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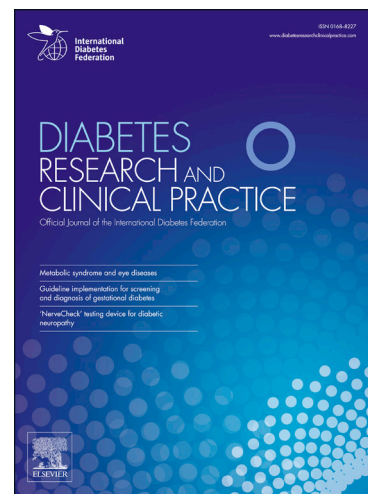
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1 **Original article**2 **Lower daily carbohydrate consumption than recommended by the Institute of Medicine is**
3 **common among women with type 2 diabetes in early pregnancy in Denmark**4 Björg Ásbjörnsdóttir^{a,b,c}, Helle Ronneby^{a,d}, Marianne Vestgaard^{a,b,c}, Lene Ringholm^{a,b,e}, Vibeke L.
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53 Aims:

54 To secure adequate carbohydrate supply in pregnancy, the Institute of Medicine (IOM) recommends
55 a minimum amount of carbohydrates of 175 g daily. Currently a low carbohydrate diet is a popular
56 health trend in the general population and this might also be common among overweight and obese
57 pregnant women with type 2 diabetes (T2D). Thus, we explored carbohydrate consumption among
58 pregnant women with T2D including women with type 1 diabetes (T1D) for comparison.

59
60 Methods:

61 A retrospective cohort study of consecutive women with T2D (N=96) and T1D (N=108), where
62 dietary records were collected at the first antenatal visit.

63
64 Results:

65 Among women with T2D and T1D, bodyweight at the first visit was 90.8 ± 22 (mean \pm SD) and
66 75.5 ± 15 kg ($P < 0.001$) while HbA1c was $6.6 \pm 1.2\%$ (49 ± 13 mmol/mol) and $6.6 \pm 0.8\%$ (48 ± 8
67 mmol/mol), $P = 0.8$, respectively. The average daily carbohydrate consumption from the major
68 carbohydrate sources was similar in the two groups (159 ± 56 and 167 ± 48 g, $P = 0.3$), as was the level
69 of total daily physical activity (median (interquartile range)): 215 (174-289) and 210 (178-267)
70 metabolic equivalent of task-hour/week ($P = 0.9$). A high proportion of women with T2D and T1D
71 (52% and 40%, $P = 0.08$) consumed fewer carbohydrates than recommended by the IOM. The
72 prevalence of ketonuria (≥ 4 mmol/L) was 1% in both groups.

73
74 Conclusions:

75 In early pregnancy, a lower daily carbohydrate consumption than recommended by the IOM was
76 common among women with T2D. The results were quite similar to women with T1D, despite a
77 markedly higher bodyweight in women with T2D. Reassuringly, ketonuria was rare in both groups.

78
79 Keywords: Carbohydrate, pregnancy, type 2 diabetes, type 1 diabetes.

80

81 1. Introduction

82 Pregnancies complicated by diabetes are associated with increased risk of adverse perinatal
83 outcomes including infants born large for gestational age (1,2). This is mostly attributed to the
84 maternal transfer of excessive glucose across the placenta leading to accelerated fetal growth (3).
85 The total amount of carbohydrates is the main dietary factor affecting postprandial blood glucose
86 (4). Therefore a restricted carbohydrate consumption in pregnant women with diabetes could be
87 sensible but as both the maternal and the fetal brain mainly use glucose as an energy source, the
88 Institute of Medicine (IOM) and the American Diabetes Association (ADA) recommend a
89 minimum of 175 g of carbohydrates daily for pregnant women (5,6). The average daily
90 carbohydrate consumption in early pregnancy in healthy women is in general reported to be well
91 above the minimum amount recommended by the IOM (7,8) and excessive gestational weight gain
92 is common (9).

93 A low carbohydrate diet aiming at reducing plasma glucose levels and obtaining weight loss is a
94 popular health trend in the general population (10) and in patients with type 2 diabetes (T2D) (11)
95 but may be harmful during pregnancy. Insufficient carbohydrate consumption can lead to increased
96 lipolysis and ketone body production and pregnant women are in general more prone to ketosis than
97 non-pregnant women (12-14). Previous observational studies in offspring of women with diabetes
98 suggests that elevated maternal ketone bodies may have a negative effect on the developing fetal
99 central nervous system (15,16). Thus, we speculate that, in pregnant women with diabetes,
100 sufficient daily carbohydrate consumption and avoidance of ketonemia are probably important for
101 normal fetal brain development.

102 The total amount of macronutrients required to maintain body weight is dependent on the body
103 composition and the level of physical activity. Therefore, the recommendations on carbohydrate
104 consumption are often given per kilo bodyweight which probably can lead to inappropriately high

105 carbohydrate consumption in obese women where the recommended gestational weight gain is
106 smaller than in normal weight women (14). High prevalence of excessive gestational weight gain
107 has been reported among pregnant women with diabetes (17-19). Recommendations on lower
108 energy percent (E%) of carbohydrates in obese pregnant women with diabetes has been suggested
109 (20).

110 Modern diabetes treatment respects a flexible lifestyle (21) and the daily amount of carbohydrates
111 varies considerably from day to day in pregnant women with type 1 diabetes (T1D) (22). In a real
112 world, daily dietary intake may therefore vary considerably from the dietary advises given. One
113 small study including 19 women with T2D at 22 gestational weeks found an average carbohydrate
114 consumption of 259 g daily (23). Sufficient intake of lipids and proteins as well as micronutrients
115 during pregnancy is also important for fetal growth (24), but this study is restricted to carbohydrate
116 consumption.

117 In a real-world setting, we aimed to explore carbohydrate consumption and prevalence of ketonuria
118 in early pregnancy among women with T2D including women with T1D for comparison.

119 2. Subjects, Materials and Methods

120 2.1 Study population

121 As a part of routine care since January 2013, all pregnant women referred to Center for Pregnant
122 Women with Diabetes at Rigshospitalet have been asked to fill out a 3-day dietary record focusing
123 on carbohydrates before their first antenatal visit at the centre. Thus, a dietary record form was sent
124 to the women along with a welcome letter by mail. The inclusion criteria in this retrospective cohort
125 study from August 2013 to September 2017 were: women with T2D or T1D, Danish speaking,
126 singleton pregnancy and first antenatal visit before 20 gestational weeks. Aiming for a comparable
127 number of women in the two diabetes groups and since data on carbohydrate consumption in

128 pregnant women with T1D have already been published for the period January 2013 to December
129 2014 (22), we decided to include women with T1D from January 2015 to September 2017.

130 In the inclusion period the following women did not meet the inclusion criteria: not-Danish
131 speaking (n=47 with T2D and n=1 with T1D), multifetal pregnancy (n=10 and n=8), first antenatal
132 visit later than 20 gestational weeks (n=20 and n=2) and 5 (n=4 and n=1) with previous bariatric
133 surgery, resulting in 171 eligible women with T2D and 248 with T1D of which 96 (56%) and 108
134 (44%), respectively had completed the dietary records.

135 2.2 Dietary analysis

136 At the first antenatal visit, all women had a one-hour appointment with a specialized dietician who
137 used the information from the dietary records as a basis for individualized dietary advice. Based on
138 the dietary records, the dietician counted the recorded carbohydrates and used validated tables (25),
139 photos (26) and a carbohydrate counting app, recommended by the Danish Diabetes Association,
140 when needed. The quantity of the carbohydrates was calculated from the major carbohydrate
141 sources only, i.e. bread products, potatoes, rice, pasta, fruits, dairy products and sweets. The major
142 carbohydrate sources account for the majority of carbohydrates consumed e.g. a commonly
143 recommended Danish diabetes diet for women, regardless of pregnancy, contains 1612 kcal (6743
144 kJ) including 175 g of carbohydrates in total (46 E%). Of those the major carbohydrate sources
145 account for 86% (150 g) of the total amount of carbohydrates while 700 g of vegetables account for
146 the remaining 25 g of carbohydrates. A pragmatic evaluation of the *glycaemic index* (27) based on
147 an calculation of the total daily carbohydrate consumption was performed by the dietician in the
148 following way: The amount of carbohydrates from low glycaemic index sources was identified and
149 divided by the total amount of carbohydrates consumed. We stratified the glycaemic index score as
150 0-33%, 34-66% or 67-100% of carbohydrates deriving from low glycaemic index sources.
151 Furthermore, the number of meals and snacks consumed daily and whether the women used

152 carbohydrate counting in each meal and snack (yes/no) were registered, whereas total E%,
153 glycaemic load, lipid- and protein consumption were not assessed.

154 In Denmark, the recommended diet for women with diabetes, regardless of pregnancy, consists of
155 approximately 55 E% of carbohydrates mainly from low glycaemic index sources with high amount
156 of fibres (28,29). In general, individualized dietary plans including 3 main meals and 2-3 snacks are
157 tailored with respect of the women's eating habits, cultural, ethnical and economic status and
158 presence of nausea (28,30). With the aim to prevent excessive gestational weight gain and by
159 assuming that eating more than recommended is frequent, a total daily energy intake of
160 approximately 1673 kcal (7000 kJ) regardless of pre-pregnancy BMI or trimester is recommended
161 for pregnant women with diabetes at our centre. The recommendation includes at least 175 g of
162 carbohydrates with 150 g deriving from the major carbohydrate sources. The initially recommended
163 total energy intake can be upregulated during pregnancy according to individual needs including
164 changes in the level of physical activity aiming for appropriate weekly gestational weight gain
165 without hunger or ketonuria. To secure sufficient intake of micro- and macronutrients, a reduction
166 in the total energy intake is not recommended and it is our experience that upregulating the
167 recommended energy intake is seldomly needed.

168 2.3 Questionnaire on physical activity and early pregnancy events

169 Since 2015, the women were asked to answer a questionnaire at first antenatal visit. The
170 questionnaire included a validated Pregnancy Physical Activity Questionnaire (PPAQ) (31)
171 consisting of 33 questions grouped into different types of activity (i.e. household/caregiving,
172 occupation, sports). The women could add two physical activities not listed in the questionnaire,
173 where the intensities were individually estimated using the Compendium of Physical Activity (32).
174 In Denmark, bicycling is very common and therefore two questions were added into the
175 questionnaire, one on bicycling as transportation and one on bicycling as leisure activity (33). For

176 each of the 35 questions, the duration of time spent in each activity was multiplied by the intensity
177 to get the average weekly energy expenditure (metabolic equivalent of task per hour (METs-
178 hr.)/wk.). The questionnaire also included non-validated questions about number of times where the
179 women had eaten extra snacks due to hypoglycaemia the previous week, number of times where the
180 women had eaten less or more due to nausea the previous week, number of episodes of vomiting in
181 the previous week, number of weekly blood glucose measurements before pregnancy as well as
182 during the previous week and average number of sleeping hours. Fifty-two percent of women with
183 T2D and 39% of women with T1D, answered this questionnaire at first antenatal visit.

184 2.4 Demographic and clinical data

185 Demographic and clinical data were collected from two standardized forms in the original medical
186 records.

187 HbA1c was measured at the first antenatal visit in capillary blood and analysed immediately by a
188 DCA 2000 analyser by a latex immunoagglutination inhibition method (DCA 200; Bayer,
189 Mishawaka, IN). Early gestational weight gain was defined as the weight measured at the first
190 antenatal visit minus self-reported weight before pregnancy (kg). Spot urine samples were collected
191 at the clinic in the morning hours of the visits. The occurrence of ketonuria was noted if the
192 concentration of ketone bodies was ≥ 4.0 mmol/L, detected on a dipstick of sterile urine (analysed
193 by Siemens CLINITEK Status[®] + Analyzer). If urine ketone bodies ≥ 4.0 mmol/L were detected,
194 blood ketone bodies were routinely measured (FreeStyle Precision, Abbott). Urine ketone body
195 levels of 4.0-7.9 mmol/L corresponding to +3 on the dipstick was equivalent to a median (range)
196 blood ketone body level of 0.2 (0-0.8) mmol/L (N=18) (unpublished data from our department).

197 2.5 Routine diabetes care

198 In Denmark, most non-pregnant women T2D receive diabetes treatment in general practice, while
199 women with T1D are treated at local diabetes centres. The national recommendations for routine

200 diabetes care aim for HbA1c ≤ 7.0 % (53 mmol/mol) before pregnancy and ≤ 6.5 % (48 mmol/mol)
201 in early pregnancy (34). The majority of women with T2D are treated with diet alone or in a
202 combination with oral antidiabetic drugs and/or injections with Glucagon-like Peptide-1 analogue
203 before pregnancy until pregnancy planning or at the latest up to the first antenatal visit where the
204 treatment is changed to an insulin regimen.

205 2.6 Statistical analysis

206 Continuous data with normal distribution are reported as mean (\pm standard deviation (SD)),
207 continuous data with skewed distribution as median (interquartile range (IQR)) and categorical data
208 as number (%). Descriptive results are given for T2D and T1D separately. Comparisons of the
209 groups were performed by student's t-test, Mann-Whitney U-test, Chi square test or Fisher's exact
210 tests when appropriate.

211 Since the carbohydrate recommendations and carbohydrate consumption during pregnancy were
212 similar for women with T2D and T1D, univariate regression analysis was performed in the
213 combined cohort (T2D and T1D) as well as in the individual diabetes groups. In the univariate
214 linear regression analyses the carbohydrate consumption per 100 g was used as an independent
215 variable and HbA1c (%) as an outcome variable.

216 The multivariate regression analysis was performed in the combined cohort only, using
217 carbohydrate consumption per 100 g as independent variable and HbA1c (%) as an outcome
218 variable with the following potential confounders; maternal age, pre-gestational BMI, daily insulin
219 dose/bodyweight (IU/kg/24h), treatment with insulin pump (yes/no) and type of diabetes (T2D and
220 T1D). The results of the linear regression analyses are given as the regression coefficient beta (β)
221 with a 95% confidence interval (CI), expressing the change in the outcome variable for a unit
222 change in the independent variable.

223 Statistical analyses were performed with IBM statistics SPSS version 22. Statistically significant
224 differences were defined as a two-sided $p < 0.05$.

225 2.7 Ethics

226 Approvals from the local Ethic committee (H-15009413) and the Danish Data Protection Agency
227 (2007-58-0015 and 2012-58-0004) were obtained and all patients gave informed consent as
228 appropriate according to Danish laws. The principles of The Helsinki Declaration were observed.

229 3. Results

230 Clinical characteristics at first antenatal visit are given in Table 1. The mean HbA1c was
231 comparable in early pregnancy, while the women with T2D had higher prepregnancy BMI and
232 lower weekly gestational weight gain prior to first antenatal visit than the women with T1D.

233 Daily carbohydrate consumption was similar in the women with T2D vs. T1D (159 ± 56 vs. 167 ± 48
234 g, $P=0.3$) with a carbohydrate consumption per bodyweight of 1.9 ± 0.9 vs. 2.3 ± 0.8 g/kg, $P < 0.001$,
235 respectively (Table 2). Fifty-two percent of the women with T2D and 40% of the women with T1D
236 consumed fewer carbohydrates than recommended by the IOM ($P=0.08$) (Table 2). In the combined
237 group of women with diabetes, the women who consumed fewer carbohydrates than recommended
238 by the IOM had comparable HbA1c ($6.5 \pm 1.0\%$ (48 ± 11 mmol/mol) vs. $6.6 \pm 1.0\%$ (49 ± 11
239 mmol/mol), $P=0.5$) but lower weekly gestational weight gain (126 ($13-260$) vs. 200 ($67-377$) g,
240 $P=0.02$) than the women following the IOM recommendations. Ten (10%) women with T2D and 8
241 (7%) women with T1D reported consuming <100 g of carbohydrates daily (Table 2) with a mean
242 daily consumption of 83 and 78 g, respectively. None of these 18 women had ketonuria at first
243 antenatal visit. Daily carbohydrate consumption >200 g was reported by 16 (17%) women with
244 T2D and 20 (19%) women with T1D.

245 Among women with T2D the glycaemic index score of the carbohydrates was less favourable
246 compared with women with T1D ($P=0.04$) and carbohydrate counting was less frequently used
247 (Table 2).

248 In an univariate linear regression analysis, a significant association between daily carbohydrate
249 consumption and HbA1c could not be detected in neither the combined cohort ($\beta:0.13$ (95% CI: -
250 0.1-0.4) %, $P=0.3$) or when calculated separately for the women with T2D ($\beta:0.2$ (95% CI: -0.2-0.6)
251 %, $P=0.4$) and T1D ($\beta:0.04$ (95% CI: -0.3-0.4) %, $P=0.8$). Similar no association was found in the
252 multiple regression analysis.

253 One woman with T2D and one woman with T1D had ketonuria with urine ketone concentration of
254 4.0-7.9 mmol/L at first antenatal visit (Table 1). The mean carbohydrate consumption was reported
255 to be 160 g/day and 121 g/day, respectively, and only the woman with T2D had a bedtime snack.

256 Data on physical activity was available in a subgroup of 56% vs. 38% patients, respectively. The
257 total physical activity level was comparable in women with T2D and T1D (Table 3). The women
258 with T2D spent significantly more energy on household/caregiving than the women with T1D while
259 no difference between the groups was found in energy expenditure during occupation and sports
260 (Table 3). A higher energy expenditure during household/caregiving was found among multipara
261 compared to nullipara (100 (66-140) vs. 49 (30-70) METs-hr./wk., $P<0.001$).

262 Insulin treated women with T2D reported consuming extra carbohydrates due to episodes of
263 hypoglycaemia twice weekly while women with T1D consumed extra carbohydrates 5.5 times/week
264 (Table 3).

265 Nausea leading to eating less or more food during the previous week was reported by 54% of the
266 women with T2D and 64% of the women with T1D (Table 3). Nauseous women consumed 165 ± 50
267 g of carbohydrates daily, while women without nausea consumed 148 ± 56 g daily ($P=0.1$).

268 Among the women with T2D, a high number were of non-North-European Origin. The
269 carbohydrate consumption in the women with T2D of North-European origin was comparable with
270 women of non-North-European origin (165 ± 60 vs. 154 ± 53 g, $P=0.4$) as was the number of women
271 consuming ≤ 150 g carbohydrates daily (46% vs. 58%, $P=0.3$). HbA1c was $6.8 \pm 1.3\%$ (51 ± 14
272 mmol/mol) vs. $6.4 \pm 1\%$ (47 ± 11 mmol/mol) $P=0.2$, in women of North-European origin vs. non-
273 North-European origin.

274 4. Discussion

275 This cohort study from Denmark, in a real-world setting, demonstrates that the women with T2D
276 often consumed fewer carbohydrates than recommended by the IOM in early pregnancy. The
277 average carbohydrate consumption from the major carbohydrate sources was similar in women with
278 T2D and T1D. Women with T2D weighted on average 15.3 kg more than women with T1D and
279 ketonuria in early pregnancy was rare in both groups.

280 The average carbohydrate consumption in this study was lower than previously described for
281 women with T2D (23), T1D (22) and healthy pregnant women where 286 and 393 g daily has been
282 reported (7,8), even if the expected 25 g from the minor sources is added. In healthy women,
283 carbohydrate consumption throughout pregnancy has been reported rather stable with an average
284 4% higher consumption in late pregnancy (7,8,35). In both our and the Canadian study (23), the
285 average carbohydrate consumption was similar in women with T2D and T1D while the bodyweight
286 was approximately 15 kg higher in women with T2D. This may reflect similar intake of the total
287 energy or a different distribution in the macronutrient consumption with higher fat and/or protein
288 intake in obese women compared with normal weight women.

289 The minimum amount of carbohydrates required to prevent ketosis is 50 to 100 g daily outside of
290 pregnancy (36). During third trimester, the fetal brain is estimated to use approximately 35 g of

291 carbohydrates per day as an energy source (6) and additional carbohydrates are used for fetal
292 growth.

293 A high proportion of women in our study reported an intake of fewer carbohydrates than
294 recommended by the IOM. Older studies have raised concern about the adverse effect of ketone
295 bodies on the developing fetal brain in pregnancies complicated with diabetes (15,16). An inverse
296 correlation between the mothers' third trimester plasma β -hydroxybutyrate and children's
297 intelligence both at the age of 2 and 3-5 years has been reported (15). A recent study from our own
298 group reported lower intelligence in teenage offspring of mothers suffering from ketoacidosis
299 during pregnancy, but numbers were small (37). Therefore, it is reassuring that the occurrence of
300 ketonuria in early pregnancy was low in the present study.

301 In contrast to our previous findings (22), we did not observe an association between carbohydrate
302 consumption and HbA1c in this cohort. This may be due to a lower number of women with a
303 carbohydrate consumption exceeding 200 g daily and less variation in HbA1c in the present cohort.
304 Carbohydrate counting is important to obtain tight glycaemic control with a flexible lifestyle in
305 patients with T1D who do not have an endogenous insulin production (22,38) and was frequently
306 used in the investigated women. Carbohydrate counting in women with T2D was rare and whether
307 pregnant women with T2D also benefit from carbohydrate counting needs to be investigated.

308 To our knowledge, this is the largest study to date, evaluating the carbohydrate consumption in
309 early pregnancy as part of routine care in a cohort of women with T2D in a real-world setting,
310 including data on ketonuria, nausea and vomiting. The evaluation of the carbohydrate consumption
311 is meaningful for insulin treated patients and diabetes caregivers. The same dietician (HR)
312 evaluated the amount of carbohydrates consumed and the glycaemic index score which gives
313 consistency of the method.

314 It is a limitation that the women's carbohydrate consumption was self-reported and the total E%,
315 glycaemic load, lipid- and protein consumption were not recorded. To minimize the recall bias, the
316 women were asked to complete the dietary records prospectively over 3 days before the first
317 antenatal visit. The women may have chosen a healthier diet during the dietary registration and/or
318 omitted to register all carbohydrates from the major carbohydrates consumed. It is known that less
319 healthy eaters are more likely to underreport food intake (39). Despite these limitations, this is one
320 of the best options for evaluation of carbohydrate consumption in a large population. All eligible
321 women reporting at least one day of dietary records were included in the study to improve the
322 external validity of the study, but this might have biased the estimation of the daily carbohydrate
323 consumption. It would have added value to our study, if the women had tested for ketonuria at
324 home the same days as the dietary registration. There is a risk of selection bias as the less compliant
325 women with unhealthy eating habits may not have filled out the dietary records. Data from the
326 PPAQ was only available in 52% and 39% of included women with T2D and T1D, respectively.

327 4.1 Conclusions

328 In early pregnancy, a lower daily carbohydrate consumption than recommended by the IOM was
329 common among women with T2D. The results were quite similar to women with T1D, despite a
330 markedly higher bodyweight in women with T2D. Reassuringly, ketonuria was rare in both groups.
331 Future studies should focus on the safety of consuming a low amount of carbohydrates during
332 pregnancy in women with diabetes.

333 5. Acknowledgements

334 Author Contributions. E.R.M. and B.Á. contributed to the idea. H.R. conducted the diet analyses in
335 the women. B.Á and M.V. collected the data. B.Á. analysed data and wrote the manuscript. All
336 authors were involved in the interpretation of data, contributed to the discussion, reviewed and
337 edited the manuscript and approved the final version. E.R.M. is the guarantor of this work and, as

338 such, has full access to all the data in the study and takes responsibility for the integrity of the data
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458 Table 1. Clinical characteristics of pregnant women with type 2 diabetes compared with pregnant
 459 women with type 1 diabetes at first antenatal visit.

| | Type 2 diabetes | Type 1 diabetes | P-value |
|---|--------------------|-------------------|---------|
| Number | 96 | 108 | |
| Age (years) | 34 ±5 | 31 ±5 | 0.001 |
| Duration of diabetes (years) | 3 (1-6) | 16 (9-22) | <0.001 |
| Prepregnancy weight (kg) | 89.5 ±23 | 73.4 ±15 | <0.001 |
| Prepregnancy diet treatment only | 23 (24%) | | |
| Prepregnancy oral antidiabetic medication [†] | 60 (63%) | | |
| Prepregnancy treatment with Glucagon-Like-Peptide-1-antagonist [‡] | 9 (9%) | | |
| Height (cm) | 165 ±7 | 168 ±6 | 0.001 |
| Prepregnancy BMI (kg/m ²) | 32.8 ±7 | 26.0 ±5 | <0.001 |
| North-European Origin | 52 (55%) | 98 (93%) | <0.001 |
| Nulliparous | 36 (38%) | 55 (51%) | 0.06 |
| Smoking | 2/49 (4%) | 1/43 (2%) | 0.6 |
| Gestational age (days) | 71 (60-87) | 63 (56-76) | 0.003 |
| HbA1c (%) (mmol/mol) | 6.6 ±1.2 49 ±13 | 6.6 ±0.8 48 ±8 | 0.8 |
| Insulin treatment | 18 (19%) | 108 (100%) | - |
| Insulin pump treatment | 0% | 36 (33%) | - |
| Insulin dose (IU/kg/24h) [§] | 0.67 ±0.40 | 0.61 ±0.28 | 0.6 |
| Weight (kg) | 90.8 ±22 | 75.5 ±15 | <0.001 |
| Early gestational weight gain (kg) | 1.5 ±2.7 | 2.1 ±2.1 | 0.07 |
| Early weekly gestational weight gain (g) | 145 ±247 | 233 ±230 | 0.01 |
| Ketonuria (≥4.0 mmol/L) | 1 (1%) | 1 (1%) | 1.0 |

460 Data are given as mean ±standard deviation, median (interquartile range) or n (%). [†]Monotherapy with Biguanide
 461 (N=39). Combination therapy with Biguanide and Glucagon-Like-Peptide-1-antagonist (GLP-1-antagonist) (N=6),
 462 Dipeptidyl Peptidase-IV (DPP-IV) Inhibitors (N=6), Sodium-Glucose co-Transporter-2 (SGLT2) Inhibitors (N=1)
 463 Sulphonylureas (N=1) and insulin (N=6) respectively. Combination therapy with Biguanide, DPP-IV-Inhibitor and
 464 SGLT-2-Inhibitor (N=1). [‡]Monotherapy with GLP-1-antagonist (N=1). Combination therapy with GLP-1-antagonist
 465 and Biguanide (N=6) and insulin (N=2), respectively. [§]Numbers are given for those on insulin treatment.

466

467 Table 2. Dietary analysis based on dietary records in early pregnancy by women with type 2
 468 diabetes and women with type 1 diabetes.

| | Type 2 diabetes | Type 1 diabetes | P-value |
|--|-----------------|-----------------|---------|
| Number | 96 | 108 | |
| Dietary records | | | |
| • 1 day | 12 (12%) | 32 (30%) | 0.002 |
| • 2 days | 15 (16%) | 23 (21%) | |
| • 3 days | 69 (72%) | 53 (49%) | |
| Carbohydrate consumption (g/day) | 159 ±56 | 167 ±48 | 0.3 |
| Carbohydrate consumption/kg bodyweight (g/kg/day) | 1.9 ±0.9 | 2.3 ±0.8 | <0.001 |
| Consuming fewer carbohydrates than recommended by the Institute of Medicine† | 50 (52%) | 43 (40%) | 0.08 |
| Consuming <100 g of carbohydrates | 10 (10%) | 8 (7%) | 0.5 |
| The glycaemic index score‡§ | | | |
| • 0-33% | 13 (18%) | 6 (6%) | 0.04 |
| • 34-66% | 21 (30%) | 36 (36%) | |
| • 67-100% | 37 (52%) | 57 (58%) | |
| Use of carbohydrate counting | 6 (6%) | 83 (77%) | <0.001 |
| Number of daily meals and snacks§ | | | |
| • ≥3 main meals | 74 (96%) | 75 (94%) | 0.7 |
| • Snacks | | | 0.002 |
| ○ 3-4 | 29 (38%) | 46 (58%) | |
| ○ 2 | 17 (22%) | 22 (27%) | |
| ○ 0-1 | 30 (40%) | 12 (15%) | |

469 Data are given as n (%) or mean ±standard deviation. Carbohydrates calculated from the major carbohydrate sources.
 470 †≤150 g daily. ‡A score of 67-100% means that the majority of recorded carbohydrates derived from low glycaemic
 471 index sources. §Data available from 74-92%.

472

473 Table 3. Eating behaviour and lifestyle in pregnant women with type 2 or type 1 diabetes in early
 474 pregnancy.

| | Type 2 diabetes | Type 1 diabetes | P-value |
|--|-----------------|-----------------|---------|
| Number | 54 | 42 | |
| Total physical activity (METs-h/wk.) [†] | 215 (174-289) | 210 (178-267) | 0.9 |
| • Household/caregiving | 85 (50-136) | 57 (36-82) | 0.002 |
| • Occupation | 71 (0-106) | 81 (71-108) | 0.06 |
| • Sports | 11 (3-19) | 10 (4-16) | 0.9 |
| • Other | 49 (34-67) | 63 (44-77) | 0.02 |
| Number of extra snacks eaten due to hypoglycaemia in the previous week | 2 (0-6) | 5.5 (3-8) | 0.005 |
| Changed eating behaviour due to nausea in the previous week | | | |
| • Eating less due to nausea ≥ 1 /wk. | 24 (44%) | 19 (49%) | 0.7 |
| • Number of times eating less due to nausea/wk. | 3 (1.5-6) | 2 (1-5) | 0.4 |
| • Eating more due to nausea ≥ 1 /wk. | 15 (29%) | 17 (41%) | 0.2 |
| • Number of times eating more due to nausea/wk. | 3 (2-7) | 6 (2-7) | 0.3 |
| • Eating less or more due to nausea ≥ 1 /wk. | 29 (54%) | 27 (64%) | 0.3 |
| Vomiting in the previous week | 12 (23%) | 14 (34%) | 0.2 |
| • Number of vomiting/wk. | 2 (1-3) | 1.5 (1-5) | 0.5 |
| Number of blood glucose measurements/wk. before pregnancy | 0.5 (0-5) | 30 (7-50) | <0.001 |
| Number of blood glucose measurements in the previous week | 48 (24-49) | 60 (30-70) | 0.001 |
| Sleeping hours/24h in the previous week | 7.7 \pm 1.3 | 7.9 \pm 1.0 | 0.5 |

475 Data are given as median (interquartile range), n (%) or mean \pm standard deviation. Data available from 93-100%.

476 [†]METs-h/wk.=metabolic equivalent of task per hour/week.

477