Dietary Patterns of Insulin Pump and Multiple Daily Injection Users During Type 1 Diabetes Pregnancy

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Insulin pump therapy offers theoretical advantages over multiple daily injections (MDI) for fine-tuning insulin dose adjustment. However, evidence regarding the effectiveness of pump compared with MDI on glycemic control during pregnancy is conflicting. The Continuous Glucose Monitoring in Women With Type 1 Diabetes in Pregnancy Trial (CONCEPTT) was a randomized trial of continuous glucose monitoring (CGM) before and during pregnancy (1). A secondary analysis found that pregnant women using pumps had suboptimal midgestation glycemic control compared with women using MDI (2). CGM measures demonstrated comparable time in range (TIR) 63–140 mg/dL at 12 and 34 weeks but 5% lower TIR in pump users at 24 weeks (48% vs. 53%), meaning that pump users spent, on average, 1 h 15 min per day less time in the glucose target range.

There are several potential explanations for this, including baseline differences in women using pump or MDI, differences in insulin dose adjustment, and differences in dietary intake. Women using pumps have more dietary flexibility with no additional injections required for snacks. Through the use of prospectively collected dietary data from U.K. and Irish CONCEPTT participants, our objective was to examine the dietary patterns of women using insulin pumps and MDI during pregnancy.

Details of the main CONCEPTT, pump versus MDI, and diet studies were previously published (1–3). All U.K. participants ($n = 113$) were invited to participate in the CONCEPTT diet study. Participants completed three-day food diaries in early (12 weeks) and late (34 weeks) pregnancy, with two weekdays and one weekend day of typical diet. Women were informed that food diaries would be de-identified and used only for research purposes. The software program Dietplan 6.70.75 (Forestfield Software Ltd., Horsham, U.K.), was used to code dietary data. Blinding to participant groups was maintained throughout dietary analyses.

Total energy and macronutrient intakes were calculated in early and late pregnancy. Carbohydrate consumption at main meals and snacks was assessed. Carbohydrate intakes were also classified by American Diabetes Association (ADA)-recommended versus nonrecommended sources (4). Independent t tests and χ^2 tests were used to assess between-group differences, with a significance threshold of 0.05. Data were analyzed using Microsoft Excel, SPSS 21.0 (IBM Corp., Armonk, NY) and Stata (version 14.1; StataCorp LP, College Station, TX).

A total of 93 of 113 (82.3%) pregnant women were included (55 MDI, 38 pump users) with 421 CONCEPTT participant days. Maternal age, BMI, duration of diabetes, education level, and baseline HbA_{1c} level did not differ between women who did and did not participate. There were also no differences in maternal age, BMI, gestational weight gain

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**A complete list of the CONCEPTT Collaborative Group members can be found in the Supplementary Data online.*

from 16 to 34 weeks, diabetes duration, or smoking between pump and MDI users, although more pump users were in stable relationships (Table 1).

Food diaries from 87/93 (93.5%) women were available at baseline and from 55/70 (78.6%) women at follow-up. Seventeen pregnancies did not continue to 34 weeks (eight miscarriages, nine preterm deliveries). Food diaries were provided by 49/70 (70.0%) women at both 12 and 34 weeks. Women using pumps and MDI had comparable total energy intakes with no between-group differences in carbohydrate, protein, fat, or fiber intakes. Average daily carbohydrate consumption was 190–200 g/day, with only 100 g/day from ADA-recommended sources. Women using pumps and MDI reported comparable distributions of carbohydrate intake between meals and snacks and comparable intakes of recommended and nonrecommended carbohydrates.

In CONCEPTT diet participants, there were no significant differences in total energy, carbohydrate intake, or snacking behaviors of pregnant women using pumps and MDI. Dietary patterns were suboptimal in both groups, but based on these data, differences in dietary behavior are unlikely to account for the suboptimal glycemic outcomes in insulin pump users.

This study benefits from comprehensive, prospectively collected dietary data in a contemporary cohort of pregnant women with type 1 diabetes. To our knowledge, it is the only study reporting dietary information in pregnant pump versus MDI users. Limitations include risk of type II error because of small cohorts and missing data, the food diary methodology which does not allow calculation of glycemic index, selection bias between women who did and did not participate, and the possibility that this U.K. cohort may not be

Table 1—Dietary intakes of U.K. CONCEPTT participants using insulin pump vs. multiple daily injections in early and late pregnancy

	Pump	Multiple daily injections	*P* value
Maternal characteristics†	*n* = 38	*n* = 55	
Maternal age	32.6 ± 5.0	31.4 ± 5.0	0.26
BMI in early pregnancy, kg/m^2	26.0 ± 4.9	26.2 ± 4.4	0.84
Gestational weight gain from 16 to 34 weeks*	9.5 ± 2.7	9.8 ± 3.6	0.71
Duration of diabetes, years	18.1 ± 8.5	16.3 ± 7.1	0.28
Smoking	4 (10.5)	4 (7.3)	0.58
Married or common-law	37 (97.4)	44 (80.0)	0.01
Early pregnancy (10–14 weeks' gestation)	*n* = 34	*n* = 53	
Total energy, kcal/day	1,609 ± 412	1,683 ± 412	0.42
Carbohydrates, g/day	189 ± 53.5	199 ± 59.8	0.46
Total sugars	60.0 ± 28.1	71.5 ± 35.4	0.11
Sucrose	25.9 ± 16.3	28.5 ± 17.0	0.48
Fiber	15.9 ± 5.5	15.9 ± 4.6	0.98
Protein, g/day	68.1 ± 17.3	68.7 ± 15.8	0.87
Fat, g/day	69.3 ± 22.9	73.3 ± 22.2	0.42
Saturated fat	25.8 ± 9.70	27.5 ± 8.56	0.41
Monounsaturated fat	23.3 ± 8.30	23.9 ± 7.51	0.70
Polyunsaturated fat	11.9 ± 4.86	12.5 ± 5.25	0.60
Trans fat	1.54 ± 0.93	1.72 ± 1.05	0.39
"Recommended" carbohydrates, g/day**	97.2 ± 35.4	97.0 ± 30.7	0.98
Carbohydrates at mealtimes, g/day	146 ± 37.5	148 ± 39.9	0.82
Carbohydrates at snacktimes, g/day	43.2 ± 31.5	50.7 ± 34.3	0.31
Late pregnancy (34 weeks' gestation)	*n* = 22	*n* = 33	
Total energy, kcal/day	1,673 ± 362	1,722 ± 327	0.61
Carbohydrates, g/day	203 ± 49.3	204 ± 50.1	0.93
Total sugars	79.4 ± 31.0	76.8 ± 34.5	0.78
Sucrose	35.7 ± 19.6	32.2 ± 17.6	0.50
Fiber	15.0 ± 4.4	14.2 ± 5.7	0.61
Protein, g/day	68.0 ± 13.8	72.5 ± 15.2	0.27
Fat, g/day	70.9 ± 22.9	73.9 ± 18.2	0.59
Saturated fat	27.4 ± 8.26	29.0 ± 7.30	0.46
Monounsaturated fat	23.9 ± 8.39	24.1 ± 6.98	0.93
Polyunsaturated fat	11.8 ± 5.40	12.3 ± 4.07	0.70
Trans fat	1.70 ± 0.89	1.71 ± 0.77	0.94
ADA-"recommended" carbohydrates, g/day**	105 ± 34.2	104 ± 33.4	0.91
Carbohydrates at mealtimes, g/day	150 ± 34.7	155 ± 39.4	0.63
Carbohydrates at snacktimes, g/day	52.5 ± 30.3	48.8 ± 24.9	0.62

Data are presented as *n* (%) or mean ± SD. Mealtimes are breakfast, lunch, and dinner. Snack times are morning, afternoon, and evening. †Ninety-three out of 113 (82.3%) potentially eligible women from the U.K. (England, Scotland) and Ireland participated in the CONCEPTT diet study. The percentage with evaluable dietary data was 87/93 (93.5%) at baseline. The 17 women whose pregnancies did not go to 34 weeks (8 miscarriages and 9 early preterm deliveries) did not provide 34-week food diaries. Thus, the percentage with evaluable dietary data at 34 weeks' gestation was 55/70 (78.6%). *Weight at 34 ± 2 weeks was missing in 15 women. **ADA-recommended sources of carbohydrate intake are vegetables, fruits, whole grains, legumes, and dairy products.

representative of other geographic locations.

In CONCEPTT, differences in dietary intake did not explain the suboptimal midgestation glycemic control in pregnant women using insulin pumps. While there is clearly scope for dietary improvements in pump and MDI users, our data suggest that clinicians should focus on optimizing insulin pump adjustments in midgestation. Earlier, more aggressive premeal boluses and increased focus on the CGM targets during this period of increasing insulin resistance, aiming for 70% CGM TIR 63–140 mg/dL in midpregnancy (5), may help insulin pump users achieve better glycemic and neonatal outcomes.

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