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## RESEARCH ARTICLE

WILEY

# Appropriateness of action prompts for hypoglycaemia and hyperglycaemia in type 2 diabetes self-management apps

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## Abstract

**Background:** Control of blood glucose levels is needed not only to alleviate symptoms of hypoglycaemia and hyperglycaemia, but also to prevent or delay diabetes-related complications. Advice for glucose control is usually provided to patients by members of the health care team. However, many diabetes apps claim to enhance self-management of blood glucose by providing decision support to patients when an out-of-range blood glucose level is recorded. In this study, we investigated the appropriateness of action prompts provided by diabetes apps for hypoglycaemia and hyperglycaemia against evidence-based guidelines.

**Methods:** We used methods previously reported to identify and select diabetes apps, which were downloaded and assessed against the American Diabetes Association (ADA) guidelines. Screenshots of action prompts corresponding to low or high out-of-range blood glucose values were subjected to content analysis.

**Results:** Of 371 diabetes self-management apps evaluated, only 217 and 216 apps alerted patients about hypoglycaemia and hyperglycaemia, respectively. Of these, 20.7% (45/217) and 15.3% (33/216) also provided action prompts. We found 5.1% of apps (hypoglycaemia: 11/217; hyperglycaemia: 11/216) provided prompts that were either too general to be helpful or not aligned with ADA guidelines. Overall, only 17.9% (39/217) and 14.8% (32/216) provided appropriate action prompts for hypoglycaemia and hyperglycaemia, respectively.

**Conclusion:** Less than one fifth of apps provided evidence-based steps to guide patients through hypoglycaemia and hyperglycaemia. The majority of apps failed to provide just-in-time diabetes self-management education to prevent frequent or severe episodes of hypoglycaemia and hyperglycaemia. Our findings emphasize the need for better design and quality assurance of diabetes apps.

## KEYWORDS

apps, decision support, diabetes, hyperglycaemia, hypoglycaemia

## 1 | INTRODUCTION

The detrimental effects of hypoglycaemia and hyperglycaemia are well known. Frequent episodes of hypoglycaemia can lead to development of hypoglycaemia unawareness, an increased risk of cerebrovascular and cardiovascular morbidity, neurocognitive dysfunction, and

vision impairment.<sup>1</sup> A history of hypoglycaemia predicts future episodes of hypoglycaemia in people with type 2 diabetes including severe hypoglycaemic events requiring medical assistance (eg, hospitalization, emergency department visit, and treatment by emergency medical personnel either at home or in a clinical setting),<sup>2</sup> which in turn is associated with an increased risk of mortality for this

population.<sup>3,4</sup> Acute hyperglycaemia has been associated with impaired cognitive function and moods in people with type 2 diabetes.<sup>5</sup> Longer-term consequences of hyperglycaemia include tissue-damaging effects to the retina, kidneys, and peripheral nerves.<sup>6</sup>

Glycaemic control is needed not only to alleviate symptoms of hypoglycaemia and hyperglycaemia, but also to prevent or delay diabetes-related complications, particularly microvascular complications.<sup>7,8</sup> Hence, the importance of appropriate action to promptly address or prevent more severe episodes of hypoglycaemia or hyperglycaemia to maintain glycaemic control.

Patient advice on glucose control is usually provided by members of the healthcare team (eg, physician, diabetes nurse educator, and dietitian). However, many diabetes apps claim (and may have the potential) to enhance self-management of blood glucose by providing decision support to patients when an out-of-range blood glucose level is recorded.<sup>9</sup> Most diabetes apps fall outside US Food and Drug Administration regulation; hence, intended effect and clinical safety are not assured.<sup>10</sup> Despite this, in 2018, an estimated 7.8% of people with diabetes who owned a smartphone used a diabetes app to support self-management.<sup>11</sup>

In this study, we investigated the appropriateness of action prompts provided by diabetes apps for hypoglycaemia and hyperglycaemia against evidence-based guidelines.

## 2 | METHODS

We used methods previously reported to identify and select diabetes apps for assessment.<sup>12</sup> Hypoglycaemia and hyperglycaemia requiring corrective action were defined as blood glucose less than or equal to 70 mg/dL (3.9 mmol/L) and greater than 180 mg/dL (10 mmol/L), respectively.<sup>8</sup>

We defined action prompts as messages prompting patients to address an out-of-range blood glucose level. Action prompts were triggered by researchers entering a predetermined set of out-of-range blood glucose values. Screenshots of action prompts corresponding to low or high out-of-range blood glucose values were subjected to content analysis. Action prompts were evaluated assuming users would enter blood glucose values at the point of measurement.

Appropriate action prompts were specific instructions aligned with the American Diabetes Association (ADA) guidelines.<sup>8</sup> In the case of hypoglycaemia, ingest glucose or carbohydrate-containing food, re-measure blood glucose after 15 minutes, and once blood glucose returns to normal, have a meal or snack to prevent recurrent hypoglycaemia. For hyperglycaemia, more frequent monitoring, check urine ketones, seek medical help especially if experiencing symptoms such as vomiting, alteration in consciousness, and use insulin (as prescribed).<sup>8</sup>

Inappropriate action prompts were defined as specific instructions not aligned with ADA guidelines, nonspecific instructions not contravening ADA guidelines but are too general to be helpful (eg, "Take steps to increase blood glucose level immediately"), or nonspecific instructions not aligned with ADA guidelines.

Comparisons between Android and iOS apps were made using Fisher's exact test with a two-sided *P* value < .05 for statistical significance.

## 3 | RESULTS

Of 5184 potential apps, 371 (198 Android; 173 iOS) met inclusion criteria and were downloaded for assessment.<sup>12</sup> Of these, 217 and 216 apps alerted patients about hypoglycaemia and hyperglycaemia, respectively. While 20.7% (45/217) of apps alerting patients regarding hypoglycaemia also provided action prompts, 15.3% (33/216) of apps did so for hyperglycaemia (Table 1).

### 3.1 | Hypoglycaemia

Thirty-nine apps (39/45, 86.7%) provided appropriate action prompts for hypoglycaemia. Of these, 51.3% (20/39) prompted the patient to have some glucose or carbohydrate-containing food, 43.6% (17/39) to re-measure blood glucose levels after 15 minutes, 10.3% (4/39) to have a meal or snack to prevent recurrent hypoglycaemia once blood glucose returned to normal, and 59.0% (23/39) advised patients to seek medical help (ie, speak to your doctor for further information) upon entry of a single low out-of-range value (Table 1). Messages that prompted the patient to reflect on the cause of low blood glucose were provided by five apps (5/45, 11.1%).

Examples of appropriate action prompts for hypoglycaemia:

Your blood glucose levels are too low. We have set an alarm in 15 minutes to remind you to check your levels again. Eat 15 grams of rapid absorption carbs (glucose gel, 2 sachets of sugar or 125 mL of juice) and wait 15 minutes, then check your glucose levels again. When at normal levels, eat 15 grams of slow absorption carbs (sustained effect gel, 3 crackers or a piece of fruit). ( App Research ID: IE1051)

Your blood sugar is low. Eat some sugar and retest in 15 minutes [app provides a "start timer" feature]. Common recommendations for adults include: half a glass of fruit juice or four glucose tablets. ( App Research ID: AE2013)

### 3.2 | Hyperglycaemia

Ninety-seven percent (32/33) of apps provided appropriate action prompts for hyperglycaemia. Of these, 25% (8/32) prompted patients to monitor blood glucose more frequently, 25% (8/32) to check urine ketones, 81.3% (26/32) to seek medical help particularly if

**TABLE 1** Diabetes self-management apps alerting patients to hypoglycaemia or hyperglycaemia accompanied by action prompts

	Total (n = 371) No. (%)	Android (n = 198) No. (%)	iOS (n = 173) No. (%)	P value (Fisher's exact)
Hypoglycaemia alert <sup>a,b</sup>	217 (58.8) <sup>c</sup>	121 (61.4) <sup>d</sup>	96 (55.8) <sup>d</sup>	.29
Message alerting user to hypoglycaemia plus action prompt	45 (20.7)	22 (18.2)	23 (24.0)	.50
Appropriate action prompts <sup>e,f</sup>	39 (86.7)	21 (95.5)	18 (78.3)	.19
Have some glucose or carbohydrate-containing food	20 (51.3)	12 (57.1)	8 (44.4)	.53
Remeasure blood glucose levels after 15 min	17 (43.6)	9 (42.9)	8 (44.4)	1.00
Have a meal or snack to prevent recurrent hypoglycaemia once blood glucose returns to normal	4 (10.3)	3 (14.3)	1 (5.6)	.61
Seek medical help	23 (59.0)	13 (61.9)	10 (55.6)	.75
Inappropriate action prompts <sup>f</sup>	11 (24.4)	5 (22.7)	6 (26.1)	1.00
Specific instructions but not aligned with ADA guidelines	0 (0.0)	0 (0.0)	0 (0.0)	-
Nonspecific instructions but does not contravene ADA guidelines	11 (100.0)	5 (100.0)	6 (100.0)	-
Nonspecific instructions and not aligned with ADA guidelines	0 (0.0)	0 (0.0)	0 (0.0)	-
Hyperglycaemia alert <sup>a,g</sup>	216 (58.4) <sup>d</sup>	118 (59.9) <sup>d</sup>	98 (56.6)	.60
Message alerting user to hyperglycaemia plus action prompt	33 (15.3)	18 (15.3)	15 (15.3)	.63
Appropriate action prompts <sup>e,f</sup>	32 (97.0)	18 (100.0)	14 (93.3)	.45
More frequent monitoring of blood glucose	8 (25.0)	5 (27.8)	3 (21.4)	1.00
Check urine ketones	8 (25.0)	4 (22.2)	4 (28.6)	.70
Seek medical help	26 (81.3)	15 (83.3)	11 (78.6)	1.00
Use insulin as prescribed	4 (12.5)	2 (11.1)	2 (14.3)	1.00
Inappropriate action prompts <sup>f</sup>	11 (33.3)	9 (50.0)	2 (13.3)	0.03
Specific instructions but not aligned with ADA guidelines	0 (0.0)	0 (0.0)	0 (0.0)	-
Nonspecific instructions but does not contravene ADA guidelines <sup>h</sup>	7 (63.6)	5 (55.6)	2 (100.0)	.49
Nonspecific instructions and not aligned with ADA guidelines <sup>i</sup>	4 (36.4)	4 (80.0)	0 (0.0)	-

<sup>a</sup>Alerts were defined as any visual or audible cue to notify patients of values outside glycaemic targets or to prompt action and included messages, sounds, colour changes, or visual cues on graphs and summary statistics (colouration of data points, colour bands on graphs).

<sup>b</sup>The arbitrary value of 18 mg/dL (1 mmol/L) or the apps' lowest permissible value was entered to test whether the app alerted the patient regarding hypoglycaemia ( $\leq 70$  mg/dL or  $\leq 3.9$  mmol/L).

<sup>c</sup>Denominator adjusted; removed two instances of unable to assess (eg, features being evaluated did not work; app closes unexpectedly each time blood glucose data is entered)

<sup>d</sup>Denominator adjusted; removed one instance of unable to assess (eg, features being evaluated did not work; app closes unexpectedly each time blood glucose data is entered)

<sup>e</sup>Subcategories are not exclusive. Apps may have one or more of these action prompts.

<sup>f</sup>Categories are not exclusive. Action prompts may consist of appropriate and inappropriate portions. For example, "Your blood glucose is low. Be sure to take steps to increase it immediately (categorized as inappropriate, instructions are nonspecific but does not contravene ADA guidelines). Talk to your doctor for more information (categorized as appropriate, patient advised to seek medical help)."

<sup>g</sup>The arbitrary value 306 mg/dL (17 mmol/L) was entered to test whether the app alerted the patient regarding hyperglycaemia ( $>180$  mg/dL or  $> 10$  mmol/L).

<sup>h</sup>Example of an inappropriate action prompt which was too general to be helpful: "Your previous reading was quite low. Please treat this as soon as! [sic]"

<sup>i</sup>Example of an inappropriate action prompt which was nonspecific and not aligned with ADA guidelines: "Warning! Your blood glucose is too high. What you can do to feel better: drink water, [... ..]"

experiencing symptoms such as vomiting or alteration in consciousness, and 12.5% (4/32) to use insulin as prescribed (Table 1).

Examples of appropriate action prompts for hyperglycaemia:

Your blood sugar level is high, please check your ketone level if you can and refer to your GP. If you feel unwell, call the emergency service. ( App Research ID: IE1126)

Your glucose levels are high. If you are on insulin, test your urine for ketones. Seek medical attention immediately if your blood glucose level is repeatedly more than 18 mmol/L, you have ketones in your urine, or if you have multiple signs and symptoms of diabetic ketoacidosis [... which] include excessive thirst, frequent urination, nausea and vomiting, abdominal pain, shortness of breath, fruity-scented breath and confusion. ( App Research ID: AE2143, excerpt)

### 3.3 | Inappropriate action prompts

Apps that provided inappropriate messages were 24.4% (11/45) and 33.3% (11/33) for hypoglycaemia and hyperglycaemia, respectively (Table 1). Examples of inappropriate action prompts which were too general to be helpful:

Your previous reading was quite low. Please treat this as soon as! [sic] ( App Research ID: AE2129, hypoglycaemia)

Based on your latest glucose, you may be experiencing hyperglycemia [sic]. It is recommended that you act immediately to decrease your glycemia [sic]. ( App Research ID: IE1012, hyperglycaemia)

Example of an inappropriate action prompt that was nonspecific and not aligned with ADA guidelines:

Warning! Your blood glucose is too high. What you can do to feel better: drink water, [... ...]. ( App Research ID: AE2046, excerpt, hyperglycaemia)

There were no significant differences between Android and iOS apps, apart from more Android apps having inappropriate action prompts for hyperglycaemia ( $P = .03$ ) compared with iOS overall.

## 4 | DISCUSSION

Of 371 diabetes self-management apps evaluated, only 217 and 216 apps alerted patients about hypoglycaemia and hyperglycaemia,

respectively. Of these, 20.7% (45/217) and 15.3% (33/216) also provided action prompts. We found 5.1% of apps (hypoglycaemia: 11/217; hyperglycaemia: 11/216) provided prompts that were either too general to be helpful or not aligned with ADA guidelines. Overall, only 17.9% (39/217) and 14.8% (32/216) provided appropriate action prompts for hypoglycaemia and hyperglycaemia, respectively.

We uncovered two important problems regarding the capability of apps to support diabetes self-management. First, less than one fifth of apps provided evidence-based steps to guide patients through hypoglycaemia and hyperglycaemia. Second, the majority of apps failed to provide just-in-time bite-size diabetes self-management education to prevent frequent or severe episodes of hypoglycaemia and hyperglycaemia. As emphasized by the ADA, diabetes self-management education is one of the most important elements for sustaining the skills and behaviours needed for ongoing self-management, and consequently, for improving patient clinical outcomes, health status, and quality of life.<sup>13</sup> Developers of diabetes self-management apps should involve diabetes specialists at the codesign stage so that educational evidence-based action prompts are triggered when out-of-range blood glucose values are recorded.

Our findings reinforce the need for better design and quality assurance of diabetes apps, consistent with literature.<sup>9,12,14,15</sup> If appropriately designed, action prompts could play a role in augmenting patient education of blood glucose management, which may translate to improved HbA1c without incurring severe hypoglycaemic episodes. The design of action prompts could be improved upon, building on previous research into alarms/alerts from medical devices and clinical decision support systems to avoid “alert fatigue” due to cognitive overload in distinguishing informative from uninformative alerts.<sup>16,17</sup>

Future research could also explore the use of nudge theory or alternatively, boosts, to design decision support and action prompts that make it easier for patients to “do the right thing” (or empower, in the case of boosts) for self-management of diabetes.<sup>18</sup> Patients may be more willing to use a diabetes app long-term if the app was well-designed and decision support is appropriately tailored to offer more valuable insights for better self-management, eg, prompts take into account patterns of hypoglycaemia and hyperglycaemia. It would also be instructive to investigate the incremental impact of diabetes apps (if any) on patient outcomes by replicating studies focused on face-to-face diabetes self-management education and support, such as the one by Ji et al,<sup>19</sup> and adding an intervention arm which includes a diabetes app with a comprehensive education component and decision support.

Findings from research could inform regulators and policymakers when setting standards for health app decision support, prioritization and classification of decision support to differentiate between potentially life-saving alerts, educational prompts, behavioural nudges or boosts, and basic reminders. Finally, research examining the impact of diabetes apps on health outcomes over a longer time period, eg, more than a year, is needed.<sup>20</sup>

Limitations include that new apps may have been released since the search and that apps syncing only to blood glucose-monitoring devices were not included (researchers unable to input blood glucose values).

## 5 | CONCLUSION

This study highlighted the low presence of appropriate action prompts for patient self-management of out-of-range blood glucose in diabetes apps. Better app design processes and standards to ensure appropriate, evidence-based action prompts for patient self-management of out-of-range blood glucose should be required for diabetes apps.

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### AUTHOR CONTRIBUTIONS

E.L. and G.J. had full access to all study data and take responsibility for the integrity of the data and accuracy of data analysis. The study was conceptualized and designed by all authors. E.L., G.J., Z.H., and L.T. were responsible for data acquisition. E.L. and G.J. conducted data analysis and interpretation. The manuscript was drafted by E.L. and revised by E.L. and G.J.. All authors provided critical review of the manuscript. J.C. obtained funding, provided methodological guidance, and supervised the work. L.T. provided administrative and technical support. All authors reviewed and approved the final version of the manuscript prior to submission. The manuscript has not been submitted or published elsewhere while under consideration by this journal.

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The funder did not have direct involvement in the research including design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication, apart from employing the authors. The research presented in this article is solely the responsibility of the authors and does not reflect the views of the funder.

### CONFLICT OF INTERESTS

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

### ETHICS STATEMENT

Human Research Ethics Approval was not required as no human subjects were involved in the study.

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### REFERENCES

1. Kaira S, Mukherjee J, Venkataraman S, et al. Hypoglycemia: the neglected complication. *Indian J Endocrinol Metab.* 2013;17(5):819-834. <https://doi.org/10.4103/2230-8210.117219>
2. Donnelly L, Morris A, Frier B, et al. Frequency and predictors of hypoglycaemia in type 1 and insulin-treated type 2 diabetes: a population-based study. *Diabet Med.* 2005;22(6):749-755.
3. Action to Control Cardiovascular Risk in Diabetes Study Group, Gerstein H, Miller M, et al. Effects of intensive glucose lowering in type 2 diabetes. *N Engl J Med.* 2008;358(24):2545-2559. <https://doi.org/10.1056/NEJMoa0802743>
4. Zoungas S, Patel A, Chalmers J, et al. Severe hypoglycemia and risks of vascular events and death. *N Engl J Med.* 2010;363(15):1410-1418. <https://doi.org/10.1056/NEJMoa1003795>
5. Sommerfield A, Deary I, Frier B. Acute hyperglycemia alters mood state and impairs cognitive performance in people with type 2 diabetes. *Diabetes Care.* 2004;27:2335-2340.
6. Brownlee M. The pathobiology of diabetic complications. *Diabetes.* 2005;54(6):1615-1625. <https://doi.org/10.2337/diabetes.54.6.1615>
7. Davies M, D'Alessio D, Fradkin J, et al. Management of hyperglycemia in type 2 diabetes, 2018. A Consensus Report by the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD). *Diabetes Care.* 2018;41(12):2669-2701. <https://doi.org/10.2337/dci18-0033>
8. American Diabetes Association. Glycemic targets: standards of medical care in diabetes—2018. *Diabetes Care.* 2018;41(S1):S55-S64.
9. Jimenez G, Lum E, Car J. Examining diabetes management apps recommended from a Google search: content analysis. *JMIR Mhealth Uhealth.* 2019;7(1):e11848. <https://doi.org/10.2196/11848>
10. US Food and Drug Administration. Policy for device software functions and mobile medical applications: guidance for Industry and Food and Drug Administration staff. 2019; <https://www.fda.gov/regulatory-information/search-fda-guidance-documents/policy-device-software-functions-and-mobile-medical-applications>. Accessed 7 October, 2019.
11. Research 2 Guidance. Currently, only 1.2% of diabetics that have a smartphone use a diabetes app. Until 2018 the share will rise to 7.8% globally. <https://research2guidance.com/currently-only-12-of-diabetics-that-have-a-smartphone-use-a-diabetes-app-until-2018-the-share-will-rise-to-78-globally/>. Accessed 30 July, 2018.
12. Lum E, Jimenez G, Huang Z, et al. Decision support and alerts of apps for self-management of blood glucose for Type 2 Diabetes. *JAMA.* 2019;321(15):1530-1532. <https://doi.org/10.1001/jama.2019.1644>, <https://doi.org/10.1001/jama.2019.1644>
13. American Diabetes Association. Lifestyle management: standards of medical care in diabetes—2018. *Diabetes Care.* 2018;41(S1):S55-S64.
14. van Galen L, Xu X, Koh M, Thng S, Car J. Eczema apps conformance with clinical guidelines: a systematic assessment of functions, tools and content. *Brit J Dermatol.* 2019;Jun 9. <https://doi.org/10.1111/bjd.18152>
15. Rose K, Petrut C, L'Heveder R, Sabata S. IDF Europe's position on mobile applications in diabetes. *Diabetes Res Clin Pract.* 2019;149:39-46. <https://doi.org/10.1016/j.diabres.2017.08.020>

16. Ancker J, Edwards A, Nosal S, et al. Effects of workload, work complexity, and repeated alerts on alert fatigue in a clinical decision support system. *BMC Med Inform Decis Mak*. 2017;17(1):36-39. <https://doi.org/10.1186/s12911-017-0430-8>
17. Mitka M. Joint Commission warns of alarm fatigue: multitude of alarms from monitoring devices problematic. *JAMA*. 2013;309(22):2315-2316. <https://doi.org/10.1001/jama.2013.6032>
18. Hertwig R, Grune-Yanoff T. Nudging and boosting: steering or empowering good decisions. *Perspec Psychol Sci*. 2017;12(6):973-986. <https://doi.org/10.1177/1745691617702496>
19. Ji H, Chen R, Huang Y, Li W, Shi C, Zhou J. Effect of simulation education and case management on glycemic control in type 2 diabetes. *Diabetes Metab Res Rev*. 2019;35(3):e3112. <https://doi.org/10.1002/dmrr.3112>
20. Rubin R. Phone apps for patients with diabetes. *JAMA*. 2018;319(24):2469. <https://doi.org/10.1001/jama.2018.8164>

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