines were included, but, as discussed by others, this fact has not had any effect on the true estimates of GDM.[5,22]

5 | CONCLUSION

The broader screening criteria for GDM resulted in a large increase in the population eligible for screening. Screening adherence increased, reaching nearly 50% in 2018, with only a minor impact on the prevalence of GDM. There may be concerns around the diagnosis of GDM, as 41% of screened women were diagnosed with GDM in 2018 based solely on fasting plasma glucose values. Stakeholders for obstetric care need to consolidate quality measures and revisit the screening algorithm.

ACKNOWLEDGMENTS

The authors are grateful to Elisabeth Ludvigsen and Aase Torunn Revholt Pettersen, Division of Surgery, Oncology and Women's Health, University Hospital of North Norway, Tromsø, for their contributions to data collection and validation.

AUTHOR CONTRIBUTIONS

Both authors contributed equally to study conception and design, validation and cleaning of data, analytic plan, interpretation of data, drafting of article, critical review for important intellectual content, selection and review of references. LG did the major part of data collection, while FES did the analysis.

CONFLICT OF INTEREST

None.

ORCID

Finn Egil Skjeldestad https://orcid.org/0000-0001-9875-4991

REFERENCES

1. O'Sullivan JB, Mahan CM. Criteria for the oral glucose test in pregnancy. *Diabetes*. 1964;13:278-285.
2. Farrar D, Duley L, Dowswell T, Lawlor DA. Different strategies for diagnosing gestational diabetes to improve maternal and infant health. *Cochrane Database Syst Rev*. 2017;8(CD007122).
3. Tieu J, McPhee AJ, Crowther CA, Middleton P, Shepherd E. Screening for gestational diabetes mellitus based on different risk profiles and settings for improving maternal and infant health. *Cochrane Database Syst Rev*. 2017;2017(8):Cd007222.
4. Hartling L, Dryden DM, Guthrie A, et al. *Screening and diagnosing gestational diabetes mellitus*. Evidence Report/Technology Assessment No. 210. AHRQ Publication No. 12(13)-E021-EF. Agency for Healthcare Research and Quality. October 2012. www.effectivehealthcare.ahrq.gov/reports/final.cfm
5. Farrar D, Simmonds M, Bryant M, et al. Risk factor screening to identify women requiring oral glucose tolerance testing to diagnose gestational diabetes: a systematic review and meta-analysis and analysis of two pregnancy cohorts. *PLoS One*. 2017;12:e0175288.
6. Tieu J, McPhee AJ, Crowther CA, Middleton P, Shepherd E. Screening for gestational diabetes mellitus based on different risk profiles and settings for improving maternal and infant health. *Cochrane Database Syst Rev*. 2017;2017(8):CD007222.
7. Farrar D, Simmonds M, Bryant M, et al. Treatments for gestational diabetes: a systematic review and meta-analysis. *BMJ Open*. 2017;7:e015557.
8. Moe N, Ladehaug B, Bakke T. Glycosuria, Chapter 6. In: Dalaker K, Berle EJ, eds. *Clinical Guidelines in Obstetrics 1999. The Norwegian Society of Obstetrics and Gynecology*. The Norwegian Society of Obstetrics and Gynecology. The Norwegain Medical Assocation; 1998:28-30 (ISBN 82-90921-66-7).
9. Retningslinjer for svangerskapsomsorgen. IS-1179. Oslo. Sosial- og helsedirektoratet. (National guidelines for antenatal care). in Norwegian.
10. Nasjonal faglige retningslinjer. Diabetes. Forebygging, diagnostikk og behandling. IS-1674. Oslo. Helsedirektoratet, 2009. (National guidelines. Diabetes. prevention, diagnositcs and treatment). in Norwegian.
11. Svangerskapsdiabetes. Nasjonal faglig retningslinje. (Gestational diabetes mellitus. National guideline.) in Norwegian. Oslo. Helsedirektoratet. 2017.
12. Svangerskapsdiabetes. Nasjonal faglig retningslinje. (Gestational diabetes mellitus. National guideline.) in Norwegian. Oslo. Helsedirektoratet. 2020.
13. Diagnostic criteria and classification of hyperglycaemia first detected in pregnancy: a World Health Organization Guideline. *Diabetes Res Clin Pract*. 2014;103:341-363.
14. Backe B. Å skyte spurve med kanoner. (To shoot sparrows with a cannon). In Norwegian. *J Norw Med Ass*. 2018. doi:10.4045/tidsskr.18.0167
15. Mjølstad BP, Roksund G, Brelin P, Hjorleifsson S, Carlsen T. Svangerskapsomsorgen må være kunnskapsbasert. (Pregnancy care must be evidence-based). In Norwegian. *J Norw Med Ass*. 2019. doi:10.4045/tidsskr.18.0377
16. Matta-Coelho C, Monteiro AM, Fernandes V, Pereira ML, Souto SB. Universal vs. risk-factor-based screening for gestational diabetes-an analysis from a 5-Year Portuguese Cohort. *Endocrine*. 2019;63:507-512.
17. Murphy NM, McCarthy FP, Khashan AS, et al. Compliance with National Institute of Health and Care Excellence risk-based screening for Gestational Diabetes Mellitus in nulliparous women. *Eur J Obstet Gynecol Reprod Biol*. 2016;199:60-65.
18. Ruengkhachorn I, Sunsaneevithayakul P, Boriboonhirunsarn D. Non-compliance to clinical practice guideline for screening of gestational diabetes mellitus in Siriraj Hospital. *J Med Assoc Thai*. 2006;89:767-772.
19. Gayet-Ageron A, Poncet B, Guerre P, et al. Specific information about the WHO guidelines for gestational diabetes screening improves clinical practices. *J Eval Clin Pract*. 2008;14:36-42.
20. Persson M, Winkvist A, Mogren I. Surprisingly low compliance to local guidelines for risk factor based screening for gestational diabetes mellitus—a population-based study. *BMC Pregnancy Childbirth*. 2009;9:53.
21. Huhn EA, Rossi SW, Hoesli I, Göbl CS. Controversies in screening and diagnostic criteria for gestational diabetes in early and late pregnancy. *Front Endocrinol*. 2018;9:696.
22. Benhalima K, Van Crombrugge P, Moyson C, et al. Risk factor screening for gestational diabetes mellitus based on the 2013 WHO criteria. *Eur J Endocrinol*. 2019;180:353-363.
23. Table F7d: Diabetes hos mor. Medisinsk fødselsregister - statistikkbank. (Diabetes in the mother. Medical birth register - statistics bank). (2020-01-15). http://statistikkbank.fhi.no/mfr/
24. Cundy T, Ackermann E, Ryan EA. Gestational diabetes: new criteria may triple the prevalence but effect on outcomes is unclear. *BMJ*. 2014;348:1567.
25. Ellenberg A, Sarvilinna N, Gissler M, Ulander VM. New guidelines for screening, diagnosing, and treating gestational diabetes—evaluation of maternal and neonatal outcomes in Finland from 2006 to 2012. *Acta Obstet Gynecol Scand*. 2017;96:372-381.
26. Long H, Cundy T. Establishing consensus in the diagnosis of gestational diabetes following HAPO: where do we stand? *Curr Diab Rep*. 2013;13:43-50.
27. HAPO Study Cooperative Research Group, Metzger BE, Lowe LP, Dyer AR, et al. Hyperglycemia and adverse pregnancy outcomes. *N Engl J Med*. 2008;358:1991-2002.
28. Agarwal MM, Hughes PF, Punnose J, Ezimokhai M. Fasting plasma glucose as a screening test for gestational diabetes in a multiethnic, high-risk population. *Diabet Med*. 2000;17:720-726.
29. Balion CM, Raina PS, Gerstein HC, et al. Reproducibility of impaired glucose tolerance (IGT) and impaired fasting glucose (IFG) classification: a systematic review. *Clin Chem Lab Med*. 2007;45:1180-1185.
30. Nielsen KK, Kapur A, Damm P, de Courten M, Bygbjerg IC. From screening to postpartum follow-up—the determinants and barriers for gestational diabetes mellitus (GDM) services, a systematic review. *BMC Pregnancy Childbirth*. 2014;14:41.
31. Werner EF, Pettker CM, Zuckerwise L, et al. Screening for gestational diabetes mellitus: are the criteria proposed by the international association of the Diabetes and Pregnancy Study Groups cost-effective? *Diabetes Care*. 2012;35:529-535.
32. Mission JF, Ohno MS, Cheng YW, Caughey AB. Gestational diabetes screening with the new IADPSG guidelines: a cost-effectiveness analysis. *Am J Obstet Gynecol*. 2012;207(326):e1-9.
33. Fitria N, van Asselt ADI, Postma MJ. Cost-effectiveness of controlling gestational diabetes mellitus: a systematic review. *Eur J Health Econ*. 2019;20:407-417.

How to cite this article: Grønvall L, Skjeldestad FE. Changed definition of disease and broader screening criteria had little impact on prevalence of gestational diabetes mellitus. *Acta Obstet Gynecol Scand*. 2021;00:1–8. doi:10.1111/aogs.14276