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Review Article

Gestational diabetes mellitus in Europe: prevalence, current screening practice and barriers to screening. A review

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Abstract

Background Gestational diabetes mellitus is a potentially serious condition that affects many pregnancies and its prevalence is increasing. Evidence suggests early detection and treatment improves outcomes, but this is hampered by continued disagreement and inconsistency regarding many aspects of its diagnosis.

Methods The Vitamin D and Lifestyle Intervention for Gestational Diabetes Mellitus Prevention (DALI) research programme aims to promote pan-European standards in the detection and diagnosis of gestational diabetes and to develop effective preventive interventions. To provide an overview of the context within which the programme will be conducted and its findings interpreted, systematic searching and narrative synthesis have been used to identify and review the best available European evidence relating to the prevalence of gestational diabetes, current screening practices and barriers to screening.

Results Prevalence is most often reported as 2–6% of pregnancies. Prevalence may be lower towards the Northern Atlantic seaboard of Europe and higher in the Southern Mediterranean seaboard. Screening practice and policy is inconsistent across Europe, hampered by lack of consensus on testing methods, diagnostic glycaemic thresholds and the value of routine screening. Poor clinician awareness of gestational diabetes, its diagnosis and local clinical guidelines further undermine detection of gestational diabetes.

Conclusions Europe-wide agreement on screening approaches and diagnostic standards for gestational diabetes could lead to better detection and treatment, improved outcomes for women and children and a strengthened evidence base. There is an urgent need for well-designed research that can inform decisions on best practice in gestational diabetes mellitus screening and diagnosis.

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Keywords gestational diabetes mellitus, prevalence, screening

Introduction

Gestational diabetes mellitus

Gestational diabetes mellitus is defined as carbohydrate intolerance resulting in hyperglycaemia, with first onset or detection during pregnancy [1,2]. Gestational diabetes includes impaired glucose tolerance [2,3]. Gestational diabetes increases the risk of complications for both mother and child during pregnancy, childbirth and beyond. Current evidence suggests early detection and management of gestational diabetes improves outcomes for both mother and child [4–7].

A 2008 *Lancet* editorial suggested that gestational diabetes incidence is spiralling, affecting up to 5% of all pregnancies [8]. American Diabetes Association (ADA) guidelines estimate that 7% of all pregnancies are affected [9]. However, estimating the prevalence of gestational diabetes is made difficult by a lack of

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universally accepted diagnostic criteria, a factor which also impedes its consistent diagnosis and management in clinical practice [6]. Several different protocols are in regular use internationally, each with its own recommendations on which pregnant women should be selected for biochemical testing, how the test should be performed and what glycaemic thresholds should be considered diagnostic [10]. Until 2011, American Diabetes Association guidance recommended that decisions to test for gestational diabetes with a 100-g oral glucose tolerance test be based on women's risk profiles, with gestational diabetes diagnosed according to Carpenter and Coustan thresholds (Table 1) [11]. In 2011, American Diabetes Association guidance changed in the light of International Association of Diabetes and Pregnancy Study Group (IADPSG) discussions following the Hyperglycemia and Adverse Pregnancy Outcomes (HAPO) study, which showed an association between increasing adverse pregnancy outcomes and blood glucose at levels hitherto considered normal [11,12]. The American Diabetes Association recommendations now closely reflect International Association of Diabetes and Pregnancy Study Group recommendations (Table 1) [13]. International Association of Diabetes and Pregnancy Study Group guidance recommends a 75-g oral glucose tolerance test at 24–28 weeks for all women not previously diagnosed with diabetes by random or fasting plasma glucose testing at the first antenatal visit, with gestational diabetes diagnosed according to International Association of Diabetes and Pregnancy Study Group thresholds (Table 1) [14]. The World Health Organization protocol is more inclusive and simple, with an oral glucose tolerance test recommended at 24–28 weeks for all women with risk factors for gestational diabetes or an abnormal fasting or random plasma glucose level and diagnostic thresholds the same as those for impaired glucose tolerance and diabetes mellitus outside pregnancy [10]. The Diabetic Pregnancy Study Group (DPSG) of the European Association for the Study of Diabetes (EASD), recommended separate diagnostic thresholds based on a 75-g oral glucose tolerance test, intended to be more in line with physiological changes in glucose tolerance during pregnancy (Table 1) [15]. Two other sets of diagnostic thresholds for the 100-g oral glucose tolerance test have been commonly used: those set by O'Sullivan and Mahan and by the National Diabetes Data Group (NDDG) (Table 1) [16,17]. In addition, the classification of gestational diabetes has changed over time. For example, for many years the definition of gestational diabetes by default encompassed diabetes first identified in antenatal consultations but likely to have pre-existed [1]. However, in recent years this approach has become unsustainable with the worldwide increase in obesity and associated increase in established but unrecognized Type 2 diabetes in women attending antenatal consultations [11]. As a result, it is now recommended that overt diabetes mellitus rather than gestational diabetes should be diagnosed in women whose hyperglycaemia is first diagnosed at a first antenatal consultation, but who were at high risk for diabetes prior to pregnancy [11,14].

Routine screening for gestational diabetes and the most effective approach for its systematic detection remain controversial topics. Systematic reviews have highlighted the lack of evidence and the need for quality research [3,18–20]. The US Preventive Services Task Force concluded in 2008 that there was insufficient evidence to assess the value of screening, while UK guidance concluded that screening by risk factors followed by biochemical testing may be clinically effective and cost-effective, although this has been disputed [3,18–21]. Ultimately, the desirability or appropriateness of screening depends upon whether detection and treatment of gestational diabetes leads to benefits for mother and child. Consideration of up-to-date evidence suggests early detection and management of gestational diabetes improves outcomes for both mother and child [4–7]. Systematic reviews of treatment of gestational diabetes and a large US cohort study concluded that diet and insulin-based therapies were associated with reduced adverse outcomes compared with normal antenatal care [22–25]. The Australian Carbohydrate Intolerance Study in Pregnant

Table 1 Gestational diabetes mellitus diagnostic thresholds for 75-g and 100-g oral glucose tolerance tests (mmol/l)

	75-g oral glucose tolerance test				100-g oral glucose tolerance test		
	World Health Organization criteria [2]		European Association for the Study of Diabetes [15]	International Association of Diabetes and Pregnancy Study Groups [14]	O'Sullivan and Mahan [17]	National Diabetes Data Group [16]	Carpenter and Coustan [11]
	Venous whole blood mmol/l (mg/dl)	Venous plasma mmol/l (mg/dl)	Venous plasma mmol/l (mg/dl)	Venous plasma mmol/l (mg/dl)	Venous whole blood mmol/l (mg/dl)	Venous plasma mmol/l (mg/dl)	Venous plasma mmol/l (mg/dl)
Fasting	≥ 6.1 (110)	≥ 7.0 (126)	≥ 6.0 (108)	≥ 5.1 (92)	≥ 5.0 (90)	≥ 5.8 (105)	≥ 5.3 (95)
1 h				≥ 10.0 (180)	≥ 9.1 (164)	≥ 10.6 (190)	≥ 10.0 (180)
2 h	≥ 6.7 (121)	≥ 7.8 (140)	≥ 9.0 (162)	≥ 8.5 (153)	≥ 8.0 (144)	≥ 9.2 (165)	≥ 8.6 (155)
3 h					≥ 6.9 (124)	≥ 8.1 (145)	≥ 7.8 (140)

Women (ACHOIS) trial reported significantly reduced risk of poor outcomes in women receiving blood sugar monitoring, dietary advice and insulin as necessary compared with normal care, although the effect of the intervention may have been added to by altered obstetric practice and there has been criticism of the trial's composite primary outcome, which combined mortality with relatively minor adverse events [4,26]. More recently, the Maternal and Fetal Medicine Units Network trial reported the effectiveness of a similar intervention in reducing adverse outcomes, including rates of macrosomia, shoulder dystocia, Caesarean section and hypertensive disorders [5]. Benefits of screening must be weighed against harms or risks. Increased demands upon service provision with no certain benefit may result in opportunity costs and there is a risk of increased anxiety and reduced quality of life caused by labelling pregnant women as ill when, for many, the likelihood of adverse outcomes may be relatively small, although Australian Carbohydrate Intolerance Study in Pregnant Women results suggest this is not the case [3,4].

The Vitamin D and Lifestyle Intervention for Gestational Diabetes Mellitus Prevention (DALI) research programme has been funded by the European Community with the aims of promoting pan-European standards in the detection and diagnosis of gestational diabetes and developing effective preventive interventions. Analysis of the current situation is an essential first step in this process. This review aims to assemble and consider the best evidence for the prevalence of gestational diabetes in Europe, current screening practices and barriers to screening in order to provide an up-to-date overview of the context within which the DALI programme will be conducted, its interventions developed and its findings interpreted.

Review of European literature

Methods

A review was conducted of European peer-reviewed literature, supplemented by other sources of information, relating to the prevalence of gestational diabetes and current screening practices and barriers to screening. To identify and access the literature, a two-stage search strategy was adopted. First, each of the DALI study centres in Austria, Belgium, Denmark, Finland, Italy, Ireland, the Netherlands, Poland, Spain, Switzerland and the UK identified literature from their own country and a neighbouring non-participating country. This approach meant that local knowledge could assist in the identification of national guidelines and government, statutory and national professional organization publications. Second, the authors conducted a search of Medline and PubMed to ensure that a consistent baseline search strategy was in place for all regions. 'Gestational diabetes' and the names of countries were searched as Medical Subject Heading (MeSH) terms and keywords for papers. To ensure the evidence reviewed was current, both search strategies sought materials produced between 2000 and 2009. In-text citations have been limited to key references for this paper. A full reference list is available from the authors.

Peer-reviewed publications were the preferred sources of data, followed by national guidelines and government, statutory and national professional organization publications. Data were also gathered in a survey conducted in the early development of the DALI programme of members of the Diabetes Pregnancy Study Group of the European Association for the Study of Diabetes. Subsequently, gaps identified in the literature relating to gestational diabetes prevalence and screening were addressed in interviews with clinical experts involved in the DALI programme. Where possible, experts were also contacted in countries not involved and for which data could not be accessed by literature search or through the Diabetes Pregnancy Study Group survey or interview.

Because the sources of information varied widely, a narrative synthesis approach was judged to be the most appropriate method for the review [27]. Information from the literature, supplemented by data from other sources, was in the first place collated and summarized by the first and second authors (BSB and JH). Subsequently, facilitated by BSB, an authorship group of key DALI Core Investigator Group experts (PD, RC, DS, AV, FD) undertook several cycles of detailed internal review, including the addition or subtraction of information, to generate a review that was judged to reflect current European evidence.

Results

The dual search strategies identified 185 separate sources of information from 23 countries, including peer-reviewed research papers, guideline publications and reports from professional and statutory bodies and national registers.

Prevalence of gestational diabetes

Research was sought that reported the prevalence of gestational diabetes in European countries, in so far as possible in nationally representative populations. Prevalence estimates were not included from populations clearly affected by selection biases, such as those identified through selection by specific risk factors or in unrepresentative settings such as high-risk pregnancy clinics. Thirty-two estimates were included (Table 2). More than half (n = 17) reported prevalence figures between 2.0 and 6.0%. A trend towards lower prevalence of gestational diabetes in Northern or Atlantic seaboard parts of Europe emerged, with estimates mostly less than 4% in that region [28,29,31–33] while, in the South or Mediterranean seaboard region, estimates higher than 6% predominated (Fig. 1) [34–39]. Most studies used World Health Organization or American Diabetes Association criteria for screening and diagnosing gestational diabetes. National Diabetes Data Group criteria were less often used and some used mixed or locally developed methods. No consistent affect of diagnostic criteria upon prevalence estimates was evident.

Table 2 Prevalence data for gestational diabetes mellitus for European countries by latitude (north to south)

Country and date of data	Setting/study type	Population	Estimated prevalence of gestational diabetes (by screening and diagnostic protocol)			
		Derivation of sample (screening applied + diagnostic test/thresholds)	World Health Organization (WHO)	American Diabetes Association (ADA)	National Diabetes Data Group (NDDG)	Other (see footnotes)
Norway, Oslo 1994–1996 [30]	Prospective cohort	3677 pregnant women attending for ultrasound as normal antenatal care (risk factor screening + WHO)	2.1% 76/3677			
Finland, Helsinki 1996–1998 [40]	Prospective cohort	532 pregnant women in primary care settings (universal 50-g GCT + 75-g OGTT, local thresholds)				3.5% 19/532*
Finland 2009 [41]	National birth register	All pregnancies ending in birth		8.9%		
Sweden 2000–2003 [28]	Retrospective study	93% of pregnant women in Skane county (universal 75-g OGTT + WHO)	1.9%			
Sweden 1998–2002 [29]	Retrospective cohort	31 542 deliveries—all deliveries in an urban district hospital (universal random blood glucose tests + WHO)	2.28% 719/31 542			
Latvia 2007 (unpublished data)	Birth register data	415 cases recorded in birth register				1.8%†
UK, Plymouth 1996–1997 [31]	Prospective cohort	4942 consecutive Caucasian, pregnant women aged 15–46 years, no history of diabetes (universal random plasma glucose tests + WHO)	1.8% 89/4942			
Ireland 1990s (year not stated) [42]	Prospective cohort	1299 consecutive consenting pregnant women at a city maternity hospital (50-g GCT + NDDG)			2.7% 35/1299	
Ireland 2006–2007 [43]	Prospective cohort	5269 consecutive consenting pregnant women at five antenatal clinics in the West of Ireland (universal 75-g OGTT + WHO)	10% 527/5269			
Denmark 1999–2000 [32]	Prospective cohort	5235 consecutive pregnant women in a multi-centre prevalence study (universal 50-g GCT + DPSG)				2.4% 124/5235‡
Lithuania 2006 (unpublished data)	National data	—	0.7%			
Germany, Berlin 1994–1997 [44]	Case–control cohorts	267 single and twin pregnancies, matched 1:2, otherwise unselected (universal 50-g GCT + mixed diagnostic test)				3.4% 9/267§
Poland, Gdansk [45]	Prospective cohort	5778 pregnant women, national sample (universal 50-g GCT + WHO)	3.4% 196/5788			
Poland 2007–2008 [46]	National register data	(Universal 50-g GCT + WHO)	3.9%¶			
Belgium, Flanders 2002–2004 [33]	Birth register data	179 715 deliveries: 99.9% of deliveries in the region of Flanders		1.0%		
France, Soissons 2005 [47]	Prospective cohort	780 consecutive pregnant women, single general hospital (universal 50-g GCT + ADA)		5.0%		
Czech Republic, Zlín 2000 [48]	Prospective cohort	All pregnant women (> 700) over 4 months in a geographic area (universal 50-g GCT + WHO)	< 3.5% (25/> 700)			
Austria 2001–2004 [49]	Prospective cohort	Referrals to five tertiary hospitals: 1466 pregnant women with risk factors, 171 with no risk factors (universal 75-g OGTT + WHO)	27.6% 451/1637			

Table 2 (*Continued*)

Country and date of data	Setting/study type	Population	Estimated prevalence of gestational diabetes (by screening and diagnostic protocol)			
Switzerland, Lausanne 2000–2002 [50]	Prospective cohort	All 5788 singleton deliveries in a university hospital. Risk factor screening (universal 100-g OGTT + NDDG)			2.7% 159/5788	
Hungary, Tolna 2000 [51]	National data	2013 unselected pregnancies in a single Hungarian county (universal 75-g OGTT + WHO)	8.6% 173/2013			
Slovenia , Ljubljana 1999–2001 [52]	Prospective cohort	1136 unselected singleton deliveries in a single hospital (universal 100-g OGTT + ADA)		2.4% 27/1136		
Spain, Aviles 2003 [53]	Retrospective study	899 unselected pregnant women in five hospitals in a single health authority district				4.7% 42/899**
Portugal 2003–2005 [54]	National Birth Register	292 170 deliveries				3.01% 8806/29 2170††
Spain, Madrid 1998–1999 [36]	Retrospective cohort	1293 consecutive pregnant women in an urban district (universal 50-g GCT + ADA)		7.3% 94/1293		
Spain, Madrid [35]	Prospective cohort	369 consecutive pregnant women in an antenatal clinic in Madrid (universal 50-g GCT + NDDG)			7.9%	
Spain, Granada 1995 [55]	Retrospective study	All 1962 births in a single university hospital (universal 50-g GCT + ADA)		3.31% 65/1962		
Spain, Cadiz 1994–1996 [56]	Prospective cohort	3986 unselected consecutive pregnant women at antenatal clinics (50-g GCT + NDDG)			5.9% 235/3986	
Spain 2001–2002 [38]	Prospective cohort	583 consecutive pregnant women (universal 50-g GCT + NDDG)			8.2% 48/583	
Spain 2002 [39]	Prospective cohort	9270 unselected pregnancies at 16 hospitals (universal 50-g GCT + ADA)		11.6% 1082/9270		
Spain, Tenerife2006 [57]	Retrospective study	Universal screening of 3724 pregnancies in a single hospital				4.4% 164/3724‡‡
Italy 1997–2000 [58]	Prospective cohort	865 unselected pregnant women in a single university hospital (universal 50-g GCT + ADA)		6.6% 56/856		
Italy 1999–2003 [37]	National data	29 732 pregnant women		7% 3465/29 732		
Italy 1995–2001 [34]	Prospective cohort	3806 consecutive women at a university hospital (universal 50-g GCT + ADA)		8.74% 333/3806		
Sardinia, Italy [59]	Prospective cohort	1103 unselected pregnant women (universal 100-g OGTT + ADA)		22.3% 247/1103		

*75-g OGTT (thresholds based on large Finnish cohort study: fasting 4.8 mmol/l, 1-h 10.0 mmol/l, 2-h 8.7 mmol/l).
†Unknown.
‡European Diabetes Pregnancy Study Group (75-g OGTT 28–32 weeks 9.0 mmol/l).
§Mixed (75-g OGTT at 30–34 weeks interpreted as per Carpenter and Coustan criteria).
¶Predominantly WHO.
**O'Sullivan and Mahan (100-g OGTT).
††100-g 3-h OGTT following Carpenter and Coustan criteria or O'Sullivan GCT > 200 mg/dl.
‡‡100-g OGTT (timing unknown and unclear whether NDDG or Carpenter and Coustan criteria).
GCT, glucose challenge test; OGTT, oral glucose tolerance test.

Gestational diabetes screening programmes, practices and methods

Screening practices for gestational diabetes are inconsistent across Europe and even within countries. Practices range from systematic screening of all pregnant women to testing on a case-by-case basis according to clinician or patient decisions. Where systematic screening is in place, variations exist in protocols followed, risk factors considered, and diagnostic tests and threshold values used. Information is presented in Table 3 about the practice of screening for gestational diabetes in European countries, extracted from the medical literature, clinical guidelines, health authority publications and online sources.

Barriers to screening in Europe

A lack of evidence to support screening as an effective strategy for preventing adverse outcomes or improving health in the mother or child has been identified as an underlying barrier to effective or consistent screening of pregnant women for gestational diabetes in Europe [19]. Similarly, the lack of consensus on best practice for detection and diagnosis of gestational diabetes has been identified as another barrier, contributing to inconsistent clinical practice in screening.

The existence of national guidelines does not preclude inconsistency. Given the aforementioned factors, their implementation is challenging and compliance with national guidelines varies between countries [60]. There also reportedly exists some degree of ignorance of prevailing screening and diagnostic practice amongst clinicians. A number of studies have shown that dissemination of clear guidance or improvement of care pathways and administrative factors linked to screening have improved compliance [61,62]. It is likely that differences may exist between clinical specialities in the perceived importance of gestational diabetes. The asymptomatic nature of gestational diabetes and an unwillingness to label pregnant women as 'ill' may also affect attitudes to its detection and diagnosis.

It has been suggested that screening for gestational diabetes can cause unnecessary anxiety for pregnant women, a potential barrier to compliance [3,63]. However, French research found little evidence to support this. A very high proportion of those screened answered a questionnaire (97.6%) and, although approximately half experienced nausea during testing and just under half found the test stressful, overall the World Health Organization test for gestational diabetes was judged to be acceptable by 97% of respondents, regardless of known gestational diabetes risk or of whether gestational diabetes was diagnosed [61]. The importance of the provision of accessible information about gestational diabetes and about screening is emphasized by the French study and by Swedish qualitative research that explored the experience of women treated for gestational diabetes [63].

European research on screening effectiveness and methods

Recent European research reflects the worldwide literature in that few studies have considered the effectiveness of screening for preventing adverse outcomes or improving health in the mother or child. Only one randomized trial was identified. This reported a higher rate of vaginal delivery at term and lower rates of adverse outcomes in women randomized to receive universal screening compared with risk factor-based screening. However, universal screening was performed some 4–6 weeks earlier than risk factor-based screening, conferring a therapeutic advantage [42]. A French cohort study, after adjusting for age, pre-pregnancy BMI, parity and ethnicity, found that the risks of macrosomia, early delivery, jaundice and neonatal

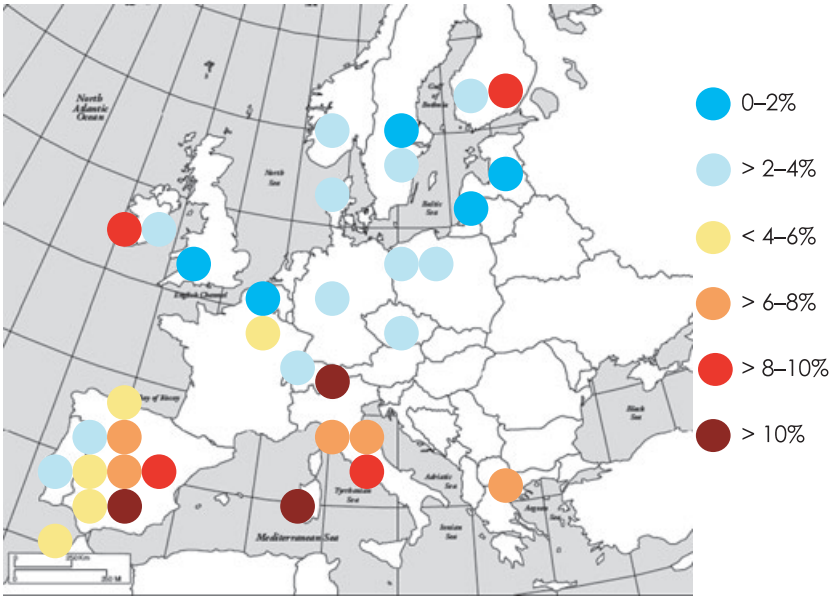

FIGURE 1 Reported prevalence of gestational diabetes in Europe.

Table 3 Screening practices for gestational diabetes mellitus in European countries

Country	Screening model	Screening and diagnostic tests; diagnostic thresholds
Austria	Screening recommended for all pregnant women. Testing at 24–28 weeks. High-risk pregnancies tested in first trimester	75-g OGTT; fasting plasma glucose ≥ 5.1 mmol/l, 1 h ≥ 10.0 mmol/l, 2 h ≥ 8.5 mmol/l
Belgium	Regional guidelines recommend screening at 24–28 weeks, although no specific method specified. Privately funded and reimbursed through social security system	100-g OGTTs most widely used, 75-g OGTTs also used; Carpenter and Coustan
Bulgaria	One paper suggests that no screening programme is in place and that OGTTs are not generally used in antenatal assessment	—
Czech Republic	One paper reports that in one district all pregnant women have been screened since 1985. It is unclear whether this is national practice	50-g GCT, followed when positive with 75-g OGTT; WHO
Denmark	Women with risk factors tested at 27–30 weeks. Guidelines based on nationally conducted observational research. Screening and testing free of charge at point of service delivery	75-g OGTT; 2 h ≥ 9.0 mmol/l
Finland	Guidance recommends OGTT at 24–28 weeks for majority of pregnant women. Exclusions: women < 25 years with first pregnancy, of normal weight (BMI 18.5–25.0 kg/m^2) and no family history of diabetes; women < 40 years with previous children, of normal weight and no previous gestational diabetes or macrosomia. High-risk pregnancies tested at 12–16 weeks (previous gestational diabetes, glycosuria, BMI > 35 kg/m^2). Screening funded by local municipal authorities	75-g OGTT; one positive test value of fasting plasma glucose ≥ 5.3 mmol/l, 1 h ≥ 10.0 mmol/l, 2 h ≥ 8.6 mmol/l
France	French National Authority for Health report concluded that, on the basis of the scientific literature, no recommendations could be made on the best strategies for screening and diagnosis of gestational diabetes until further evidence is available. Within one health authority region only 15.15% received GCT and 6.0% an OGTT	—
Germany	Most women unsystematically offered screening for gestational diabetes, but often must pay for it themselves. The Institute for Quality and Efficiency in Health Care was unable to identify sufficient evidence to recommend screening	—
Hungary	More than 94% of pregnant women attend antenatal care services, available in every major area of habitation, with mobile services serving more remote areas. Screening for gestational diabetes as well as other conditions is performed routinely	Unclear
Ireland	Screening is not systematic, but it is normal for women to be screened by risk factors and tested as appropriate between 24 and 28 weeks of gestation. Dual system of health service reimbursement: lowest socio-economic strata (approximately 30%) tested free of charge; others pay privately or are covered by personally funded health insurance	Variable, most commonly 75-g OGTT; WHO
Italy	Pre-screening by risk factor and GCT at 24–28 weeks. Screening paid for by patients. Treatment paid for by national health services if gestational diabetes diagnosed	Pre-March 2010: 100-g OGTT; Carpenter and Coustan. Post-March 2010 75-g OGTT; IADPSG.
Lithuania	One paper suggests that universal screening is practiced in some centres using WHO protocol	—
Malta	Pregnant women routinely screened for gestational diabetes using a risk factor-based protocol. Women judged to be medium or high risk are tested	75-g OGTT; DPSG and European Association of Perinatal Medicine criteria
The Netherlands	Pregnant women who are obese or who have a family history of diabetes, gestational diabetes in a previous pregnancy or possible macrosomia in the current pregnancy are tested at 24 weeks	75-g OGTT; WHO
Poland	All pregnant woman offered screening under the public health system at 24–28 weeks. Private testing is also available	75-g OGTT; WHO
Portugal	No description of screening policy was identified, but national register of data suggests that screening is widespread or universal	100-g OGTT; Carpenter and Coustan or O'Sullivan
Spain	Screening almost universally provided. 50-g GCT at 24–28 weeks with OGTT where positive for the most part free of charge by obstetricians operating within a state-funded healthcare system. Regional protocols also consider screening at first pregnancy visit or in the third trimester when risk factors present	100-g OGTT; O'Sullivan and Mahan, and Carpenter and Coustan

Table 3 (*Continued*)

Country	Screening model	Screening and diagnostic tests; diagnostic thresholds
Sweden	Local screening guidelines exist but compliance with these appears to be inconsistent, with one study reporting only 30.7% of women eligible for screening being screened and another 93%	Unclear
UK	National guidance recommends screening by risk factor followed by OGTT for those with risk factors at 24–28 weeks. Reportedly, screening practice varies widely. Scottish national guidelines were revised in 2010 and are broadly in line with IADPSG guidelines	75-g OGTT; WHO

No information about screening was found in the literature for Cyprus, Estonia, Greece, Latvia, Luxembourg, Norway, Romania, Slovakia, Slovenia or Switzerland.
DPSG, Diabetes Pregnancy Study Group; GCT, glucose challenge test; IADPSG, International Association of Diabetes and Pregnancy Study Groups; OGTT, oral glucose tolerance test; WHO, World Health Organization.

hospitalization were similar in 1255 women with no gestational diabetes and in 265 women diagnosed with gestational diabetes by universal screening, but higher in 159 women diagnosed through risk factor screening [64]. In either study, notwithstanding adjustments made, uncertainty remains as to whether a lower incidence of adverse outcomes following universal screening reflects the treatment opportunity conferred by diagnosis or simply the greater likelihood of events in the group with known risk factors. A large Danish cohort involving over 5000 women considered that risk factor-based screening was as effective as universal screening, finding that glucose intolerance in those 'missed' by risk factor screening was only slight compared with those successfully identified [32].

Much more research has considered the relative effectiveness of different screening methods at case finding rather than at improving clinical outcomes. Studies have variously suggested that universal screening identifies greater numbers of women with gestational diabetes than risk factor-based screening [28,43,66,65], that 11% of cases may be missed if women with American Diabetes Association-defined low risk are not tested [66] and that risk factor-based screening is associated with low sensitivity and low specificity. Repeated random blood glucose tests at 4- to 6-week intervals have been found to be equally sensitive but more specific than risk factor-based methods for selecting women for diagnostic testing with oral glucose tolerance test [67], while universal screening with a 50-g glucose challenge test has been found to be more sensitive than screening by risk factors [40] or random glucose tests [68]. Researchers have found little clear advantage in any specific age threshold as a risk factor [56]. UK guidelines have concluded that increasing maternal age should not be used as a risk factor for screening, because this would result in most pregnant women receiving an oral glucose tolerance test [10,69].

Discussion

Estimates of between 2 and 6% of pregnancies were reported in the majority of the studies identified that calculated prevalence for apparently representative, unselected populations. Collating gestational diabetes prevalence data is hampered by heterogeneity in approaches to screening and methods and thresholds for diagnosis. Some criteria have been demonstrated in the literature to determine lower or higher estimates than others [56]. However, no such effect is consistently seen in the prevalence data reported in this review, with some of the lowest estimates being determined by criteria that are considered 'more inclusive'. A trend emerges for lower prevalence in the North of Europe and higher prevalence in the South. This geographic variance reflects previous research in Australia that identified higher prevalence in women of Mediterranean birth than those of Northern European birth [70]. Some estimates calculated in apparently unselected populations raise questions about the existence of pockets of high prevalence, such as in Finland, the West of Ireland or, most notably, Sardinia, where universal screening using American Diabetes Association criteria of 1103 pregnant women gave a prevalence of 22.3%, a very high proportion that could not be explained by correspondingly high prevalence of gestational diabetes risk factors [41,44,60].

Information about screening practices was difficult to access from some countries so that some uncertainty remains as to whether all information presented is nationally representative. Notwithstanding this limitation, the review of screening practice in European countries reveals a picture of widespread inconsistency, involving a variety of testing methods and diagnostic thresholds and ranging from limited or informal screening to universal testing.

Usefully, a number of studies considered barriers to screening. Lack of evidence for the clinical effectiveness of screening appears to play a major role in preventing enthusiasm for the implementation of screening recommendations. Consistent screening is also hampered by the lack of universally accepted, evidence-based testing methods and diagnostic thresholds for gestational diabetes. This seems set to continue. While adoption of International Association of Diabetes and Pregnancy Study Group recommendations would bring Europe in line with the USA, they remain controversial: it has been argued that their effect would be to increase the number of diagnoses of

gestational diabetes dramatically, possibly with little therapeutic justification [71]. Recent European research has done little to shed light on the clinical effectiveness of screening to inform these debates. There remains a need for large-scale, well-designed research that compares different screening and diagnostic methods in terms of meaningful clinical outcomes. There is some evidence that poor clinician awareness of gestational diabetes, methods of testing and local guidelines affect the standard and consistency of care provided. Provision of information and training for clinicians about gestational diabetes screening appears both effective and appreciated. Despite concerns to the contrary, there is some European evidence that screening is likely to be widely acceptable to pregnant women, but that the provision of accessible explanatory information is of importance.

Strengths and limitations

The review has considerable strengths. It represents the combined efforts of many researchers and clinicians with a particular interest in gestational diabetes and its methods have enabled the use of their knowledge of national research and practice relating to gestational diabetes. It can thus present a wide-ranging overview of current knowledge and practice in Europe. Limitations also affect the review, and these must be acknowledged. There has been little high-quality experimental research. Much of the research has been observational and often retrospective so that quality of data recording cannot be validated and there is always a chance of residual confounding. A review such as this is inevitably affected by the absence of evidence in some areas and we have sought information from a wider range of sources than just the literature in order to offer as complete a picture as possible of the context within which the DALI research programme will be developed and conducted. However, the limitations of unpublished sources and of information provided by individual experts must be acknowledged.

Conclusions

Gestational diabetes is a potentially serious condition affecting 2–6% of pregnancies in Europe, yet practice relating to its detection is inconsistent and suboptimal. Europe-wide agreement on screening approaches and diagnostic standards for gestational diabetes could lead to increased clinician adherence to guidance, more consistency in detection and treatment and improved outcomes for women and children. In addition, uniform diagnostic standards could lead to a strengthened evidence base, facilitating research and the development of effective health care. There is an urgent need for well-designed research that can inform decisions on best practice in gestational diabetes screening and diagnosis.

Competing interests

Nothing to declare.

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