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Original article

Caregivers' knowledge and practice regarding hypoglycemia prevention in children with type one diabetes mellitus at Saint Paul's Hospital Millennium Medical College, Addis Ababa, Ethiopia

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Abstract

Background: *Achieving optimal glycemic control with a stringent preventive interventions targeting hypoglycemia is at the core of diabetic care. Caregivers for pediatric diabetic patients are the primary providers. Therefore, enabling them to have adequate knowledge about hypoglycemia and its prevention is critical.*

Objective: *To assess the knowledge and practice of preventing hypoglycemia among caregivers for diabetic patients on follow-up at a tertiary care at a pediatric endocrine clinic in Ethiopia.*

Methods: *A cross-sectional study was conducted on caregivers for children with type one diabetes patients attending follow-up visits at a tertiary care with a pediatric endocrinology clinic in Ethiopia, from August 16 to October 10, 2021. We collected relevant data using interviews and pretested questionnaire. We analyzed the collected data using statistical Package for Social Science Software.*

Results: *From a total of 101 caregivers, 76.2 % were females, and 23.8% were males. 64.4 % had good knowledge about hypoglycemia. Among 19 caregivers whose child was less than four years old, 10 caregivers had a good practice and 9 had poor hypoglycemia practice and from 75 caregivers whose child was four years and above, 31 caregivers had a good practice and 44 had poor hypoglycemia prevention practice. Overall, 43.6 % had good hypoglycemia prevention practices.*

Conclusion: *Caregiver's knowledge regarding hypoglycemia was satisfactory, but the hypoglycemia prevention practice was poor. Therefore, education about hypoglycemia and its prevention practice should be emphasized during the regular clinic follow-up.*

Keywords: Hypoglycemia, T1DM, Caregivers

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Introduction

Hypoglycemia is a common acute complication in children with type one diabetes mellitus (T1DM). Blood Glucose level of ≤ 3.9 mmol /l or 70 mg /dl is defined as hypoglycemia Common causes of hypoglycemia are insulin therapy, intensive or prolonged exercise, missing main meals and snacks, and ingestion of alcohol in adolescents (1). The signs and symptoms of hypoglycemia are not specific, and the manifestations are different in children and adults (2). Hypoglycemia should be prevented because its occurrence is frequently predictable and often associated with significant psychosocial dysfunction; more importantly, it can rarely lead to permanent long-term squelae and may be potentially life-threatening (1). Approaches known to decrease the risk of hypoglycemia include patient education, dietary and exercise modifications, medication adjustment, careful glucose monitoring by the patient, and surveillance by the clinician (3). Furthermore, knowledge about the symptoms of hypoglycemia is an important step in influencing self-care practices in preventing hypoglycemia as informed people are more likely to exercise better preventive measures (4). Good knowledge about hypoglycemia is positively associated with good practices of hypoglycemia prevention (5). Primary providers for pediatric patients are caregivers, enabling them to have good knowledge and preventive practices for hypoglycemia are parts of core diabetic care.

Hypoglycemia is a common problem in children with type 1 diabetes Because of the challenges of insulin dosing, variable eating patterns, erratic activity, and the limited ability of young children to detect hypoglycemia, it is a frequent problem in children with type 1 diabetes. The infant, young child, and adolescent typically exhibit unpredictable feeding styles, may not eat all the required quantity of food at major meal times and snacks, the interval between meals is unpredictable, , and often overnight fasting is prolonged. (3). Though hypoglycemic episodes tend to be common, evidence suggests that children with type 1 diabetes and their parents fail to recognize hypoglycemic episodes in 40–50% of the time. (6). Failure to recognize hypoglycemia and manage hypoglycemia episodes is dangerous because the recurrence risk increases subsequently, and it causes impaired hypoglycemia awareness (1). Although knowledge about hypoglycemia and its prevention practice is at the core of diabetic care, it is not studied well, especially in the pediatric age group. Therefore, this study aimed to assess the status of knowledge about hypoglycemia and its prevention practices among caregivers of pediatric diabetic patients at the Saint Paul's hospital millennium medical college (SPHMMC) diabetes follow-up clinic.

Methods

The study was conducted at SPHMMC pediatrics and child health department outpatient endocrine clinic. SPHMMC is located in

Addis Ababa Ethiopia. It is one of tertiary hospitals in the country serving population of 8 million. The pediatrics and child health department has inpatient and outpatient services including Neonatal and child intensive care unit.

A hospital-based cross-sectional study was conducted on 101 caregivers of children with T1DM at SPHMMC pediatrics and child health department outpatient endocrine clinic who attended follow-up clinic from August 16 to October 10, 2021. Data was collected at the follow-up clinic using the interview method via a pretested questionnaire after the study got institutional review board approval by the research directorate office of SPHMMC and verbal consent from the caregivers. The study population was all caregivers of diabetes mellitus patients who attended follow-up visits during the study period at pediatrics endocrine clinic. Since patients are coming every 2 to 3 months all the caregivers who attended the follow-up visits during the study period who fulfilled the inclusion criteria were included in the study.

Inclusion criteria: All caregivers of T1DM patients who were above 18 years of age and who were willing to participate in the study during the study period and attended follow-up at pediatric endocrine clinic were included.

Exclusion criteria: All Caregivers of T1DM patients who were unwilling to participate in the study and those who were less than 18 years of age were excluded.

The data was collected using pretested structured interview questionnaire. The questionnaire was first prepared in English then it was translated to Amharic and Afanoromo languages (local languages) and translated back to English . The data was collected by interns who were trained by the principal investigator on the objective, relevance of the study and confidentiality of information before the data collection and it was supervised by the clinical advisor and principal investigator throughout the course. All the data was checked for completeness, clarity and consistency by the principal investigator.

Dependent variables: Hypoglycemia knowledge and prevention practice of hypoglycemia. Independent variables: Socio-demographic variables (age, sex, income, marital status, education, religion, and occupation). Clinical characteristics-related variables (Types of diabetes of the child, duration of illness, type of medication used, frequency of taking medication, having a glucometer, knowing glucose level, history of hypoglycemia, and co-morbidity). The items for the hypoglycemia knowledge and prevention practice were collected from International Society of Pediatrics and Adolescents Diabetes (ISPAD) guideline (1).

For knowledge assessment, twenty-four yes or no questions each with a point score were used. For the practice section a total of seven questions, four yes or no questions each with one-point score, and three questions each with a score of zero to three points were used. Mean was computed using 7 variables for caregivers of children at the age of four years

and above and using three variables for those less than four years. The mean score was calculated by adding each participant's score questions about specific variables (knowledge or practice) and dividing it by the total number of participants using Likert scale which is a psychometeric score scale used to measure opinion, attitude or behavior. The collected data was analyzed using SPSS.

Operational definitions

Knowledge: It is the awareness of the caregivers about hypoglycemia. It is measured by calculating the mean score of the 24 items and categorized as good knowledge (if participants scored ≥ mean score from the knowledge questions on hypoglycemia) or poor knowledge (if participants scored <mean score from the knowledge questions on hypoglycemia).

Practice: The practice of the caregivers in the prevention of hypoglycemia. It is measured by 7 questions using a Likert scale to obtain total mean scores and categorized as good practice or poor practice. All caregivers' answers to practice questions were computed to obtain total mean scores and categorized as good practice (if participants scored ≥ mean score) or poor practice (if participants scored < mean score) (5,7).

Results

Caregivers' Sociodemographic Assessment

A total of 101 caregivers were included in the study. 76.2 % were females. Around 92.1% of the caregivers were their biological parents and 89.1% of the caregivers were married ones. Around 61.4% of the caregivers attended secondary and college level education. All of them had at least one means of health-related information. The majority came from urban areas (91.1%), and only 5.9% came from rural areas (Table 1).

Table 1: Sociodemographic assessment of the caregivers of children with T1DM attending pediatrics Endocrine Clinic at SPHMMC, August 16 to October 10, 2021

Study characteristics	Category	Frequency (%)
Caregivers' relation with the child	Parent	93 (92.1)
	Relative	6 (5.9)
	Legal guardian	2 (2.0)
Caregivers' age	18-34	50 (49.5)
	35-60	48 (47.5)
	>60	3 (3)
Child age in Years	3-5	12 (11.9)
	< 3	24 (23.8)
	6-13	46 (45.5)
	14-17	19 (18.8)
	Mean	8.6±4.7
Caregivers' sex	Male	24 (23.8)
	Female	77 (76.2)
Child sex	Male	48 (47.5)
	Female	53 (52.5)
Religion	Orthodox Christian	61 (60.4)
	Protestant	21 (20.8)
	Muslim	18 (17.8)
	Catholic	1 (1.0)
Marital status	Married	90 (89.1)
	Single	7 (6.9)
	Others*	4 (4.0)
Educational status	No formal education	15 (14.9)
	Primary education	24 (23.8)
	Secondary education	31 (30.7)
	College and above	31 (30.7)
Occupation	Unemployed	51 (50.5)
	Private employ	26 (25.7)
	Government employee	13 (12.9)
	Others**	11 (10.9)
Residence	Urban	92 (91.1)
	Rural	6 (5.9)
	Semi-urban	3 (3.0)
Income per month	<40 USD	57 (56.4)
	40-99 USD	27 (26.7)
	≥100 USD	17 (16.8)

*-separated and widowed ** -Daily laborer and retired #-USD—United States dollar

Caregivers' knowledge of hypoglycemia

The caregivers have attended a regular follow-up at this clinic for a minimum of 6 weeks, a maximum of 13 years, and a mean of follow-up 2.9 years. More than half (51.5%) didn't know the type of diabetes the child was having. Around 82.2% of caregivers received diabetic education 66.3% were educated specifically about hypoglycemia, 71.6% got education at the SPHMMC diabetes clinic, and 11.9% both at Ethiopian diabetes association (EDA) and SPHMMC diabetes clinic.

Participants were asked about the causes, symptoms, and preventive measures of hypoglycemia. Of 101 participants, 59.4 % can define hypoglycemia correctly based on glucometer measurement. Among the five causes of hypoglycemia listed, inadequate feeding or missing meals and insulin overdose were among the well-known causes of hypoglycemia by 96% and 81.2% of the participants respectively. Alcohol ingestion was the least known cause by caregivers (42.6%). Of the symptoms shakiness, loss of consciousness, and dizziness & unsteady gait were the most commonly known symptoms (94. 1%). Inconsolable crying and nightmares were the least known symptoms, 51.5 %, and 64.4 % respectively (Table 2).

Regarding the prevention of hypoglycemia majority of caregivers (89.1%) believed that hypoglycemia is preventable and 82.2 % knew hypoglycemia was a concern as hyperglycemia. Only 45.5 % knew that the chance of recurrence of hypoglycemia increases even after one episode of hypoglycemia.

Table 2: Knowledge about Hypoglycemia among Caregivers of children with T1DM attending pediatrics Endocrine Clinic at SPHMMC, August 16 to October 10, 2021.

Study characteristics	**Good knowledge response N (%)**	**Poor knowledge response N (%)**
Hypoglycemia definition	60 (59.4)	41 (40.6)
Cause of hypoglycemia		
Giving excessive dose of insulin	82 (81.2)	19 (18.8)
Exercise	65 (64.4)	36 (35.6)
Missing meal/Inadequate feeding	97 (96.0)	4 (4.0)
Alcohol ingestion	43 (42.6)	58 (57.4)
Sleep cause hypoglycemia	61 (60.4)	40 (39.6)
Symptoms of hypoglycemia		
Shakiness	95 (94.1)	6 (5.9)
Sweatiness	91 (90.1)	10 (9.9)
Poor concentration	87 (86.1)	14 (13.9)
Loss of consciousness	95 (94.1)	6 (5.9)
Seizure	92 (91.1)	9 (8.9)
Irritability	76 (75.2)	25 (24.8)
Hunger	86 (85.1)	15 (14.9)
Headache	74 (73.3)	27 (26.7)
Slurred speech	75 (74.3)	26 (25.7)
Dizziness and unsteady gait	95 (94.1)	6 (5.9)
Inconsolable crying	52 (51.5)	49 (48.5)
Nightmare	65 (64.4)	36 (35.6)
Ways to prevent hypoglycemia		
Measuring glucose before exercise	95 (94.1)	6 (5.9)
Giving snacks before intense exercise	84 (83.2)	17 (16.8)
Make avail sugar/snack when child is not around home	46 (45.5)	55 (54.5)
Wearing DM identification in hand	75 (74.3)	26 (25.7)
Ways of initial management of hypoglycemia		
Give sweets (Mirinda, tea, sugar, bread)	61 (60.4)	40 (39.6)
Bring the child to nearby clinic	13 (12.9)	88 (87.1)

26.73 % of the caregivers didn't know what should be done in case of inadvertent over-administration of insulin and the remaining answered that either the child should be brought to the nearby clinic (12.87%) or should be given sweets like Mirinda, sugar, tea and the like (60.4%).

From the 24 yes or no type knowledge questions each with one point, the mean score was 18.82 with a minimum of 9, maximum of 24, and standard deviation of 3.16. Accordingly, 64.4 % had good knowledge and 35.6 had poor knowledge (Table 2).

Caregivers Practice on hypoglycemia prevention

Caregivers Hypoglycemia prevention practice in children less than four years

Twenty caregivers of children less than four years old were assessed. All of them had a glucometer and they monitored the blood glucose level twice and more daily. 19 (95%) of them, their children had experienced hypoglycemia before, and 16 (84.2%) had reported the episode to their physician. Only four caregivers failed to make snacks available when the child was not around home. The majority of the caregivers made snacks available to their children (Table 3)

Table 3: Hypoglycemia prevention practice among caregivers of children < 4 years with T1DM, attending pediatrics Endocrine Clinic at SPHMMC, August 16 to October 10, 2021.

Variables	Frequency	Percentage
Glucometer		
Yes	20	100.0
Frequency of measurement		
Twice	11	55.0
Three times	5	25.0
Four times and more	4	20.0
Total	20	100.0
Hypoglycemic episodes occurred ever		
Yes	19	95.0
No	1	5.0
Total	20	100.0
Report to physicians		
Yes	16	84.2
No	3	15.8
Total	19	100.0
Making snacks available when child is not around home		
Never	1	5.0
Sometimes	3	15.0
Usually,	4	20.0
Always	12	60.0
Total	20	100.0

The practice was assessed by computing a mean score using three variables, regular monitoring (1 point), reporting episodes to physicians (1 point), and making snacks available when the child was not around home (0 to 3 points). It was computed for 19 caregivers who answered all the 3 questions. The mean score was 4.1 with a minimum of 2, a maximum of 5, and a St. Deviation of 1.06. Accordingly, ten caregivers had good practice and 9 had poor practice.

Caregivers Hypoglycemia prevention practice in children four years and above

Eighty-one caregivers of Children four years and above were studied. 79 (97.5%) had a glucometer and 76 monitored the blood glucose level twice and above per day. Seventy-five noticed hypoglycemic episodes before in their children and 67 reported the episode to the physician. The majority of caregivers 76 (93.8%) told the child's DM status to teachers or friends. Nearly half 39 (48.1%) caregivers never measured blood glucose before the child did intense exercise. Twenty-five (30.9%) children were never given snacks before intense exercise and 23 (28.4) were given sometimes. Making snacks available is better practiced regularly by nearly half of caregivers 39 (48.1%). Wearing a DM identification is the least to be practiced 19 (23.5%) (Table 4).

Table 4: Hypoglycemia prevention practice among caregivers of children ≥ 4 years (n= 81) with T1DM, attending pediatrics Endocrine Clinic at SPHMMC, August 16 to October 10, 2021.

Variables	Frequency	Percentages
Glucometer		
Yes	79	97.5
No	2	2.5
Total	81	100.0
Frequency of measurement		
Once	3	3.8
Twice	61	77.2
Three times	12	15.2
Four times and more	3	3.8
Total	79	100.0
Hypoglycemia symptoms occurred		
Yes	75	92.6
No	6	7.4
Total	81	100.0
Report to physicians		
No	8	10.7
Yes	67	89.3
Total	75	100.0
Glucose measurement before exercise		
Never	39	48.1
Sometimes	25	30.9
Usually,	4	4.9
Always	13	16.0
Total	81	100.0
Giving snacks before intense exercise		
Never	25	30.9
Sometimes	23	28.4
Usually,	7	8.6
Always	26	32.1
Total	81	100.0
Making snacks available when child is not around home		
Never	13	16.0
Sometimes	23	28.4
Usually,	6	7.4
Always	39	48.1
Total	81	100.0
Wearing DM ID		
No	62	76.5
Yes	19	23.5
Total	81	100.0
Telling DM status to friends/teachers		
No	5	6.2
Yes	76	93.8
Total	81	100.0

The practice was assessed by computing a mean score using seven variables (regular monitoring, reporting episodes to physicians, wearing DM ID and telling DM status for teachers/friends 1 point for each) and making snacks available when a child is not around home measuring and giving snacks before intense exercise (0 to 3 points for each). It was computed for 75 caregivers who answered all 7 questions. The mean score was 7.17 with a minimum of 2, a maximum of 13, and a St. Deviation of 2.67. Accordingly, 31 caregivers had good practice and 44 had poor practice.

Caregivers practice on primary management of hypoglycemic episodes

Caregivers who witnessed hypoglycemia (symptoms or blood glucose less than or equal to 70 mg/dl) in their children were asked how they managed it using open-ended questions and their answers were as follows. Among 94 caregivers who witnessed hypoglycemia, about 83 did manage it appropriately. Around 69 caregivers said they gave sweets like mirinda, tea with sugar and food, 4 of the caregivers said they give sweets and measure the glucose frequently. One caregiver said she gives sweets then take the child to the clinic and 9 of the caregivers took the children to the clinic. Eleven of the caregivers gave inappropriate answers. Five of them said they only measure the glucose without intervention and 6 of the caregivers said to omit or adjust the next insulindose.

Discussion

In the current study, we discovered that 92.1% of caregivers were their biological parents, with the majority (76.2%) of them being their mothers. We observed also a significant number of caregivers were from urban and they were married and had completed secondary and college level education. Despite these factors which might affect the findings positively, we found that the overall knowledge about causes, symptoms, and preventive measures of hypoglycemia was good only in 64.4% of the caregivers, with a significant portion of them (35.6%) were having poor knowledge.

Generally hypoglycemia in the setting of diabetes is a fundamental area of patient care. Regarding the association between caregivers knowledge and glycemic control, many studies showed that there is a significant association between mothers' knowledge of diabetes and Hemoglobin A1C (HbA1C) level that, higher knowledge ultimately leads to better control of HbA1c level. This fact was demonstrated in many studies , the higher a mother's knowledge, the better metabolic control of children and adolescents with T1DM (8,9,10). The exact incidence of hypoglycemia is difficult to ascertain, but generally mild hypoglycemia is common in children with T1DM (11). In the current study, 94 (93.1%) of the children experienced hypoglycemia, this finding was consistent with a previous study done in T1DM patients in a tertiary hospital at a diabetic clinic in Ethiopia in which 94.3% of them experienced hypoglycemia ever since they were diagnosed with T1DM (12).

Although the finding in the current study regarding the overall knowledge about causes, symptoms and preventive measures was better than other studies a significant portion of the caregivers (35.6%) had poor knowledge. Studies done among adult DM patients in the rural community in India, 63.3% had inadequate knowledge (13). In another study done in India among Type-2 diabetes patients and their caregivers about awareness of symptoms of hypoglycemia, only 38% of diabetic patients had average knowledge about symptoms of hypoglycemia (14). This is a major challenge to address as knowledge about hypoglycemia is an important step to self-care practice because informed people are more likely to have better practice (8). Poor knowledge of hypoglycemia was also observed in other studies. One study done in Sudan, 52% of diabetic patients who were taking insulin had poor knowledge of hypoglycemia symptoms and in another study done in Ethiopia around 51.2% of participants had poor knowledge of identifying symptoms of hypoglycemia respectively (15,16).

In this study, we found that around 82.2% of of the caregivers had received diabetic education, and a considerable number of caregivers had particularly received education about hypoglycemia despite that, a remarkable number of caregivers had poor knowledge about hypoglycemia, this might be the education they received might be less effective as it might lack user friendly teaching materials and because of the high patient burden and a small number of diabetic educators one to one session might not be feasible, Therefore, the caregivers should be thought about every issues related to hypoglycemia using different methods regularly which later affect their practice towards prevention of hypoglycemia.

In our study, although all participants practiced regular blood glucose monitoring, only 59.4 % can define hypoglycemia correctly based on glucometer measurement, which makes subsequent management of hypoglycemia episode difficult and increases the hypoglycemia recurrence rate. As the management of diabetes in the pediatric age depends on the caregivers, it is expected that all caregivers should receive diabetic education regularly.

In the current study, 90% of the caregivers know hypoglycemia can be prevented. Despite this 54.5% of them didn't know the recurrence rate would increase after one episode of hypoglycemia which is highly alarming because, in a previous study done in the same setting, the recurrence rate was also high with a total of 6.9 events of hypoglycemia per patient per year (7). This is a serious gap identified as they are less likely to practice prevention strategies if they didn't anticipate the high chance of hypoglycemia recurrence which needs serious intervention. In addition to this, once hypoglycemia becomes recurring, hypoglycemia fear makes the patients to modify their behaviors and take excess food to decrease hypoglycemia episodes, which in turn could contribute to a poor glycemic control (17). Fear of hypoglycemia should be assessed in children with Type 1 diabetes and their parents on a routine

basis to identify families who may need support or intervention (18). Moreover, symptoms of hypoglycemia tend to be correlated with significantly lower health-related quality of life, lower treatment satisfaction, and higher levels of healthcare resource utilization (19). That is why we need to give much emphasis on the hypoglycemia education in order to decrease its consequences.

In this study, nearly all patients practiced regular glucose measurement and the hypoglycemia reporting rate was satisfying. However, there was a huge gap in practicing preventive measures like measuring blood glucose and giving snacks before intense exercise, and wearing DM identification. And the overall hypoglycemia prevention practice is poor though the practice in those less than four years seems better. This can be due to two factors. First, it could be due to the small number of participants in this group (only 19 caregivers) and another possible explanation is that it might be due to the use of more difficult practices to calculate the mean score in those age group (four years and above) like wearing DM identification, measuring blood glucose and giving snacks before intense exercise.

Regarding prevention practice in one study in South Gondar, Ethiopia, only 21.4% of study participants had good practice in hypoglycemia prevention (16). Another study done in 2019 in the same setting showed significant improvement in terms of knowledge and practice which might be because of certain interventions (20). One study done in Tigray, Ethiopia also showed two-thirds of the study participants were found to have good hypoglycemia prevention practices which was higher than the current study (5). As it was evidenced in one study done in Iran in mothers of children with diabetes from 6-12 years old family or caregivers' empowerment the results showed significant differences in the control and study group in terms of knowledge about DM and its complications and problem-solving ability those who had received empowerment showed better outcomes (7).

In the current study as the caregivers are expected to manage the episodes primarily by their own, the practice of primary management was satisfactory as 83% of the caregivers who witnessed hypoglycemia succeeded in managing it with the administration of sweets immediately with subsequent frequent monitoring or seeking medical care. This behaviour should be encouraged.

In summary, although SPHMMC is one of the tertiary hospitals in the country with specialty care, the prevention practice of hypoglycemia in the current study was not satisfactory. Most patients are from urban areas and they have at least one or more means of getting health information. In addition to that about two-thirds of the patients received diabetic education and had good knowledge. Nevertheless, the prevention practice remained poor. It is quite logical to argue that the condition is highly likely to be worse in patients attending care in low-level setups and in remote parts of the country.

This will have two huge impacts. First, hypoglycemia will be a barrier against optimal glycemic control which is the most essential parameter to decrease the long-term complications. Second, it has a huge financial impact by increasing direct health utilization-related costs and indirect costs (21, 22).

Diabetic education is the basis of diabetic care including hypoglycemia prevention and additionally the use of continuous glucose monitoring is currently highly advocated to decrease the frequency and severity of hypoglycemic episodes in children with T1DM (23 -25).

In conclusion, we recommend healthcare providers to give proper diabetic education focusing on hypoglycemia prevention and management, and empowering families and caregivers to practice prevention of hypoglycemia is also very crucial.

Declaration

Ethical consideration

Ethical approval was obtained from St. Paul's Hospital Millennium Medical College IRB and verbal consent was obtained from the participants of the study.

Conflict of interest

No known competing interests to declare

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Authors' Contribution: NM conceived the study, designed a data abstraction tool, undertook a review, analysis and interpretation of the data, and drafted the initial manuscript. **BF** was involved in topic selection, revised data abstraction tool, supervised data collection and analysis, wrote the final manuscript. **AY** was involved in the data analysis. All authors revised the manuscript and approved the final version.

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Availability of data and materials: All relevant data are available upon reasonable request.

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