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Rising trends in the incidence of shoulder dystocia and
development of a novel shoulder dystocia risk score tool : a
nationwide population-based study of 800 484 Finnish deliveries

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**TITLE: Rising Trends in the Incidence of Shoulder Dystocia and Development of a Novel
Shoulder Dystocia Risk Score Tool: a Nationwide Population-Based Study of 800 484 Finnish
Deliveries**

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1 **Conflict of interest**

2 The authors have no conflicts of interest to disclose.

3

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1 ABSTRACT

2 **Introduction:** Shoulder dystocia has remained an unpredictable and feared emergency in obstetrics.
3 Some risk factors have been identified, but nevertheless there is a lack of risk evaluation tools in
4 clinical practice. The aim of this study was to evaluate the incidence and risk factors of shoulder
5 dystocia in the Finnish population, and to develop a shoulder dystocia risk score tool.

6 **Material and methods:** This retrospective, population-based study included all deliveries in
7 Finland between 2004 and 2017 ($n = 800\,484$). The annual numbers of shoulder dystocia diagnoses
8 were gathered from nationwide Finnish Medical Birth Register and Hospital Discharge Register.
9 The incidence of shoulder dystocia was calculated in subgroups according to the mode of delivery,
10 maternal diabetes status, BMI, age, parity, and gestational age. Based on these numbers, a shoulder
11 dystocia risk score tool was created.

12 **Results:** The overall incidence of shoulder dystocia was 0.18%. It increased significantly during the
13 study period from 0.10% to 0.32% ($P < 0.001$). More specifically, the incidence increased
14 significantly in all analyzed subgroups except for women with BMI < 18.5 or age < 20 years. To
15 evaluate the importance of risk factors, practical and simple shoulder dystocia risk score tool was
16 created. Instrumental vaginal delivery, maternal diabetes of any kind, BMI ≥ 25 , age ≥ 40 years, and
17 gestational age ≥ 41 weeks were associated with higher shoulder dystocia risk compared to non-
18 diabetic, non-obese, and younger women with spontaneous deliveries before 41 weeks of gestation.
19 In our risk score tool, cases with shoulder dystocia had significantly higher risk points than those
20 without it (15.2 vs 10.4, $P < 0.001$). The risk was significantly high, when the points were ≥ 18 (RR
21 9.54, CI 8.61-10.57).

22 **Conclusions:** The incidence of shoulder dystocia in Finland increased during the study period, but
23 it is still low compared to previous studies from other countries. In clinical daily practice, the new
24 shoulder dystocia risk score tool helps to evaluate the individual risk profile of the parturient.
25 According to this risk score tool, the highest risk was achieved with the combination of instrumental
26 vaginal delivery, maternal diabetes, BMI ≥ 25 , age ≥ 40 years, and gestational age ≥ 41 weeks.

27

28

1 **Keywords**

2 Shoulder dystocia, incidence, risk factors, risk score tool, instrumental vaginal delivery, maternal
3 diabetes, obesity.

4

5 **Abbreviations**

6 IVD Instrumental vaginal delivery

7 ICD-10 International Statistical Classification of Diseases and Related Health Problems 10th
8 Revision

9 DM maternal diabetes mellitus

10 BMI body mass index

11 GDM gestational diabetes mellitus

12 CS cesarean section

13 ROC receiver operating characteristic

14

15 **Key message**

16 The incidence of shoulder dystocia increases in Finland. Instrumental vaginal delivery, age ≥ 40
17 years, maternal obesity, maternal diabetes, and gestational age ≥ 41 weeks were associated with
18 higher risk for shoulder dystocia. Shoulder dystocia risk score tool allows individual risk
19 assessment.

1 INTRODUCTION

2 Shoulder dystocia is a rare but feared obstetric emergency. It is defined as a vaginal delivery, which
3 requires additional obstetric maneuvers to deliver fetal shoulders after the head has been delivered.¹
4 This is a broad definition, and diagnosis of shoulder dystocia typically depends on clinical
5 subjective assessment. This leads to varying incidences and makes comparison of incidences
6 between areas and countries challenging. The incidence of shoulder dystocia varies widely between
7 0.1% and 3.0% in the literature.^{2,3}

8 Shoulder dystocia is generally regarded as a highly unpredictable complication, but some risk
9 factors have been identified, including fetal macrosomia and maternal diabetes and obesity.⁴⁻⁸
10 Instrumental vaginal delivery (IVD) has been linked to a higher risk of shoulder dystocia in some
11 earlier studies.^{6,9,10} However, the predictive values of separate risk factors are quite poor, and in
12 most cases shoulder dystocia occurs without any known risk factors.

13 Shoulder dystocia causes considerable morbidity, and typical maternal complications include
14 perineal lacerations and increased hemorrhage.¹¹ The most common neonatal complications of
15 shoulder dystocia include clavicle fracture and transient or permanent brachial plexus injury, but at
16 its worst it can cause asphyxia, hypoxic ischemic encephalopathy, and fetal death.¹¹

17 The incidence of shoulder dystocia is unknown in Finland. Moreover, there is a lack of practical
18 tools for clinicians to estimate the risk of shoulder dystocia in clinical daily practice. The aims of
19 this study were to study the incidence of shoulder dystocia and its trends in Finland, to identify
20 potential risk factors, and to provide a risk evaluation tool for obstetricians.

21

22 MATERIAL AND METHODS

23 We designed a register-based cohort study based on data from the Finnish Medical Birth Register
24 and the Hospital Discharge Register in 2004–2017. These registers are maintained by the Finnish
25 Institute for Health and Welfare (THL). It is obligatory to report all live births and stillbirths with a
26 gestational age of ≥ 22 weeks or a birth weight of ≥ 500 grams to the Finnish Medical Birth Register
27 using a standardized form. The Hospital Discharge Register collects information on all hospital
28 inpatient and outpatient care episodes. This nationwide register data includes all deliveries in
29 Finland during the study period. The good data quality of the registers has been verified
30 previously.^{12,13}

31

Shoulder dystocia cases were found by searching for International Statistical Classification of Diseases and Related Health Problems 10th Revision (ICD-10) code O66.0 (Obstructed labor due to shoulder dystocia) among all deliveries in Finland during 2004–2017 ($n = 800\,484$) in the Medical Birth Register and the Hospital Discharge Register. We also searched for codes P13.4 (Fracture of clavicle due to birth injury), P14.0 (Erb's palsy due to birth injury), and P14.1 (Klumpke's palsy due to birth injury) among the children in the Medical Birth Register (until the age of seven days) and the Hospital Discharge Register (until the age of one year). Shoulder dystocia cases were sorted by the mode of delivery, maternal diabetes (DM) status, age, body mass index (BMI), gestational age, and parity, and incidences of the shoulder dystocia in these subgroups were calculated.

To evaluate the risk of shoulder dystocia we developed a shoulder dystocia risk score tool based on the same register data to help in evaluating individual shoulder-dystocia risk at any time before and during the labor and delivery. Singleton and multifetal live births were included ($n = 809\,721$, Table 1). The mode of delivery included only spontaneous vaginal deliveries and IVD. Cesarean sections (CS) ($n = 137\,753$) were excluded. We studied six variables in our model (maternal DM status, age, BMI, gestational age, parity, and mode of delivery), each of which was divided into different subcategories (Table 2). These categories were considered as separate risk factors and individual risk points were calculated for each of them using incidence data of this study. Overweight parturients were evaluated in more detail. The individual risk values were calculated separately for three subclasses of overweight parturients (BMI 25–29.9, BMI 30–34.9, and BMI ≥ 35). Maternal diabetes includes parturients with gestational diabetes (GDM) and parturients with type 1 or 2 diabetes. Parity was not included in the final risk score tool, because there was no significant difference in the incidences of shoulder dystocia between nulliparous and multiparous women.

The general risk to experience shoulder dystocia was calculated in separate risk factor groups to control for the annual variation in the risk (Table 2). For example, there were altogether 595 892 spontaneous vaginal deliveries and 589 shoulder dystocia cases among them in 2004–2017. Thus, the average risk of shoulder dystocia was 0.1% ($589/595\,892$) in spontaneous vaginal delivery group during the 14-year study period. Next, each individual risk was divided with the lowest risk (which was in the group BMI < 18.5) to obtain the integer numbers for risk values. The sums of separate risk points were calculated in all possible combinations of the risk factors to establish different risk profiles. For simplification, gestational age was not directly added to the risk score table, but it is taken into consideration when calculating the woman's individual risk.

We analyzed general trends among parturients during the study period and found out that distribution of deliveries between the different modes of delivery, DM status, BMI classes, and age

groups changed during the study period in Finland. The proportion of IVD (7.0% vs 9.4%, $P < 0.001$) and the prevalence of parturients with GDM (7.6% vs 16.8%, $P < 0.001$) and type 1 or 2 diabetes (0.6% vs 1.0%, $P < 0.001$) increased significantly between 2004 and 2017 (Table 1) as well as the numbers of overweight (BMI ≥ 25) parturients (33.0% vs 37.6%, $P < 0.001$) and parturients aged ≥ 40 years (3.8% vs 4.5%, $P < 0.001$) (Table 1). The proportion of nulliparous women declined (42.2% vs 40.9%, $P < 0.001$) and the use of oxytocin during labor decreased significantly during the study period (48.9% vs 42.4%, $P < 0.001$). The proportion of infants with birthweight ≥ 4000 g (18.6% vs 16.7%, $P < 0.001$) and ≥ 4500 g (3.0% vs 2.4%, $P < 0.001$) declined. The proportion of postterm deliveries (gestational age ≥ 42 weeks) decreased from 4.8% to 3.5% ($P < 0.001$). Mean gestational age did not change (39.71 weeks vs 39.69 weeks, $P = 0.97$). The portion of large for gestational age infants decreased from 3.1% to 2.9% ($P = 0.012$). The CS rate remained unchanged (17.2% vs 17.2%, $P = 0.79$) (Table 1).

13 **Statistical analyses**

14 The test for relative proportions for two samples and the Chi-square test were used to test the
15 statistical significance of the changes in the incidences during the study period. Fisher's exact test
16 was used, if the requirements for the Chi-square test were not fulfilled. Student's t-test was used to
17 compare means. We performed logistic regression analyses for each factor of risk score model
18 adjusted for the year in question. A receiver operating characteristic (ROC) curve was constructed
19 to test diagnostic performance of risk score tool. Statistical analyses were performed using IBM
20 SPSS Statistics software (version 25) and Microsoft Excel (version 16.0).

21 **Ethics approval**

22 Ethics approval was received from the Ethical Committee of Hospital District of Helsinki and
23 Uusimaa (HUS) before the beginning of the study (HUS/1543/2017; 18th May 2017). Due to the
24 retrospective and register-based nature of the study, no patients were contacted or otherwise
25 involved.

26

27 **RESULTS**

28 Baseline characteristics of the research data are presented in Table 1. The overall incidence of
29 shoulder dystocia was 0.18% (1467/800 484) (Table 1). Incidence tripled from 2004 to 2017
30 (0.10% vs 0.32%, Figure 1A). The rise was seen among both nulliparous and multiparous women,
31 increasing up to 0.12% and 0.20%, respectively (Figure 1A). Coincidentally, the incidences of

clavicle fractures and Erb's palsies declined: from 1.43% to 0.51% and from 0.33% to 0.17%, respectively (Figure 1B). There were only 21 reported Klumpke's palsies during the 14-year timespan, and there was no significant change in its incidence.

The incidence of shoulder dystocia in different subgroups is presented in Figure 2. The incidence of shoulder dystocia more than doubled among IVD and tripled among spontaneous vaginal delivery during the 14-year timespan: from 0.67% to 1.53% ($P < 0.001$) and from 0.07% to 0.23% ($P < 0.001$), respectively (Figure 2A). Similarly, the incidence of shoulder dystocia increased both among the diabetic and non-diabetic woman (Figure 2B). With type 1 or 2 diabetes, the increase was four-fold up to 2.65% ($P = 0.040$), it was two-fold up to 0.49% ($P = 0.030$) for GDM women and almost three-fold up to 0.26% ($P < 0.001$) for non-diabetic parturients (Figure 2B).

Incidence of shoulder dystocia among women with BMI 18.5-24.9 increased 3.3-fold from 0.084% to 0.28% ($P < 0.001$) (Figure 2C). The incidence more than doubled with BMI 25 or more up to 0.42% during the study period ($P < 0.001$) (Figure 2C). The rising trends in the incidence remained, when overweight parturients were divided into subgroups: from 0.17% up to 0.45% ($P < 0.001$) with BMI 25-29.9, from 0.23% up to 0.30% ($P = 0.55$) with BMI 30-34.9, and from 0.26% to 0.43% ($P = 0.39$) with BMI ≥ 35 . When we analyzed different age groups, most of the shoulder dystocia cases were seen among women aged 20–39 years, where the incidence increased three-fold in this group (from 0.11% to 0.31%, $P < 0.001$) (Table 1, Figure 2D). There was a rising trend in the incidence among the parturients aged at least 40 years (Figure 2D) and its highest value was 0.53% in 2017 ($P = 0.026$).

Figure 3 shows a rising trend in the incidence of shoulder dystocia with increasing gestational age. The highest incidence (0.30%) was observed, when gestational age was completed 42 weeks or more (Figure 3). The increase in incidence became statistically significant, when gestational age was 41 weeks or more ($P = 0.041$).

Finally, we wanted to establish the importance of different risk factors in this extensive study by using the incidence data described above. We also sought to develop a shoulder dystocia risk score tool to help clinicians to identify low- and high-risk parturients before and during the labor and delivery (Table 3). Risk points for a separate risk factor varied between 1 and 12: the lowest with BMI < 18.5 and the highest with IVD (Table 2). The risk point difference between gestational age 33-40 weeks and 41-42 weeks was one point, and therefore additional one point is added to the total sum of risk points when gestational age is 41 weeks or more (Tables 2 and 3). The highest sum was 25 points and it was achieved, when a parturient had any type of DM, her age was ≥ 40 years, her

BMI was ≥ 35 , gestational age was ≥ 41 weeks, and IVD was performed. The lowest sum (6 points) was achieved, when the parturient was non-diabetic, underweight (BMI < 18.5), < 40 years old, gestational age was < 41 weeks, and she had spontaneous vaginal delivery.

Our analyses showed that the mean sum of shoulder dystocia risk score points was significantly higher among shoulder dystocia cases than among other parturients: 15.2 (SD 5.6) vs 10.4 (SD 3.3) ($P < 0.001$). By comparing the distribution of risk score points between shoulder dystocia cases and those without, we managed to define a cut-off value for high-risk women, which was 18 points. When the sum of risk score points was 18-25, RR for having shoulder dystocia was 9.54 (CI 8.61-10.57) compared to lower sum of points. During the study period, a logistic regression for individual risk factors showed a declining risk for shoulder dystocia by time for all other factors (OR from 0.92 to 0.99) except for gestational age (OR 1.003). The ROC curve for risk score tool, as presented in Figure 4, provides c statistics 0.78, and thus this test can be considered as acceptable.

DISCUSSION

The incidence of shoulder dystocia was 0.18% among all deliveries in this study. However, the incidence increased significantly during the 14-year study period. The overall incidence in our study was clearly lower than the incidences of 0.6–3.6% reported in many earlier studies.^{4,5,9,14} As for other Nordic countries, incidence of shoulder dystocia in Sweden has been correspondingly low (0.11–0.13%)^{8,15} and slightly higher in Norway (0.73%)⁵ and in Denmark (0.76%)¹⁶. This might be due to different criteria for diagnosing shoulder dystocia. Typically, it depends on clinician's subjective assessment of the situation and not on eg objective parameters. Since our register data contains only diagnosis codes, it is impossible to know, which diagnostic criteria have been used.

The trends in the incidence of shoulder dystocia vary in the literature. Our results are consistent with some earlier studies^{4,5,16}, while others have not observed a rise in the incidences.^{5,9} In Finland, one explanation for our results could be the rising numbers of overweight and ≥ 40 years old parturients and women with gestational and pre-existing diabetes. However, rate for CS has remained between 16.5% and 17.7% for several years (Table 1). Simulation-based and hands-on training for shoulder dystocia started in Finland in 2014 (Kaijomaa M, personal communication), which might have contributed to the better recognition and reporting of shoulder dystocia and thus increasing the incidence.

1 Diagnosing shoulder dystocia requires more uniformity in the future. Typically, the use of
2 additional obstetrical maneuvers is demanded.^{1,17} Correctly diagnosed shoulder dystocia is also
3 important considering the planning of future deliveries, because previous shoulder dystocia is a
4 significant risk factor for recurrent shoulder dystocia.^{18,19} Yet, overdiagnosing would lead to
5 unnecessary CSs in subsequent deliveries.

6 Conversely, the incidences of both clavicle fracture and Erb's palsies declined significantly during
7 the study period. The declining incidence of Erb's palsies is inconsistent with the increasing
8 incidence of shoulder dystocia. The incidence of Erb's palsies in our study (0.17–0.33%) is within
9 the range of incidences in previous studies (0.1–3.3%).^{20,21} The trends in the incidences vary: both
10 rising, decreasing, or unchanged incidences have been reported.^{15,21-23} The observed decline in
11 macrosomic birthweights can partly explain the fall in the incidence of Erb's palsy in this study.
12 The increase in hands-on and simulation-based training could also lead to better treatment of
13 shoulder dystocia.

14 Of all the risk factors studied here, IVD was most strongly associated with the risk of shoulder
15 dystocia as shown previously.^{4,6,9} There are common underlying factors that predispose to shoulder
16 dystocia, but which also lead to performing IVD (eg prolonged second stage of labor or imminent
17 asphyxia). It might be that the practice of IVD has changed during the study period. At least
18 significantly more IVDs are performed today than 14 years ago (9.4% vs 7.0%). As the number of
19 increasing CSs continues to be a discussion point in all Western countries, has it become
20 unacceptable to perform CS during the second stage of labor without trying IVD first? Is there a
21 need for evaluating our obstetric practices? Nonetheless, as children's complication rates have
22 declined simultaneously, there may be no need for any emergency braking.

23 There was an apparent increasing incidence of shoulder dystocia with gestational age, which is
24 consistent with the fact that bigger babies are in a higher risk than smaller ones in developing
25 dystocia. A similar trend was reported in a large Norwegian population-based study.⁵ Even though
26 the proportion of macrosomic and large for gestational age infants declined during the study period,
27 late- or postterm infants are more likely to be bigger than those born before 41 weeks of gestation
28 and therefore more prone to shoulder dystocia without actual macrosomia.

29 Our study confirms that shoulder dystocia is associated with maternal diabetes and obesity as
30 observed in several earlier studies.^{4-8,24} High maternal age was also linked to higher risk of shoulder
31 dystocia, although some studies have not observed this association.^{5,25} It is difficult, however, to
32 estimate whether all or some of these independent risk factors are in fact confounding factors. High

maternal age together with obesity can predispose to GDM and there is also higher risk for CS during labor and delivery.²⁶ On the other hand, our novel risk score tool allows more individual risk assessment. Logistic regression analyses on individual risk factors of shoulder dystocia risk score conflicts with the fact that incidences increased in almost all subgroups. This indicates that the combination of risk factors is relevant for the risk of shoulder dystocia or there may be additional risk factors, which are not taken into account in this model.

Our novel shoulder dystocia risk score tool is freely available, simple, and quick to use, and it uses information that is usually known about the parturient. It can be used during and before labor and delivery to estimate accumulation of risk factors and to elicit differences in the parturients' risk profiles. When used during the labor and delivery, the mode of delivery is decided based on the overall situation and not only the risk score. However, the risk score helps a clinician to be more prepared for shoulder dystocia, when proceeding to IVD with a high-risk parturient. To our knowledge, there are no previous equivalent tools or risk calculators available. Daly et al.²⁷ presented a prenatal counselling program for shoulder dystocia, which used web-based algorithms, but these algorithms are not freely accessible. Furthermore, adding more variables (eg prior shoulder dystocia, pregnancy weight gain, induction of labor) into the risk score tool would provide a more accurate risk evaluation. Based on our results, we suggest that a clinician should be careful when considering IVD, if the parturient is ≥ 40 years old, obese, and diabetic. These patients are also prone to other types of obstetrical complications and therefore may benefit from a more attentive observation before and during labor and delivery. By using our data, we were able to define a cut-off value (18 points or more), which can be used to identify high-risk parturients for shoulder dystocia.

One variable in the shoulder dystocia risk score is BMI, which is calculated during the first trimester of the pregnancy. Unfortunately, it was impossible to calculate the weight gain during pregnancy, since the Finnish Medical Birth Register collects no such data. Extensive weight gain can also be an independent risk factor for shoulder dystocia.^{24,28} Our risk score tool also fails to take into account some other possible risk factors of shoulder dystocia (eg prior shoulder dystocia or macrosomia, ethnic origin, estimated fetal weight or growth profile), because this information was not included in the register data. The risk score was both developed and tested on the same data source, which can be seen as a limitation of our study.

Ideally, the risk score tool would provide a precise risk evaluation protocol to select women at the highest risk of shoulder dystocia who would most likely benefit from CS. However, elective CS has appeared as an ineffective way to prevent shoulder dystocia, at least when based on the estimated

fetal macrosomia in ultrasonography.²⁹ The estimated number of elective CS to prevent one permanent brachial plexus injury has varied between 155 and 588 in previous studies.^{29,30} Nonetheless, there may be subgroups of women who could benefit from CS more than others and it would be crucial to identify them, potentially with the help of the shoulder dystocia risk score tool. Previous studies have focused primarily on the possibility of elective CS to prevent shoulder dystocia. We think that the question could instead be whether an obstetrician attempts IVD or proceeds straight to non-elective CS, when the second stage of labor prolongs in the presence of multiple risk factors of shoulder dystocia. Nevertheless, the selection of the high-risk women must be more accurate than in previously suggested protocols^{29,30} to avoid unnecessary increase in maternal and neonatal complications associated with CS.

CONCLUSION

The incidence of shoulder dystocia is increasing in Finland, but it is lower than in most other countries. At the same time, the incidences of clavicle fracture and Erb's palsy are declining. IVD, maternal diabetes, obesity, age 40 years or more, and gestational age 41 weeks or more are associated with higher risk of shoulder dystocia compared to non-diabetic, non-obese, younger women with spontaneous deliveries and gestational age <41 weeks. The shoulder dystocia risk score tool offers a novel, freely available, simple, yet crude way to evaluate the risk of shoulder dystocia before and during labor and delivery. It helps to observe accumulation of risk factors and estimate parturients' individual risk profiles.

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Tweetable abstract

The increasing incidence of shoulder dystocia and a novel risk score tool - a Finnish population-based study

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Table 1. Baseline characteristics of the research data

Year	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	In total
Deliveries, <i>n</i>	56 878	56 960	58 158	58 025	58 925	59 918	60 422	59 384	59 039	57 728	57 019	55 007	52 870	50 151	800 484
Live births, <i>n</i> *	57 569	57 634	58 859	58 727	59 607	60 583	61 192	60 094	59 693	58 373	57 639	55 588	53 453	50 710	809 721
Shoulder dystocia, <i>n</i>	60	91	76	91	85	94	102	122	116	98	112	114	142	164	1467
DM status, <i>n</i>															
Non-diabetic	52 912	53 533	54 842	54 413	55 122	55 447	55 503	53 536	53 052	50 958	49 937	48 248	45 844	41 780	725 127
Shoulder dystocia	48	68	62	76	72	75	80	94	78	76	69	81	109	110	1098
Gestational diabetes	4344	3802	3616	3924	4081	4687	5228	6108	6171	6924	7186	6893	7140	8440	78 544
Shoulder dystocia	10	19	11	13	12	16	18	22	32	20	37	27	25	41	303
Type 1 diabetes	293	267	355	339	339	387	379	364	390	377	403	344	332	358	4927
Shoulder dystocia	2	4	3	2	1	3	4	5	5	2	6	6	5	12	60
Type 2 diabetes	20	32	46	51	65	62	82	86	80	114	113	103	137	132	1123
Shoulder dystocia	0	0	0	0	0	0	0	1	1	0	0	0	3	1	6
Mode of delivery, <i>n</i>															
Spontaneous vaginal	43 629	43 390	43 996	43 455	44 250	45 419	45 511	44 729	44 350	43 354	42 912	41 287	39 323	37 251	602 856
Shoulder dystocia	32	49	33	45	40	45	47	63	56	48	64	43	72	87	724
Instrumental vaginal delivery	4025	4342	4802	4851	5039	5184	5332	5171	5262	5110	5092	5131	5014	4757	69 112
Shoulder dystocia	27	35	39	38	40	47	48	54	56	49	46	69	68	73	689
Other**	9915	9902	10 061	10 421	10 318	9980	10 349	10 194	10 081	9909	9635	9170	9116	8702	137 753
Shoulder dystocia	1	7	4	8	5	2	7	5	4	1	2	2	2	4	54
BMI, <i>n</i>															
<18.5 kg/m ²	1751	1813	2307	2168	2323	2147	2203	2098	2201	2045	2058	1894	1735	1587	28 330
Shoulder dystocia	0	0	4	3	2	4	0	1	0	1	4	1	2	1	23
18.5–24.9 kg/m ²	28 643	30 605	36 404	36 282	36 873	36 882	37 226	36 344	36 020	34 933	34 607	33 323	31 638	29 416	479 196
Shoulder dystocia	24	40	31	45	43	53	51	61	63	51	49	62	78	82	733
≥25.0 kg/m ²	14 943	15 770	18 238	18 471	18 816	19 784	20 504	20 582	20 666	20 580	19 987	19 244	19 131	18 662	265 378
Shoulder dystocia	29	45	36	39	38	34	50	57	52	42	59	49	60	79	669
Unknown	12 232	9 446	1910	1806	1595	1770	1259	1070	806	815	987	1127	949	1045	36 817
Shoulder dystocia	7	6	5	4	2	3	1	3	1	4	0	2	2	2	42
Age, <i>n</i>															
<20 years	1664	1609	1510	1480	1413	1406	1398	1264	1207	1150	1112	936	843	724	17 716
Shoulder dystocia	0	0	0	3	4	3	3	3	2	0	1	2	2	1	24
20–39 years	53 743	53 920	55 227	55 053	56 014	56 961	57 661	56 647	56 306	55 138	54 474	52 651	50 254	47 709	761 758
Shoulder dystocia	57	85	73	83	76	87	95	114	109	92	109	105	135	151	1371
≥40 years	2162	2105	2122	2194	2180	2216	2133	2183	2180	2085	2053	2001	2356	2277	30 247
Shoulder dystocia	3	6	3	5	5	4	4	5	5	6	2	7	5	12	72

*, Includes ~~twins~~multifetal pregnancies; **Includes caesarean sections and a few cases in which mode of delivery was not reported; DM, Diabetes; BMI, Body mass index

Table 2. Calculation data for risk values of shoulder dystocia

Risk factor	BMI						Mode of delivery		Age			DM status		Gestational age (weeks)	
	<18.5	18.5– 24.9	≥25	25– 29.9	30– 34.9	≥35	Spontaneous vaginal	Instrumental vaginal	<20 years	20–39 years	≥40 years	DM -	DM +	33-40	41-42
Total number of shoulder dystocia diagnosis <i>n</i>	23	733	669	391	171	107	724	689	24	1371	72	1098	369	1003	457
Total number of deliveries <i>n</i>	28 330	479 196	265 378	170 162	63 738	31 478	602 856	69 112	17 716	761 758	30 247	725 127	84 594	610 218	188 954
Risk of shoulder dystocia* %	0.081	0.15	0.25	0.23	0.27	0.34	0.12	1.00	0.14	0.18	0.24	0.15	0.44	0.16	0.24
Risk value**	1	2	3	3	3	4	1	12	2	2	3	2	5	2	3***

BMI, Body mass index; DM, Diabetes; DM-, No maternal diabetes; DM+, Maternal diabetes;

*Calculated as total number of shoulder dystocia diagnoses per total number of live births

** Risk of shoulder dystocia when the risk is compared to the risk of shoulder dystocia with deliveries, which have the lowest risk

*** The difference between risk points with gestational age 33-40 weeks and 41-42 weeks was one point.

Table 3A. Shoulder dystocia risk score tool to evaluate parturient's individual risk for shoulder dystocia among underweight, normal weight and overweight parturients. If the gestational age is 41 weeks or more, add 1 point to the total sum of other risk points.

DM +				
Mode of delivery				
		Spontaneous vaginal	Instrumental vaginal	
Age (years)	<20	9	20	<18.5
	20–39	10	21	18.5–24.9
	≥40	12	23	≥25
	<20	10	21	18.5–24.9
	20–39	11	22	≥25
	≥40	10	21	<18.5
	<20	11	22	≥25
	20–39	9	20	<18.5
	≥40	11	22	18.5–24.9
	DM -			
	Mode of delivery			
			Spontaneous vaginal	Instrumental vaginal
	<20	6*	17	<18.5
	20–39	7	18	18.5–24.9
	≥40	9	20	≥25
Age (years)	<20	7	18	18.5–24.9
	20–39	8	19	≥25
	≥40	7	18	<18.5
	<20	8	19	≥25
	20–39	6*	17	<18.5
	≥40	8	19	18.5–24.9

Table 3B. Shoulder dystocia risk score tool for overweight women to provide more accurate risk evaluation. If the gestational age is 41 weeks or more, add 1 point to the total sum of other risk points.

DM +				
Mode of delivery				
		Spontaneous vaginal	Instrumental vaginal	
Age (years)	<20	11	22	25–29.9
	20–39	11	22	30–34.9
	≥40	13	24**	≥35
	<20	11	22	30–34.9
	20–39	12	23	≥35
	≥40	12	23	25–29.9
	<20	12	23	≥35
	20–39	11	22	25–29.9
	≥40	12	23	30–34.9
	DM -			
	Mode of delivery			
			Spontaneous vaginal	Instrumental vaginal
	<20	8	19	25–29.9
	20–39	8	19	30–34.9
	≥40	10	21	≥35
Age (years)	<20	8	19	30–34.9
	20–39	9	20	≥35
	≥40	9	20	25–29.9
	<20	9	20	≥35
	20–39	8	19	25–29.9
	≥40	9	20	30–34.9

DM+, Maternal diabetes; DM-, No maternal diabetes; BMI, Body mass index; *, The lowest sum of the risk values; **, The highest sum of the risk values

Figure 1

(A) The total incidence of shoulder dystocia and incidence according to parity in Finland in 2004–2017. (B) The incidences of shoulder dystocia and shoulder dystocia -related diagnoses in Finland in 2004–2017. All incidence rates are adjusted to the annual number of live births. All changes in the incidences were statistically significant ($P < 0.001$) except for Klumpke's palsy ($P = 0.58$).

Figure 2

(A) Incidence of shoulder dystocia according to the mode of delivery in Finland in 2004–2017. Other, elective and non-elective cesarean sections (B) Incidence of shoulder dystocia by diabetes status in Finland in 2004–2017. DM-, non-diabetic; GDM, gestational diabetes; DM1+2, type 1 or 2 diabetes (C) Incidence of shoulder dystocia by BMI (kg/m²) in Finland in 2004–2017. BMI, Body Mass Index (D). Incidence of shoulder dystocia by age in Finland in 2004–2017. Incidence rates were calculated within each subgroup.

Figure 3

Incidence of shoulder dystocia and the number of all deliveries by gestational age in Finland in 2004–2017. O66.0, shoulder dystocia.

ROC Curve for Model
Area Under the Curve = 0.7766