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The Association between Nutrition Style through the First 2 Years of Life, Maternal and Childhood Indicators with Type 1 Diabetes Mellitus in Children: A Case-Control Study

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ABSTRACT

Background: Nutrition and dietary habits is one of the determinant factor on glycemic control of diabetes mellitus. This study aims to investigate the association between type 1 diabetes mellitus (T1DM) and diet in the first two years of life as well as a select group of demographic variables. **Methods**: This case-control study was conducted on 76 children with T1DM and 209 non-diabetic children selected through convenience sampling from the population of people visiting the community health centers of the city of Jahrom, Iran. The required data were collected by a questionnaire of diet and demographic information completed by the mothers of the children. The data were analyzed using logistic regression and adjusted odds ratio. **Results**: Finally, the results of multiple backward logistic regression showed that the studied factors had a significant association with T1DM ($P < 0.05$), including body mass index (BMI) less than 18 kg/m^2 for mothers before pregnancy (OR: 4.4, 95% CI: 1.61 to 11.97), mothers without a history of diabetes (OR: 0.02, 95% CI: 0.001 to 0.60), mother's weight before pregnancy (OR: 0.88, 95% CI: 0.84 to 0.91), mother's excess weight during pregnancy (OR: 0.83, 95% CI: 0.75 to 0.93), exclusive breastfeeding for more than six months (OR: 0.19, 95% CI: 0.03 to 0.96), low weight gain in the first two years of life (OR: 6.98, 95% CI: 2.16 to 22.5), and the breastfeeding less than 12 months (OR: 10.52, 95% CI: 1.62 to 66.64). **Conclusion**: BMI less than 18 kg/m^2 for mothers before pregnancy, low weight gain in the first two years of life, and breastfeeding less than 12 months increased the risk of developing T1DM in children.

Keywords: *Type 1 diabetes mellitus; Breast milk; Breastfeeding; Diet; Children*

Introduction

Type 1 diabetes mellitus (T1DM) is a chronic autoimmune disease associated with the destruction of pancreatic β cells, which leads to extreme or absolute insulin deficiency. People with T1DM require lifelong insulin therapy. T1DM is a major public health problem with an increasing

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prevalence worldwide (Baden *et al.*, 2019, Rak and Bronkowska, 2018).

The increase in knowledge of T1DM over the past 25 years has led to a broad understanding of many aspects of the disease, including genetics, epidemiology, the phenotype of immune cells, beta cells, and the burden of disease. Globally, T1DM is increasing in both prevalence and incidence, with an overall annual increase in occurrence of about 2-3% per year (DiMeglio *et al.*, 2018).

However, the incidence of T1DM varies in different countries (Rogers *et al.*, 2017). For instance, at northern latitudes, people born in the spring are more likely to develop the disease than those born in other seasons (Vaiserman *et al.*, 2007).

T1DM is one of the most common chronic diseases that develops in childhood. For unknown reasons, its incidence in children increases from 3% to 5% every year worldwide (Krzewska and Ben-Skowronek, 2016). The peak incidence of diagnosis is seen in children aged 10–14 years (DiMeglio *et al.*, 2018, Rogers *et al.*, 2017).

On the other hand, diabetes is the most common chronic metabolic disease diagnosed in children and adolescents. Although diabetes is not contagious, it is the first and only disease that the United Nations has designated as a 21st-century epidemic (Krzewska and Ben-Skowronek, 2016).

The results of international research reveal an increasing trend in diabetes prevalence in most regions of the world, with the highest growth dynamics in the youngest age group (Krzewska and Ben-Skowronek, 2016, Soltesz *et al.*, 2007).

The global increase in T1DM prevalence is a well-known fact; with the highest rate reported from developing countries (Green *et al.*, 2001, Jarosz-Chobot *et al.*, 2011).

Infants experience many changes in their diet in the first year of life. In many cases, their diet initially consists exclusively of breast milk, but gradually shifts from being entirely liquid (breast milk, cow milk, and formula) to a variety of solid food (Erkkola *et al.*, 2005, Rahmanian *et al.*, 2018). Research studies have shown that using cow milk in infancy increases the risk of β-cell autoimmunity, probably because of the similarity of the molecular sequence of cow milk proteins with the body's own antigens (Patelarou *et al.*, 2012, Strotmeyer *et al.*, 2004). According to several studies, introducing gluten or cereals, fruits, roots, and seeds to the food before 3 months of age is a risk factor for the autoimmunity to the islets of Langerhans (Chmiel *et al.*, 2015, Nucci *et al.*, 2017). Solid food can also play a pathogenic role in the development of T1DM in the same way as hypothesized for cow milk (Strotmeyer *et al.*, 2004). Some have recommended that to reduce the risk of immunodeficiency disorders, complementary food should be added to breast milk starting from the age of 4 to 6 months (Nucci *et al.*, 2017). However, numerous epidemiological studies have reported that there is an association between increased risk of T1DM and short breastfeeding period and early introduction of cow milk, formula, or complementary food to the baby's diet (Malcova *et al.*, 2006, Nucci *et al.*, 2017, Sorkio *et al.*, 2010).

Currently, no specific dietary factor has been shown to be a risk factor for T1DM, and there are a number of inconsistent documents with regard to the influence of different food. This could mirror environmental and cultural variances in child-feeding practices. Some studies have recommend that the early introduction of complex foreign proteins may be a risk factor for T1DM (Knip *et al.*, 2010). The results of a meta-analysis showed that the risk of T1DM significantly decreased in children who were supplemented with vitamin D compared to children who were not supplemented (Zipitis and Akobeng, 2008). Another study showed that consuming cod liver oil in the first year was associated with a lower risk of T1DM (Stene *et al.*, 2003).

It has been widely recommended to continue exclusively breastfeeding for the first 4 to 6 months of the infant's life. Research studies have confirmed the health benefits of this breastfeeding and also continued breastfeeding during the first year of life. In any case, it is not recommended to start complementary feeding before 4 months of age (Erkkola *et al.*, 2005, Malcova *et al.*, 2006, Nucci *et al.*, 2017, Sorkio *et al.*, 2010).

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With the increasing prevalence of T1DM worldwide, the management and treatment of this disease and its acute and chronic complications are imposing significant burdens on patients as well as healthcare systems (Huber *et al.*, 2014, Kähm *et al.*, 2018). The present study aims to investigate the potential association between T1DM and infant's diet in the first two years of life as well as some demographic variables.

Materials and Methods

Study design and participants: This case-control study was carried out in Jahrom city of Fars province, Iran in 2018. Based on the 95% confidence interval (α=0.05), 80% power (β = 0.2), OR = 5.6, and 56% prediction interval in the control group (Rabiei, 2011), the sample size was calculated to be 310 based on the following formulas:

$$P1 = P0\frac{OR}{1 + P0(OR - 1)}$$

$$p = \frac{P0 + P1}{2}$$

$$n = \frac{2\left(Z1 - \frac{\alpha}{2} + Z1 - B\right)^2 P(1 - P)}{(P0 - P1)^2}$$

The children referred, by their parents, to the community health centers in the city of Jahrom, Fars province, Iran, to receive primary health care (PHC) services.

In this study, the cluster sampling method was used, in which each health center was considered as a cluster. At first, at each center a sequential number was assigned to all children with T1DM. Then, regarding the proportion of participants, case samples were selected randomly using the table of random numbers. Next, control samples were selected from healthy children referred to health centers and matched with case samples in terms of age and gender.

The inclusion criteria for the case group were the presence of T1DM in children according to the mothers' reports, treatment under the supervision of the physician, and the age range of 2 to 15 years. The inclusion criteria for the control group were no history of type 1 or type 2 diabetes or impaired glucose tolerance (IGT) at the time of the study and being in the same age range as the case group.

Measurements: The mothers of the eligible children were asked to complete a self-administered questionnaire of diet and demographic information, which consisted of two groups of questions: 1- Questions about the child (gender, age, duration of exclusive breastfeeding, age of onset of complementary feeding, age of complete weaning, use of formula or similar products in the first six months of life, use of pasteurized milk in the first year of life, birth weight, weight at 1 year of age (children with growth curves below the third percentile line in more than one measurement and youngsters above the third percentile with failure to gain weight or with weight loss during at least 1 month are considered low weight), fetal age at birth, and birth order, 2- Questions about the mother (age at delivery, excess weight during pregnancy, method of delivery, history of diabetes, history of diabetes among the child's other first-degree relatives).

Data analysis: After collecting the questionnaires, the obtained data were entered into SPSS version 16. The normality of the data was checked by the Kolmogorov-Smirnov test. For normally distributed data, the Chi-square *test* and the *t-test*, and for non-normally distributed data, the Mann-Whitney *test* was used to compare qualitative and quantitative variables of the case and control groups. Finally, logistic regression with the backward technique was used to compute the odds ratio and the 95% confidence interval and investigate the association between T1DM and the variables.

Ethical considerations: At first, the aims of this study were clarified to the mothers of children, and then informed consent forms were completed and signed by them. The project of this study was approved by the Ethical Committee of Jahrom University of Medical Sciences (under code no. IR.JUMS.REC.1395.173).

Results

This study comprised of 285 children, including 165 (57.89%) males and 120 (42.11%) females, with 76 case and 209 control participants. The

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obtained results did not reveal any significant association between child age, maternal age during pregnancy, gestational age, sex, birth weight, one-year weight, birth rank, history of diabetes in relatives, age of starting complementary feeding, consumption of cow milk under one year, and consumption of artificial milk ($P > 0.05$, **Tables 1 and 2**).

Table 3 indicates the univariate and adjusted association of independent variables with the T1DM. The unadjusted results showed a significant association between T1DM in children and the mothers without a history of diabetes (OR: 0.12, 95% CI: 0.01 to 0.12), maternal weight before pregnancy (OR: 0.94, 95% CI: 0.88 to 0.97), maternal overweight during pregnancy (OR: 0.84, 95% CI: 0.76 to 0.92), cesarean delivery (OR: 0.45, 95% CI: 0.25 to 0.81), BMI less than 18 kg/m^2 for mothers before pregnancy (OR: 2.73, 95% CI: 1.28 to 5.79), exclusive breastfeeding for more than six months (compared to less than 4 months) (OR: 0.42, 95% CI: 0.18 to 0.94), and the breastfeeding less than 12 months (compared to over 24 months) (OR: 3.54, 95% CI: 1.33 to 9.41).

Finally, the results of multiple backward logistic regression showed that BMI less than 18 kg/m^2 for mothers before pregnancy (OR: 4.4, 95% CI: 1.61 to 11.97), mothers without a history of diabetes (OR: 0.02, 95% CI: 0.001 to 0.60), mother's weight before pregnancy (OR: 0.88, 95% CI: 0.84 to 0.91), mother's excess weight during pregnancy (OR: 0.83, 95% CI: 0.75 to 0.93), exclusive breastfeeding for more than six months (OR: 0.19, 95% CI: 0.03 to 0.96), low weight gain in the first two years of life (OR: 6.98, 95% CI: 2.16 to 22.5), and the breastfeeding less than 12 months (OR: 10.52, 95% CI: 1.62 to 66.64) have association with T1DM ($P < 0.05$, **Table 3**).

Table 1. Mean (±SD) of the child's and mother's age at delivery, weight before pregnancy, and excess weight during pregnancy in the case and control groups.

Variables	Control group	Case group	P-value
Child's age (year)	11.94 ± 3.3	12.14 ± 4.13	0.69[a]
Mother's age at delivery (years)	25.58 ± 6.87	25.71 ± 5.31	0.88[b]
Mother's weight before pregnancy (kg)	64.81 ± 8.81	56.62 ± 10.72	0.0001[a]
Mother's excess weight during pregnancy (kg)	10.72 ± 2.91	8.92 ± 4.51	0.0001[a]

[a]: Student *t-test;* [b]: Mann-Whitney *test*.

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Table 2. Frequency and distribution of the variables in the case and control groups.

Variables		Control group	Case group	P-value[a]
Child's non-diet variables				
Fetal age at birth (week)	< 37	22 (10.5)[b]	10 (13.1)	0.53
	> 37	187 (89.5)	66 (86.9)	
Gender	Female	90 (43.1)	30 (39.5)	0.58
	Male	119 (56.9)	46 (60.5)	
Birth weight (g)	< 2500	20 (9.6)	8 (10.5)	0.81
	> 2500	189 (90.4)	68 (89.5)	
Weight at 1 year of age (g)	< 9500	49 (23.4)	21 (27.6)	0.47
	> 9500	160 (76.6)	55 (72.4)	
Birth order	First or second	143 (68.4)	57 (75)	0.28
	Third or fourth	66 (31.6)	19 (25)	
Mother's variables				
History of diabetes	Yes (before pregnancy/pre-gestational)	1 (0.5)	3 (3.9)	0.07
	Yes (during pregnancy/gestational)	13 (6.2)	6 (7.9)	
	No	195 (93.3)	67 (88.2)	
Method of delivery	Vaginal	119 (56.9)	57 (75.0)	0.02
	C-section	90 (43.1)	19 (25.0)	
Mother's weight status	Normal	119 (56.9)	49 (64.5)	0.0001
	Underweight	16 (7.7)	18 (23.7)	
	Overweight	62 (29.7)	8 (10.5)	
	Obese	12 (5.7)	1 (1.3)	
History of diabetes in first-degree family members	Yes	112 (53.6)	33 (43.4)	0.12
	No	97 (46.4)	43 (56.6)	
Child's diet and growth variables (in the first two years of life)				
Exclusive breastfeeding (month)	< 4	19 (9.1)	13 (17.1)	0.04
	5	17 (8.1)	2 (2.6)	
	6	65 (31.1)	30 (39.5)	
	> 6	108 (51.7)	31 (40.8)	
Status of the baby's weight gain chart during the first two years of life	Below the normal line	49 (23.4)	10 (13.2)	0.08
	Normal	146 (69.9)	63 (82.9)	
	Above the normal line	14 (6.7)	3 (3.9)	
Age of onset of complementary feeding (month)	< 4	7 (3.3)	4 (5.3)	0.18
	5	16 (7.7)	8 (10.5)	
	6	118 (56.5)	49 (64.5)	
	> 6	68 (32.5)	15 (19.7)	
Use of cow milk in the first year of life	Yes	20 (9.6)	12 (15.8)	0.14
	No	189 (90.4)	64 (84.2)	
Use of artificial milk	Yes - along with breast milk	33 (15.8)	12 (15.8)	0.64
	Yes - without breast milk	34 (16.3)	9 (11.8)	
	No	142 (67.9)	55 (72.4)	
Breastfeeding period (month)	< 12	21 (10.0)	11 (14.5)	0.0001
	12-24	174 (83.3)	39 (51.3)	
	> 24	14 (6.7)	26 (34.2)	

[a]: Chi square *test*; [b]: N (%).

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Table 3. Results of univariate and multivariable logistic regression for independent variables with the T1DM in children aged 2 to 15 years.

Variables	Unadjusted OR [95% CI]	P-value	Adjusted OR [95% CI]	P-value
Child's non-diet variables				
Age (year)	1.01 [0.94 – 1.09]	0.66	1.002[0.88 – 1.13]	0.97
Fetal age at birth				
More than 37 weeks (compared to less than 37 weeks)	0.77 [0.34 - 1.72]	0.53	1.43[0.27 – 7.59]	0.66
Gender				
Female (compared to male)	0.86 [0.50 - 1.47]	0.58	0.6[0.26 – 1.38]	0.23
Birth weight				
More than 2500 g (compared to less than 2500 g)	2.13 [0.37 - 2.14]	0.81	0.47[0.11 – 1.92]	0.29
Weight at 1 year of age				
More than 9500 g (compared to less than 9500 g)	1.25 [0.42 - 3.66]	0.68	1.21[0.04 – 3.62]	0.72
Birth order				
Third or fourth (compared to first or second)	0.72 [0.39 – 1.31]	0.28	0.5[0.2 – 1.23]	0.13
Mother's variables				
Mother's age at delivery (year)	1.006[0.95 – 1.05]	0.81	1.02[0.94 – 1.14]	0.49
History of diabetes				
Gestational diabetes (compared to pre-gestational diabetes)	0.15[0.01-1.81]	0.13	0.04[0.001 – 1.15]	0.06
No diabetes (compared to pre-gestational diabetes)	0.12 [0.01- 0.12]	0.06	0.02[0.001 – 0.60]	0.02
Mother's weight before pregnancy	0.94[0.88 – 0.97]	0.0001	0.88[0.84 – 0.91]	0.0001
Mother's excess weight during pregnancy	0.84[0.76 – 0.92]	0.0001	0.83[0.75 – 0.93]	0.001
Method of delivery (C-section compared to vaginal)	0.45[0.25- 0.81]	0.007	0.56[0.24 – 1.3]	0.18
Mother's weight status				
Underweight (compared to normal)	2.73[1.28-5.79]	0.009	4.4[1.61 – 11.97]	0.004
Overweight (compared to normal)	0.31 [0.14-0.70]	0.005	0.18[0.06 – 0.53]	0.002
Obese (compared to normal)	0.20[0.02 -1.59]	0.13	0.03[0.002 – 0.45]	0.011
History of diabetes in first-degree family members (No compared to Yes)	1.5[0.88-2.55]	0.13	1.76[0.79 – 3.87]	0.16
Child's diet and growth variables (in the first two years of life)				
Exclusive breastfeeding				
5 months (compared to less than 4 months)	0.17 [0.034 - 0.87]	0.03	0.08[0.006 – 1.06]	0.05
6 months (compared to less than 4 months)	0.67[0.29 – 1.54]	0.35	0.35[0.07 – 1.68]	0.19
More than 6 months (compared to less than 4 months)	0.42[0.18 – 094]	0.03	0.19[0.03 – 0.96]	0.04
Status of the baby's weight (Abnormal [compared to normal)	2.11[1.007-4.43]	0.049	6.98[2.16 – 22.5]	0.001
Chart during the first two years of life (Above the normal line compared to below the normal line)	1.05[0.25-4.35]	0.94	1.31[0.19 – 8.93]	0.78
Age of onset of complementary feeding				
5 months (compared to less than 4 months)	0.87 [0.19 – 3.89]	0.86	15.25[0.88 – 262.01]	0.06
6 months (compared to less than 4 months)	0.72[0.20 – 2.59]	0.62	0.86[0.08 – 7.56]	0.86
More than 6 months (compared to less than 4 months)	0.36[0.10 – 1.48]	0.17	0.54[0.05 – 5.65]	0.61
Use of cow milk in the first year of life (No compared to Yes)	0.56[0.26 – 1.21]	0.14	0.34[0.08 – 1.45]	0.14

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Table 3. Results of univariate and multivariable logistic regression for independent variables with the T1DM in children aged 2 to 15 years.

Variables	Unadjusted OR [95% CI]	P-value	Adjusted OR [95% CI]	P-value
Use of artificial milk				
Yes - along with breast milk [compared to No]	0.68[0.30 – 1.51]	0.35	0.54[0.24 – 0.1.32]	0. 30
Yes -without breast milk [compared to No]	0.93[0.45 – 1.94]	0.86	1.38[0.45 – 4.24]	0.56
Breastfeeding period				
12-24 months compared to over 24 months	0.43[0.19 – 0.96]	0.04	0.89[0.17 – 4.62]	0.88
Less than 12 months compared to over 24 months	3.54[1.33 – 9.41]	0.01	10.52[1.62 – 66.64]	0.01

Discussion

The results of this study showed that exclusive breastfeeding for six months and more can be effective in preventing the development of T1DM in children (OR = 0.19). Some studies have also reported that exclusive breastfeeding can prevent T1DM (Gunderson, 2008, Malcova *et al.*, 2006, Rabiei, 2011, Rosenbauer *et al.*, 2008, Stuebe, 2009). In a case-control study, Rosenbauer *et al*. showed that there is an inverse and significant association between breastfeeding duration and risk of T1DM in children and the dose-response relationship. In this study, the adjusted odds ratio for breastfeeding for longer or equal to 5 months versus less than 2 weeks was 0.71 (Rosenbauer *et al.*, 2008).

Over the last three decades, the prevalence of obesity has more than doubled in children and tripled in adolescents (Sanyaolu *et al.*, 2019). Short-term breastfeeding and early introduction of complementary food may be associated with respiratory and gastrointestinal infections and obesity in children (Nucci *et al.*, 2017). Also, the consumption of excess protein in childhood is associated with an increase in BMI at older ages. The protein contained in artificial milk can also lead to the secretion of insulin and insulin-like growth factor, which may explain why formula-fed babies have higher plasma insulin levels than breastfed children (Rabiei, 2011). The results of this study showed higher odds of developing T1DM in children whose weight gain was below the normal growth line (OR: 6.98) and also those whose weight gain was above the normal growth line (OR: 1.31). It was also found that exclusively breastfed babies had lower odds of developing T1DM at an older age than exclusively formula-fed ones (OR: 0.19). This suggests that exclusive formula feeding is associated with a higher risk of T1DM, and is consistent with the findings of Rabiei *et al.* (Rabiei, 2011), which showed a higher risk of T1DM at an older age in babies breastfed for less than 12 months compared to those breastfed for more than 24 months (OR: 10.52).

This study found no association between T1DM and cow milk consumption in the first year of life, which is consistent with the results of Rabiei *et al.* (Rabiei, 2011) and Savilahti and Saarinen (Savilahti and Saarinen, 2009). It appears that the early introduction of complementary food may also stimulate the development of T1DM by disrupting the autoimmune responses. This is especially true for children who are genetically predisposed to diabetes (Luopajärvi *et al.*, 2008, Savilahti and Saarinen, 2009). According to some studies, the levels of the hormones insulin, leptin, and ghrelin, which regulate energy homeostasis in early life, can be affected by the infant's behavior and eating habits. A clinical trial study showed that the production of immunoglobulin G versus beta-lactoglobin in children with diabetes increased significantly from 3 to 18 months of age. Also, the production of immunoglobulin A in response to cow's milk consumption in children with diabetes compared to children in the control group, showed

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a significant increase at 9 months.

Accordingly, children who develop diabetes later in life show an increased humoral immune response to various cow milk proteins during childhood. Therefore, it can be stated that non-regulation of the immune response against oral antigens is one of the early factors involved in the pathogenesis of T1DM (Luopajärvi *et al.*, 2008).

In this study, children whose complementary feeding had started before the age of fourth months were 46% more likely to develop T1DM than those whose complementary feeding had started after the age of six months. However, this association was not statistically significant.

The results showed less maternal pregnancy weight gain reduces the risk of developing T1DM in the baby. Rasmussen *et al.* in a study showed that, having less than 10.75 kg excess weight during pregnancy decreases the risk of T1DM in the child by approximately 17% (Luopajärvi *et al.*, 2008). This finding is consistent with the results of Lindell *et al.*, suggesting an association between maternal body mass index (BMI) and maternal pregnancy weight gain with T1DM in children who are genetically predisposed to diabetes (Lindell *et al.*, 2018).

In the present study, the occurrence of T1DM in children had a direct association with the mothers having diabetes during pregnancy (gestational diabetes), but had no association with diabetes in the child's other first-degree family members, which is consistent with other reports (Rabiei, 2011, Turtinen *et al.*, 2019). Some studies have investigated the effect of having diabetes before or during pregnancy (gestational or pregestational) on the risk of diabetes in the delivered child, and it is still not clear whether the breast milk of diabetic mothers has the same ingredients as the breast milk of healthy mothers. Some researchers believe that breastfeeding from diabetic mothers is also effective in preventing diabetes in children (Gunderson, 2008, Malcova *et al.*, 2006). However, others have suggested that the breast milk of diabetic mothers should be considered a risk factor for the development of diabetes in children (Rabiei, 2011).

In the present study, there was no significant difference in terms of incidence of T1DM between the children born vaginally and those born by C-section. Therefore, it seems that there is no association between the incidence of diabetes and the type of delivery. This finding is consistent with the findings of Rabiei *et al.* (Rabiei, 2011); it should be noted that limited studies have been conducted on this association. Breastfeeding has nutritional, immunological, and physiological benefits. It also plays an important role in the formation of a healthy maternal attachment and the healthy development of the baby (Cetisli *et al.*, 2018). Some researchers believe that the method of delivery affects the success of breastfeeding, as mothers who give birth naturally tend to breastfeed their baby longer than those who give birth by C-section (Cetisli *et al.*, 2018, Örün *et al.*, 2010).

One of the limitations of this study was that some respondents in both case and control groups had difficulty recalling the information of interest. This problem had two dimensions. The first was the general differences among the respondents in terms of their capacity to recall events. To resolve the issue, researchers tried to compare the respondents' inputs with their medical records and detect and correct inconsistencies as much as possible. The second dimension was the difference between the mothers in the case group and those in the control group in terms of accuracy in remembering the event related to their child. Furthermore, some variables can confound causal pathway of T1DM, for instance physical activity, calorie and micronutrient intake, current weight, and BMI which is not studied and can affect the results of this study.

Conclusion

BMI less than 18 kg/m^2 for mothers before pregnancy, low weight gain in the first two years of life, and breastfeeding less than 12 months increase the risk of developing T1DM in children. However, the findings did not confirm the role of the early introduction of complementary food and the use of cow milk in the development of T1DM. Considering the findings of this study and the

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proven health benefits of breastfeeding, it is recommended to commit to exclusive breastfeeding for at least six months after birth.

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Authors' contributions

The initial idea of this study was by Zamani M and Rezaei S, Zamani M and Rahmanian V contributed to the design and management of the study and writing of the manuscript and implementing all comments from the reviewers. Khoubfekr H participated in the statistical analysis. Rahmanian V and Khoubfekr H wrote the manuscript. Rahmanian V contributed to editing and revision. Rahmanian V and Namdar A translated the manuscript. All authors read and approved the final manuscript.

Conflicts of interest

The authors report no conflict of interest in this study.

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