Centre size and glycemic control: An international study with 504 centres from seven countries

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The variance in glycemic control between different childhood diabetes centres is not fully understood. Although the ISPAD guidelines from 2014 recommended centre sizes of more than 150 patients (1), it is not thoroughly investigated if glycemic control is associated with centre size (2-4). We have data from more than 500 childhood diabetes centres from seven different countries and thereby a unique opportunity to elaborate further on this association. Therefore, this study aims to investigate the relationship between centre size and glycemic control in children with type 1 diabetes (T1D).

Patient data have been described previously (5). Briefly, the population comprised children with T1D in the age group less than 18 years and diabetes duration of more than three months from seven high-income countries during 2013-2014: Austria, Denmark, England, Germany, Norway, Sweden and Wales. Data were anonymized and obtained from five national registries / audits on children with T1D (Austria and Germany use the same electronic health record, and England and Wales have a common National Pediatric Diabetes Audit, while Denmark, Norway and Sweden have national registries). Mean HbA_{1c} was compared between groups after adjusting for gender, age (<6 years, 6 to <12 years, and 12 to 18 years), duration of diabetes (<2 years, 2 to <5 years, and ≥ 5 years), minority status (yes/no) (HbA_{1c} adj) before and after stratifying for treatment modality (insulin injection/pump). Centre size was defined as the number of diabetes patients reported to be cared for in a centre. Centre size groupings were: 1) < 20; 2) 20 - < 50; 3) 50 - < 100; 4) 100 - < 200; 5) ≥ 200 patients.

In total 54,494 children (48% females) with T1D across 504 centres in seven countries were included in the study. The number of centres per country varied between 14 (Wales) and 219 (Germany). Mean (standard deviation) for age was 12.5 (3.9) years, mean age at T1D onset was 7.5

(4.0) years, and mean T1D duration was 5.0 (3.7) years. 21% of patients had minority status, which varied between 5% (Wales) and 28 % (Austria). 38.1% of patients were on pump treatment and the percentage varied between 25% (England) and 69% (Denmark). **N**ational coverage of T1D patients was above 95% in all countries, apart from Austria with about 80% data coverage. Included patients had 100% data coverage for all variables, gender, age, diabetes duration, minority status and HbA_{1c}. Data on treatment modality were not available for 2428 patients (4.5%); of them 2130 were from England and 154 from Sweden.

23.2% of centres had <50 patients (small centres) with T1D, which represented 4.9% of the total patient population. Most children (45.6%) were cared for in diabetes centres with a centre size between 100 and 200 patients. 30.2% of children were cared for in centres with more than 200 patients, representing 12.3 % of all centres. The distribution of small and large centres in the seven countries varied. England and Sweden had few small centres (< 12%) while Austria, Germany and Norway had a higher percentage of small centres (>34%). HbA_{1c} adj was significantly higher in the centres with less than 50 patients compared with larger centres (P<0.001), while there was no difference in HbA_{1c}adj with increasing centre size above 50 patients (figure). Stratification for treatment modality (insulin injection /pump) revealed that HbA_{1c}adj was significantly higher in centres with less than 50 patients compared with centres with more than 50 patients, both in pen users (P< 0.001) and pump users (P< 0.01). The influence of centre size was more pronounced in pen users, and pen users had higher HbA_{1c}adj than pump users for all centre sizes (P<0.02) (figure**).**

We conclude that the percentage of small and larger centres differed between countries, but in total the small centres (< 50 patients) comprised 23.2 percent of all diabetes centres in the seven countries. In all countries combined, childhood diabetes centres with less than 50 patients had

higher HbA_{1c}, This indicates that, where geographically possible, it may be beneficial to reduce the number of small centres and combine them into larger entities. As small centres did better on pump than pen, small remote centres may benefit from encouraging pump use. Diabetes centres with more than 50 patients managed equally well, therefore centralizing to very high-volume diabetes centres may not necessarily be an advantage. Future research should focus on identifying reasons leading to differences in glycemic control in T1D patients cared for in small and large centres, e.g the lack or presence of an updated multidisciplinary diabetes team.

ACKNOWLEDGEMENT

The authors thank all national pediatric diabetes groups, all participating centres, and all patients.

Author contribution

NHB contributed to the design of the study and data acquisition, conducted the literature search, re-searched data and wrote the manuscript. NHB takes full responsibility for the work as a whole, including the study design, and the decision to submit and publish the manuscript, and NHB is the guarantor of the work. JMH was responsible for data management, did the statistical analysis, was as such lead statistician for the project, and contributed to the manuscript; JMH has full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. LH, KAa, TS, AKD contributed to the design of the study, data acquisition and edited the manuscript drafts**.** RWH contributed to the design of the study, contributed to the manuscript, and leads the DPV registry. DC, TS contributed to the design of the study, and contributed to the manuscript. JS, JTW, RH contributed to the design of the study, data acquisition, and contributed to the manuscript. RA, AMS, SF, KDJ, SJK, BRM, AJ, TMK, DH, EFR, MF contributed to data acquisition and edited the manuscript drafts. SEH contributed to data acquisition, was involved in

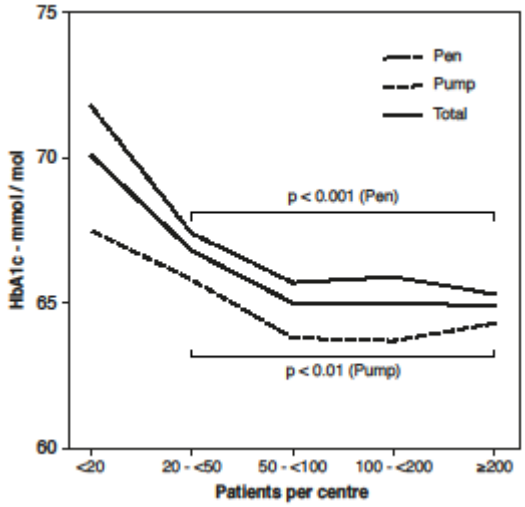
interpreting the data, and edited the manuscript drafts. All authors provided substantial contributions to data interpretation and critically reviewed and commented on several drafts of the paper.

Duality of interest:

None.

Funding

German Diabetes Association (DDG), German Centre for Diabetes Research (DZD, FKZ: 82DZD01402), European Foundation for the Study of Diabetes (EFSD), and the EU-IMI2 consortium INNODIA. University College London Children's Policy Research Unit (CPRU) is funded by the UK Department of Health Policy Research Programme (funding reference 10090001) and supported by the National Institute for Health Research Biomedical Research Centre at Great Ormond Street Hospital for Children NHS Foundation Trust and University College London. The Norwegian Childhood Diabetes Registry (NCDR) is funded by the South-Eastern Norway Regional Health Authority. The Danish National Diabetes Registry (DanDiabKids) is funded by the Health Research Fund of Central Denmark Region. The Swedish Pediatric Diabetes Quality Registry (SWEDIABKIDS) is supported from the Swedish Association of Local Authorities and Regions (SALAR). Funding sources had no role in the study design, data collection, data analysis, data interpretation, or writing of the paper.



Legend to figure

HbA_{1c} adj by centre size total and by treatment modality. Pen users had higher HbA_{1c}adj than pump users for all centre sizes (P<0.02).

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