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Perceptions about professionally and non-professionally trained hypoglycemia detection dogs

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Abstract

Aims—Patients with diabetes increasingly have questions about diabetes alert dogs. This study evaluated perceptions about dogs trained professionally or otherwise to detect glucose levels.

Methods—A link to a survey about glucose detecting dogs was announced on diabetes websites.

Results—135 persons responded, with 63 answering about their child with diabetes. Most respondents obtained their dog from a professional trainer (n=54) or trained it themselves (n=51). Owners of self-and professionally-trained dogs were very positive about dogs' abilities to alert them to low and high glucose levels, while owners of dogs that learned entirely on their own (n=15) reported lower frequencies of alerts and more missed hypoglycemic episodes, $p < .01$. Regardless of how dogs learned, perceptions about managing diabetes were improved during periods of dog ownership relative to times without, $p < .001$. Self-reported rates of diabetes-related hospitalizations, assistance from others for treating hypoglycemia, and accidents or near accidents while driving reduced during periods of dog ownership compared to periods without dogs, $ps < .01$.

Conclusions—These data suggest potential effectiveness of and high satisfaction with glucose-detecting dogs. Clinicians can use these results to address pros and cons of dog ownership with patients who inquire about them.

Keywords

hypoglycemia; dogs; diabetes

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1. Introduction

Diabetes alert dogs are gaining attention in the media [1], and patients with diabetes are increasingly inquiring about dogs' abilities to identify hypoglycemic episodes. However, little scientific data exist about their effectiveness, and clinicians are unable to provide informed advice about their utility. This paper initially reviews the evidence surrounding dogs' ability to detect blood glucose levels, and it describes results from the largest survey of owners of diabetic alert dogs.

Case reports have long described altered behaviors in untrained dogs when patients with diabetes had low blood glucose levels [2–4]. Over twenty years ago, Lim et al. [5] interviewed 37 persons with diabetes whose dogs were not specifically trained to detect hypoglycemia, and 14 (38%) reported a change in their pet's behavior during a hypoglycemic episode, including barking and alerting others. Stocks [6] conducted a survey of 304 dog owners with diabetes. Of the 106 whose dogs witnessed a significant hypoglycemic event, 67.9% reported behavior such as alerting the patient or another person, agitation, barking, growling, nuzzling, and licking. Wells et al. [7] surveyed 212 persons with type 1 diabetes who were dog owners, and 65.1% indicated that their dog had a behavioral reaction to at least one hypoglycemic episode, with 31.9% of dogs reacting to 11 or more events. Thirty-six percent surveyed believed that their dogs reacted "most of the time" they had low blood glucose levels, and one-third indicated that their dogs reacted before they themselves were aware they were hypoglycemic. These findings suggest that behavioral reactions to hypoglycemic episodes may occur in some untrained dogs owned by persons with diabetes.

In addition to untrained dogs that learn to detect hypoglycemic episodes on their own, anecdotal reports exist of dog owners who specifically seek to train their dogs to detect out-of-range glucose levels, and professional training facilities exist. Rooney et al. [8] interviewed owners of 16 dogs trained by Medical Detection Dogs in the United Kingdom. Owners were highly satisfied with their dogs, and the majority of those with blood glucose data available before and after dog acquisition had significantly more values in range with the dog. Reports of unconsciousness and paramedic calls decreased with dog ownership relative to periods before dog ownership. Gonder-Frederick et al. [9] reported similar findings in a survey of 36 dog owners whose dog was trained by a trainer in the United States (US). These data provide evidence of the effectiveness of trained glucose detecting dogs, but they are limited to a small sample of owners receiving dogs from single trainers. No known studies have been directed toward individuals who sought to train a dog to detect glucose levels on their own, without professional involvement.

The present study was designed to evaluate perceptions about glucose detecting dogs in a larger and more diverse sample. The survey was available online for one year, inviting individuals to participate if they had dogs that were able to, or that were trained to, detect glucose levels. We compared perceptions about the ability of professionally trained versus self/family-trained dogs and owners of dogs that learned on their own to assess low and high blood glucose levels. We also examined owners' opinions about the utility of these dogs for diabetes management.

2. Methods

2.1

Participants were recruited via websites and word-of-mouth, such that anyone who knew a person who has or had a glucose detecting dog could forward the link. Announcements were posted on diabetes websites and chat rooms three times during the year. It read, “Researchers are conducting a survey about dogs that can detect glucose levels in persons with diabetes. If you or someone you know has such a dog, please complete our survey at [link to website].”

Inclusion criteria for the study were having had a dog that could, or that was trained to, detect out-of-range glucose levels. The survey was written at the 6th grade level and available in English only. The survey was intentionally not restricted to persons with type 1 diabetes, as anecdotal reports exist of persons with type 2 diabetes who own glucose-detecting dogs as well.

Questions were administered online using SurveyMonkey. Written informed consent was waived, but all participants read text describing the study and indicated consent by checking a box. Parents responded on behalf of children with diabetes, but a child with diabetes under age 18 could respond on his/her own, so long as s/he responded affirmatively to an item that inquired about whether parental permission had been granted to participate. Individuals unwilling to consent, and minors who did not indicate they had parental consent, were directed to a “study exit” page. University of Connecticut School of Medicine Institutional Review Board approved procedures.

Data were collected anonymously, with no identifying information. No compensation for participation was provided. Mean survey completion time was 25.9 ± 20.6 minutes.

2.2 Measures

The survey asked about demographics, diabetes history and management (e.g., type, insulin administration, duration, A1c levels and histories of complications), dog ownership (e.g., how acquired, trained/learned), dog’s reactions to low and high glucose levels, and perceptions of the utility of the dogs. Respondents who indicated having two or more glucose detecting dogs were instructed to base responses on the dog that was best at detecting levels. The survey is available from the authors, and the Results section details specific wording of items.

Two parallel survey versions were available, one for parents of children with diabetes, and one for individuals with diabetes. When a parent was responding, the word “your,” for example, was altered to “your child.” Additionally, items inquiring about glucose levels and A1cs were available in the US system using mg/dl and percentages and the international system of mmol/l and mmol/mol, so individuals could respond using the system with which they were familiar.

2.3 Data analysis

Participants were divided into one of three groups based on how their dog learned to detect glucose levels: the dog was trained in whole or part by a professional trainer; the dog was trained entirely by the person with diabetes (or the family, for children with diabetes) with no professional trainer involvement; or the dog learned on its own. Fifteen respondents did not indicate how their dogs learned to detect glucose levels; their responses are included in the total sample, but not in analyses comparing the three training groups.

Demographics, diabetes, and dog information is provided for the sample as a whole and for three groups based on how their dog learned to detect glucose levels. Responses were missing on some items, so number of respondents to each category is shown, and the sum reflects the number who answered each categorical item. Chi-squared analyses compared groups based on how their dogs learned for categorical variables, Mann Whitney U tests for ordinal variables, and ANOVA for continuous variables.

To evaluate the potential utility of dogs for managing diabetes, responses were compared on four parallel items based on periods with and without dogs: hospitalizations for complications of diabetes, times needed assistance from another person to treat a low blood sugar, glucagon injections, and accidents or near accidents while driving. One version of each item, presented early in the questionnaire, inquired about lifetime occurrences of each event, and the second version, presented later, was prefaced by, “When the dog was with you (at your side), how many times…” Wilcoxon paired-tests for non-normally distributed data compared event per year ratios derived from each respondent during periods with and without dogs. These analyses were corrected for multiple comparisons using the Bonferroni correction, with $p < .01$ considered significant due to the number of tests performed. Similar tests evaluated responses to Likert-scale items about how much having diabetes interfered with daily activities before having a dog and while having a dog.

2. Results

A total of 177 surveys were initiated between October 2012 and October 2013. Of these, 22 were terminated early, with only minimal demographic data provided, and 18 individuals completed demographic items but no questions related to dogs. One survey was completed in full about a cat and removed from analyses. Three identical survey responses were recorded over a 2-day period, presumably belonging to the same individual; responses to only one survey were included in the analyses. After removing 42 incomplete or ineligible responses, a total of 135 surveys remained.

As shown in Table 1, parents of children with diabetes completed nearly half the surveys. The youngest child with diabetes was 3 years old, and the oldest respondent was 81. Most respondents were from the US, with the most represented states being Texas (n=15), Florida (n=11), Pennsylvania (n=10), and California (n=9). Over 90% of surveys were completed by, or on behalf of, individuals with type 1 diabetes. Over half the sample reported experiencing high blood glucose levels (defined as over 240 mg/dl in the US system) and low blood glucose levels (defined as those treated with rapid acting glucose, such as under

70 mg/dl) on average four or more times per week. Nearly half the sample noted that the individual with diabetes could "never" or "rarely" detect low blood sugars on their own.

Some differences were noted across groups in demographic characteristics and diabetes management based on how the respondents' dogs learned to detect glucose levels. New England was over represented in terms of the proportion of respondents of owners of dogs that learned on their own to detect glucose levels. Although there were very few respondents with type 2 diabetes, these individuals were more likely to train dogs on their own than respondents with type 1 diabetes. Insulin pump users were significantly more likely to have professionally trained dogs than those who administered insulin by injection only. There were no differences across groups with respect to self-reported frequencies of hypoglycemia and hyperglycemia.

Table 2 displays information about the dogs. The vast majority of responses (>85%) came from persons who currently owned dogs, but respondents who no longer owned a dog were more likely to report their dog learned on its own than those who taught the dog or had it professionally trained. Those whose dogs learned on their own were also less likely to have registered their dog as a service dog, but they had greater length of dog ownership than the other training groups. The most common breed was a Labrador retriever, and this breed was overwhelmingly used by individuals who had their dogs trained by a professional. Of those with professionally trained dogs (data not shown), eight reported their dogs were donated, and of those who paid, prices ranged from $500 to $20,000 US, mean ± SD: $6,070 ± $6,119. Respondents received their dogs from 18 different trainers.

The groups differed with respect to the thresholds at which they felt their dogs could detect glucose levels. Dogs that learned on their own typically were able to respond to glucose levels only below 60 mg/dl, and very few of these dogs alerted to high glucose levels. In contrast, the family and professionally trained dogs did not differ in terms of detection thresholds, with most alerting for values under 80 mg/dl and over 160 mg/dl. Frequencies of awakenings at night also differed across groups, with professionally trained dogs alerting more often than dogs that learned on their own.

Figure 1 shows frequencies with which owners reported their dogs alerted correctly and incorrectly to low blood glucose values. Correct alerts (top) differed across training groups, χ^2 (2) = 36.12, $p < .001$, with post-hoc tests indicating owners of professionally trained dogs felt their dogs alerted correctly more often than the other groups, and owners of dogs that learned on their own the least often, *p*s < .05. Missed alerts (middle) also differed significantly across groups, χ^2 (2) = 8.34, $p < .01$, with dogs that learned on their own failing to alert to lows more often than family and professionally trained dogs, *p*s < .05. Differences across groups did not reach significance for false alarms.

The data related to alerting to high glucose levels revealed a similar pattern (data not shown; available from authors). Owners of family and professionally trained dogs were more likely to report that the dog alerted correctly than owners of dogs that learned on their own, $\chi^2(2)$ = 13.33, $p < .001$. Further, owners of dogs that learned on their own missed alerting to high glucose values more often than family or professionally trained dogs, χ^2 (2) = 13.33, $p < .001$. Rates of incorrectly alerting for high glucose levels did not differ by training group.

Table 3 shows the impact of dog ownership on self-reported diabetes-related adverse events. There were no differences between respondents of family and professionally trained dogs in frequencies of diabetes-related adverse events during periods without or with a dog (data not shown; all *p*s > .20), but owners of dogs that learned on their own had trends toward higher rates of low blood glucose levels that required help from others to treat and more hospitalizations for high blood glucose levels during periods with a dog than owners of family or professionally trained dogs (*p*s < .06). Results comparing periods of dog ownership to periods without dogs were similar whether owners of dogs that learned on their own were included or excluded, so we present the most conservative analysis including all respondents with complete data, regardless of how their dogs learned. Rates of hospitalizations, needing assistance from another to treat a low blood glucose value, and accidents or near accidents while driving were significantly lower when individuals had a dog compared to when they did not.

Respondents in the three groups did not vary in perceptions about how much diabetes interfered with daily activities (data not shown). However, perceptions about how much diabetes interfered with daily activities were significantly lower with a dog relative to without (Table 3).

Figure 2 shows responses to other survey items. In the top panel, larger proportions of owners of family and professionally trained dogs felt their dogs had saved their or their child's life on one or more occasion than owners of dogs who learned to detect glucose levels on their own, χ^2 (2) = 10.49, $p < .01$. Professionally and family trained dog owners were also more likely to rate their dogs as "extremely" useful, χ^2 (2) =19.28, $p < .001$ (middle panel), but all three groups were equally likely to recommend these dogs ($p > .50$; bottom panel). The main reservation expressed was the level of commitment required to train and re-calibrate dogs to detection thresholds (data not shown).

3. Discussion

The vast majority of respondents to this survey had trained a dog themselves to detect glucose levels or obtained a dog from a professional trainer, and few respondents had dogs that learned on their own. This later group noted significantly lower frequencies of notification for out of range glucose levels, with very few of these dogs able to detect high glucose levels. Owners of dogs that learned on their own also reported lower overall usefulness of the dog. However, professionally and self-trained dog owners reported generally similar experiences and perceptions. The vast majority indicated their dogs were "very" or "extremely" useful and that living with diabetes was easier with a glucose detecting dog than without one.

These overall positive experiences may reflect a response bias. Persons who were satisfied with their glucose detecting dogs may have been more likely to complete the survey than those who had these dogs but did not find them helpful in managing diabetes. Further, the sampling methods relied primarily on advertisements on diabetes websites, and people who participate in these websites may differ from people with diabetes who do not. A snowballing technique was also employed, but website participants may have been most likely to forward the survey link to persons they knew were satisfied with their glucose detecting dogs. Thus, it is not clear how generalizable these results are to all owners of dogs that were trained to detect glucose levels, and few surveys were completed by owners of dogs that learned on their own. Nevertheless, this survey did reach a large number of persons who obtained dogs from a range of training facilities, and a nearly equal number of persons who trained a dog on their own, without professional involvement.

As a whole, respondents to this survey appeared highly adherent to their own diabetes care and management, as shown in Table 1. The self-reported mean number of blood glucose tests was over 6 per day, and modal A1c levels were under 7.5% (58 mmol/mol). The vast majority of respondents were using insulin pumps. Nearly half the respondents were parents of children with diabetes, indicating dogs may be overrepresented for use in younger patients. In part due to use of dogs with children in this sample, rates of hypoglycemia unawareness were high, with nearly half reporting they (or their child) rarely or never detected low blood sugars on their own. Thus, persons with diabetes who own glucose detecting dogs and responded to this survey appear different than their counterparts with diabetes who do not own these dogs in terms of diabetes management and ability to detect hypoglycemia.

Analyses of adverse events per year of diabetes indicated significantly lower rates of hospitalizations, needing assistance from another to manage a low blood sugar, and near accidents while driving when respondents had dogs relative to when they did not. Rates of glucagon injections per year were also numerically higher during periods without a dog relative to periods with one, although this comparison was not statistically significant after correcting for multiple testing. Although these data were based entirely on self reports and may reflect recall biases, they parallel those from another report [8] and together suggest that the dogs may have utility in preventing complications of diabetes and its treatment. Most dog owners felt their dogs had saved their (or their child's) life on one or more occasion.

Although these results suggest perceived utility of glucose detecting dogs, there are a number of limitations. In addition to concerns about sampling noted above, comparison of adverse events during periods with and without a dog may be confounded by overall improvements in diabetes care and management over time. Further, objective indices were not collected, and all questions relied on self reports, with recall periods of years previously in some cases.

Nevertheless, these results, while preliminary, are derived from the largest, and thus far most generalizable, survey related to glucose detecting dogs. How these dogs detect glucose levels is not well understood. Presumably, they rely on scent, but a recent report [10] found that three ostensibly well-trained dogs from a professional training facility could not detect hypoglycemic samples at rates better than chance when skin samples were taken during hypoglycemic and normoglycemic episodes from persons with type 1 diabetes with whom the dogs were unfamiliar and from whom the dogs had no behavioral cues. As noted in response to an open-ended question on this survey, training and consistently re-calibrating the dogs on glucose level detection entails considerable work, whether the dog was trained by the owner or a professional. Studies using blinded continuous glucose monitors and detailed record keeping of dog alerts may elucidate the ability of these dogs to detect hypo- and hyperglycemic episodes. Systematic studies of the efficacy and effectiveness of these dogs during periods before and with a dog are also warranted.

Clinicians can use results from this survey to review the potential benefits and limitations of glucose detecting dogs with their patients who have questions about them. These data suggest that owner- and professionally-trained dogs can ease some of the burden associated with living with diabetes. Persons who trained dogs themselves or obtained dogs from professional trainers were generally very positive about them, including feeling they had saved their or their child's lives on occasion, with regular altering during the night. Most persons with these dogs were highly adherent to their own (or their child's) diabetes care, and importantly, clinicians must convey that these dogs are clearly not a substitute for diligently monitoring blood glucose levels and treating appropriately those levels. Clinicians should also emphasize that the dogs require substantial work to train and recalibrate to ensure continued ability to detect out-of-range glucose levels. Nevertheless, they may aid in detecting out of range glucose levels when appropriately trained, and persons with commitment to training them do perceive substantial benefits from them.

Acknowledgments

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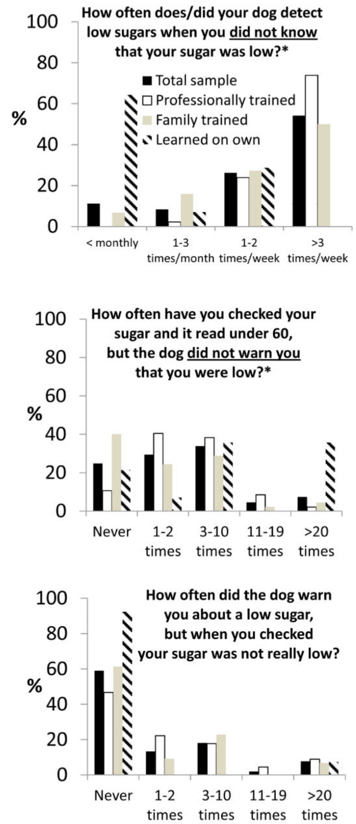

Figure 1.

Responses to items about detecting low blood sugar levels. Low blood sugars were defined for respondents as those requiring administration of fast acting glucose (e.g., under 70 mg/dl). Proportions of persons endorsing each response category are shown for the full sample (n = 135) in filled black bars. Additionally, proportions of persons endorsing each response category are also shown based on how the dogs learned to detect glucose levels; owners of professionally trained dogs are shown in open bars (n = 54), owners who trained the dogs themselves are shown in grey bars (n = 51), and owners of dogs who learned on their own are shown in hatched bars (n = 15). The asterisks indicate statistically significant differences between the three groups. See text for further details.

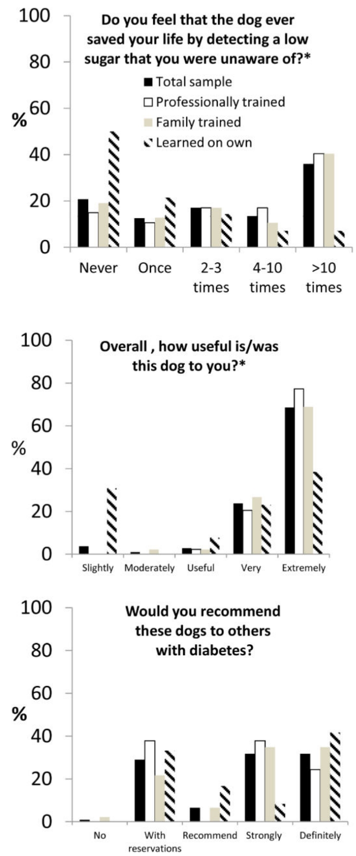

Figure 2.

Responses to items about perceptions of glucose detecting dogs. Proportions of respondents endorsing each response category are shown for the full sample (n = 135) in filled black bars. Additionally, proportions of persons endorsing each response category are also shown based on how the dogs learned to detect glucose levels; owners of professionally trained dogs are shown in open bars (n = 54), owners who trained the dogs themselves are shown in grey bars (n = 51), and owners of dogs who learned on their own are shown in hatched bars (n = 15). The asterisks indicate statistically significant differences between the three groups. See text for further details.

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Table 1

Demographic and diabetes characteristics. Values represent means and standard deviations unless otherwise noted.

	Total sample*	Dog trained in part or whole by professional	Dog trained entirely by self or family	Dog learned on its own	Analyses across training groups
% (n)	135	43.2 (54)	35.2 (51)	12.8 (15)	
Child has diabetes, % (n)	46.7 (63)	59.3 (32)	39.2 (20)	40.0 (6)	$\chi^2(2)=4.70$, $p=.10$
Age of child with diabetes	11.7 ± 5.2	11.1 ± 5.0	11.8 ± 4.3	13.7 ± 7.7	$F(2,57)=0.75$, $p=.48$
Age of adult with diabetes	42.1 ± 15.9	38.9 ±15.9	43.8 ± 14.1	42.7 ± 17.9	$F(2,61)=0.69$, $p=.50$
Person with diabetes is female, % (n)	65.9 (89)	61.1 (33)	68.6 (35)	66.7 (10)	$\chi^2(2)=0.67$, $p=.72$
Education of respondent, % (n)					$\chi^2(8)=8.57$, $p=.38$
Still in school	3.7 (5)	5.6 (3)	0.0 (0)	6.7 (1)	
High school or less	8.2 (11)	7.4 (4)	7.8 (4)	0.0 (0)	
Some college	35.5 (48)	35.2 (19)	41.2 (21)	33.3 (5)	
College graduate	27.4 (37)	35.2 (19)	21.6 (11)	26.7 (4)	
Advanced degree	25.2 (34)	16.7 (9)	29.4 (15)	33.3 (5)	
Family income, % (n)					$\chi^2(8)=7{,}32$, $p=.50$
Under $50,000	26.4 (28)	23.9 (11)	27.9 (12)	14.3 (1)	
$50,000–$75,000	23.6 (25)	19.6 (9)	25.6 (11)	57.1 (4)	
$75,000–$100,000	18.5 (20)	19.6 (9)	20.9 (9)	14.3 (1)	
$100,000–$150,000	21.7 (23)	28.3 (13)	14.0 (6)	14.3 (1)	
Over $150,000	9.4 (10)	8.7 (4)	11.6 (5)	0.0 (0)	
Live alone, % (n)	8.1 (11)	9.3 (5)	5.9 (3)	13.3 (2)	$\chi^2(2)=0.95$, $p=.62$
Place of residence, % (n)					$\chi^2(2)=24.58$, $p<.02$
New England, USA	11.9 (16)	5.6 (3)	8.0 (4)	40.0 (6)	
South, USA	37.3 (50)	44.4 (24)	38.0 (19)	13.3 (2)	
Midwest, USA	29.1 (39)	31.5 (17)	28.0 (14)	33.3 (5)	
West, USA	15.7 (21)	18.5 (10)	16.0 (8)	6.7 (1)	
Canada	3.7 (5)	0.0 (0)	4.0 (2)	6.7 (1)	
Europe (Germany, UK)	1.4 (2)	0.0 (0)	4.0 (2)	0.0 (0)	
Australia	0.7 (1)	0.0 (0)	2.0 (1)	0.0 (0)	
Type 1 diabetes, % (n)	93.2 (124)	100.0 (54)	88.0 (44)	100.0 (15)	$\chi^2(2)=8.72$, $p<.01$

	Total sample*	Dog trained in part or whole by professional	Dog trained entirely by self or family	Dog learned on its own	Analyses across training groups
Insulin pump user, % (n)	86.0 (111)	96.2 (51)	83.3 (40)	73.3 (11)	$\chi^2(2)=7.41$, $p<.03$
Years with diabetes, % (n)	13.5 ± 12.8	11.5 ± 11.8	15.5 ± 13.0	16.7 ± 15.7	$F(2,118)=1.68$, $p=.19$
Blood sugar checks per day	6.5 ± 2.0	7.0 ± 1.6	6.2 ± 2.1	6.2 ± 1.9	$F(2,116)=2.31$, $p=.10$
Average last year A1c, % (n)					$\chi^2(8)=10.59$, $p=.23$
7.0% or lower (<53 mmol/mol)	36.3 (49)	40.7 (22)	38.3 (18)	13.3 (2)	
7.1% to 7.5% (54–59 mmol/mol)	30.4 (41)	35.2 (19)	31.9 (15)	26.7 (4)	
7.6% to 8.0% (60–64 mmol/mol)	13.3 (18)	11.1 (6)	12.8 (6)	26.7 (4)	
8.1% to 8.5% (65–69 mmol/mol)	7.4 (10)	7.4 (4)	8.5 (4)	6.7 (1)	
Over 8.5% (>70 mmol/mol)	8.9 (12)	5.6 (3)	8.5 (4)	26.7 (4)	
Frequency of low blood glucose levels (e.g., <70), % (n)					$\chi^2(8)=8.34$, $p=.40$
Once a month or less	7.4 (10)	5.6 (3)	6.0 (3)	13.3 (2)	
More than monthly, but less than weekly	14.9 (20)	5.6 (3)	22.0 (11)	20.0 (3)	
About 1–3 times per week	30.6 (41)	37.0 (20)	26.0 (13)	26.7 (4)	
About 4–6 times per week, but not daily	20.1 (27)	22.2 (12)	22.0 (11)	13.3 (2)	
One or more per day	26.9 (36)	29.6 (16)	24.0 (12)	26.7 (4)	
Frequency of high blood glucose levels (e.g., >240), % (n)					$\chi^2(8)=4.74$, $p=.79$
Once a month or less	7.5 (10)	3.7 (2)	6.0 (3)	13.3 (2)	
More than monthly, but less than weekly	11.2 (15)	13.0 (7)	10.0 (5)	6.7 (1)	
About 1–3 times per week	32.8 (44)	33.3 (18)	36.0 (18)	20.0 (3)	
About 4–6 times per week, but not daily	26.1 (35)	29.6 (16)	22.0 (11)	26.7 (4)	
One or more per day	22.4 (30)	20.4 (11)	26.0 (13)	33.3 (5)	
How often detect low blood glucose levels on own, % (n)					$\chi^2(8)=3.62$, $p=.89$
Always or almost always	8.9 (12)	7.4 (4)	7.8 (4)	13.3 (2)	
Usually	21.5 (29)	20.4 (11)	21.6 (11)	26.7 (4)	
Sometimes	25.2 (34)	24.1 (13)	25.5 (13)	20.0 (3)	
Rarely	23.7 (32)	22.2 (12)	25.5 (13)	33.3 (5)	
Never/hypoglycemia unawareness	20.7 (28)	25.9 (14)	19.6 (10)	6.7 (1)	

*Total sample also includes 15 respondents who did not indicate how dog learned to detect glucose levels. Not all columns add to total sample size because some participants did not respond to all items.

Table 2

Information about dogs

	Total*	Dog trained in part or whole by professional	Dog trained entirely by self or family	Dog learned on its own	Analyses across training groups
% (N)	100.0 (135)	43.2 (54)	35.2 (51)	12.8 (15)	
Currently have a dog, % (n)	86.4 (114)	94.4 (51)	94.0 (47)	53.3 (8)	$\chi^2(2)=22.54$, $p<.001$
Years with dog	2.6 ± 3.1	1.9 ± 2.8	2.5 ± 2.4	5.9 ± 4.9	$F(2,116)=10.08$, $p<.001$
Registered as service dog, % (n)	53.3 (63)	79.5 (35)	51.3 (26)	7.1 (1)	$\chi^2(2)=23.73$, $p<.001$
Dog breed					$\chi^2(114)=44.53$, $p<.001$
Labrador retriever	45.7 (58)	72.2 (39)	33.3 (17)	7.1 (1)	
German shepherd	9.4 (12)	13.0 (7)	5.9 (3)	7.1 (1)	
Golden retriever	8.7 (11)	1.9 (1)	13.7 (7)	21.4 (3)	
Goldendoodle, Labradoodle	8.7 (11)	9.3 (5)	7.8 (4)	7.1 (1)	
Poodle	3.9 (5)	1.9 (1)	5.9 (3)	7.1 (1)	
Terrier	3.9 (5)	0.0 (0)	5.9 (3)	14.3 (2)	
Australian shepherd	2.4 (3)	0.0 (0)	3.9 (2)	0.0 (0)	
Other	17.3 (22)	1.9 (1)	23.5 (12)	35.7 (5)	
(Of those whose dog sleeps in the room) How often has the dog woken you up at night because of a low sugar?					$\chi^2(10)=32.42$, $p<.001$
Very often (3+ times/week)	10.8 (11)	6.8 (3)	19.0 (8)	0.0 (0)	
Often (1–2 times/week)	25.5 (26)	40.9 (18)	11.9 (5)	15.4 (2)	
Occasionally (1–3 times/month)	25.5 (26)	27.3 (12)	23.8 (10)	15.4 (2)	
Sometimes (but < monthly)	14.7 (15)	13.6 (6)	11.9 (5)	30.8 (4)	
Very rarely (< yearly)	11.8 (12)	6.8 (3)	9.5 (4)	38.5 (5)	
Never	11.8 (12)	4.5 (2)	23.8 (10)	0.0 (0)	
Level at which dog could detect low glucose values					$\chi^2(2)=20.81$, $p<.001$
Less than 90	31.8 (35)	39.1 (18)	34.0 (16)	0.0 (0)	
Less than 80	39.1 (43)	45.7 (21)	38.3 (18)	21.4 (3)	
Less than 70	16.4 (18)	13.0 (6)	14.9 (7)	28.6 (4)	
Less than 60	9.1 (10)	0.0 (0)	10.6 (5)	35.7 (5)	
Less than 50	3.6 (4)	2.2 (1)	2.1 (1)	14.3 (2)	
Level at which dog could detect high glucose values					$\chi^2(2)=18.29$, $p<.001$

	Total*	Dog trained in part or whole by professional	Dog trained entirely by self or family	Dog learned on its own	Analyses across training groups
Over 120	4.3 (4)	7.1 (3)	2.4 (1)	0.0 (0)	
Over 160	38.3 (36)	47.6 (20)	39.0 (16)	0.0 (0)	
Over 200	27.7 (26)	33.3 (14)	22.0 (9)	12.5 (1)	
Over 240	10.6 (10)	7.1 (3)	12.2 (5)	25.0 (2)	
Over 300	6.4 (6)	2.4 (1)	12.2 (5)	0.0 (0)	
Over 400	1.1 (1)	0.0 (0)	2.4 (1)	0.0 (0)	
Cannot detect high values	11.7 (11)	2.4 (1)	9.8 (4)	62.5 (5)	

*Total sample also includes 15 respondents who did not indicate how dog learned to detect glucose levels. Not all columns add to total sample size because some participants did not respond to all items.

Table 3

Impact of diabetes during periods with and without a dog.

	Without a dog	**With a dog**	***Z* (n), *p***
"How many times were you hospitalized for diabetic ketoacidosis (DKA) or other problems related to high blood sugars (do not include hospitalizations at time of diagnosis)?"	0.12 ± 0.40	0.02 ± 0.11	*Z* (102) = 3.44, *p* < .001
None, % (n)	72.5 (74)	96.1 (98)	
One or more, % (n)	27.5 (28)	3.9 (4)	
"How many times have you needed help from another person to treat a low blood sugar?" [a]	0.93 ± 1.97	0.63 ± 1.70	*Z* (102) = 2.86, *p* < .001
None, % (n)	24.5 (25)	70.6 (72)	
One or more, % (n)	75.5 (77)	29.4 (30)	
"How many times have you had a glucagon injection because of a low sugar?"	0.22 ± 1.07	0.13 ± 0.59	*Z* (103) = 2.19, *p* = .03
None, % (n)	66.0 (68)	90.3 (93)	
One or more, % (n)	34.0 (35)	9.7 (10)	
"How many times have you had an accident or near accident when driving a car because of a low blood sugar?" [b]	0.07 ± 0.24	0.01 ± 0.06	*Z* (48) = 3.21, *p* < .001
None, % (n)	60.4 (29)	97.9 (47)	
One or more, % (n)	39.6 (19)	2.1 (1)	
"How much does/did diabetes interfere with normal daily activities?" mean Likert rating (range 0 – 4) ± standard deviation	2.7 ± 1.1	1.6 ± 1.0	*Z* (104) = 6.87, *p* < .001
Not at all, % (n)	2.9 (3)	12.5 (13)	
A little, % (n)	14.4 (15)	39.4 (41)	
Moderately, % (n)	26.9 (28)	31.7 (33)	
Somewhat seriously, % (n)	26.0 (27)	12.5 (13)	
Seriously, % (n)	29.8 (31)	3.8 (4)	

Values reported are calculated means ± standard deviations for years of diabetes with and without a dog, unless noted.

[a] Parents of young children were instructed to include only times the child was unable to eat or drink on his or her own; providing appropriate drinks and foods to treat a low sugar in a child was not included.

[b] Only drivers were included in this question.