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1 **Acceptance of home blood glucose monitoring by owners of recently diagnosed diabetic cats, and**
2 **impact on quality of life changes in cat and owner**

3

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23 A part of this study was presented as an oral abstract presentation at the 25th ECVIM-CA annual congress in
24 2015 in Lisbon, Portugal.

25 **Keywords**

26 diabetes mellitus, cat, home monitoring, quality of life, glycaemic control, blood glucose, remission

27 **Abstract**

28 **Objectives**

29 This study aimed to evaluate the acceptance of home blood glucose monitoring (HBGM) by owners of
30 recently diagnosed diabetic cats, and the impact of choosing HBGM on the quality of life (QoL) changes of cat
31 and owner, in addition to glycaemic changes during 6 months' follow-up.

32 **Methods**

33 Owners of cats diagnosed with diabetes mellitus (DM) and treated with insulin for 6-20 weeks were divided
34 into a HBGM group and a non-HBGM group based on their ability and willingness to perform HBGM after
35 standardised instruction session. The HBGM acceptance level and reasons for acceptance failure were
36 documented; a questionnaire evaluated owners' experiences. For the following 6 months, changes in QoL,
37 measured using the validated DIAQoL-pet quantification tool, and changes in glycaemic control parameters
38 (clinical signs, serum fructosamine, blood glucose curve average/minimal/maximal/pre-insulin blood glucose
39 [BG]) were compared between HBGM and non-HBGM groups at months 1, 3 and 6, as well as within the
40 groups between baseline and months 1, 3 and 6.

41 **Results**

42 Thirty-eight cats were enrolled; 28 (74%) entered the HBGM group. There was no significant difference
43 between groups in overall DIAQoL-pet score or glycaemic control parameters at any time point apart from the
44 maximal BG at month 6 (lower in the HBGM group). However, the DIAQoL-pet score, including indicators of
45 owner worry about DM, worry about hypoglycaemia and costs, as well as glycaemic parameters, improved at
46 all time-points within the HBGM group, but not within the non-HBGM group. Remission occurred in 9/28 (32%)
47 HBGM group cats and 1/10 (10%) non-HBGM group cats ($p=0.236$).

48 **Conclusions and Relevance**

49 HBGM was adopted successfully by most diabetic cat owners. Despite the extra task, positive changes in
50 QoL-parameters occurred in the HBGM group and not in the non-HBGM group. Although no difference was
51 found in glycaemic control between HBGM and non-HBGM group during the 6 months' follow-up, significant
52 glycaemic improvements were documented in the HBGM group.

53

54 **Introduction**

55 The management of feline diabetes mellitus (DM) is complex and is facilitated by cat owners understanding
56 the disease and their active participation in treatment. These factors help achieve the main treatment goals,
57 which include resolution of clinical signs and avoidance of hypoglycaemia and diabetic complications.^{1,2}
58 However, the daily involvement in the management of their pets' diabetes can also be perceived as a
59 substantial burden by some owners.^{3,4} A tool called DIAQoL-pet has been developed and psychometrically
60 validated to qualify and quantify the quality of life (QoL) of diabetic pets and their owners, allowing more
61 specific monitoring of this important aspect of feline diabetes, alongside more traditional glycaemic
62 parameters.^{3,4}

63 Although not considered a main treatment goal,^{1,2} some diabetic cats enter diabetic remission. The highest
64 remission rates have been reported in cats where good glycaemic control has been established early in the
65 course of the disease.^{5,6} The role of home blood glucose monitoring (HBGM) in achieving early good
66 glycaemic control has been widely acknowledged and has been included in the latest guidelines for
67 management of DM in cats.² In human medicine, self-monitoring of blood glucose (SMBG) has been an
68 integral part of management of humans with type 1 and insulin-treated type 2 diabetes for many decades.⁷
69 However, although the recommendations for treatment of human diabetes emphasise the utility of SMBG to
70 assess individual responses to therapy and prevention of hypoglycaemia, concerns about the potential
71 impacts of SMBG on QoL, particularly in people with type 2 DM, have been raised.^{8,9} In veterinary medicine,
72 the difficulties pet owners might encounter and the reasons for reluctance to perform HBGM have been
73 sporadically addressed in previous canine and feline studies.¹⁰⁻¹³ However, these reports were mostly
74 concerned with biological effects as outcome parameters and merely listed what owners perceived as
75 challenges and benefits of HBGM. A prospective assessment of the possible psychosocial impact of HBGM,
76 using an objective validated measure such as the DIAQoL-pet, in a substantial number of patients with a
77 longer-term follow-up is yet to be reported in veterinary medicine.

78 The main aim of this study was therefore to evaluate the acceptance of HBGM by cat owners and its impact
79 on QoL changes in diabetic cats and their owners over a 6-month period using the previously validated QoL
80 tool, DIAQoL-pet.³ A secondary aim was to assess the effect of HBGM on glycaemic changes over the same
81 time period.

82

83 **Materials and methods**

84 Cats diagnosed with DM \leq 5 months previously and treated with insulin for at least 6 weeks prior to enrolment
85 were recruited for the study between October 2013 and September 2015. The study was approved by the
86 institutional Clinical Research and Ethical Review Board and was performed under Home Office Licence no.
87 70/7393. The diagnosis of DM was made based on a combination of appropriate clinical signs (polyuria,
88 polydipsia, polyphagia, weight loss) and laboratory parameters (hyperglycaemia [blood glucose (BG) >15
89 mmol/L], glycosuria). Cats were excluded if they received short-acting systemic glucocorticoids in the previous
90 month, depot glucocorticoids in the previous 2 months or progestogens in the previous 6 months. Cats were
91 also excluded if they were diagnosed with diabetic ketoacidosis at initial evaluation, if they were diagnosed
92 and treated for hyperthyroidism (except for cats successfully treated with radioactive iodine or thyroidectomy)
93 or were diagnosed with severe disease that could increase the risk associated with study participation or
94 require long-term medication. All cats were screened for hypersomatotropism and if found positive (based on
95 insulin-like growth factor 1 [IGF-1] >1000 ng/mL)¹⁴ were not included.

96 On initial presentation, a thorough history was taken and physical examination, including body weight (BW),
97 estimation of body condition score (BCS; 1-9/9)¹⁵ and percentage of body fat (% of BF)¹⁶, were performed.
98 The severity of each cat's clinical signs at trial recruitment was graded using the validated clinical scoring
99 system (Diabetic Clinical Score) shown in Table 1.¹⁷ Cat owners were also asked to complete the DIAQoL-pet
100 survey to assess the influence of DM and its treatment on QoL.³ The DIAQoL-pet generated an Average-
101 Weighted Impact Score (AWIS) to reflect pet and owner QoL, with more negative values reflecting a more
102 negative impact of DM.^{3,4}

103 All cats underwent initial screening tests including complete blood count (CBC), plasma biochemistry, full
104 urinalysis (including urine culture), and serum fructosamine, total T4 (TT4), feline pancreatic lipase
105 immunoreactivity (fPLI), IGF-1 measurement, and abdominal ultrasound. A 24-hour blood glucose curve
106 (BGC) was performed on each cat after admission, using either a continuous glucose monitoring system for
107 the measurement of glucose in the subcutaneous interstitial fluid (Guardian REAL-Time system, Medtronic) or
108 serial BG measurements in capillary blood collected from the ear using a portable BG meter (AlphaTRAK[®] 2,
109 Zoetis). In the latter case, BG was measured every 2 hours or more frequently if hypoglycaemia (BG <3
110 mmol/L) occurred. All cats were then transitioned onto a longer-acting insulin type (recombinant human
111 protamine zinc insulin [PZIR; ProZinc, Boehringer Ingelheim] or synthetic insulin analogue glargine [Lantus,
112 Sanofi]) at an initial dose of 0.2-0.7 U/kg. Cats were fed a low carbohydrate, high protein diet (Purina Pro Plan

113 DM, Nestle Purina PetCare; wet or dry, depending on cat's preference), which commenced at least 10 days
114 prior to the enrolment visit.

115 At discharge from the hospital, all cats received comprehensive introduction to HBGM which took at least 30
116 minutes. Owners were shown how to obtain a blood drop using the marginal ear vein technique and they
117 practised the technique on their own cat with the clinician. Cat owners were also taught how to use the
118 glucometer for measurement and how to calibrate it. To generate data for a BGC, owners were asked to
119 measure BG every 2 hours over a 12-hours period, starting just before morning feeding and insulin injection,
120 and finishing just before evening feeding and insulin injection. Owners were asked to record the data and
121 send the results to the research clinic and describe any clinical signs of diabetes that occurred around the
122 time of the BGC. Owners were asked to perform a BCG at the 1-week and 2-, 4- and 5-month trial time-points,
123 and also 1-2 weeks after any insulin dose adjustments. If owners did not perform HBGM, it was requested that
124 these BGCs were performed at the cat's primary-care practice. Cats that entered diabetic remission were
125 initially monitored using spot blood glucose checks 2-4 times weekly, but spot blood glucose measurements
126 were not otherwise routinely requested for monitoring.

127 Re-examinations at the research clinic were performed 2 weeks, 1 month, 3 and 6 months after joining the
128 trial. At these time points, a full history and physical examination, serum fructosamine measurement, diabetic
129 clinical score (DCS), and a 24-hour BGC were performed in all cats. Owners were also asked to complete the
130 DIAQoL-pet survey. Additional monthly to bimonthly re-examinations took place at the referring veterinary
131 practices, depending on the needs of individual cats. During the study, insulin dose was adjusted according to
132 a single, nadir-led protocol, based on BGC results.¹⁷ Diabetic remission was defined as not requiring insulin
133 for more than 4 weeks.

134 Owners were considered to have successfully adopted HBGM ("HBGM group") if they had performed a
135 minimum of 2 BGCs at home within the first 3 months of enrolment. The remaining owners and their cats
136 were included in the "non-HBGM group". This arbitrary cut-off of 2 BGCs was chosen, since the investigators
137 explicitly did not want to include owners into the HBGM group if they had successfully performed one curve,
138 though decided against further testing as a result of this experience.

139 At the end of the study period, owners were contacted by email and/or telephone and asked to complete a
140 questionnaire to describe their experiences with HBGM. The owners of cats included in the HBGM group were
141 asked about their general opinions of HBGM (e.g. if their lives were restricted by HBGM;
142 advantages/disadvantages of HBGM), the technique used for generating the BGCs, and difficulties they

143 encountered during HBGM (Supplement 1). The owners of cats in the non-HBGM group were asked why they
144 decided not to perform HBGM, or, if they performed some monitoring but then discontinued, why they
145 discontinued (Supplement 2).

146

147 **Statistical analysis**

148 The data were tested for normality where appropriate (Shapiro-Wilks test). Signalment, BW, BCS, % of BF,
149 fPLI, total number of BGCs performed during the study period, the time on insulin prior to enrolment, insulin
150 type choice (PZIR vs. glargine) and the insulin dose at enrolment were compared between cats in the HBGM-
151 and non-HBGM group using Mann-Whitney and Chi-Square tests, as appropriate. To evaluate the impact of
152 HBGM on QoL changes in diabetic cats and owners, total DIAQoL-pet score and individual item-weighted
153 impact scores (IWIS) for specific questions (Table 2) were compared between HBGM- and non-HBGM groups
154 at enrolment and 1, 3 and 6 months after joining the trial. Similarly, DCS, twice-daily insulin dose and
155 parameters of glycaemic control (serum fructosamine, average BG, average pre-insulin BG, minimal and
156 maximal BG) were compared between the HBGM- and non-HBGM group at the same time points. Remission
157 rate between groups (HBGM- vs. non-HBGM group) and the effect of the insulin type used (PZIR vs. glargine)
158 on whether owners achieved HBGM, were compared using Chi-Square tests.

159 DIAQoL-pet score, IWIS for specific questions (as above), DCS, insulin dose and parameters of glycaemic
160 control (as above) were compared within each group to assess changes in QoL and glycaemic control over
161 time. Wilcoxon Signed Ranks test were used to compare values at months 1, 3 and 6 to baseline (enrolment)
162 values.

163 Statistical analysis was performed using commercially available statistical software (SPSS version 22, IBM
164 Statistics).

165

166 **Results**

167 Sixty-three cats were initially screened prior to enrolment in the 6-month trial and 46 cats were enrolled.

168 Reasons for exclusion of the 17 cats were as follows: neoplastic disease/mass lesion (n=4); probable
169 hypersomatotropism (on the basis of IGF-1>1000 ng/mL; n=3); excessively fearful or aggressive cats (n=3);
170 cats already non-insulin dependent based on an in-hospital BGC (n=2); hyperthyroidism (n=1);
171 gastrointestinal disease (n=1); clinical signs suggestive of a forebrain disease (n=1); hypertrophic

172 cardiomyopathy with congestive heart failure (n=1); and cat owners declining study enrolment due to time
173 constraints (n=1).

174 Among the 46 cats enrolled in the 6-month trial, 8 were already performing HBGM, leaving 38 cats for study
175 inclusion. Owners of 28 cats (74%) were able to perform HBGM (HBGM group). The remaining 10 cats (26%)
176 were included in the non-HBGM group.

177 There was no significant difference in the signalment, BW, BCS, % of BF, fPLI, time on insulin, insulin dose
178 prior to enrolment, choice of insulin (PZIR vs glargine) between cats in the HBGM- and non-HBGM groups
179 (Table 3). In the non-HBGM group, 90% cats (n=9) were male neutered compared to 46% (n=13) in the
180 HBGM group (p=0.025).

181 Cats in the HBGM group had a median of 5 (range 2-10) BGCs performed at home, while cats in the non-
182 HBGM had a median of 2.5 (range 1-7) BGCs performed at their primary veterinary practices during the 6-
183 months follow-up period. Each cat had additional 4 (range 2-4) BGCs performed at the research clinic during
184 the same time period. The total number of BGCs (including curves performed at home, at the primary
185 veterinary practices and at the research clinic) was not significantly different between the HBGM and non-
186 HBGM group (p=0.082).

187 There was no difference between the HBGM- and non-HBGM group in regard to the total DIAQoL-pet score,
188 scores for specific questions, DCS, insulin dose, or parameters of glycaemic control at any time point during
189 the study, except for maximal BG at month 6, which was lower in the HBGM group (p=0.03; data shown in
190 Supplement 3) (Figures 1-3, Table 3, Supplement 3). Total DIAQoL-pet score was significantly improved at
191 months 1, 3 and 6 compared to baseline in the HBGM group but not in the non-HBGM group (Figure 1, Table
192 4). There were significant decreases in scores (and therefore positive impact) for general worry about
193 diabetes (“worry”; months 1, 3 and 6) and worry about hypoglycaemia in particular (“worry hypo”; months 3
194 and 6), and worry about costs (months 3 and 6) in the HBGM group. There were also significant decreases in
195 scores (indicating positive impact) for “restriction of owners’ activities” and “work restrictions” (month 6) in the
196 HBGM group (Table 4). Overall, the scores for 6 of 9 specifically examined QoL areas had improved at month
197 6 compared to baseline in the HBGM group (Table 4) but not in the non-HBGM group (Supplement 4). There
198 were also significant reductions (i.e. improvements) in DCS, insulin dose and most parameters of glycaemic
199 control (fructosamine, average BG, average pre-insulin BG, minimal/maximal BG) at months 1, 3 and 6
200 compared to baseline in the HBGM group (Figures 2 and 3, Table 5), except for minimal BG at months 3 and
201 6. In the non-HBGM group, DCS also decreased at months 1, 3 and 6 compared to baseline (p<0.05).

202 Regarding insulin dose and parameters of glycaemic control in this group, only average pre-insulin BG at
203 month 6 and maximal BG at month 1 were significantly different (lower; $p < 0.05$) from baseline (Supplement 5).
204 Diabetic remission occurred in 9/28 (32%) cats in the HBGM- and 1/10 (10%) cats in the non-HBGM group
205 ($p = 0.236$).
206 Nineteen (68%) questionnaires were completed by owners of cats in the HBGM group. Ten of the 19 (53%)
207 owners performed >10 BGCs and 17/19 (89%) found HBGM “straightforward” or “mostly straightforward” to
208 perform; 2/19 (11%) respondents described it as “difficult”. Technical difficulties (pricking the ear, obtaining
209 sufficient blood) were the most common challenges reported by 10/19 (53%) owners, followed by finding time
210 to perform HBGM ($n = 6/19$; 32%), and gaining confidence ($n = 5/19$; 26%). Ten of the 19 (53%) respondents felt
211 that their lives were not at all/not really restricted by HBGM, while 6/19 (32%) and 4/19 (21%) reported mild or
212 moderate restriction, respectively. Most owners mentioned several advantages of HBGM; not having to take
213 their cat to the veterinarian ($n = 16/19$; 84%) or leave the cat at the practice ($n = 11/19$; 58%) were the most
214 commonly reported. A summary of the advantages and disadvantages of HBGM, and a description of the
215 technique and difficulties encountered during HBGM, can be found in Table 6. Of cats in the HBGM group that
216 were alive at the time of writing, all owners were still performing HBGM.
217 Three of 10 questionnaires in the non-HBGM group were completed. Two owners managed to perform a few
218 spot blood glucose measurements but not a whole curve; one owner tried performing curves but did not
219 succeed. The reasons for discontinuing HBGM were stated as lack of assistance ($n = 2$); a perception that the
220 cat was anxious ($n = 3$); difficulties obtaining a blood drop ($n = 2$) or using a glucometer ($n = 2$); and the
221 perception that he/she was hurting the cat ($n = 1$). Despite not being successful, one owner expressed a desire
222 to try HBGM again, while the other two would “probably not”/“not” try it again.

223

224 **Discussion**

225 The main aim of this study was to determine the acceptance, and especially also the impact of HBGM on the
226 QoL of diabetic cats and their owners. Although no significant difference in the overall QoL assessed by the
227 DIAQoL-pet tool was found between the HBGM and non-HBGM group during the 6-months’ study period, the
228 overall QoL scores improved at all post-enrolment time-points in the HBGM group and not in the non-HBGM
229 group. This suggests a possible positive impact of HBGM. The acceptance of HBGM by the owners of
230 diabetic cats was high, with approximately 3 out of 4 successfully adopting HBGM. This proportion is similar or
231 higher than in previous studies evaluating HBGM in diabetic cats.^{11,12} Importantly, 89% of those performing

232 HBGM found it “straightforward” or “mostly straightforward” and all questionnaire-respondents in the HBGM
233 group would recommend HBGM to all or at least some owners of diabetic cats. Based on the questionnaire
234 results, for owners practising HBGM, the benefits clearly outweighed any disadvantages. Notably, about half
235 the owners in the HBGM group stated that they did not feel their lives were restricted by HBGM. This agreed
236 with the results of the DIAQoL-pet assessment, indicating improvement of the overall QoL in the group
237 performing HBGM. Further, owners practicing HBGM reported significantly less worry about their cat’s
238 diabetes in general, and particularly about hypoglycaemia, compared to before the trial. This might be due to
239 feeling more in control because of the ability to check blood glucose at home, as has been previously
240 reported.¹¹ The scores of specific questions about possible restriction of owners’ lives (“restrict your activities”,
241 “social life”, “working life”) did not reveal negative effects associated with HBGM compared with the non-
242 HBGM group. The item “costs” also improved over time in the HBGM group, but not in the non-HBGM group,
243 possibly reflecting cost savings because glycaemic checks were performed at home rather than at the
244 veterinary clinic.

245 The psychometrically validated DIAQoL-pet tool was used to objectively evaluate QoL in diabetic cats and
246 their owners. Although other factors might have contributed to the score, successful adoption of HBGM was
247 the major difference in the diabetes management after enrolment on the study. It is therefore likely that any
248 negative impact HBGM might have had on the QoL would have been reflected in deterioration of the total
249 DIAQoL-pet score or in the scores for the specific questions mentioned above. Since an improvement in
250 DIAQoL-pet score occurred, HBGM was considered to most likely have a positive effect on QoL, rather than
251 imposing an additional burden. In fact, HBGM group owners reported an improvement in impact on DIAQoL-
252 pet factors relating to life and work restrictions once the trial had started. This improvement was not
253 documented in the non-HBGM group.

254 Although improvement in QoL was documented in the HBGM group and not in the non-HBGM- group over
255 time, the QoL scores were not different between these 2 groups at any time-point in the study. This lack of
256 statistically significant difference might have several reasons. Firstly, the non-HBGM group was smaller than
257 the HBGM group; secondly, the trial design resulted in cat owners essentially self-selecting group
258 assignments; thirdly, the HBGM group was not absolutely homogenous in terms of the frequency and intensity
259 of performing HBGM. However, the total number of BGCs was not significantly different between the HBGM
260 and non-HBGM group. Finally, lack of randomisation and owners’ self-assignment to the groups might allow
261 for owner- or pet-related characteristics, intrinsic to the decision to accept or decline HBGM, to confound

262 treatment outcomes. For instance, if HBGM group owners were more motivated to do everything possible to
263 control their cat's diabetes, better treatment outcomes might be expected in that group. Nevertheless, owners
264 in both groups were prepared to follow the other aspects of the clinical trial, which included regular visits to the
265 research clinic, indicating that even the owners in the non-HBGM group were committed to the care of their
266 diabetic cat. Additionally, assigning owners to one of the two groups, and thus forcing some of them to accept
267 HBGM, would not be feasible or ethical. On the basis of direct comparison of QoL and glycaemic parameters,
268 the two groups were very similar at enrolment, further strengthening the validity of the comparisons drawn.
269 We used a questionnaire to assess the cat owners' experiences with the HBGM. Although closed-ended
270 questions offering fixed answer(s) were used, the option "other" was included in most of the questions, to
271 enable owners to provide additional free text information. Using open-ended questions might have been more
272 suitable to assess the owners' opinions on some issues (e.g. advantages/disadvantages of HBGM) without
273 introducing bias. However, using open-ended questions is also associated with higher risk of larger item non-
274 response or invalid answers, resulting in missing data.¹⁸ Therefore, we compromised by including the option
275 "other".

276 The maximal BG at month 6 was significantly lower in the HBGM group compared to the non-HBGM group.
277 Additionally, in the HBGM-group, all glycaemic control parameters (except for minimal BG at months 3 and 6)
278 decreased significantly compared to enrolment values. In contrast, in the non-HBGM group, improvement in
279 only 2 glycaemic control parameters (maximal BG at month 1 and average BG at month 6) was identified, and
280 there was no consistent pattern for the remaining parameters. Nevertheless, it should also be emphasised
281 that when performing a direct comparison between cats in the HBGM- and non-HBGM group, a statistical
282 significant difference was not shown at any time point during the study. Superior glycaemic control has been
283 linked with higher remission rates.¹⁹ Also, HBGM was an essential part of management in studies reporting
284 the highest remission rates.^{5,6} Interestingly, 9/28 (32%) cats in the HBGM group underwent diabetic remission,
285 but this occurred in only 1/10 (10%) cats in the non-HBGM group. However, the difference between groups in
286 remission rates was not statistically significant. Large randomised prospective studies are recommended to
287 further investigate the impact of HBGM on remission rates.

288 Finally, random assignment of owners and cats to equally-sized HBGM- and non-HBGM groups might have
289 yielded superior results in this respect. Given the importance of HBGM suggested in previous studies,^{5,6} our
290 research group, guided by our ethical committee, considered that it would be inappropriate to not actively offer
291 HBGM to owners as part of best clinical practice. Conversely, forcing owners, who could not or did not want to

292 perform HBGM to enrol in the HBGM group would not be feasible or ethical either. Although this approach
293 might have introduced selection bias into the study, this situation is more likely to reflect the “real-life”
294 circumstances when, ideally, all owners should be able to make an informed choice about the protocol they
295 use to manage their cat’s diabetes.

296

297 **Conclusions**

298 Most (n=28/38; 74%) owners of diabetic cats were able to perform HBGM and the majority (n=17/19; 89%)
299 considered it to be (mostly) straightforward. Overall QoL evaluated by the validated psychometric tool
300 DIAQoL-pet improved significantly in cats/ owners choosing to perform HBGM. Specifically of interest was an
301 owner-reported decrease in worry about the diabetes and particularly hypoglycaemia in the HBGM group,
302 which did not occur in the non-HBGM group. This study adds to the body of peer-reviewed evidence that
303 suggests HBGM is a practical monitoring tool for many owners of diabetic cats and suggests it is associated
304 with a positive impact on QoL in both the diabetic cat and the owner. Further studies are warranted to assess
305 its possible positive impact on glycaemic control.

306

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309

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312 disposables were provided by Zoetis. The research clinic also receives funding from Boehringer Ingelheim
313 and Nestlé Purina PetCare.

314

315 **Conflicts of interest**

316 This research was supported by Zoetis, which sells glucometers for use in dogs and cats. However, under the
317 Royal Veterinary College’s Code of Research Conduct, the authors performed the research entirely
318 independently, and did not allow external influence over the generation, reporting or interpretation of the
319 results reported in this paper.

320

321 **Supplementary information:**

322 Supplement 1 - Questionnaire about owner's experience with home blood glucose monitoring – HBGM-group.
323 Supplement 2 - Questionnaire about owner's experience with home blood glucose monitoring – non-HBGM-
324 group.
325 Supplement 3 – Supplementary material to Table 1.
326 Supplement 4 - Comparison of DIAQoL-pet at different time points within the non-HBGM group.
327 Supplement 5 - Comparison of parameters of glycaemic control at different time points within the non-HBGM
328 group.

329

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331

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375 **Table 1.** The validated Diabetic Clinical Score (DCS) used to grade the severity of diabetes-associated clinical
 376 signs in participating cats

Clinical Sign Being Scored	Severity	Assigned Score
Unintended weight loss over the past 2 months (Assessed using bodyweight records or measurements)	None, or weight gain	0
	Mild (<5% loss)	1
	Moderate (5-10% loss)	2
	Severe (>10% loss)	3
Increased drinking and/or urination (Assessed by questioning owner)	None	0
	Mild – some increase noted	1
	Moderate – increased filling of water bowl	2
	Severe – constantly seen to drink	3
Increased appetite (Assessed by questioning owner)	Normal or decreased appetite	0
	Mild – finishes food eagerly	1
	Moderate – finishes food eagerly and begs for more	2
	Severe – obsessed with food	3
Decreased activity/ attitude (Assessed by questioning owner)	Normal or increased activity	0
	Mild – slightly less active	1
	Moderate – certainly less active	2
	Severe – mainly lying around	3
	Total score	/12

377

378

379 **Table 2.** Overview of questions (items) of the DIAQoL-pet survey³ pertinent with regards to home blood
380 glucose monitoring (HBGM). Each item was scored according to frequency at which it impacted on owner's
381 and pets' lives (all the time [3], often [2], occasionally [1], never [0]) and how important the item was in the
382 individual owner's and pet's lives (very important [4], important [3], moderately important [2], low importance
383 [1], not at all important [0]). Item-weighted impact score (IWIS) was calculated for each item by multiplying
384 frequency and importance ratings for each question.

Abbreviation	Question (item)
More control	Do you ever feel you want to take more control of the diabetes on your own, without the help of vets and other people?
Hypoglycaemia	Does your pet ever show signs of a low blood sugar? (eg, wobbliness, collapse)
Worry hypo	Do you ever feel worried about your pet suffering from an episode of low blood glucose?
Costs	Do you ever worry about how much money your pet's diabetes costs you and your family?
Worry	Do you ever worry about your pet's diabetes?
Restrict your activities	Do you ever find the diabetes of your pet restricts or limits what you are doing or what you want to do, like going on holidays, away on weekends, away for the day/night, working?
Social life	Do you ever find you need to fit your pet's diabetes into your social life? (eg, carrying needles, food, insulin, providing food on time)
Working life	Do you ever find you need to fit your pet's diabetes into your working life? (eg, having to make special arrangements when you need to work late or need to start working earlier)
Special bond	Do you feel you have a more special bond with your pet now that you are managing his/her diabetes?

385

386 **Table 3.** Comparison of the demographic data, DIAQoL-pet score (quality of life tool) and parameters of
 387 glycaemic control (DCS – diabetic clinical score; serum fructosamine; average blood glucose based on blood
 388 glucose curve) between the HBGM (home blood glucose monitoring)- and non-HBGM group at enrolment,
 389 months 1, 3 and 6.

Parameter	HBGM group	Non-HBGM group	p-value
Number of cats	28	10	
Age (years) (median, range)	12.05 (4-17.2)	9.5 (7-15.5)	0.076
Age (months) (median, range)	144.7 (48.4-206.8)	113.3 (84.1-185.4)	0.085
Breed			1.00
- Domestic Shorthair+Longhair	25	9	
- Other breed	3	1	
Gender			0.025
- female spayed	15	1	
- male neutered	13	9	
BW (kg) (median, range)	4.4 (2.8-8.3)	5.1 (3-6.9)	0.226
BCS (median, range)	5 (1-8)	5 (3-8)	0.723
% BF (median, range)	22.8 (2.11-42.5)	21.6 (16.6-32.4)	0.921
fPLI (ug/L) (median, range)	3.55 (0.5-58.0)	3.8 (0.5-50)	0.715
Time on insulin prior to enrolment (days)	59 (36-150)	60.5 (44-108)	0.947
Insulin dose prior to enrolment (U/cat)	2 (1-5)	2.5 (1-6)	0.893
Insulin dose prior to enrolment (U/kg BW)	0.51 (0.22-1.32)	0.54 (0.24-1.16)	0.691
Insulin type subsequently used	14 ProZinc/ 14 Glargine	5 ProZinc / 5 Glargine	1.00
DIAQoL-pet month 0 (median, range)	-1.52 (-4.45 - -0.31)	-1.31 (-5.34 - -0.1)	0.390

DIAQoL-pet month 1 (median, range)	-1.12 (-3.69 - +0.28)	-1.21 (-3.59 - -0.3)	0.940
DIAQoL-pet month 3 (median, range)	-0.95 (-4.83 - +0.38)	-0.76 (-1.59 - -0.3)	0.603
DIAQoL-pet month 6 (median, range)	-0.45 (-3.14 - +0.14)	-0.9 (-2.28 - -0.3)	0.352
Serum fructosamine month 0 (umol/L) (median, range)	476.5 (59-715)	431.5 (168-715)	0.703
Serum fructosamine month 1 (umol/L) (median, range)	380 (232-572)	398.5(233-575)	0.473
Serum fructosamine month 3 (umol/L) (median, range)	302 (215-606)	349 (241-560)	0.406
Serum fructosamine month 6 (umol/L) (median, range)	307 (215-636)	351 (248-561)	0.429
DCS month 0 (median, range)	3.5 (0-11)	3.5 (0-9)	0.651
DCS month 1 (median, range)	1 (0-5)	1.5 (0-5)	0.750
DCS month 3 (median, range)	0 (0-6)	1 (0-4)	0.118
DCS month 6 (median, range)	0 (0-6)	1 (0-2)	0.417
Average BG month 0 (mmol/L) (median, range)	14.2 (7.9-21.7)	12.9 (7.7-22.2)	0.829
Average BG month 1 (mmol/L) (median, range)	10.6 (4.1-21.5)	10.5 (4-19.2)	0.572
Average BG month 3 (mmol/L) (median, range)	10.85 (4.1-21.4)	14.35 (7.6-19.7)	0.234
Average BG month 6 (mmol/L) (median, range)	9.95 (3.4-19.9)	13.75 (7.7-19.3)	0.146
Remission rate (remission/all)	9/28	1/10	0.236
Time to remission	70 (40-130)	45 (n/a)	n/a

390 BW – body weight; BCS – body condition score (1-9/9)¹⁵; % BF – percentage of body fat¹⁶; BG – blood
391 glucose; n/a – not applicable

392 **Table 4.** Comparison of DIAQoL-pet (quality-of-life tool), including specific questions (see below), between
 393 enrolment and months 1, 3 and 6 within the HBGM group.

Parameter	Enrolment (month 0)	Month 1	Month 3	Month 6
DIAQoL-pet (median, range)	-1.52 (-4.45 - -0.31)	-1.12 * (-3.69 - +0.28)	-0.95 ** (-4.83 - +0.38)	-0.45 **** (-3.14 - +0.14)
“owner wanting more control” (median, range)	0.00 (-12.00 – 0.00)	0.00 (-8.00 – 0.00)	0.00 (-6.00 – 0.00)	0.00 * (-4.00 – 0.00)
“hypo” (median, range)	0.00 (-4.00 – 0.00)	0.00 (-3.00 – 0.00)	0.00 (-8.00 – 0.00)	0.00 (-4.00 – 0.00)
“worry hypo” (median, range)	-3.00 (-8.00 – 0.00)	-3.00 (-9.00 – 0.00)	-1.00 ** (-12.00 – 0.00)	0.00 *** (-8.00 – 0.00)
“costs” (median, range)	-4.00 (-12.00 – 0.00)	-2.00 (-12.00 – 0.00)	-1.00 * (-12.00 – 0.00)	0.00 *** (-12.00 – 0.00)
“worry” (median, range)	-4.00 (-12.00 - -1.00)	-2.00 * (-12.00 – 0.00)	-3.00 ** (-12.00 – 0.00)	-2.00 ** (-12.00 – 0.00)
“restrict your activities” (median, range)	-3.00 (-12.00 – 0.00)	-2.00 (-12.00 – 0.00)	-2.00 (-12.00 – 0.00)	0.00 ** (-9.00 – 0.00)
“social life” (median, range)	-3.00 (-12.00 – 0.00)	-2.00 (-12.00 – 0.00)	-1.00 (-12.00 – 0.00)	0.00 (-9.00 – 0.00)
“working life” (median, range)	-2.00 (-12.00 – 0.00)	0.00 (-12.00 – 0.00)	-2.00 (-12.00 – 0.00)	0.00 * (-12.00 – 0.00)
“special bond” (median, range)	2.00 (0.00 – 12.00)	2.00 (0.00 – 12.00)	1.00 (0.00 – 12.00)	2.00 (0.00 – 12.00)

394 * The value is significantly different from enrolment (month 0) at a level of significance $p < 0.05$

395 ** The value is significantly different from enrolment (month 0) at a level of significance $p < 0.01$

396 *** The value is significantly different from enrolment (month 0) at a level of significance $p < 0.001$

397 **** The value is significantly different from enrolment (month 0) at a level of significance $p < 0.0001$

398

399 **Table 5.** Comparison of parameters of glycaemic control at different time points within the HBGM group.

Parameter	Enrolment (month 0)	Month 1	Month 3	Month 6
DCS (median, range)	3.5 (0-11)	1 **** (0-5)	0 **** (0-6)	0 *** (0-6)
Serum fructosamine (umol/L) (median, range)	476.5 (59-715)	380 ** (232-572)	302 ** (215-606)	307 *** (215-636)
Insulin dose (U/cat) (median, range)	2 (1-5)	2 * (0.25-5.5)	2 * (0-5)	1.5 * (0-6.5)
Insulin dose (U/kg BW) (median, range)	0.51 (0.22-1.32)	0.45 * (0.06-1.36)	0.41 * (0-1.08)	0.32 ** (0-1.65)
Average BG (mmol/L) (median, range)	14.2 (7.9-21.7)	10.6 *** (4.1-21.5)	10.85 *** (4.1-21.4)	9.95 ** (3.4-19.9)
Average pre-insulin BG (mmol/L) (median, range)	18.2 (8.3-23.3)	11.75 **** (5.5-20.6)	11.45 ** (3.6-22.2)	13.1 * (6.7-19.9)
Minimal BG (mmol/L) (median, range)	6.55 (2.2-18.4)	3.5 * (2.2-18.4)	5.7 (2.2-17.1)	4.9 (2.2-12.8)
Maximal BG (mmol/L) (median, range)	22.2 (13.2-22.2)	20.2 * (8.9-22.2)	19.5 ** (6.3-22.2)	14.9 *** (5.4-22.2)

400 DCS – diabetic clinical; BG – blood glucose

401 * The value is significantly different from enrolment (month 0) at a level of significance $p < 0.05$

402 ** The value is significantly different from enrolment (month 0) at a level of significance $p < 0.01$

403 *** The value is significantly different from enrolment (month 0) at a level of significance $p < 0.001$

404 **** The value is significantly different from enrolment (month 0) at a level of significance $p < 0.0001$

405

406 **Table 6.** Summary of advantages and disadvantages of home blood glucose monitoring (HBGM) as well as
 407 description of the technique and difficulties encountered during HMBG. Number and percentage of
 408 respondents (of 19 returned questionnaires) are given in brackets after the item.

<p>Advantages of HMBG:</p> <ul style="list-style-type: none"> - not having to take their cat to the veterinarian or leave the cat at the practice (n=16; 84%) - owner feeling to have more control over their cat's diabetes (n=13; 68%) - owner feeling their cat's diabetes is better controlled since performing HMBG (n=12; 63%) - lower costs compared to glucose curves at veterinary practice (n=12; 63%) - less stressful compared to glucose curves at veterinary practice (n=11; 58%)
<p>Disadvantages of HMBG:</p> <ul style="list-style-type: none"> - no disadvantages (n=6; 32%) - HMBG is time consuming (n=7; 37%) - cat seems uncomfortable during the procedure (n=6; 32%) - owner feeling he/she is hurting the cat (n=6; 32%)
<p>Sampling site:</p> <ul style="list-style-type: none"> - outer pinna (n=14; 74%), outer + inner pinna (n=1; 5%) - paw pad of the front limb (n=1; 5%), paw pad of the hind limb (n=1; 5%), paw pad of the front and hind limb (n=2; 11%)
<p>Tools used to obtain blood samples:</p> <ul style="list-style-type: none"> - lancet (n=16; 84%), hypodermic needle (n=1; 5%), insulin needle (n=1; 5%), needle from the lancet (n=1; 5%)
<p>Additional procedures to enhance blood sampling:</p> <ul style="list-style-type: none"> - massage the ear before puncturing it (n=12; 63%) - apply vaseline (n=7; 37%) - apply anaesthetic cream (e.g. EMLA) (n=5; 26%) - clipping the ear for better visualisation of the marginal ear vein (n=2; 11%) - using a small torch for better visualisation of the marginal ear vein (n=1; 5%)
<p>Need for other person to assist during HBGM:</p> <ul style="list-style-type: none"> - always (n=7; 37%), sometimes (n=5; 26%), never (n=7; 37%)

Recording of blood glucose readings:

- using a diary (not digital) (n=13; 68%)
- creating tables/graphs using a computer programme/software, e.g. Microsoft Excel (n=3; 16%)
- using a chart supplied with the glucometer (n=2; 11%)
- using an App for human diabetics or pets (n=1; 5%)

Difficulties encountered during HMBG:

- need for more than 1 puncture due to technical difficulties (n=17; 89%)
- obtaining a too small blood drop (n=8; 42%)
- difficulties using the glucometer (n=8; 42%)
- cat resisting the sampling (n=6; 32%)
- bruising (n=1; 5%) or formation of scar tissue (n=1; 5%) at the puncture site

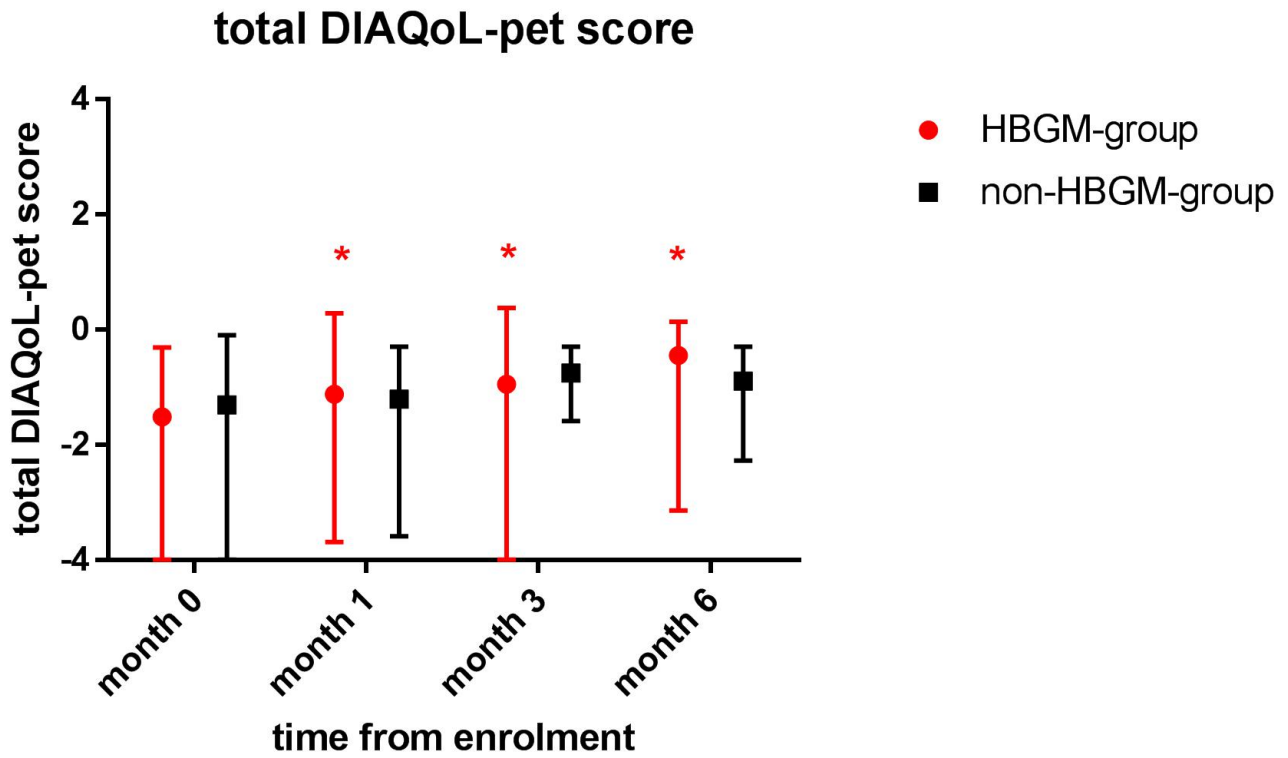
How the difficulties with HMBG could be resolved:

- practising the technique and the use of the glucometer (n=13; 68%)
- advice given at the re-examination at our clinic or local veterinarian (n=4; 21%)

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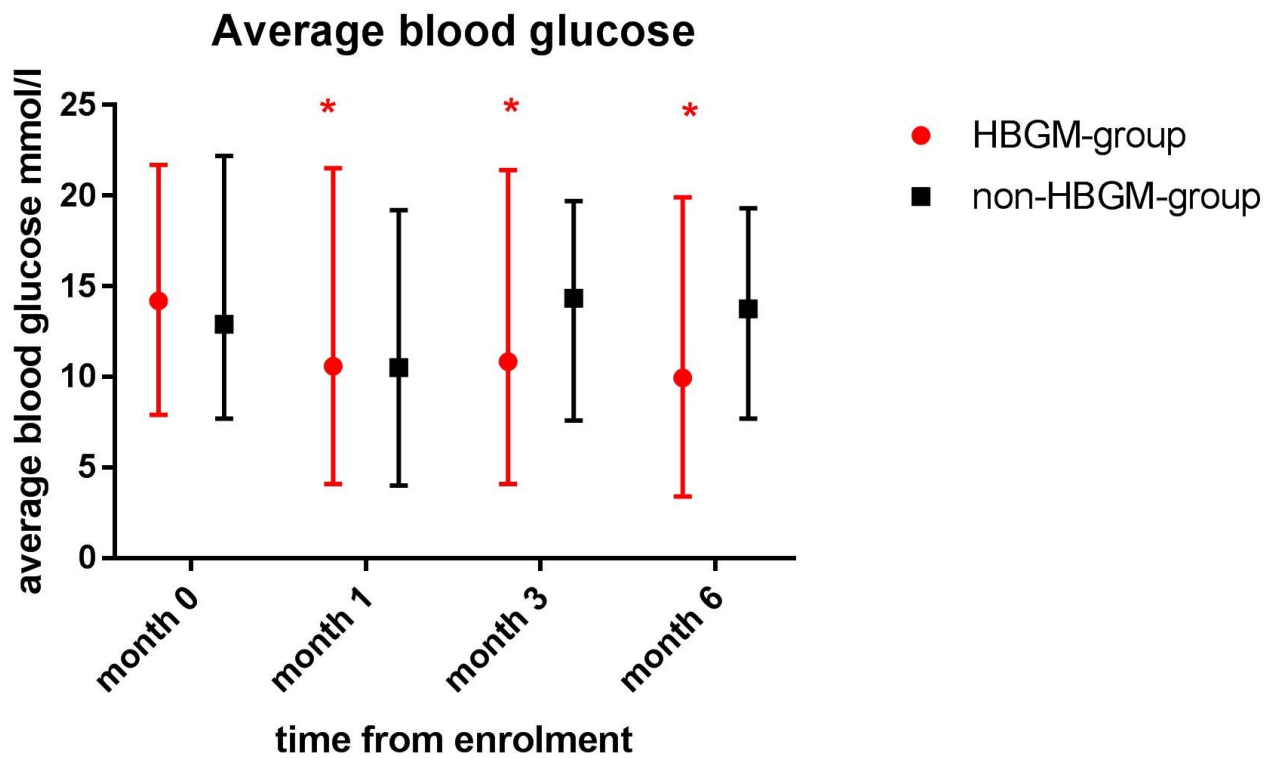
411 **Figure 1.** DIAQoL-pet score (quality-of-life tool) in the home blood glucose monitoring (HBGM) and non-
412 HBGM groups over the 6 month study period. Higher scores are suggestive of better quality of life.
413 Circles/squares and error bars represent median and range. Significantly different values ($P < 0.05$) are
414 marked with an asterisk.



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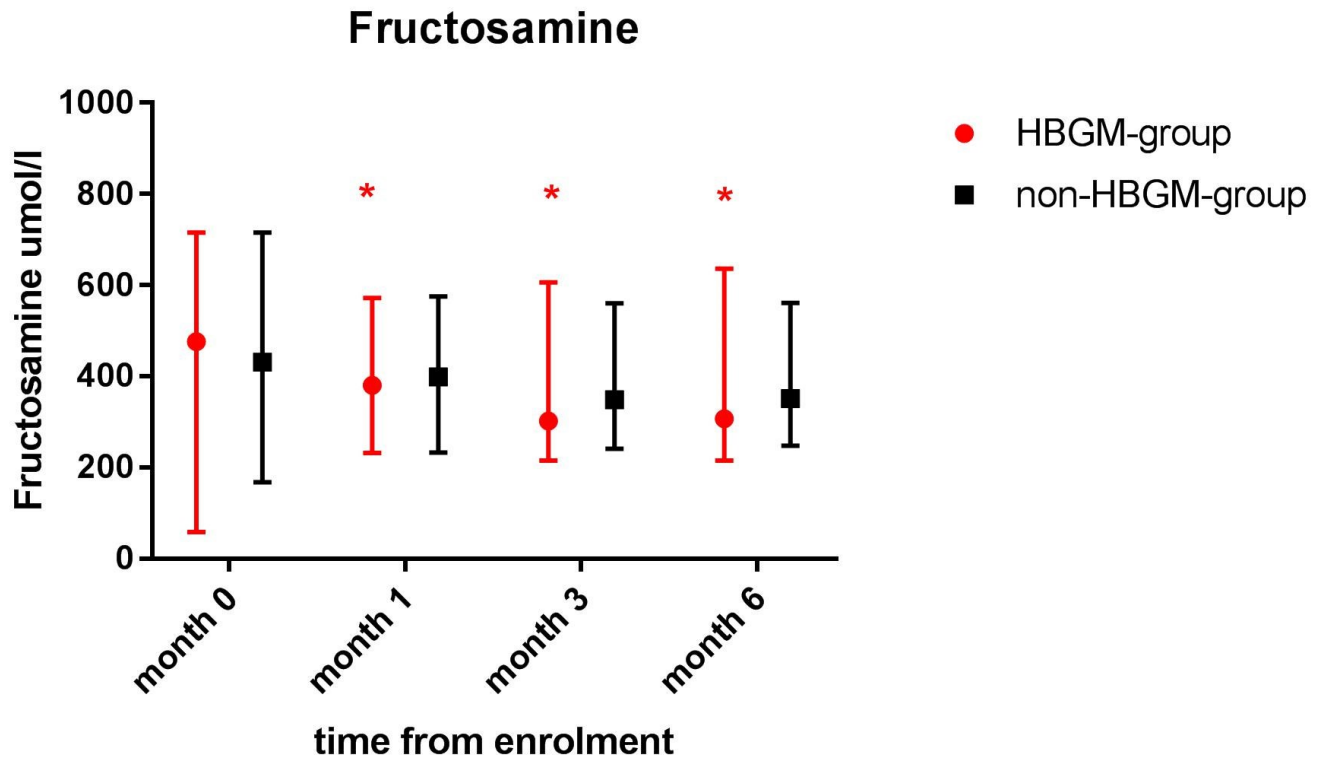
417 **Figure 2.** Average blood glucose (obtained from 24 h blood glucose curves) in the home blood glucose
418 monitoring (HBGM) and non-HBGM groups over the 6 month study period. Circles/squares and error bars
419 represent median and range. Significantly different values ($P < 0.05$) are marked with an asterisk. Average
420 blood glucose was significantly lower at months 1, 3 and 6 compared with baseline in the HBGM group but not
421 in the non-HBGM group. There were no significant differences in average blood glucose between the groups
422 at any time point.



423

424

425 **Figure 3.** Serum fructosamine concentration in the home blood glucose monitoring (HBGM) and non-HBGM
426 group over the study period. Circles/squares and error bars represent median and range. Significantly
427 different values ($P < 0.05$) are marked with an asterisk. Serum fructosamine concentrations were significantly
428 lower at months 1, 3 and 6 compared with baseline in the HBGM group but not in the non-HBGM group.
429 There were no significant differences in serum fructosamine concentrations between the groups at any time
430 point



431