Review

Diabetes Awareness Campaigns to Prevent Ketoacidosis at the Diagnosis of Type 1 Diabetes: Efficacy on Multiple Outcomes and Predictors of Success: A Systematic Review

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Review

Diabetes Awareness Campaigns to Prevent Ketoacidosis at the Diagnosis of Type 1 Diabetes: Efficacy on Multiple Outcomes and Predictors of Success: A Systematic Review

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Abstract: In our country, the incidence of diabetic ketoacidosis (DKA) at diagnosis of type 1 diabetes (T1D) is still very high (35.7-39.6%), especially in youths. We aimed to determine the efficacy of awareness campaigns to prevent DKA on multiple outcomes and identify success predictors. The review included studies that focused on children under 18 years old, and outcomes were measured by comparing before and after implementing the campaigns in the same area and between areas where interventions took place or not. Of 177 records identified, 15 were eligible for analysis. The pooled difference in DKA frequency after a campaign implementation was between 1% and 65.5%. A decrease in the rate of acute complications, such as cerebral edema, was reported. Hemoglobin A1c (HbA1c) at onset showed a mean reduction of 0.7%- 5.1%; C-peptide increased in patients without DKA at diagnosis, and length of hospitalization decreased. Campaign costs were lower than costs of treating subjects with DKA. This review demonstrated that DKA awareness campaigns effectively reduce DKA incidence and improve other parameters, such as acute complications, HbA1c and C-peptide levels, length of hospitalization, and costs, among youths with T1D. To be effective, campaigns must follow specific principles of target population, modality, and minimal duration, reported in this review.

Keywords: type 1 diabetes; diabetes ketoacidosis; DKA prevention; campaign; youth

1. Introduction

Diabetic ketoacidosis (DKA) is a severe acute complication of type 1 diabetes (T1D) that is associated with increased mortality, morbidity, and hospitalization costs [1]. It can occur at the clinical diagnosis of T1D in children and adolescents and predicts poor long-term metabolic control [1].

In new-onset T1D, the presence of DKA often results from a delay in diagnosis. The frequency of DKA at T1D onset varies from 12.8% to 80% worldwide [2]; in Italy, the frequency of DKA at the onset of T1D is still very high (35.7-39.6%), especially in the younger age group [3], and in our region Trentino Alto Adige has been on average 46% in the last decade [4]. DKA and severe DKA increased during the early pandemic and continued throughout 2020 [3,5,6].

The frequency of DKA at T1D onset is lower in countries where the background incidence of T1D is higher [7], and the persistence of high prevalence of DKA is due to the lack of awareness among parents and healthcare providers about symptoms of T1D [8].

In recent years, the increasing incidence of T1D globally has pushed different countries, including Europe and the United States, to implement antibody screening programs, achieving excellent results [9]. The main objective of T1D screening programs is to identify individuals at risk

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or in an early stage to avoid DKA and offer them interventions to prevent or postpone the disease. Over time, the goal will be to integrate such screening into the standard care of national and regional health systems. On September 17, 2023, the Italian Parliament approved a law introducing nationwide screening for T1D in the general population aged 1–17 as part of the public health program to reduce the effects of this chronic condition. However, annual islet autoantibodies (IAb) screening from early childhood to early adolescence [10] or at landmark ages (2, 6, and 10 years), as suggested by other Authors [11–13], is cost-saving only if it reduces the rate of DKA by 20%, with a subsequent lower hemoglobin A1c (HbA1c) by 0.1% over a lifetime [14].

An alternative or complementary strategy consists of implementing public educational campaigns, and the Parma campaign in 1991 demonstrated the effectiveness of a public education program in reducing the frequency of DKA at diabetes diagnosis in a restricted area in Italy [15]. Subsequent analysis suggested that such prevention campaigns should be repeated periodically to maintain effectiveness over time [16], but what makes the campaign effective is an area of inquiry [17], and information on the target population, modality of the intervention and how to assess impact are a matter of debate. A recent systematic review and meta-analysis by Cherubini et al. [3] demonstrated that DKA awareness campaigns effectively reduce DKA among children and adolescents with T1D, and the Authors considered only the frequency of DKA as an outcome. Therefore, we performed a systematic review of the efficacy on multiple outcomes (comprehensive of HbA1c, C-peptide, complications, hospitalization duration, and costs) and possible predictors of the success of prevention campaigns.

2. Search Strategy

We searched electronic databases (PubMed, Cochrane, and Web of Science) for studies published between 1 August 1990 and 1 August 2024. The search terms or "MESH" (Medical Subject Headings) for this review included different combinations: "type 1 diabetes" or "T1D" AND "campaigns" or "awareness" AND "ketoacidosis." We included studies on youths with T1D, randomized clinical trials, and observational studies. We excluded case reports or studies with less than 100 pediatric participants. Languages other than English were not a priori exclusion criteria. For each study, in the full paper, we evaluated the reference details, the population and study characteristics, the methodology used (public posters or flyers, lectures, social networking, and free phone line), the outcomes measured, and the results.

3. Results

In total, 177 studies were found by using the MESH defined above. After removing duplicates, 172 studies were analyzed. We reviewed the titles and abstracts; 156 additional records were excluded. A total of 16 full-text manuscripts were assessed for eligibility: after full-text examination, 1 study was excluded, and a final number of 15 studies was included in this review. All the studies were prospective longitudinal in design. The number of patients enrolled in the studies was between 106 and 438.232 [15,18]. In Table 1, we summarize the characteristics of the studies included in the review (target population, geographic area, description of intervention, campaign duration, results). Below, we present the main results divided into five categories: frequency of DKA at the onset, acute complications, HbA1c, C-peptide, duration of hospitalization, and costs. The summary of evidence for each outcome is reported in Table 2.

3.1. Frequency of DKA

Overall, 14 studies included the frequency of DKA at diagnosis in their results. Four studies evaluated the effectiveness of interventions by comparing the frequency of DKA in an area where the preventive intervention was implemented and in a control area where no campaign was conducted. The other ten studies compared the frequency of DKA in the same area before and after the prevention campaign. The pooled difference in DKA was between 1% and 65.5%. The DKA incidence

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after the campaign ranged from 5.9% to 47.6%, proving the efficacy of interventions in some studies but not in others.

Analyzing the effective campaigns, the study of Cangelosi et al. [19] measured a DKA frequency of less than 6% after the 5-year campaign, reporting a decreased frequency in the intervention and control areas. The decrease in the control area might be associated with a spontaneous sensibilization of the campaign promoted by pediatricians, the parents' community of children with T1D, or new graduates in Medicine and Paediatrics at the University of Parma who were informed of the prevention program. Other studies [15,18,20] showed a significant decrease in DKA incidence, with a 25% or less frequency.

The studies of Derraik et al. [21], Rabbone et al. [17], Fritsch et al. [22], and Lansdown et al. [23] reported an increase in the frequency of DKA after implementing the interventions. In the one of Derraik et al. [21], the campaign lasted only a year and targeted the general population, not a specific one. Furthermore, it didn't consider the natural fluctuation in DKA incidence from year to year and the other factors that may influence it. In addition, more than 40% of all those diagnosed with T1D over the study period were non-European children, indicating that the campaign design didn't manage to reach the more vulnerable populations. Rabbone et al. [17] measured an increased DKA frequency after the interventions, probably related to the limited duration of the study (only two years) and the shortage of family pediatricians observed in Italy in those years. Moreover, the study didn't include either a control group or a method to verify that the posters were displayed and seen by the target population. The survey of Fritsch et al. [22] measured a non-significant decrease in the rate of DKA incidence. The 1-years campaign involved displaying posters and flyers with any educational session. The dissemination of the interventions was covered by general practitioners and not by primary pediatric care. Another study that found a non-statistically significant decrease in the rate of DKA was the one of Lansdown et al. [23]. The questionnaire survey showed that only a few parents and GPs had seen the posters and were aware of the media coverage.

3.2. Complications

Six studies included acute complications in the results, comparing the rate of complications before and after the campaign or in patients with or without DKA at the onset. Uçar et al. [20] and Patwardhan et al. [18] found a reduction in the severity of DKA. Rabbone et al. [17] described the decrease in the rate of cerebral edema in patients with vs without DKA, while Patwardhan et al. [18] reported an increase in this outcome, even though this result was classified as non-statistically significant because of the restricted number of participants and the sporadic nature of this complication. In the study of Choleau et al. [24], there was a decrease in the rate of loss of consciousness, deep coma, and hospitalization in Intensive Care Units, comparing patients with DKA, without it, or with severe DKA at diagnosis. The interventions carried out by Ahmed et al. [25] determined an absence of severe complications during the 4-year campaign, and the overall morbidity and mortality in the DKA cohort were comparable to those of other population-based studies.

3.3. HbA1c

Seven studies measured HbA1c as an outcome of the effectiveness of the prevention campaign at the diagnosis and during the follow-up [20,21,26] or comparing the value in the patients with vs without DKA at diabetes diagnosis [15,16,18–21,25,26]. In each of these studies, the group of patients without DKA at the onset had a lower value of HbA1c than the ones with DKA, with a reduction in its rate from 0.7% to 5.1% and a range from 9.1 to 11.8%.

One of the best results was achieved by Cangelosi et al. [19], who reported a decrease in HbA1c from 13.7% to 9.9% in patients without DKA at diagnosis of T1D. This result may be attributed to the awareness raised by the campaign on early symptoms of T1D at onset, leading to a shorter period of relative insulin deficiency status in children. Ahmed et al. [25] and Uçar et al. [20] reported lower HbA1c values at diabetes diagnosis after the campaign, confirming the interventions' effectiveness. The study of Vanelli et al. [15] compared HbA1c in children from the Parma area with others from

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two nearby areas, showing a decrease in the ones coming from the province of Parma, where the prevention campaign was implemented.

3.4. C-Peptide

Only two studies included C-peptide as an outcome and analyzed its relation with DKA. In the study of Vanelli et al. [15], there was an increase in the C-peptide value of 0.03 ng/mL (from 0.12 to 0.15 ng/mL in patients with DKA vs without it). Uçar et al. [20] associated the significant increase in c-peptide of 0.10 ng/mL (from 0.50 to 0.60 ng/mL) with the absence of DKA at the disease onset because of the limited destruction of beta-cells.

3.5. Length of Hospitalization

Three studies measured the length of hospitalization. Derraik et al. [21] reported an association between DKA and hospitalization, showing that children without DKA at T1D diagnosis were hospitalized for fewer days (5.5 vs 4.7 days in children with DKA vs without it, p=0.036). Moreover, the studies of Darmonkow et al. [27] and Vanelli et al. [15] analyzed the length of hospitalization before and after the campaign, with a reduction of the duration after implementing the interventions. In the study of Vanelli et al. [15], there was a difference in this outcome of 8 days in children from the area of Parma compared to the two nearby Provinces. Darmonkow et al. [27] found a significant difference in the length of hospitalization comparing data before, during, and after the campaign (45,8%, 30,9%, and 40,6%, respectively, with p<0,001).

3.6. Costs

Three studies reported the costs of the campaign. They estimated the difference between treatment costs in patients with DKA diagnosis and those without it. Each study calculated an increase in hospitalization costs associated with DKA, with a range from a minimum of $12.192,91 in the study of Derraik et al. [21] to a maximum of $ 141.101 in the one of Vanelli et al. [15]. Jelley et al. [28] reported an estimated cost savings of $85.000 for DKA-related hospitalizations. Moreover, Vanelli et al. [16] and Jelley et al. [28] included the total cost of the campaign and considered the campaign cost-effective or even costless, given the benefits obtained.

Table 1. Summary of the selected studies.

Study (author, year)	Region	Population target	Description of intervention	Duration	Results				
					Frequency of DKA	Complications	HbA1c	C-peptide	Hospitalization and Costs
Vanelli et al., 1999	Italy, Parma	Age: 6-14 years Number of children: 438,232 Target: students, family with young children, schoolteachers, primary care physicians	Educational session of 1-hour duration to general paediatricians. Posters about medical information of DKA. Postcards with criteria for the diagnosis of T1D according to the WHO. Devices for measurement of	8 years (1991-1998)	Decrease in rate of DKA from 78% to 12.5% (p< 0.0001) in the province of Parma vs control provinces. Decreased frequency of DKA from	-	Decreased rate of HbA1c from 14.5% to 9.4% in children from control provinces vs from Parma.	Increased level of C-peptide C from 0.12 to 0.15 ng/mL in children from Parma vs from two nearby areas.	Reduction in length of hospitalization from 13.3 days to 5.4 days in patients from Parma vs from Reggio Emilia and Piacenza. Total cost of the campaign was $23.470. Lower cost from treatment and education

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			capillary blood glucose and glycosuria Toll-free information phone number.		83% to 12.5% in children from Parma vs from two nearby areas.				from $196,457 to $53,356 in patients without DKA vs with DKA:
Vanelli et al., 2008	Italy, Parma	Age: 6-14 years Number of children: not mentioned Target: students, family with young children, schoolteachers, general paediatrician	Poster indicating early symptoms of T1D, flyers with guidelines about T1D diagnosis.	8 years (1998-2006)	Reduction in DKA frequency from 27% to 19% (p< 0.0001) in the province of Parma vs control provinces.	-	-	-	Total cost of the campaign was $23,470.
Jelley, Marra, & Paul, 2010	USA, Oklahoma	Age: not mentioned Number of children: 193 Target: students, schoolteachers, primary care physicians	Informational posters, postcards indicating early symptoms, media blitz on local television, advertising on a regional newspaper.	6 months (2009)	Decreased rate of DKA from 29.9% to 23% in the year of the campaign vs 6 months before it (p< 0.05).	-	-	-	Total cost of the campaign was $1100.
King et al., 2012	Australia, Gosford	Age: 0-18 years Number: 328 between children centres, schools, doctors' offices. Target: schoolteachers, primary care physicians.	Posters and postcards. Educational session. Glucose and ketone testing equipment. A toll-free diabetes information phone number.	2 years (2008-2010)	Reduction in DKA frequency from 37.5% to 13.8% (p< 0.03). Any change in the control regions.	-	-	-	-
Lansdown et al. 2012	UK, Wales	Age: < 15 years Number of children: 3033 Target: schoolteachers,	Advertising posters. Television and radio interviews about symptoms and late diagnosis.	19 years (1991-2009)	Non statistically significant reduction in DKA frequency from	-	-	-	-

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		primary care physicians			27.5% to 25.6% (p<0.72) .				
Fritsch et al., 2013	Austria, Vienna	Age: < 15 years Number of children: 4038 Target: general population , kindergartens, primary and secondary schools, pharmacies, primary care physicians .	Posters focused on early symptoms of DKA. Medical journals about DKA. Educational sessions about diabetes and DKA. Broadcast in tv and articles on regional newspaper.	22 years (1989-2011)	Non-significant reduction in DKA frequency from 37.8% to 36.8% (p-value -).	-	-	-	-
Uçar et al., 2013	Turkey, Istanbul	Median age: 8-5 years (0.5-17.5 years) Number: 401 children and 60.000 schools. Target: general population , family, students, schoolteachers.	Awareness posters and brochure on diabetes. Educational material on specific websites.	2 years (2011-2012)	Decreased DKA frequency from 49.3% to 23.9% (p<0,001) in patients of 2011-2012 vs the ones of 2003-2010	-	-	-	-
Choleau et al., 2014	France	Age: < 15 years Number: 1299 children and 146 paediatric centres. Target: general population , schoolteachers, primary care physicians .	National information campaign. Publication on general and specific newspapers . Posters. Interviews and spots on national and regional televisions and radios.	1 years (2009)	Decreased frequency of DKA from 43.9% to 40.5% (p= 0.08).	Decrease in rate of loss of consciousness from 30.2% a 0.30%, of deep coma from 3.2% to 0 and of hospitalisation in Intensive Care Units from 53.6% to 5.3% comparing patients with DKA, without it or with severe DKA at diagnosis.	-	-	-

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Ahmed et al., 2015	North of Saudi Arabia	Age: < 12 years Number of children: 541 Target: general population, family, schoolteachers, primary care physicians.	Educational interventions and sessions. Poster and flyers. Media coverage.	4 years (2010-2014)	Reduction in DKA frequency from 48% to 39% (p<0.01)	Any severe complications during the intervention years. Rates of mortality and morbidity of DKA cohorte were comparable to other population-based studies.	Decreased rate of HbA1c from 10.0% to 9.1% after the campaign (p<0.001)	-	-
Cangelosi et al., 2017	Italy, Parma	Age: 6-14 years Number of children: 135 Target: general population, schoolteachers, primary care physicians.	Poster and leaflets. Local radio announcements.	5 years (2012-2016)	Decreased rate of DKA frequency from 52.7% to 5.9% in children from province of Parma vs from two other nearby provinces (p=0.002).	No cases of severe DKA.	Decreased rate of HbA1c from 13.6% to 9.9% in patients without DKA vs with DKA.	-	-
Patwardhan et al., 2018	Australia, Queensland	Age: 0-18 years Number of children: 106 Target: health professionals	Educational section of 1-hour duration.	1 years (2015-2016)	Reduction in rate of DKA frequency from 54.9% to 25% (p=0.01).	Decreased rate of severe and moderate DKA and a decrease in patients being admitted to the ICU for DKA at first presentation. Increase in rate of cerebral oedema from 0.5-0.9% to 1.96% in median vs in patients with DKA during this study.	Reduction in rate of HbA1c from 12.74% to 11.45% in patients without DKA vs with DKA (p=0.09).	-	-
Derraik et al., 2018	New Zealand. Auckland	Age: < 16 years	Posters delivered to mailboxes of individual	2 years (2015-2017)	Increase in rate of DKA frequency from	-	in rate of HbA1c from 12.5%	-	The total cost of the campaign was $ 40.107.

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		Number: 460,000 residents Target: general population, primary care physicians	residential household and to general practitioners and surgery staff to be displayed in waiting rooms.		27% to 28.8%.		to 11.8% in patients without DKA vs with DKA (p=0.276).		This campaign prevented three cases of DKA, which means it saved approximately from $13,369 to $33,569 per case. Decreased in rate of hospitalization from 5.5 days to 4.7 days in not DKA cohorte vs DKA cohorte.
Rabbone et al., 2019	Italy	Age: 0-18 years Number: 2361 children and 250 schools	A national awareness campaign. Poster and bimonthly magazine with information regarding diabetes symptoms. Short commercial on tv and announcements on national and regional television channels.	2 years (2015-2017)	Increase in rate of DKA frequency from 38.5% to 47.6% (p= 0.002).	Decreased rate of cerebral oedema from 0.53% to 0.35% after intervention.	-	-	-
Holder & Ehehalt, 2020	Germany, Stuttgart	Age: 0-18 years with median age 4.5 years Number of children: 44.000 Target: general population, schoolteachers, family, students, pharmacists, paediatrician	Lecture to schoolteachers Public poster, flyers, newsletter illustrating typical clinical symptoms of T1D.	3 years (2015-2017)	Decreased DKA frequency from 283% to 16,1% in patients of 2015-2017 vs 2011-2013 (p< 0.02).	-	Decreased HbA1c of 1.4% in patients without DKA vs with DKA (p< 0.0001)	-	-
Darmonkow et al., 2021	Canada, Québec	Age: < 25 years	Educational sections, posters, a	6 years: three	-	-	-	-	Decrease in hospitalization for

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		Number of children: 232 Target: general population, family, students, schoolteachers, primary care physicians, pharmacists.	DKA prevention kit.	periods of 2 years each (2009-2010, 2011-2012, 2013-2014)					DKA from 45.8% to 40.6% after vs before the campaign in children from 0 to 19 years old.

Table 2. Summary of the evidence for each outcome.

Title, authors e publication year	**Number of children and duration of follow-up**	**Frequency and decrease in DKA**	**HbA1c** (in patients without DKA)	**C-peptide**	**Hospitalization**	**Costs of patients with DKA / without DKA**
Vanelli et al., 1999	438,232; 8 years	1.,5 (-65.5)	9.4 (-5.1)	0,15 (+0.03)	-8 days (Intervention vs Control cohort)	+ 131,090€
Vanelli et al., 2008	-; 8 years	19; (8)	-	-	-	-
Jelley et al., 2010	193; 6 months	23; (-6.9)	-	-	-	+ 75,841€
King et al., 2012	-; 2 years	13,8 (-23.7)	-	-	-	-
Lansdown et al., 2012	3033;19 years	25,6 (-1.9)	-	-	-	-
Fritsch et al, 2013	4038; 22 years	36.8 (-1.0)	-	-	-	-
Uçar et al., 2013	401; 2 years	23.9 (-25.4)	10.3 (-0,7)	0.60 (+0.10)	-	-
Choleau et al., 2014	1299; 2 years	40.5 (-3.4)	-	-	-	-
Ahmed et al., 2015	541; 4 years	39.0 (-9.0)	9.1 (-0.9) after vs before the campaign	-	-	-
Cangelosi et al., 2017	135; 5 years	5.9 (-46.8)	9.9 (-3.7)	-	-	-
Patwardhan et al., 2018	106; 1 year	25.0 (-29.9)	11.5 (-1.3)	-	-	-
Derraik et al., 2018	-; 2 years	28.8 (+1.8)	11.8 (-0.7)	-	- 1 day (in patients without DKA vs with DKA)	+ (10,062 – 30,188€) € 2.2 times higher
Rabbone et al., 2019	2361; 2 years	47.6 (+9.1)	-	-	-	-
Holder & Ehehalt, 2020	44.000; 3 years	16.1 (-12.2)	(-1.4)	-	-	-
Darmonkow et al., 2021	232; 6 years	-	-	-	-5.2% (0-19 years old) after the campaign	-

4. Discussion

This review aimed to determine the efficacy of diabetes awareness campaigns on DKA frequency at T1D onset, HbA1c, complications, C-peptide, length of hospitalization, and costs. We conducted accurate research in the scientific literature to identify all the studies related to the topic. Here, we discuss the results of the various campaigns to draw some conclusions based on the evidence from the literature.

Diabetes awareness campaigns effectively reduced the frequency of DKA at diagnosis in children, but the results were very different along the studies, with an impact ranging from -1% to -65%. A higher decrease in the frequency of DKA was obtained if the following characteristics were respected:

1. Target population: addressing the campaign not to the general population but to a specific target population, often including families with young children, schoolteachers, general

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practitioners, pediatricians, and healthcare professionals [21–23] and in a delimited geographical area.

2. Multiple warning tools as:

- a system to evaluate that the target population has been reached, which means that they saw and read the posters and flyers displayed with information about DKA and diabetes diagnosis [15,17,20–29];
- organizing lectures or educational meetings [18,19,22,25,27,29];
- providing the equipment to measure blood glucose levels and check for the presence of glycosuria [15,29];
- posting on social media, making announcements on television or radio [17,19,22–24,28];
- including a toll-free telephone line directly connected with the diabetes team of the department [15,16,19];

3. Campaign duration: the campaign should be at least 2 years long [17,21,22] because the intervention is effective only if it lasts in time, and it's essential to renew it possibly every five years [16] so that it maintains effectiveness.
4. Follow-up: monitor the campaign's effectiveness by interviewing the target population and estimating the trend of DKA.

Our results for this outcome are similar to the ones reported by Cherubini et al. [3] in 2021 in a systematic review, as they reported a significant reduction of DKA frequency at T1D diagnosis. Some characteristics of the campaigns emerged more frequently as favorable: a small intervention area with less than 700,000 inhabitants, a well-defined target population, and multiple warning tools.

We also analyzed other outcomes, and as expected, the impact of the campaigns was positive in reducing the severity of DKA [18,20] and acute neurological complications associated with DKA, such as loss of consciousness, coma, cerebral edema, and mortality [17,25].

A decrease in the rate of HbA1c at diagnosis of T1D (from -0.7% to -5.1% reduction) was detected in all the studies that analyzed this outcome [15,18–21,25,26], as well as a higher c-peptide reserve was reported, concordant with preservation of more functional residual beta-cells [15,20]. Moreover, the reduced frequency of DKA at the T1D onset led to better glycemic control during follow-up, as evidenced in terms of HbA1c [30] and this could decrease the risk of long-term complications, including brain damage associated with hyperglycemia and hypoglycemia, as well as vascular complications" [31].

Due to the reduction of DKA frequency, the length of hospitalization was reduced in subjects without DKA at the disease onset after the awareness campaign [15,27]. Therefore, by reducing the DKA frequency and days of hospitalization, the campaigns reduced the costs related to DKA treatment and possible hospital-acquired infections. In the long term, additional economic benefits are associated with reducing chronic complications due to the better metabolic control of patients who didn't have DKA at diabetes onset. Conversely, the cost of a prevention campaign has been reported as less expensive [16,32].

The strengths of this systematic review are:

1. It's the first one presenting the analysis of other outcomes besides DKA frequency, on which a recent systematic review already exists; as a matter of fact, this review also includes data on HbA1c at onset, complications linked to DKA, C-peptide, length of hospitalization and costs
2. It includes studies from 1990 to analyze every form and modality of prevention campaign published nowadays
3. We were able to report the characteristics that give efficacy to this type of campaign.

The limitations of this study are:

1. We didn't report a metanalysis about the DKA frequency because it was already included in the previous review of 2021
2. It was impossible to create a metanalysis about other parameters (for example, HbA1c at onset) considering the heterogeneity of the data in terms of the analyzed population, study design, duration of the campaign, and multiple implementation modalities.

For clinical practice, results from this review give us the principles and modalities to design a diabetes awareness campaign in our region, which we expect to drop the frequency of DKA, reduce

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costs, and improve metabolic control. For research, we planned to evaluate whether implementing a prevention campaign will improve HbA1c, Time in Range, and other glucose metrics.

5. Conclusions

The frequency of ketoacidosis at diabetes onset is still high in our country because of the delay in diagnosis due to a lack of awareness among parents, other caregivers, or healthcare professionals about symptoms of T1D in children [3]. Antibodies screening of the general population could help reduce DKA frequency at disease onset. At the same time, diabetes awareness campaigns are an effective tool in lowering DKA and costs and improving metabolic control in the future. However, these preventive interventions must be organized by following specific principles of target population, modality, and minimal campaign duration, which we reported above.

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