



Poor Adherence to Ketone Testing in Patients With Type 1 Diabetes

DOI: 10.2337/dc16-2620

Anastasia Albanese-O'Neill,¹
Mengdi Wu,² Kellee M. Miller,²
Laura Jacobsen,¹ Michael J. Haller,¹
and Desmond Schatz¹, for the T1D
Exchange Clinic Network

Diabetic ketoacidosis (DKA) is an acute, still common, and preventable complication of type 1 diabetes (T1D) associated with increased health care costs, morbidity, and mortality (1,2). Clinical recommendations advise self-monitoring of ketones in people with T1D during hyperglycemia and illness to allow for early diagnosis of ketonemia or ketonuria and to reduce the risk of DKA (3,4). The potential benefits of self-monitoring of ketones can only be realized if ketone monitoring and management are conducted as advised. The purpose of this study was to characterize ketone monitoring behaviors in both children and adults with T1D who completed an online questionnaire during October and November 2015 as part of the T1D Exchange Clinic Registry.

Participants were asked a number of questions about ketone monitoring, including when and how often they checked for ketones and what method they used (urine or blood). Questionnaires for participants under 18 years of age were completed by the participant's parent or legal guardian.

Data from 2,995 participants aged 4–12 years and 18–89 years (median age 27 years, mean T1D duration 18 years, 58% female, 89% non-Hispanic white, 70% on insulin pump therapy) were included in the study. Of total respondents, 62% ($n = 1,865$) had urine ketone test strips at home, 18% (525) had a blood ketone meter at home, and 32% (965)

reported no ketone testing supplies at home at the time of the survey. Overall, 30% (904) reported “never” and 20% (591) reported “rarely” checking ketones. Checking ketones “most of the time” or “always” when the glucose level was above 300 mg/dL for an hour or more was reported by 15% (460) of all participants and by 53% (10) aged 6 years and younger, 33% (162) aged 6–12 years, 17% (149) aged 18–25 years, 7% (81) aged 26–49 years, and 11% (58) aged ≥ 50 years. Checking ketones “always” when nauseated and/or vomiting was reported by 21% (632) of overall respondents and by 68% (13) aged <6 years, 57% (275) aged 6–12 years, 23% (201) aged 18–25 years, 9% (95) aged 26–49 years, and 9% (48) aged ≥ 50 years (Fig. 1). Overall, 38% (1,140) reported “never” checking ketones when nauseated and/or vomiting, and 45% (1,333) reported “never” checking ketones when they detected a fever.

Although reported ketone self-monitoring among very young children with T1D (or their parent caregivers) adhered most closely to clinical guidelines, ketone monitoring among adult participants was infrequent when blood glucose was high, when nauseated and/or vomiting, and when fever was detected. Overall, the reported rate of ketone monitoring is low, which suggests a need for more robust diabetes education related to this self-

care behavior for patients with established T1D.

Funding. Funding was provided by the Leona M. and Harry B. Helmsley Charitable Trust.

Duality of Interest. No potential conflicts of interest relevant to this article were reported.

Author Contributions. A.A.-O. contributed to data interpretation and wrote and edited the manuscript. M.W. performed statistical analysis and wrote and edited the manuscript. K.M.M., L.J., M.J.H., and D.S. contributed to data interpretation and reviewed and edited the manuscript. K.M.M. is the guarantor of this work and, as such, had 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.

References

1. Maahs DM, Hermann JM, Holman N, et al.; National Paediatric Diabetes Audit and Royal College of Paediatrics and Child Health; DPV Initiative; T1D Exchange Clinic Network. Rates of diabetic ketoacidosis: international comparison with 49,859 pediatric patients with type 1 diabetes from England, Wales, the U.S., Austria, and Germany. *Diabetes Care* 2015;38:1876–1882
2. Tiedler JS, McLeod L, Keren R, et al.; Pediatric Research in Inpatient Settings Network. Variation in resource use and readmission for diabetic ketoacidosis in children's hospitals. *Pediatrics* 2013;132:229–236
3. American Diabetes Association. *Standards of Medical Care in Diabetes—2016*. *Diabetes Care* 2016;39(Suppl. 1):S1–S108
4. Chiang JL, Kirkman MS, Laffel LMB, Peters AL; Type 1 Diabetes Sourcebook Authors. Type 1 diabetes through the life span: a position statement of the American Diabetes Association. *Diabetes Care* 2014;37:2034–2054

¹University of Florida, Gainesville, FL

²Jaeb Center for Health Research, Tampa, FL

Corresponding author: Kellee M. Miller, t1dstats1@jaeb.org.

Received 7 December 2016 and accepted 26 December 2016.

© 2017 by the American Diabetes Association. Readers may use this article as long as the work is properly cited, the use is educational and not for profit, and the work is not altered. More information is available at <http://www.diabetesjournals.org/content/license>.

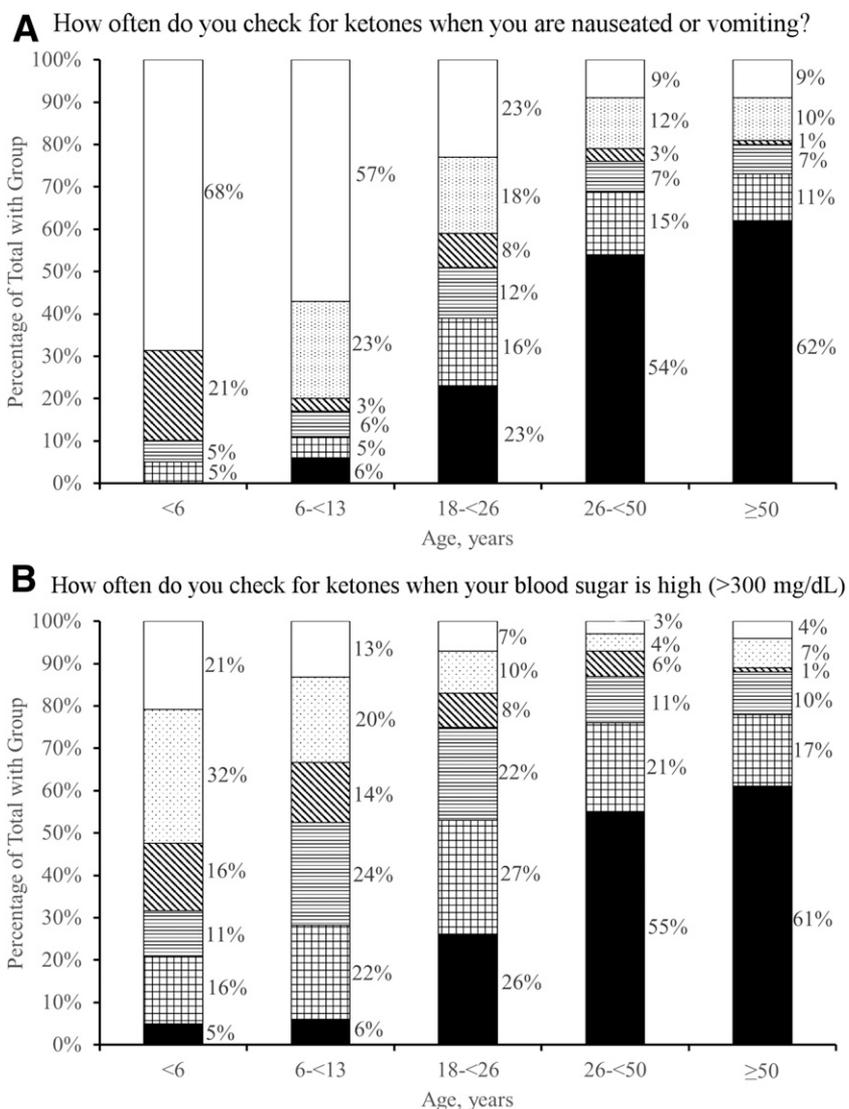


Figure 1—Frequency of ketone monitoring in T1D Exchange Clinic Registry survey participants. Solid black bar represents “never,” square line pattern bar represents “rarely,” horizontal line pattern bar represents “occasionally,” striped line pattern bar represents “about half of the time,” dotted pattern bar represents “most of the time,” and solid white bar represents “always.”