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Evaluation of knowledge about gestational diabetes mellitus among postpartum women and its connection with women's sociodemographic and clinical characteristics: a quantitative cross-sectional study

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ABSTRACT

Objective: to define the knowledge level among postpartum women affected by gestational diabetes and identify its association with women's sociodemographic and clinical characteristics.
Design and Setting: a cross-sectional comparative study was conducted. Data collection took place in a single university hospital in the German speaking part of Switzerland.
Participants: a total of 107 postpartum women diagnosed with gestational diabetes in the current pregnancy completed a gestational diabetes mellitus specific knowledge questionnaire (GDMKQ) in German or English in their postpartum period. Further, sociodemographic and clinical characteristics were collected.
Results: Women were between 24 and 45 years old, 56.1% had an academic degree, 60.7% were migrant women coming mainly from other European countries, 17.8% had a previous history of gestational diabetes, and 31.8% had a family history of diabetes. As measured with the GDMKQ, women with a higher educational level obtained higher scores and therefore showed a better knowledge level about gestational diabetes compared to women with primary and secondary educational levels (M 13.3 vs M 11.1 and 12.5; χ^2 (2) = 13.003, p = .002). In addition, women with a previous history of gestational diabetes also reached higher scores compared to women with no history of gestational diabetes (M 13.6 vs M 12.5, $Z = -2.278$, p = .023).
Conclusion and implication for practice: Even if the knowledge status among women attending this single Swiss hospital is presently very good, a lower educational level was associated with a lower knowledge level and identified as the main factor to hinder women's comprehension of gestational diabetes. More individually tailored consultations by health care professionals may serve to meet women's needs more adequately and support them better in the understanding of their condition.

Introduction

Gestational Diabetes Mellitus (GDM) is defined as "diabetes diagnosed in the second or third trimester of pregnancy that was not clearly overt diabetes prior to gestation" (American Diabetes Association, 2020). Nowadays, GDM is considered one of

List of abbreviations: DM, Diabetes mellitus; GDM, Gestational diabetes mellitus; GDMKQ, Gestational diabetes mellitus knowledge questionnaire; HAPO, Hyperglycaemia and Adverse Pregnancy Outcome; HCPs, Health care professionals; HL, Health literacy; IADPSG, International Association of the Diabetes and Pregnancy Study Groups; NICE, National Institute for Health and Care Excellence; T2DM, Type 2 diabetes mellitus.

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the most frequent complications during pregnancy (Johns et al., 2018). However, a consistent GDM prevalence rate is difficult to estimate, given that the rates differ between studies due to risk factors in the population and the diagnostic criteria used (Behboudi-Gandevani et al., 2019). The International Association of the Diabetes and Pregnancy Study Groups (IADPSG) suggested glucose threshold rates for the diagnosis of GDM, those being ≥ 5.1 mmol/L plasma glucose concentrations by fasting, ≥ 10 mmol/L an hour after consuming food, and ≥ 8.5 mmol/L after two hours. Following these criteria, GDM is diagnosed when one or more of these values meet or exceed the threshold (Metzger, 2018). Based on the IADPSG criteria, the Hyperglycaemia and Adverse Pregnancy Outcome (HAPO) Study suggested an average prevalence of 17.8% (range of 9.3-25.5%) among 15 study centres worldwide (Sacks et al., 2012). Similar values were reported in a more recent study, where the suggested global estimated prevalence of hyperglycaemia in pregnancy is 14% (Cho et al., 2018). In 2012, the estimated prevalence of women affected by GDM in Switzerland was 10.9% (Ryser Rüetschi et al., 2016).

Diverse risk factors for developing GDM frequently emerge in the literature, even if the variability in results regarding assessments of risk factors hinder consistency in determining the risk factors associated with GDM (Plows et al., 2018). The most important known risk factors include a family history of type 2 diabetes mellitus (T2DM), previous personal history of GDM, obesity (BMI > 30 kg/m^2), maternal age, and parity (Deutsche Diabetes Gesellschaft (DDG) 2018). In addition, foetal macrosomia (birth weight > 4500 g) or congenital foetal malformation in previous pregnancies are also considered factors that increase the risk for the development of GDM (Amylidi-Mohr, 2019; Kautzky-Willer et al., 2019).

After a GDM has been diagnosed, lifestyle modifications, including diet, physical activity, and blood glucose self-measurement, should be implemented (Amylidi-Mohr, 2019). Insulin therapy should only be initiated if half of the glycaemic values are exceeded within a week and when the lifestyle modifications are not effective (Amylidi-Mohr, 2019). The type of insulin is selected individually, based on the patient's blood glucose values and life rhythm (Althof, 2015). According to international guidelines, oral antidiabetic agents are additionally used if there is suspicion of pronounced insulin resistance with very high insulin requirements (Schäfer-Graf et al., 2018).

Uncontrolled GDM is a serious threat to maternal and child health. Associated complications include pre-eclampsia and increased risk of caesarean section for the mother as well as foetal macrosomia and shoulder dystocia in infants (Crowther and McPhee, 2005; Landon et al., 2009). Additionally, long-term complications are associated with GDM. In women affected by GDM, the risk of developing T2DM is 18.9%, nine years after birth, compared to 2% in non-GDM women (Feig et al., 2008). Children have an increased risk of overweight or T2DM development and metabolic and cardiovascular complications (Stewart and Malhotra, 2015). Due to the various possible adverse maternal and child health outcomes, it is vital that women with a diagnosed GDM understand their condition. To increase their awareness about GDM, women require information about its aetiology, therapy, risks, and future implications during their pregnancy.

The terms «knowledge» and «awareness» are often used indistinctly to address the same concept in the literature. Despite the high prevalence of GDM worldwide, several studies conducted in different countries reveal a poor or low knowledge or awareness of GDM and investigated possible influencing factors. Exemplarily, these studies revealed the knowledge level to be poor, particularly in rural areas or areas with a higher prevalence of GDM in Saudi Arabia, India and China (Alharthi et al., 2018; Bhavadharini et al., 2017; Ge et al., 2016). A study conducted in Poland in both urban and rural areas, and where a higher percentage of participants lived in large cities, also indicated that women had low-to-moderate level of knowledge about GDM (Lis-Kuberka and Orczyk-Pawiłowicz, 2021). Migration background and poor language skills showed to be related to a lower knowledge level of GDM as shown in a multi-ethnic study carried out in Norway (Borgen et al., 2019). An older age (Wander et al., 2016) and having a family history of diabetes mellitus (DM) (Monir et al., 2019) appeared to be further influencing factors in women's knowledge level in two studies performed respectively in India and Bangladesh. Various studies conducted in Ghana, Australia and Korea also proved that the higher women's educational level was, the better was their knowledge about GDM (Azu et al., 2017; Carolan et al., 2010; Park et al., 2018). One further study performed in Malaysia showed that participants with a higher knowledge about GDM presented better glycaemic control than those with a poorer understanding of their condition (Hussain et al., 2015).

A better understanding of GDM among affected women could prevent many complications related to this condition. Patient education has proven to be effective in recent studies. Women can better understand their condition either through group education (Caro et al., 2018) or by following the educational interventions by specialised diabetes advisors (Alayoub et al., 2018).

This evidence suggests that educating women about GDM has a beneficial impact. However, for a more specific coverage of women's educational needs in a particular community, understanding their knowledge status and the influencing factors is essential. To the authors' understanding, no study on this issue has been conducted to date in Switzerland. Therefore, the current study aimed to assess the knowledge level of GDM among affected women who gave birth at a Swiss university hospital. This evaluation was conducted to consider if the development of further patient education interventions was required to support these women better. The researchers additionally sought to identify associations between GDM knowledge status and sociodemographic and clinical characteristics. Accordingly, two hypotheses were formulated to guide the analysis of the data: the knowledge about GDM differs depending on women's 1) sociodemographic characteristics (such as age, educational level, and country of origin) and 2) clinical characteristics (such as a family history of DM, parity, a previous history of GDM, GDM therapy, and newborns' birth weight).

Methods

Setting and participants

This cross-sectional study was conducted at the clinic for obstetrics at the University Hospital Zurich. This hospital, which reached a total number of 2919 births in 2019, is one of the largest in Switzerland. In the same year, 448 women diagnosed with GDM gave birth at this hospital. The length of stay is usually around four days after vaginal birth and five days after a caesarean section. Women were considered eligible to participate in this study if they were diagnosed with GDM in the current pregnancy, hospitalised and in the postpartum period, 18 years or older, and able to understand oral and written German or English. Women who were not able to give their informed consent, i.e., due to the language barrier or cognitive impairment, were excluded from the study.

Data collection

The study was carried out between August and December 2020. Data consisting of the participants' knowledge level about GDM, were collected using the GDM Knowledge Questionnaire (GDMKQ), developed and validated by Hussain et al. (Hussain et al., 2015).

The GDMKQ is a self-administered questionnaire created to evaluate knowledge about GDM. It contains 15 questions split into five domains with three questions each. These domains are «basic knowledge about GDM», «risk factors», «food and diet values», «management», and «complications and outcomes». Using the multiple-choice format, each question has four possible answers, one of them always being "I don't know", to refrain participants from guessing or not answering. Every correct answer receives a score of 1 and every incorrect answer a score of 0. Participants can reach a minimum score of 0 and a maximum of 15, the latter indicating better knowledge about GDM. The cut-off values appointed by Hussain and colleagues determine scores reaching eight or below as an inadequate knowledge level, whereas scores including nine or above are identified as an adequate knowledge level (Hussain et al., 2015). Reliability analyses revealed that the GDMKQ's Cronbach's alpha was 0.77 after testing it on 30 patients.

The GDMKQ was initially developed in English. As German is one of the four national languages in Switzerland and the main one in the region of Zurich, a translated version of the questionnaire was required for the present study. The translation of the original questionnaire was executed following the principles and methods of good practice for the translation process for instruments of nursing research and nursing practice, which helped prove its accuracy and reliability (Martin et al., 2007; Wild et al., 2005). Two German and two English translators were involved in the process. One of the two translators in each group was a healthcare professional (HCP). A forward translation into German and a backward translation into English were performed, ensuring the questionnaire's main content. The content itself was partially modified to adapt it culturally. These adaptations were carried out with an expert team formed by a diabetes advisor, four nurses, and two midwives. Before starting the recruitment, a pre-test of the translated version of the GDMKQ was performed with five women. For the translated and culturally adapted GDMKQ in the presented study with 107 participants, the Cronbach's alpha was 0.67.

The sociodemographic and clinical data were retrieved from the electronic medical records. The collected sociodemographic data included age, educational level and country of origin, and the collected clinical data BMI (body mass index), birth weight, parity, gestational age at delivery, family history of DM, previous history of GDM and GDM specific treatment during pregnancy.

Procedure and ethical considerations

Data was collected between August and December 2020. Potential participants were informed that their participation was entirely voluntary. They were also given 24 hours to consider taking part in the study. After obtaining oral and written informed consent, participants were requested to complete the GDMKQ, either in German or English, during their hospitalisation period. Informed consents and questionnaires were collected by the first author and stored in a sealed container.

Statistical analysis

Analyses were completed using the Statistical Package for the Social Sciences, version 27. Descriptive statistics included frequency and percentage tables for categorical data. Mean, standard deviation, and range values were used for the total GDMKQ score, each domain's individual score, and further metric variables. To determine the association of sociodemographic and clinical characteristics with the GDMKQ scores, either the Mann-Whitney U test (for two independent samples) or the Kruskal-Wallis test (for more than two independent samples) were employed. Non-parametric tests were used due to the lack of normal distribution of the dependent variable. Normal distribution was checked with the Shapiro-Wilk test. A p-value $< .05$ was considered to be statistically significant. A Bonferroni post hoc adjustment was performed for pairwise group comparisons if a significant difference was obtained by using Kruskal-Wallis tests.

Results

Out of 141 women diagnosed with GDM during the recruitment period, 20 did not meet the inclusion criteria and 121 were invited to participate in the study. Of all 121 women, 14 declined to participate. Ultimately, a total of 107 consented. The recruitment flowchart with more detailed information about the excluded participants and these who declined to participate is presented in Figure 1.

Sociodemographic characteristics

Women in this study were between 24 and 45 years old, their mean age being 34.3 years ($SD \pm 4.38$). The majority of the women were married or living in a partnership ($n = 79$, 72.9%). All 31 women (29%) with secondary educational level had completed an apprenticeship. Based on their country of origin, 60% ($n = 39$) of migrant women and 50% ($n = 21$) of Swiss women had an academic degree. Of the 42 migrant women coming from European countries, 4.8% ($n = 2$) were Northern European, 33.3% ($n = 14$) Western European, 31% ($n = 13$) Eastern European and 31% ($n = 13$) Southern European. The detailed women's sociodemographic characteristics are presented in Table 1.

Clinical characteristics

The mean BMI was 25.4 ($SD \pm 4.9$). Of the 22 women with a BMI over 30 kg/m^2, 40.9% ($n = 9$) had a previous history of GDM. In terms of parity, among the 16 women in the group of three or more births, only 1.9% ($n = 2$) had given birth four times, which was the maximum. The means of gestational age at delivery and of birth weight were 37.6 weeks ($SD \pm 2.44$) and 3082.4 grams ($SD \pm 638.01$), respectively. Birth weight ranged between 1130 and 4480 grams. Seven women delivered twins between the 32nd and 35th week of gestation, and all these newborns had a low birth weight. Of the mothers of the three newborns with high birth weight, only one (33.3%) had a previous history of GDM. Of the 31 women with insulin therapy, 29% ($n = 9$) had a previous history of GDM and 45.2% ($n = 14$) had a family history of DM. The women's clinical characteristics are presented in Table 2.

GDM knowledge status

To complete the questionnaire, 80.4% ($n = 86$) of women preferred the German version. Out of all women, 95.3% obtained scores in the «adequate knowledge» range, and 25.2% ($n = 27$) reached the maximum score of 15. Only five women obtained scores in the "inadequate knowledge" range and scored correspondingly less well in all five domains. Women's knowledge status scores together with the scores of each domain are presented in Table 3. Amid the GDM knowledge domains, the lowest mean scores were observed in the domain «management», with 2.1 ($SD \pm 0.9$). Regarding the question referring to what to do when experiencing a hypoglycaemic reaction, 35.5% ($n = 38$) did not know or chose the wrong answer. From these women 8.5% ($n = 9$) were on insulin therapy and 27.4% ($n = 29$) underwent lifestyle modifications during pregnancy. When asked about the most common sign of hyperglycaemia, out of the 31 women with insulin therapy, 12.9% ($n = 4$) chose the wrong answer, and 19.4% ($n = 6$) did not know it. Most of the women ($n = 100$) knew that they had

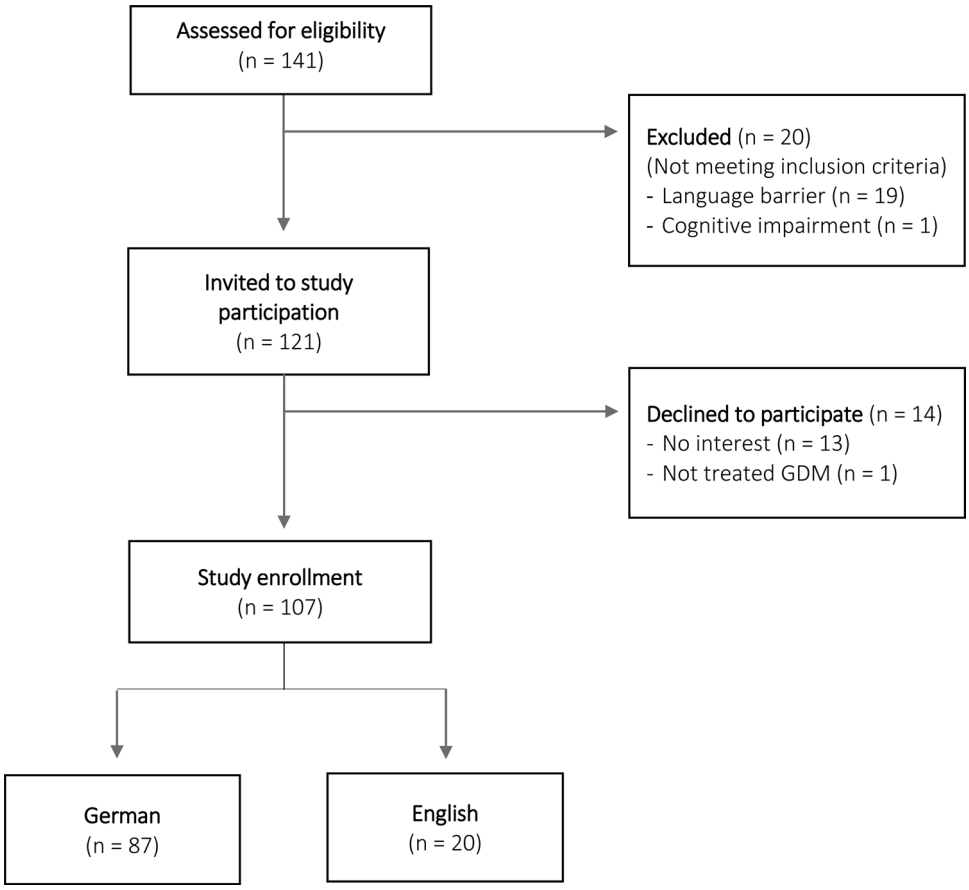

Figure 1. Recruitment flowchart.

Table 1
Sociodemographic characteristics (incl. classification depending on knowledge status).

	Total N = 107	Adequate knowledge status[1] n = 102	Inadequate knowledge status[2] n = 5
Characteristic	n (%)	n (%)	n (%)
Age			
18-34 years	53 (49.5)	49 (48)	4 (80)
≥ 35 years	54 (50.5)	53 (52)	1 (20)
Marital status			
Single	24 (22.4)	23 (22.5)	1 (20)
Married/partnership	79 (73.8)	75 (73.5)	4 (80)
Divorce/separated	4 (3.7)	4 (3.9)	0
Widowed	0	0	0
Educational level			
None	0	0	0
Primary education	16 (15)	14 (13.7)	2 (40)
Secondary education	31 (29)	29 (28.4)	2 (40)
Higher education	60 (56.1)	59 (57.8)	1 (20)
Country of origin			
Swiss national	42 (39.3)	41 (40.2)	1 (20)
Migrant	65 (60.7)	61 (59.8)	4 (80)
Continent of origin	***n* = *65***	***n* = *61***	***n* = *4***
Europa	42 (64.6)	40 (65.6)	2 (50)
Africa	3 (4.6)	3 (4.9)	0
United States	1 (1.5)	1 (1.6)	0
South America	4 (6.2)	3 (4.9)	1 (25)
Asia	15 (23.1)	14 (23)	1 (25)

N = Population size, n = sample
[1] Adequate knowledge: ≥ 9
[2] Inadequate knowledge: ≤ 8

Table 2
Clinical characteristics (incl. classification depending on knowledge status).

Characteristic	Total N = 107 n (%)	Adequate knowledge status[1] n = 102 n (%)	Inadequate knowledge status[2] n = 5 n (%)
BMI before pregnancy	***n = 101***	***n = 97***	***n = 4***
Underweight (BMI < 18.4)	2 (2)	2 (2.1)	0
Normal weight (BMI 18.5 - 24.9)	51 (50.5)	48 (49.5)	3 (75)
Overweight (BMI 25 - 29.9)	26 (25.7)	25 (25.8)	1 (25)
Adiposity (BMI ≥ 30)	22 (21.8)	22 (22.7)	0
Birth weight			
Low birth weight (< 2499 g)	20 (18.7)	19 (18.6)	1 (20)
Normal birth weight (2500 - 3999 g)	84 (78.5)	80 (78.4)	4 (80)
High birth weight (≥ 4000 g)	3 (2.8)	3 (2.9)	0
Parity			
1	44 (41.1)	43 (42.2)	1 (20)
2	47 (43.9)	45 (44.1)	2 (40)
≥ 3	16 (15)	14 (13.7)	2 (40)
Gestational age at delivery			
≤ 36 weeks	23 (21.5)	22 (21.6)	1 (20)
≥ 37 weeks	84 (78.5)	80 (78.4)	4 (80)
Family history of DM			
Yes	34 (31.8)	32 (31.4)	2 (40)
No	73 (68.2)	70 (68.6)	3 (60)
Previous history of GDM			
Yes	19 (17.8)	19 (18.6)	0
No	88 (82.2)	83 (81.4)	5 (100)
GDM therapy	***n = 106***	***n = 101***	
Lifestyle modification	75 (70.8)	73 (72.3)	2 (40)
Insulin	31 (29.2)	28 (27.7)	3 (60)

N = Population size, n = sample
[1] Adequate knowledge: ≥ 9
[2] Inadequate knowledge: ≤ 8

to reduce the consumption of food with high content of carbohydrates during their pregnancies. The majority of them were also aware (n = 104) that the nutritional source mainly provided by rice, bread, and pasta are carbohydrates. Yet, only 74.8% (n = 80) chose "fresh salad" as the correct answer on the question about the food that they could consume without restriction during pregnancy. On the question addressing the possible future complications, 6.5% (n = 7) of women chose the wrong answer, and 9.3% (n = 10) did not know that their condition could increase the risk of developing T2DM. Further, 95.3% (n = 102) of women were aware that due to an uncontrolled GDM, their baby could have foetal macrosomia, that is, have a birth weight over 4000 grams. However, when asked about the fact that increases the chances of developing GDM, 7.5% (n = 8) of women chose an incorrect answer, and 28% (n = 30) did not know that it could be due to previous foetal macrosomia, i.e., the previous baby had high birth weight (HBW). In this question, all 13 women who had given birth to their second child chose the correct answer, as well as five out of the six women who had their third pregnancy. Out of the 44 women who had had their first child, 52.3% (n = 23) were also aware of this fact.

GDM knowledge status and sociodemographic characteristics

The classification of adequate or inadequate knowledge levels according to the GDMKQ in relation to the women's sociodemographic characteristics is shown in Table 1. A Mann-Whitney U test showed no statistical difference in GDM knowledge between women of advanced maternal age and younger age. However, according to a Kruskal-Wallis test, women with primary (11.1 ± 2.2), secondary (12.5 ± 2.1), and higher (13.3 ± 1.9) educational levels differed significantly concerning their knowledge level about GDM (χ^2 (2) = 13.003, p = .002). Furthermore, the Bonferroni post hoc test showed that the significance was due to the differences between women with primary and higher education (p = .001).

Further, a Kruskal-Wallis test indicated that the knowledge level differed depending on whether women were Northern (14.5 ± 0.7), Western (13.9 ± 2), Eastern (13 ± 2.1) or Southern European (11.8 ± 2.3; χ^2 (3) = 7.900, p = .048). The Bonferroni post hoc test showed the significance was due to the differences between Western and Southern Europeans (p = .047). Comparisons between Swiss women and European migrants as well as the entire migrant women group revealed no statistically significant differences. Details are presented in Table 4.

GDM knowledge status and clinical characteristics

The classification of adequate or inadequate knowledge levels according to the GDMKQ in relation to the women's clinical characteristics is shown in Table 2. Knowledge level proved to only significantly differ if women had a previous history of GDM or not. However, based on a Mann-Whitney U test, women diagnosed with GDM in earlier pregnancies obtained a higher score (13.6 ± 1.9) compared to women diagnosed with GDM for the first time (12.5 ± 2.2; Z = − 2.278, p = .023). Details are presented in Table 5.

GDM knowledge domains and sociodemographic characteristics

Differences on the knowledge status depending on women's educational level proved to be significant in the domains «basic knowledge» (χ^2 (2) = 10.707, p = .005), «risk factors» (χ^2 (2) = 14.297, p = .001), and «complications and outcomes» (χ^2 (2) = 13.821, p = .001). The Bonferroni post hoc test showed, both in the domains «basic knowledge» (p = .003) and «risk factors» (p = .001), that the significance was due to the differences between women with primary and higher educational levels. However, in the domain «complications and outcomes», the Bonferroni post hoc test showed that the significance was due to the differences between women with primary and higher educational levels

Table 3
Knowledge status scores (total and domains).

		Knowledge status	
	Total N = 107 M ± SD	Adequate n = 102 M ± SD	Inadequate n = 5 M ± SD
Total score			
GDMKQ	12.7 ± 2.2	12.9 ± 1.9	7.6 ± 0.5
Scores of knowledge domains[1]			
Basic knowledge about GDM	2.8 ± 0.4	2.8 ± 0.3	1.6 ± 0.5
Knowledge about risk factors	2.3 ± 0.9	2.4 ± 0.9	1.4 ± 0.5
Knowledge about diet and food values	2.6 ± 0.6	2.7 ± 0.5	1.8 ± 0.4
Knowledge about management of GDM	2.1 ± 0.9	2.2 ± 0.9	1.2 ± 0.8
Knowledge about complications and outcomes	2.8 ± 0.5	2.8 ± 0.4	1.6 ± 0.9

N = Population size, n = sample, M = mean, SD = standard deviation
[1] Scale: 0 – 3 (= all correct)

Table 4
Differences between GDM knowledge status and sociodemographic characteristics.

		Total	GDM knowledge status		
		N = 107			
Characteristic	**Categories**		**M ± SD**	**Test Statistic**	**p-value**
Age	18-34 years		12.4 ± 2.3	− 1.239[1]	.215
	≥ 35 years		13 ± 2		
Educational level	Primary education		11.1 ± 2.2	130.032,30[2]	**.002**[3]
	Secondary education		12.5 ± 2.1		
	Higher education		13.3 ± 1.9		
Country of origin	Swiss national		12.9 ± 2.1	− 0.634[1]	.526
	Migrant		12.6 ± 2.2		
European migrants (origin)		***n* = *42***			
	Northern Europe	2 (4.8)	14.5 ± 0.7	79.002,40[2]	**.048**[4]
	Western Europe	14 (33.3)	13.9 ± 2		
	Eastern Europe	13 (31)	13 ± 2.1		
	Southern Europe	13 (31)	11.8 ± 2.3		

N = Population size, n = sample, M = mean, SD = standard deviation
[1] Mann-Whitney U test
[2] Kruskal-Wallis test, effect sizes (*Cohen's f*) = .37[3], .39[4]

Table 5
Differences between GDM knowledge status and clinical characteristics.

		GDM knowledge status		
Characteristic	Categories	M ± SD	Test Statistic	p-value
Family history of DM	Yes	12.2 ± 2.3	− 1.566[5]	.117
	No	12.9 ± 2.1		
Parity	1	12.6 ± 2.1	3.340[6]	.188
	2	13.1 ± 1.9		
	≥ 3	11.8 ± 2.7		
Previous history of GDM	Yes	13.6 ± 1.9	− 2.278[5,7]	**.023**
	No	12.5 ± 2.2		
GDM therapy	L.M.[1]	12.9 ± 2.1	− 0.842[5]	.400
	Insulin	12.3 ± 2.4		
Birth weight	LBW[2]	13.1 ± 1.9	0.981[6]	.612
	NBW[3]	12.6 ± 2.2		
	HBW[4]	13.3 ± 2.9		

N = Population size, n = sample, M = mean, SD = standard deviation
[1] Lifestyle modifications
[2] Low
[3] normal, and
[4] high birth weight
[5] Mann-Whitney U test
[6] Kruskal-Wallis test, effect sizes (*Cohen's f*) = .55[7]

(p = .022) and between secondary and higher educational levels (p = .004). Further, in the domain «risk factors», knowledge level had a statistical significance between Northern (3 ± 0), Western (2.8 ± 0.5), Eastern (2.5 ± 0.8) and Southern (2 ± 0.9) Europeans (χ^2 (3) = 11.074, p = .011). Based on the Bonferroni post hoc test, the difference was significant due to the differences between Western and Southern Europeans (p = .010). Out of the 25 European migrant women who had attended university, 44% (n = 11) were Western European and 24% (n = 6) Southern European. Details are presented in Table 6.

GDM knowledge domains and clinical characteristics

As a Mann-Whitney U test showed the knowledge status about risk factors proved to be statistically different between women diagnosed with GDM in previous pregnancies and those affected by

Table 6
Differences between GDM knowledge domains and sociodemographic characteristics.

		Basics		Risk factors		Food and diet		Management		Complications	
Characteristic	**Categories**	**M ± SD**	**p-value**	**M ± SD**	**p-value**	**M ± SD**	**p-value**	**M ± SD**	**p-value**	**M ± SD**	**p-value**
Age	18-34 years	2.7 ± 0.5	.382[5]	2.2 ± 0.9	.247[5]	2.6 ± 0.6	.390[5]	2.1 ± 0.9	.973[5]	2.7 ± 0.6	.196[5]
	≥ 35 years	2.8 ± 0.3		2.4 ± 0.8		2.7 ± 0.4		2.1 ± 0.9		2.8 ± 0.3	
Educational level	Primary	2.4 ± 0.7	**.005**[6,7]	1.8 ± 0.9	**.001**[6,8]	2.3 ± 0.8	.055[7]	1.9 ± 0.8	.289[7]	2.6 ± 0.5	**.001**[6,9]
	Secondary	2.8 ± 0.4		2.2 ± 0.9		2.7 ± 0.5		2.2 ± 0.8		2.6 ± 0.5	
	Higher	2.9 ± 0.3		2.6 ± 0.8		2.7 ± 0.5		2.2 ± 0.9		2.9 ± 0.4	
Country of origin	Swiss national	2.8 ± 0.3	.419[5]	2.3 ± 0.9	.861[5]	2.7 ± 0.7	.164[5]	2.1 ± 0.9	.840[5]	2.8 ± 0.5	.297[5]
	Migrant	2.8 ± 0.5		2.3 ± 0.8		2.6 ± 0.5		2.1 ± 0.9		2.8 ± 0.4	
European migrants (origin)	NE[1]	3 ± 0	.374[6]	3 ± 0	**.011**[6,10]	2.5 ± 0.7	.903[6]	3 ± 0	.062[6]	3 ± 0	.070[6]
	WE[2]	2.9 ± 0.3		2.8 ± 0.5		2.7 ± 0.5		2.5 ± 0.9		2.9 ± 0.3	
	EE[3]	2.7 ± 0.5		2.5 ± 0.8		2.6 ± 0.5		2.3 ± 0.9		2.8 ± 0.4	
	SE[4]	2.8 ± 0.4		2 ± 0.9		2.7 ± 0.5		1.8 ± 0.9		2.5 ± 0.5	

M = mean, SD = standard deviation
[1] Northern
[2] Western
[3] Eastern, and
[4] Southern European women
[5] Mann-Whitney U test
[6] Kruskal-Wallis test, effect sizes (*Cohen's f*) = .31[7], .31[8], .32[9], .53[10]

Table 7
Differences between GDM knowledge domains and clinical characteristics.

		Basics		Risk factors		Food and diet		Management		Complications	
Characteristic	**Categories**	**M ± SD**	**p-value**	**M ± SD**	**p-value**	**M ± SD**	**p-value**	**M ± SD**	**p-value**	**M ± SD**	**p-value**
Family history DM	Yes	2.8 ± 0.4	.653[5]	2.1 ± 0.9	**.012**[5,6]	2.5 ± 0.7	.349[5]	2.2 ± 0.9	.797[5]	2.7 ± 0.6	.205[5]
	No	2.8 ± 0.5		2.5 ± 0.8		2.7 ± 0.4		2.1 ± 0.9		2.8 ± 0.4	
Parity	1	2.8 ± 0.4	.071[8]	2.1 ± 1	0.55[8]	2.7 ± 0.5	.700[8]	2.2 ± 0.9	.272[8]	2.7 ± 0.4	.063[8]
	2	2.8 ± 0.4		2.5 ± 0.8		2.6 ± 0.5		2.2 ± 0.9		2.8 ± 0.5	
	≥ 3	2.5 ± 0.6		2.3 ± 0.8		2.5 ± 0.8		1.8 ± 0.9		2.6 ± 0.5	
Previous GDM	Yes	2.9 ± 0.3	.353[5]	2.8 ± 0.5	**.010**[5,7]	2.7 ± 0.4	.588[5]	2.3 ± 1	.253[5]	2.9 ± 0.3	.268[5]
	No	2.8 ± 0.5		2.2 ± 0.9		2.6 ± 0.6		2.1 ± 0.9		2.7 ± 0.5	
GDM therapy	L.M.[1]	2.8 ± 0.4	.356[5]	2.4 ± 0.8	.110[5]	2.7 ± 0.5	.099[5]	2.1 ± 0.9	.384[5]	2.8 ± 0.5	.673[5]
	Insulin	2.7 ± 0.6		2.1 ± 0.9		2.5 ± 0.7		2.2 ± 0.9		2.8 ± 0.4	
Birth weight	LBW[2]	2.9 ± 0.3	.396[8]	2.2 ± 0.9	.713[8]	2.7 ± 0.5	.983[8]	2.4 ± 0.8	.285[8]	2.8 ± 0.4	.839[8]
	NBW[3]	2.7 ± 0.5		2.3 ± 0.9		2.6 ± 0.6		2.1 ± 0.9		2.8 ± 0.5	
	HBW[4]	3 ± 0		2.7 ± 0.6		2.7 ± 0.6		2.3 ± 1.1		2.7 ± 0.6	

M = mean, SD = standard deviation
[1] Lifestyle modifications
[2] Low
[3] normal, and
[4] high birth weight
[5] Mann-Whitney U test, effect sizes (*Cohen's f*) = .47[6], .82[7]
[8] Kruskal-Wallis test

it for the first time. The former obtained a higher score (2.8 ± 0.5) than the latter (2.2. ± 0.9; $Z = -2.585$, $p = .010$). Furthermore, the difference in knowledge level about risk factors demonstrated a statistical difference between women who had direct family members with DM and those who did not have them. The latter obtained a higher score (2.5 ± 0.3) than the one (2.1± 0.9) reached by women with a family history of DM ($Z = -2.505$, $p = .012$). Of the 73 women with no family history of DM, 45.2% ($n = 33$) had a BMI of 25 kg/m^2 and above. Details are presented in Table 7.

Discussion

To the authors' knowledge, this is the first study evaluating the knowledge status of GDM in reference, among others, to its aetiology, risk factors, and management among affected women in Switzerland. Furthermore, this work associates women's sociodemographic as well as clinical characteristics with their knowledge level about this condition.

Four important findings emerge from this study. First, it indicates that the knowledge level regarding GDM among women attending the considered hospital is very high, given that 95% of women displayed adequate knowledge and the average of total scores was over 80%. This could suggest that women received sufficient information, advice, and guidance during their pregnancies from diabetes advisors and nutritionists. Our findings differed from the aforementioned study results, probably since most of these studies included rural areas or populations with multiple ethnicities (Alharthi et al., 2018; Bhavadharini et al., 2017; Ge et al., 2016). This study was conducted in an urban environment, providing a questionnaire in English in addition to the German version, and the majority of participants had a higher educational level. All these factors could also explain why the participants' knowledge status was higher. Comparing the different domains, women scored the lowest on the management of GDM itself. Women who underwent lifestyle modifications appeared to be less knowledgeable about managing the onset of hypoglycaemic symptoms than those who had insulin therapy. Nevertheless, almost the third of women with insulin therapy were not aware of the most common sign of hyperglycaemia. A study revealed that time constraint was possibly the main difficulty encountered by women in the self-management of

GDM due to the need of an immediate therapy after being diagnosed (Carolan et al., 2012), which could explain why women in this study were not familiar with every aspect of their condition. These results could also imply that these women might not have experienced a hypoglycaemic or hyperglycaemic episode during their pregnancies and, therefore, were less conscious of the exact signs and symptoms. Eades et al. (2018) suggest that after experiencing a diabetes-related symptom-free pregnancy, women could be less aware of the severity of their condition. However, even if some women can easily control their condition and have good glycaemic values during and after pregnancy, the importance of education to properly manage their condition, regardless of whether it is treated with insulin or lifestyle modifications, is highlighted by the present study's results. Further, although women obtained high scores in the domain about diet and food values, the majority of women showed more awareness about the food containing carbohydrates as well as the importance of their moderate intake than the food that could be eaten without restrictions. A study showed how women who underwent lifestyle modifications during pregnancy strictly limited their carbohydrate consumption to avoid insulin therapy (Hui et al., 2014). The fear of going on insulin treatment and not maintaining good glycaemic values in both women with exclusively nutrition or insulin therapy could explain their strong awareness about the dietary restrictions over the dietary allowances.

Second, the educational level seemed to be the main factor associated with the knowledge status about GDM. Differences were statistically significant, and women with academic degrees obtained better scores than those with lower educational level. This could suggest that the latter have probably more difficulties understanding the information received by HCPs. Our findings correspond with other studies' results, where a higher knowledge about GDM seemed to be associated with a higher educational level (Carolan et al., 2010; Hussain et al., 2015; Park et al., 2018). Various studies demonstrate that a higher educational level is also related to better health literacy (HL) (Bailey et al., 2014; Berkman et al., 2011; Kim and Lee, 2016). Having adequate HL gains importance because it could reduce the chances of uncontrolled GDM to one-third (Pirdehghan et al., 2020). Women with higher HL levels may also be more capable of profiting from other available services aside from consultations. In this context, Kim et al. (Kim et al., 2020) investigated how patients' behaviour towards diabetes education differed depending on their HL level. Their results showed that patients with adequate HL levels were more likely to ask questions during consultations and use other resources (e.g., online services) to expand their knowledge**.** In contrast, patients with lower HL levels were hesitant during consultations and were reluctant to use online resources.

Third, women with a previous history of GDM showed a higher knowledge level, which corresponds with findings by Park et al. (2018). Women affected by this condition in previous pregnancies may be more aware of its characteristics and therefore have a better knowledge about it. According to other studies, women with a family history of DM possess a better knowledge status about GDM (Hussain et al., 2015; Thomas et al., 2020). Hussain et al. (2015) suggested that the involvement in the care of a diabetic parent might raise their understanding of this condition and better accessibility to diabetes-related information. In contradiction to their findings, no difference in the general knowledge level between women with or without a family history of DM could be observed in this study. Surprisingly, knowledge about risk factors was significantly higher among women without a family history of DM. An explanation could be that almost half of these women had a BMI of 25 kg/m^2 and above. Since a high BMI is associated with an increased risk of developing GDM (Kautzky-Willer and Winzer, 2002; Lin et al., 2016), women with a BMI above the normal range may receive more information from obstetricians about risk factors than other women. Coinciding with other study results (Neufeld, 2011; Sharma et al., 2019), women in this study were less aware of their increased risk of developing T2DM in the future due to GDM. This perception could be triggered if women feel that their condition is limited to the pregnancy period (Sharma et al., 2019). Consequently, women would not maintain lifestyle changes postpartum, as they either might consider that the risk for their unborn child does not longer exist (Nielsen et al., 2015) or if their concern shifts after birth towards their baby's health over their own one (Chang et al., 2014; Neufeld, 2011). Further, having insulin therapy could increase women's perception of the gravity of their condition (Draffin et al., 2016). However, our study results showed similar results regarding the knowledge about complications and outcomes in both women with insulin and lifestyle modification treatments. The fact that women in this study had better understanding of the complications for the babies may be a consequence of women's tendency to focus on their children's wellbeing rather than their personal one (Devsam et al., 2013; Parsons et al., 2014).

Fourth, the knowledge level of migrant women proved to be very similar to the one of Swiss women. Including women's country of origin in the study was considered to evaluate a possible difference in the knowledge level between Swiss and migrant women, as an influence was anticipated based on the results of another study (Borgen et al., 2019). On the contrary, migrant women proved to also to have adequate knowledge about GDM. This could be explained by the fact that most migrant participants had a higher educational level. These findings correspond with a bulletin of the Swiss Federal Statistical Office (Bundesamt für Statistik, 2020), which reported a progressive increase in the number of migrants with a higher educational level in Switzerland in the last decade. A further reason could be the exclusion of women who were not fluent in either German or English from this investigation. Being a non-native speaker appeared to be linked to a lower knowledge status about GDM (Borgen et al., 2019). Usually, these women are more challenged to understand the information related to their health provided by HCPs, due to the language barrier (Ikhilor et al., 2017). The results also indicate a significant difference between the knowledge level of Western and Southern European women. This could be related to the distribution of educational levels among the participants from European countries in this study, where the share of a higher level of education was lower among Southern European women.

Strengths and limitations

This study employed the translated and culturally adapted version of the GDMKQ, which facilitated the systematic assessment of the knowledge status about GDM. The Cronbach's alpha of 0.67 indicated an adequate internal consistency for the translated and culturally adapted version of the GDMKQ used in this study. Distributing the questionnaire in both German and English enabled the collection of a diverse sample. Participants' characteristics varied in educational level and country of origin as well as previous history of GDM, family history of DM, and GDM therapy. Further, contacting participants to complete unanswered questions or limit their choice to a single possible answer contributed to avoiding data loss.

However, the limitations of the study should be accounted for in the interpretations of the results. First, the translated GDMKQ was not validated. Second, the small number in the inadequate knowledge group did not allow to perform multivariate analyses, which should be taken into account in further research to consider potential correlations between factors like age, migration background, country of origin, and educational level. Third, out of the

141 women with a GDM diagnosis during the recruitment period, 19 could not participate in the study due to an existing language barrier. Having the option to include them in the study could have added additional details about the possible differences in knowledge status between non-native speakers and women with fluency in German or English. Forth, since a single hospital was surveyed, the findings in this study are not generalizable. Nevertheless, it provides valuable initial insight and opens the door to further research on the topic.

Implications of findings

Building on the knowledge of this work and previous study findings, women with lower educational levels and, consequently, lower HL levels will probably encounter more difficulties to gain sufficient knowledge to understand their condition. Following the recommendations of the NICE guidelines for T2DM patient education (National Institute for Health and Care Excellence (NICE) 2015), HCPs should adopt different approaches when advising women with varying HL levels. In contrast, patients with low HL levels prefer using easy jargon by HCPs, repetition of information, and having enough time during consultations, whereas patients with better HL levels expect to get more detailed information about their condition (Howe et al., 2015). Therefore, it is necessary to adapt consultations to each woman's individual needs and avoid a one-size-fits-all approach to diabetes education interventions (Coates, 2018; Fisher et al., 2014; Gray and Threlkeld, 2019). This could be achieved by making an individual assessment of the existing knowledge about GDM and women's dietary and lifestyle habits during the first consultation. By first assessing the information needs of each woman, the complexity of the provided information could be adjusted according to their HL levels. Using different techniques, such as the use of common words, the limitation of the number of new concepts, the repetition of important points, and the use of the teach-back method (Kim and Lee, 2016) could enable a clear understanding of the given information among women with lower HL levels. Visual material (e.g., portion plate pictures) could also be included to support the verbal information. Additionally, women's food choices should be taken into consideration for diet plans or recommendations to avoid malnutrition during pregnancy (Hui et al., 2014) or non-adherence to diet modifications before (Hui et al., 2014) and after giving birth (Dickson and Buchmann, 2020). Addressing women's individual habits could allow a more personalised advice and thus motivate diet and lifestyle changes based on their particular situation. As a result of knowledge gain, their self-management and self-efficacy may also be improved (Viswanath and Jose, 2014). Furthermore, providing GDM education to all pregnant women should also be considered. Research generally focuses on how the knowledge level among affected women could be improved (Aluş Tokat et al., 2016; Carolan-Olah, 2016; Evert, 2006; Minschart et al., 2020; Petkova, 2011). However, 82.2% of women in this study had no previous history of GDM. To prevent a further increase in the future prevalence of GDM, all pregnant women, regardless of being affected, should be provided with information about this pregnancy complication. Additionally, since some women may believe that GDM remits after birth, the maintenance of a healthy lifestyle should be emphasised by HCPs to prevent the development of GDM in successive pregnancies and T2DM later in life.

For the future utilization of the translated and culturally adapted GDMKQ as an instrument, its validation is needed to confirm how effectively it measures women's knowledge level about GDM (Polit & Beck, 2017). Furthermore, considering the cultural diversity, further research is suggested to evaluate non-native speakers' knowledge status about this condition in Switzerland. Such research will enable the understanding of possible knowledge deficits and needs, allowing HCPs to provide more meaningful support to these women.

Conclusions

This study has underlined that, even if women overall have an adequate knowledge status about GDM, their educational level plays a role in the deficit of understanding of their condition. Therefore, HCPs in charge of providing information to affected women need to consider their HL levels to better address their needs during consultations. Additionally, patient education should not exclusively be meant for affected populations and, therefore, all pregnant women should be informed about this condition. Further research needs to be conducted to evaluate non-native speakers' knowledge status and identify how they can be best advised and supported. This will allow HCPs to also integrate a culturally adapted approach, tailor the consultations to each woman's needs and thus enhance the quality of care.

Ethical approval and consent to participate

The project did not fall within the scope of the Swiss Human Research Act and therefore did not require the approval of the Ethics Committee for its execution. This was confirmed by the responsible Cantonal Ethics Committee Zurich, Switzerland (KEK-ZH-Nr: 2020-01980).

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CRediT authorship contribution statement

Aroa Gomez Gonzalez de Langarica: Conceptualization, Project administration, Formal analysis, Data curation, Writing – original draft. **Hannele Hediger:** Conceptualization, Formal analysis, Writing – review & editing. **Barbara Meier Kaeppeli:** Conceptualization, Writing – review & editing. **Anita Keller-Senn:** Supervision, Conceptualization, Methodology, Writing – review & editing.

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Supplementary materials

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