

SYSTEMATIC REVIEW

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Systematic review of oral carbohydrate treatment for hypoglycemia in people living with type 2 diabetes mellitus

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Abstract

Background The common recommendation for hypoglycemia treatment, oral ingestion of 15 g of simple carbohydrates and glucose recheck in 15 min, was predominantly based on expert opinion, and two small-sized studies of intravenous insulin-induced hypoglycemia in people living with type 1 diabetes mellitus (T1D). The evidence for “15 grams/15 minutes” treatment for people living with type 2 diabetes mellitus (T2D) needs to be explored. The objective of this systematic review is to determine which oral carbohydrate treatments were studied in adults living with T2D for timely resolution of hypoglycemia events.

Methods Medline, Embase, Scopus, and Cochrane Central Register of Controlled Trials were searched from January 1990 to 24 March 2025, for full-text studies of oral treatment for hypoglycemia in T2D. Two authors screened the results and extracted data. Inclusion criteria included age ≥ 18 years with T2D, treated with a defined quantity of simple carbohydrates, and reported hypoglycemia event resolution as a defined time of first glucose recheck after treatment completion. Exclusion criteria included non-oral route of hypoglycemia treatment. The Newcastle–Ottawa scale was used for risk of bias assessment.

Results Three studies were included, which reported on 152 insulin-treated adults who experienced 366 hypoglycemia events. None of these three studies presented if the participants were or were not on sulfonylurea concurrently, nor did they present a breakdown of the types of insulin(s) (long-acting versus rapid-acting) for the participants. All studies had different oral hypoglycemia treatments and various glucose recheck times. Hence, data synthesis was not possible. There was near 100% hypoglycemia resolution with 15 g carbohydrates at 30-minute recheck in a study of mild hypoglycemia in hospitalized people living with type 2 diabetes. An at-home study showed 95% hypoglycemia resolution with 30 g carbohydrates at 10-minute recheck, although rebound hyperglycemia became a concern. The studies had low risk of bias.

Conclusion Three studies provided a very limited evidence base for hypoglycemia treatment in T2D. Future studies are encouraged to identify and analyze people living with T2D who are treated with sulfonylurea, with or without insulin therapy, to reflect hypoglycemia treatment over the breadth of T2D pharmacotherapy.

Clinical trial number Not applicable.

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Trial registration Prospero registration number CRD420251032322. No amendments. Study protocol can be obtained by sending a written request to the corresponding author.

Keywords Type 2 diabetes mellitus, Hypoglycemia treatment, Oral carbohydrates, Hypoglycemia resolution

Introduction

Amongst the pharmacotherapies for people living with type 2 diabetes mellitus (T2D), insulin and sulfonylurea classes of medications are often associated with hypoglycemia [1]. The definition of hypoglycemia has varied over the years and amongst worldwide expert opinion [2]. However, most current guidelines recommend a glucose threshold of below 3.9 or 4.0 mmol/L as requiring prompt treatment, especially when insulin or sulfonylurea is active in the body [3–5].

Level 1 hypoglycemia (glucose 3.0 to 3.9 mmol/L), also known as mild hypoglycemia, is when the person living with diabetes experiences adrenergic symptoms such as palpitations, hunger, sweating, and shakiness [3–5]. Lack to timely treatment will then lead to Level 2 hypoglycemia (glucose below 3.0 mmol/L), also known as moderate hypoglycemia, when the person living with diabetes experiences neuroglycopenic symptoms such as confusion, drowsiness, slurred speech, and weakness [3–5]. Severe hypoglycemia is generally defined as altered mental or physical status including seizures or coma, and requires assistance from another person for treatment [3–5]. Therefore, treatment of non-severe hypoglycemia is crucial to prevent the rapid progression to severe hypoglycemia.

The majority of non-severe hypoglycemia events are treated by the person living with diabetes with oral ingestion of simple carbohydrates to rapidly raise the blood glucose levels [3–5]. Simple carbohydrates usually refer to food sources high in monosaccharides and disaccharides that are easily absorbed into the bloodstream. Common examples of simple carbohydrates are fruit juice, table sugar (sucrose) dissolved in water for easier and faster absorption, honey, and real sugar-containing (not artificially-sweetened) candies and beverages.

The most common recommendation for hypoglycemia treatment is the oral ingestion of 15 g of simple carbohydrates, with glucose recheck in 15 min [3–5]. This recommendation has been widespread in clinical guidelines for the past few decades and has been suggested for both people living with T2D and type 1 diabetes mellitus (T1D) [3–5]. Remarkably, this “15 grams/15 minutes” treatment is solely based on expert opinion, and two frequently-referenced, small-sized studies of intravenous insulin-induced hypoglycemia in people living with T1D [3–7]. T2D that is not treated with insulin therapy is associated with better preservation of the counter-regulatory response to hypoglycemia [1], which merits separate considerations in hypoglycemia treatment. In

people living with T2D, the counter-regulatory response to hypoglycemia, namely the secretion of glucagon and catecholamines, is often only mildly decreased, when compared with people living with T1D [1]. In addition, in people living with T2D who are not being treated with insulin, the counter-regulatory response can occur at a higher blood glucose level, than for people living with T1D [1]. These pathophysiologic characteristics of T2D suggest that hypoglycemia could potentially be treated with less carbohydrates, when compared to T1D pathophysiology. Furthermore, when T2D is treated with both sulfonylurea and insulin therapy, the counter-regulatory response is likely to be quite impaired, which can cause more severe hypoglycemia events to occur [1].

Notably, this “15 grams/15 minutes” treatment has been widely recommended to people living with T2D while lacking a strong evidence base. The objective of this systematic review is to determine which oral carbohydrate treatments (intervention) have been studied in adults living with type 2 diabetes (population) for timely resolution of hypoglycemia events (outcome). There was no comparator required for included studies.

Subjects, materials and methods

Inclusion and exclusion criteria

The inclusion criteria were the following:

- Population: adults (age >= 18 years) living with T2D.
- Intervention: hypoglycemia treatment with oral ingestion of a defined quantity of simple carbohydrates.
- Comparator: studies were not required to have a comparator. If there was a comparator which was also an oral ingestion of a defined quantity of simple carbohydrates, then we also extracted the data generated from the comparator.
- Outcome: reported the time to hypoglycemia event resolution defined in minutes since the first oral hypoglycemia treatment was completed. Hypoglycemia resolution was defined by each study as repeat glucose level above a pre-defined threshold.

The exclusion criteria were:

- Articles that did not contain a treatment for hypoglycemia event.
- Review articles.
- Participant age < 18 years.

- Non-oral administration of simple carbohydrates for hypoglycemia treatment.

Literature search

A comprehensive literature search was conducted across Ovid MEDLINE, Embase, Scopus, and the Cochrane Central Register of Controlled Trials from January 1990 to March 24, 2025. The search strategy incorporated both Medical Subject Headings and free-text terms related to diabetes, hypoglycemia, and carbohydrates. The main search variables included “diabetes mellitus, type 2” and “hypoglycemia” and “carbohydrates” and “treatment or therapy”. The terms were restricted to titles, but were also used in the adjacent operator to search in abstracts. The search was limited to studies reporting glucose outcomes. Only full-text articles published in English or French were considered for inclusion. The full electronic search strategy for each database is provided in the supplementary materials.

Selection process

Screening and data extraction were independently performed by two authors. For included studies, reference list checking was also performed by two authors. Any differences were resolved by discussion to reach consensus. Studies with both T1D and T2D participants were included to maximize the data. If a study included both T1D and T2D, we described this in the results, and reported if the T1D and T2D data could be disaggregated.

Data extraction

Data items extracted included: first author, year, country where study was carried out, number of participants, percentage of participants taking sulfonylurea or insulin, study setting, who administered the oral hypoglycemia treatment and follow up, capillary blood glucose (CBG) threshold to define hypoglycemia, type of oral treatment administered, grams of simple carbohydrates in oral treatment administered, CBG level that defined the initial onset of hypoglycemia event, time to hypoglycemia resolution, was repeat oral treatment administered if recheck CBG did not show resolution, if there was assessment for rebound hyperglycemia.

Study risk of bias assessment

Risk of bias was assessed independently by two authors using the Newcastle-Ottawa scale which is an accepted tool for evaluation of non-randomized studies [8].

Effect measures

The effect measure was the percentage of hypoglycemia event resolution at a defined time in minutes since the completion of the first oral hypoglycemia treatment.

Data synthesis methods

Data were synthesized for studies where there was the same type and grams of oral carbohydrates ingested, and the same time to recheck for hypoglycemia event resolution.

Synthesized data were used to calculate the percentage of hypoglycemia events resolved at a pre-defined time, if the same type and quantity of oral carbohydrate treatment was administered.

If there were studies meeting the criteria for data synthesis, the results were tabulated. We did not plan a meta-analysis because guidelines had not referenced any studies of oral hypoglycemia treatment for people living with T2D. Therefore, we were not expecting there to be a substantial number of studies that would allow for meta-analyses, and this was confirmed by our comprehensive literature search.

Reporting bias assessment and certainty assessment

We did not anticipate that studies would have risk of bias due to missing results. Moreover, we did not expect to need to assess for certainty in the outcome because it is clearly defined based on repeat CBG level on the glucose meter.

Results

Study selection

The Preferred Reporting Items for Systematic Review and Meta-Analysis Protocol [9, 10] flow chart for the literature search results and screening process is presented in Fig. 1.

Study characteristics

Data extracted from the three included studies are presented in Table 1.

Three studies were included, which reported on 152 insulin-treated adults who experienced 366 hypoglycemia events. None of these three studies presented if the participants were or were not on sulfonylurea concurrently, nor did they present a breakdown of the types of insulin(s) (long-acting versus rapid-acting) for the participants.

First included study

Kim et al. 2016 performed a study [11] on 30 adults living with T2D who were receiving insulin therapy when they were admitted to their internal medicine ward. It was not reported whether these participants were also taking sulfonylurea. The intent of their study was to assess for the time of peak rise in blood glucose after 175 mL of orange juice containing 15 g of carbohydrates was administered for hospitalized people living with type 2 diabetes who had an average CBG of 3.5 (standard deviation (SD) 0.1)

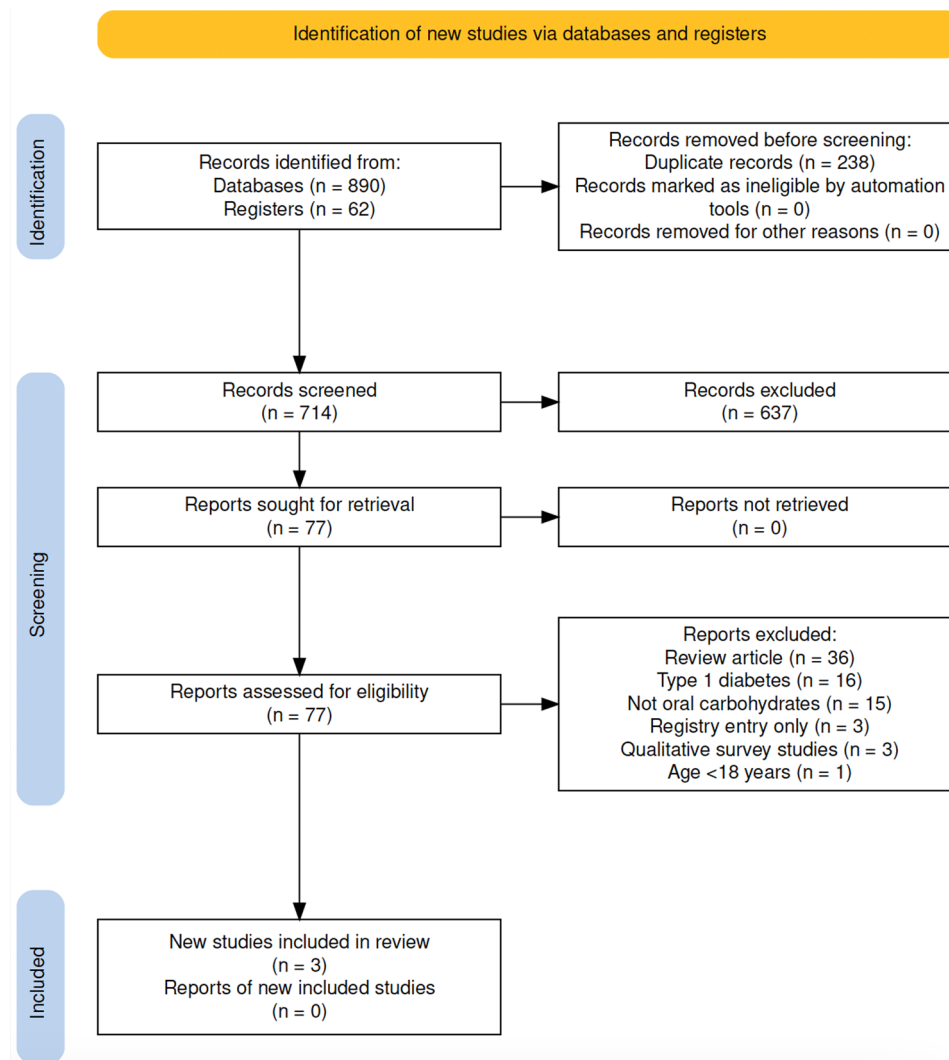


Fig. 1 Literature search and screening flow diagram [9, 10]

mmol/L. The authors defined the hypoglycemia threshold as < 3.9 mmol/L, which is consistent with mild or level 1 hypoglycemia at blood glucose level between 3.0 mmol/L to 3.8 mmol/L [3–5]. At 15 min, 30 min, and 45 min after the single orange juice administration, they reported the mean CBG (SD). The percentage of hypoglycemia event resolution was not reported. This was the only study of in-hospital adults living with T2D. Therefore, we reached consensus to include it and make an assumption of normal distribution of attained mean CBG at recheck time points.

For this Kim et al. study's outcome [11], we assumed a normal distribution, and then calculated the 2.5 percentile (%ile) as mean glucose minus 2 standard deviations (2SD), and 97.5%ile as mean glucose plus 2SD. The outcome reported is therefore at least 97.5% hypoglycemia event resolution if the 2.5%ile is 3.9 mmol/L or above. At the first recheck CBG which occurred at 15 min after the

orange juice 15 g of simple carbohydrates administered, there was at least 97.5% hypoglycemia event resolution. At the second recheck CBG which occurred at 30 min after the orange juice 15 g of simple carbohydrates administered at time 0 min, the 2.5%ile was 5.4 mmol/L, which is highly suggestive of near 100% hypoglycemia event resolution.

Second included study

The Krebs et al. 2018 study [12] recruited adults living with T2D treated with insulin therapy, from outpatient diabetes clinics. The authors defined the hypoglycemia threshold as < 4.0 mmol/L. The study team gave the participants a supply of Dextro glucose tablets containing 3 g of glucose per tablet, and Mentos candies that the authors reported as also containing 3 g of glucose per candy. Each study participant was sent home with 15 sealed envelopes to be opened one per hypoglycemia

Table 1 Data extracted from the three included studies

First author et al. (Publication Year)	Country	Kim et al. (2016) South Korea	Krebs et al. (2018) New Zealand	Vindedzis et al. (2012) Australia
Number of participants living with type 2 diabetes mellitus (T2D)	30	30 (Total of 244 hypoglycemia events amongst participants)	30	Not reported (92 "insulin-treated participants")
Sulfonylurea (%)	Not reported	Not reported	Not reported	Not reported
Insulin-treated (%)	100	100	100	100
Prospective or retrospective	Prospective	Prospective	Prospective	Prospective
Study setting	Inpatient internal medicine wards	Participant's home	Participant's home	Outpatient diabetes clinic
Who administered treatment	Inpatient nurse	Participant	Participant	Outpatient clinic nurse
Capillary Blood Glucose (CBG) defining hypoglycemia (mmol/L)	<3.9	<4.0	<4.0	<3.5
Type(s) of simple oral carbohydrate	Orange juice	Investigator supplied: Dextro (glucose) tablets 3 g each or Mentos 3 g glucose each	Investigator supplied: Dextro (glucose) tablets 3 g each or Mentos 3 g glucose each	Glucose-containing fluid (carbotest)
CBG reached by participants (mean (SD)) (mmol/L)	3.5 (0.1)	3.4 (0.4)	3.4 (0.4)	2.8 (0.5)
Simple oral carbohydrates (grams)	15	12	0.3 g glucose per one kg body weight	2.7 (0.4)
Time of 1st CBG recheck (minutes since 1st hypoglycemia treatment)	15	10	5	10
Hypoglycemia event resolution (%) at 1st CBG recheck	Not reported; Mean CBG 5.6 mmol/L (SD 0.5) Estimated > 95% Assume normal distribution: 2.5%ile = 4.6 mmol/L 97.5%ile = 6.6 mmol/L	66	95	85
2nd hypoglycemia treatment administered?	No	Yes, if 1st CBG recheck < 4.0 mmol/L	Yes, if 1st CBG recheck < 4.0 mmol/L	Yes, if 1st CBG recheck < 3.5 mmol/L
Time of 2nd CBG recheck (minutes since 1st hypoglycemia treatment)	30	20	20	10
Hypoglycemia event resolution (%) at 2nd CBG recheck	Not reported; Mean CBG 6.4 mmol/L (SD 0.5) Estimated near 100% Assume normal distribution: 2.5%ile = 5.4 mmol/L 97.5%ile = 7.4 mmol/L	Not reported	Not reported	44
3rd hypoglycemia treatment administered?	No	Yes, if 2nd CBG recheck < 4.0 mmol/L	Yes, if 2nd CBG recheck < 4.0 mmol/L	Yes, if 2nd CBG recheck < 3.5 mmol/L
Time of 3rd CBG recheck (minutes since 1st hypoglycemia treatment)	45	30	30	15
				30

Table 1 (continued)

First author et al. (Publication Year)	Country	Kim et al. (2016) South Korea	Krebs et al. (2018) New Zealand	Vindedzis et al. (2012) Australia
Hypoglycemia event resolution (%) at 3rd CBG recheck		Not reported; Mean CBG 6.1 mmol/L (SD 0.5) Assume normal distribution: 2.5%ile = 5.1 mmol/L 97.5%ile = 7.1 mmol/L	Not reported	24
Rebound hyperglycemia part of study design?	No	Yes; defined as CBG >= 8 mmol/L at 30 min since first hypoglycemia treatment. Occurred in: 28% events with 12 g treatment; 62% events with 30 g treatment; 63% events with weight-based oral hypoglycemia carbohydrate treatment.	Yes; defined as CBG > 10 mmol/L at 30 min after resolution of hypoglycemia. Occurred in 2 participants and too infrequent to compare between treatments received.	15
				0

event experienced. There were five sealed envelopes for each of the three treatments: 12 g of carbohydrates; 30 g of carbohydrates; 0.3 g of carbohydrates per one kilogram of body weight. Notably, 244 hypoglycemia events occurred in 30 participants.

The sealed envelopes were designed to randomize the order of participant self-administered oral carbohydrate treatment types at home, and data were aggregated by type of oral carbohydrate treatment irrespective of the treatment order. Therefore, the Krebs et al. 2018 study fits better with conventional definition of a non-randomized study type for the purpose of risk of bias assessment. The study team supplied each participant with a timer, and the first CBG recheck was set at 10 min after the self-administered oral carbohydrate treatment.

Third included study

Vindedzis et al. 2012 recruited 92 “insulin-treated” adults who had capillary blood glucose < 3.5 mmol/L when “attending scheduled diabetes clinic appointment” [13]. The authors defined the hypoglycemia threshold as < 3.5 mmol/L, which they acknowledged was lower than the < 3.9 or 4.0 mmol/L threshold that is commonly recommended.

The main concern with this study for our systematic review question was that the authors did not report how many of the participants had T2D. Therefore, the results are assumed to be a mix of T2D and T1D. We included this study under the assumption that there is a substantial percentage of T2D participants. However, this could not be verified. The authors reported the outcome of hypoglycemia event resolution at each of the three CBG checks. However, since their threshold for hypoglycemia was set quite low, their percentage hypoglycemia resolution was likely an over-estimate where many did not reach the more common hypoglycemia resolution threshold of 3.9 or 4.0 mmol/L and above.

Furthermore, the mean initial hypoglycemia in this study was 2.7 to 2.9 mmol/L [13], which was level 2 moderate hypoglycemia (glucose < 3.0 mmol/l) [3–5], and was substantially lower than that of the other two included studies [11, 12].

Risk of bias assessment

The assessment of risk of bias was based on the Newcastle-Ottawa scale ratings [8] presented in Table 2. The independent assessment by two authors had full agreement. The included studies had a low risk of bias.

Results of syntheses, reporting biases, and certainty of evidence

Data syntheses were not applicable because all three included studies had various hypoglycemia threshold definitions, different oral carbohydrate treatment types and

Table 2 Newcastle-Ottawa risk of bias assessment for included studies

First author et al. (Publication Year) Country	Kim et al. (2016)* South Korea	Krebs et al. (2018)** New Zealand	Vindedzis et al. (2012) Australia
Selection			
Representativeness of exposed cohort	Yes	Yes	Unclear because the percentage of participants with T2D was not reported.
Selection of non-exposed cohort	Not applicable for all studies		
Ascertainment of exposure (hypoglycemia treatment)	Yes	Yes	Yes
Outcome of interest (hypoglycemia resolution) was not present at start of study	Yes	Yes	Yes
Comparability			
Study controls for grams of simple carbohydrate administered	Yes	Yes**	Yes
Study controls for time to hypoglycemia resolution	Yes*	Yes**	Yes
Outcome			
Assessment of outcome	Yes*	Yes**	Yes
Follow-up long enough for outcome	Yes	Yes	Yes
Adequacy of follow-up	Yes	Yes	Yes

*The Kim et al. 2016 study's objective was to determine the peak glucose response after 15 g of oral carbohydrates administered. They reported the mean glucose (standard deviation (SD)), and defined the hypoglycemia threshold as < 3.9 mmol/L. To determine the outcome for this systematic review, we assumed a normal distribution, and then calculated the 2.5%ile as mean glucose minus 2SD, and 97.5%ile as mean glucose plus 2SD. The outcome reported is therefore at least 97.5% hypoglycemia event resolution if the 2.5%ile is 3.9 mmol/L or above

**The Krebs et al. 2018 study used envelopes to randomize the order of participant self-administered oral carbohydrate treatment types at home, and data were aggregated irrespective of the treatment order. This study was people living with type 2 diabetes self-treatment at home following the instructions from the study team

quantities, and different CBG recheck times. Therefore, none of the results in the three studies could be combined together. Reporting biases are also less applicable because the studies' interventions were different. The certainty of evidence assessment is limited because only three studies fit the inclusion criteria, and one of the three studies did not differentiate between T2D versus T1D participants.

Discussion

General interpretation of results

There is only a very weak evidence base for hypoglycemia oral carbohydrate treatment and recheck CBG time in T2D. Although the widely recommended treatment with 15 g of carbohydrates and recheck CBG in 15 min has been entrenched in clinical guidelines [3–5], there are only three studies that have examined this approach in adults living with T2D [11–13]. These three studies used different sources and quantities of simple carbohydrates, and different times for recheck CBG. Furthermore, they ranged from participants starting with very mild hypoglycemia (CBG 3.5 mmol/L) to participants already in moderate hypoglycemia (CBG < 3.0 mmol/L) [11–13].

For mild hypoglycemia, one study showed that 15 g of carbohydrates with 30-minute re-check had near 100% hypoglycemia resolution [11]. In another study, for a slightly less mild hypoglycemia, 30 g of carbohydrates

with 10-minute recheck had 95% hypoglycemia resolution [12]. The complicating factor was that this study also examined the concept of rebound hyperglycemia at 30-minutes defined as glucose ≥ 8 mmol/L which occurred in 62% and 63% of hypoglycemia events treated with 30 g of carbohydrates, and 0.3 g per kilogram of body weight, respectively [12]. This was a rather strict definition for rebound hyperglycemia, because most time-in-range recommendations allow up to 10 mmol/L as the upper threshold [14–16]. If this study also allowed for rebound hyperglycemia to be > 10 mmol/L, then they would have likely had substantially less concern for rebound hyperglycemia.

Limitations

The only study where people living with type 2 diabetes reached moderate hypoglycemia (glucose < 3.0 mmol/L) used attainment of a very low glucose < 3.5 mmol/L to define hypoglycemia resolution [13]. Their reported 89% hypoglycemia event resolution with 20 g of carbohydrates at 10-minute recheck [13] was of very limited applicability because most current guidelines define hypoglycemia resolution as above 3.9 or 4.0 mmol/L [3–5].

While the studies reported that participants were treated with insulin, the studies did not present the breakdown of the types of insulin(s) (long-acting versus

rapid-acting) that participants were taking. Moreover, the studies did not present whether some people living with type 2 diabetes were also taking sulfonylurea. Sulfonylurea can cause hypoglycemia by increasing endogenous insulin that may also contribute to local interactions with glucagon counter-regulation during hypoglycemia [1, 17, 18]. Although T2D is associated with hyperglucagonemia, glucagon's action and potency may gradually wane over time [1, 19–21]. A longer duration of type 2 diabetes is associated with a diminished counter-regulatory response to hypoglycemia [1, 17–21]. Therefore, it would be worthwhile to analyse if people living with type 2 diabetes for a shorter duration who take sulfonylurea (and are not taking insulin) require less oral carbohydrate treatment for hypoglycemia due to a relatively more intact glucagon response.

Physiological symptoms due to hypoglycemia, and ability to self-treat both decline with increasing age [17, 22, 23]. Future studies could stratify hypoglycemia treatment and resolution based on age categories to make tailored recommendations for elderly, frail, cognitively-impaired, or caregiver-dependent adults living with T2D.

The review process was thorough and independently completed by two authors. We searched for full-text articles in English or French, and therefore would have missed those published only as an abstract or conference proceeding or in other languages. We only searched the Cochrane Central Register of Controlled Trials, and acknowledge that we did not search other clinical trials registries. We focused on published literature, and hence there is publication bias because we did not search unpublished literature. Compared to another commonly-used tool for risk-of-bias assessment (“Risk Of Bias In Non-randomised Studies - of Interventions” [24]), the Newcastle-Ottawa scale includes less detailed criteria for the evaluation of confounders, and protocol deviations. We found that the designs of the studies fit well with using the Newcastle-Ottawa scale.

Our review question focused on achievement of a threshold above which hypoglycemia is considered resolved. We acknowledge that people living with diabetes may have hypoglycemia symptomatic resolution at CBG levels lower or higher than the commonly used threshold of 3.9 or 4.0 mmol/L. Due to the need for biochemical and medical-legal glucose level definitions for hypoglycemia resolution, we focused on the attainment of hypoglycemia resolution based on glucose levels.

Implications of review findings

The main implication of this systematic review is that there is very limited evidence base for recommendation of oral simple carbohydrate quantity and recheck time for hypoglycemia resolution in T2D. People living with T2D who self-manage their condition have likely had

opportunities to self-treat their hypoglycemia events. Indeed, they live with T2D all day, every day, and through trial-and-error would have personalized their hypoglycemia treatment based on their own experiences with a variety of oral carbohydrate sources and quantities, and timings of glucose recheck. Fear of hypoglycemia is a known factor that can limit attainment of glycemic goals [25–27].

For clinicians and guidelines, we suggest to refrain from being too prescriptive about the “15 grams / 15 minutes” for T2D because of the very weak evidence base which cannot recommend a quantity of simple carbohydrates and a recheck CBG time for the spectrum of mild to moderate hypoglycemia.

Hypoglycemia oral treatment in T2D is an area that would benefit from future research spanning the spectrum of hypoglycemia severity ranges, the type of medication that caused the hypoglycemia, simple carbohydrate treatment types and quantities, timings for glucose recheck, and detection of rebound hyperglycemia. With the increased use of continuous glucose monitors in people living with T2D, continuous glucose monitors could be integrated into future study designs for hypoglycemia treatment and personalized responses to various types and quantities of simple carbohydrate treatments [4]. Recent consensus recommendations suggest starting hypoglycemia treatment with 5 to 10 g of simple carbohydrates for automated insulin delivery systems where insulin pump algorithms integrate real-time data from continuous glucose monitors [28]. There are separate consensus recommendations for people using automated insulin delivery who experience a hypoglycemia caused by exercise or excessive bolus of rapid-acting insulin [28].

Conclusion

The three small-sized studies provided a very weak evidence base for hypoglycemia treatment in T2D. Future studies are encouraged to identify and analyze people living with T2D who are treated with sulfonylurea, with or without insulin therapy, to reflect hypoglycemia treatment over the breadth of T2D pharmacotherapy. Furthermore, future studies could evaluate various quantities of carbohydrates for hypoglycemia treatment in T2D.

Abbreviations

T2D	Type 2 diabetes mellitus
BG	Blood glucose
CBG	Capillary blood glucose
T1D	Type 1 diabetes mellitus

Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12902-025-02144-3>.

Supplementary Material 1

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Author contributions

Nicole Prince: Methodology, investigation, data curation, formal analysis, writing: review and editing. Heather Lochnan: writing: review and editing. Risa Shorr: Methodology, writing: review and editing. Annie Garon-Mailer: Writing: review and editing. Cathy J. Sun: Conceptualization, methodology, investigation, data curation, formal analysis, supervision, writing: original draft, review and editing.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

Not applicable for a systematic review.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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