

Eating disorders between male and female adolescents with type 1 diabetes mellitus in Korea

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Abstract

Background: Diabetes mellitus and its prevalence are rising dramatically in Korea and throughout the world, not only in adults but in adolescents.

Objective: This study aimed to identify the sex-specific factors that influence eating disorders in adolescents with type 1 diabetes.

Methods: A secondary analysis of a descriptive survey was employed. Raw data from 136 adolescents aged 13 to 18 years who were diagnosed with type 1 diabetes were obtained in the original study using the Diabetes Eating Problem Survey-Revised (DEPS-R), Rosenberg Self-Esteem Scale (RSES), and Beck Depression Inventory-II (BDI-II). The data were analyzed using the independent *t*-test and multiple regression analysis.

Results: The female and male participants with eating disorders scored 21.67 ± 11.70 and 13.15 ± 8.03 points, respectively. Among the adolescents with type 1 diabetes, the factors related to eating disorders in female participants were body image satisfaction ($\beta = 0.48, p < 0.001$) and depression ($\beta = 0.22, p = 0.043$), accounting for 33.4% of the variance. While the factors related to eating disorders in the male participants were BMI ($\beta = 0.33, p = 0.006$) and depression ($\beta = 0.28, p = 0.017$), accounting for 17.4% of the variance.

Conclusion: Sex-specific factors should be considered to induce healthy eating behavior in adolescents with type 1 diabetes and reduce eating disorders. Moreover, it is necessary for female adolescents to perceive their body type accurately, and male adolescents need exercise and nutrition education to lower their body mass index. Collaborations between medical practitioners, changes in the medical environment, and social interests are necessary. Since depression is the common factor associated with eating disorders in female and male adolescents with type 1 diabetes, a periodic depression screening test and intervention program that can lower depression should be developed. At the government level, it is necessary to strengthen economic support for cost interventions.

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Keywords

Korea; type 1 diabetes mellitus; eating disorder; sex; nursing

Background

The incidence of Diabetes Mellitus (DM) is rising dramatically worldwide, and the prevalence of DM is also on the rise in Korea ([Korean Diabetes Association, 2018](#)), increasing to 13.8% in 2018 (4.94 million people) from 10.1% (3.2 million people) in 2012 ([Korean Diabetes Association, 2020](#)). The annual incidence of type 1 DM (T1DM) was 1.4 per 100,000 people between 1995 and 2001 but rose to 3.2 per 100,000 between 2012 and 2014. The prevalence increased rapidly over the years, with an annual rate of 5.6% between 1995 and 2014 ([Kim et al., 2016](#); [Korean Diabetes Association, 2018](#)).

Type 1 Diabetes Mellitus (T1DM) is a metabolic disorder characterized by the destruction of pancreatic beta cells, and insulin injection is critical for survival ([Korean Diabetes Association, 2018](#)). While patients with T1DM can live a healthy life, failing to regulate metabolism can result in diabetic

neuropathy, diabetic retinopathy, and diabetic ketoacidosis ([Jin, 2016](#)). Prevention of these conditions requires several types of management, including exercise, diet, periodic blood sugar tests, and insulin therapy ([Jin, 2016](#); [Korean Diabetes Association, 2018](#)).

Diet therapy is an effective treatment strategy for T1DM. It involves determining the required daily calories and continuously monitoring meal intervals and sizes with consideration of insulin action ([Korean Diabetes Association, 2018](#)). Adolescents require more meticulous management as their basal metabolism and levels of activity increase during puberty. However, adolescents show an increased interest in their appearance and thus become sensitive regarding their physical appearance, which increases their vulnerability to Eating Disorders (ED) ([Jin, 2016](#); [Korean Diabetes Association, 2018](#)). While normal patients with ED tend to vomit after binge eating or avoid eating, patients with T1DM

either reduce their insulin dose or omit insulin injections in addition to these behaviors (Franke, 2014). In fact, a study on patients with T1DM in Korea reported that 7.3% of patients omitted their routine insulin injection after overeating, and 24.3% intentionally reduced their insulin doses (Park et al., 2019).

Intentional omission or restriction of required insulin doses in order to lose weight by adolescents with T1DM could be life-threatening (Franke, 2014). Insulin omission results in inadequate insulin levels in the body, which in turn leads to the elevated secretion of glucagon, cortisol, and adrenaline, which results in increased blood sugar levels (Jin, 2016), thereby causing serious complications, such as diabetic ketoacidosis and diabetic nephropathy (Franke, 2014).

Factors such as age, BMI, body image satisfaction, self-esteem, depression, and glycosylated hemoglobin type A1c (HbA1c) levels have been identified to be associated with ED in adolescents with T1DM. The prevalence of ED increases with advancing age (Araia et al., 2017) and BMI (Araia et al., 2017; Olmsted et al., 2008), decreasing body image satisfaction (Hevelke et al., 2016) and self-esteem (Gonçalves et al., 2016), and increasing severity of depression (Cecilia Costa et al., 2019). HbA1c level is an objective indicator of average metabolic regulation and is used as a marker for diabetes management (Korean Diabetes Association, 2018). ED is reported to be associated with metabolic regulation in T1DM, and adolescents with T1DM and ED exhibit higher HbA1c levels than their counterparts without ED (Araia et al., 2017). Furthermore, many reports have found sex to be the most potent factor of ED in adolescents with T1DM (Araia et al., 2017; Park et al., 2019). Furthermore, Araia et al. (2017) highlighted the need for studies that use sex-specific approaches to examine the characteristics of ED. However, studies investigating ED and its associated factors of ED in consideration of sex gaps in adolescents with T1DM are virtually lacking in Korea. Thus, this study aimed to analyze the associations between ED in adolescents with T1DM and its related factors, such as body image satisfaction, self-esteem, depression, and HbA1c levels, with consideration of the sex difference. Ultimately, we seek to deepen the current understanding of ED in adolescents with T1DM and present foundational data for developing strategies targeting ED in this population.

This study aimed to examine sex-specific features of ED and identify sex-specific associated factors of ED in adolescents with T1DM. The specific objectives were as follows: (1) examine the characteristics and degree of body image satisfaction, self-esteem, depression, and ED among adolescents with T1DM; (2) compare the general characteristics, body image satisfaction, self-esteem, depression, and ED between sexes among adolescents with T1DM, and (3) identify the sex-specific factors associated with ED among adolescents with T1DM.

Methods

Study Design

This study employed a secondary analysis of a descriptive aiming to identify the sex-specific factors associated with ED among adolescents with T1DM.

Participants

Raw data were collected from a previous study (Park et al., 2019) on the associated factors of ED among adolescents with T1DM. The data were collected from 136 adolescents aged 13 to 18 years and diagnosed with T1DM in accordance with criteria of World Health Organization (1999) and American Diabetes Association (2013).

Instruments

Five instruments were used: 1) General characteristics, including sex, age, BMI, illness duration, latest HbA1c levels, continuous glucose monitoring, and use of an insulin pump were acquired. First, BMI was calculated by dividing weight (kg) by height (m) squared. Then, percentiles were calculated using the 2017 Growth chart for children and adolescents as follows: underweight (<5th percentile), normal (5th–84th percentile), overweight (85th–94th percentile), and obese (≥95th percentile) (Kim et al., 2018).

2) Body image satisfaction was assessed using the scale used by Nam and Park (2013). This scale comprises one item, rated using 1 for “very satisfied,” 2 for “satisfied,” 3 for “dissatisfied,” and 4 for “very dissatisfied.” A higher score indicated lower body image satisfaction.

3) Self-esteem, assessed using the Korean version (Jeon, 1974) of the Rosenberg (1965) self-esteem scale (RSES). This 10-item scale uses a four-point scale, with 1 denoting “strongly disagree,” 2 denoting “disagree,” 3 denoting “agree,” and 4 denoting “strongly agree.” The total score ranges from 10–40, and negatively worded items were reverse scored. A higher score indicated greater self-esteem. The reliability (Cronbach’s α) of the scale was 0.88 at the time of development and 0.85 in this study.

4) Depression was assessed using the Beck depression inventory-II (BDI-II) updated by Beck (1996). This inventory comprises 21 items, and each item is rated on a scale from 0–3. The total score ranges from 0–63, and a higher score indicates more severe depression. The reliability (Cronbach’s α) of the scale was 0.89 at the time of development and 0.85 in this study.

5) Eating Disorder (ED), measured using the adolescent-revised version (Markowitz et al., 2010) of the Diabetes Eating Problem Survey-Revised (DEPS-R), originally developed by Antisdel et al. (2001) for adults with DM. This 16-item scale is rated on a six-point scale, with 0 denoting “never,” 1 denoting “rarely,” 2 denoting “occasionally,” 3 denoting “frequently,” 4 denoting “very frequently,” and 5 denoting “always.” The total score ranges from 0–88, and a higher score indicates a more severe eating disorder. The reliability (Cronbach’s α) of the scale was 0.86 at the time of revision and 0.85 in this study.

Data Collection

The original data were collected from a diabetes camp hosted by the Korean Insulin Dependent Diabetes Association and two hospitals in Busan Metropolitan City from August to December 2017. Recruitment notices were posted in the diabetes camps and outpatient departments. A structured questionnaire was distributed to those who wanted to participate. Height and weight were measured at the diabetes camp and outpatient clinics, and HbA1c levels measured in the past three months were used. The researchers collected

all data after obtaining grant permission from the original authors (Park et al., 2019).

Data Analysis

The raw data were analyzed using the SPSS Program 26.0. A two-tailed test was performed at a significance level of 0.05. In addition, the following analyses were performed: 1) Participants' general characteristics, body image satisfaction, self-esteem, depression, and ED were analyzed using mean, standard deviation, and percentage; 2) Sex-specific general characteristics, self-esteem, body image satisfaction, depression, and ED were analyzed using mean, standard deviation, and percentage. Further, the differences in general characteristics, body image satisfaction, self-esteem, depression, and ED according to sex were analyzed using an independent *t*-test and Chi-squared test; and 3) Sex-specific factors associated with ED were analyzed using stepwise multiple regression analysis.

Results

Participants' General Characteristics

The participants comprised 70 females (51.5%) and 66 males (48.5%), and the mean age of patients was 15.4 ± 2.1 years. According to BMI, there were six underweight (4.4%), 90 normal (66.2%), 25 overweight (18.4%), and 26 obese (11.0%) adolescents. The mean age at DM diagnosis was 9.2 ± 3.8 years, and the mean illness duration was 6 years and 3 months. The mean HbA1c level was $8.5 \pm 1.7\%$. Eight participants (5.9%) used a continuous glucose monitoring

(CGM) system, while 11 (8.1%) used an insulin pump for insulin treatment (Table 1).

Table 1 General characteristics of participants ($N = 136$)

Characteristics	<i>n</i> (%)	<i>M</i> \pm <i>SD</i>
Sex		
Female	70 (51.5)	
Male	66 (48.5)	
Age (year)		15.4 ± 2.1
BMI (percentile)		
Underweight	6 (4.4)	
Normal	90 (66.2)	
Overweight	25 (18.4)	
Obesity	15 (11.0)	
Duration of T1DM (year)		6.3 ± 8.5
HbA1c		8.5 ± 1.7
Continuous Glucose Monitoring (CGM)	8 (5.9)	
Insulin pump	11 (8.1)	

Major Study Parameters According to Sex

The female participants had a mean HbA1c level of $8.9 \pm 1.9\%$, a body image satisfaction score of 2.83 ± 0.85 , a self-esteem score of 28.54 ± 5.82 , a depression score of 13.49 ± 7.75 , and an ED score of 21.67 ± 11.70 . The male participants had a mean HbA1c level of $8.0 \pm 1.3\%$, a body image satisfaction score of 2.26 ± 0.71 , a self-esteem score of 29.70 ± 8.12 , a depression score of 8.17 ± 6.83 , and an ED score of 13.15 ± 8.03 . There were significant differences in ED ($t = 4.92, p < 0.001$), body image satisfaction ($t = 4.26, p < 0.001$), depression ($t = 4.25, p < 0.001$), and HbA1c levels ($t = 3.04, p = 0.003$) between the sexes (Table 2).

Table 2 Major study parameters according to sex

Variables	Total ($n = 136$)		Female ($n = 70$)		Male ($n = 66$)		<i>t</i>	<i>p</i>
	<i>M</i>	\pm <i>SD</i>	<i>M</i>	\pm <i>SD</i>	<i>M</i>	\pm <i>SD</i>		
Eating disorders (ED)	17.54	± 10.92	21.67	± 11.70	13.15	± 8.03	4.92	<0.001
Body image satisfaction	2.55	± 0.83	2.83	± 0.85	2.26	± 0.71	4.26	<0.001
Self-esteem	29.10	± 7.08	28.54	± 5.82	29.70	± 8.12	-0.94	0.349
Depression	10.90	± 7.77	13.49	± 7.75	8.17	± 6.83	4.25	<0.001

Factors Associated with ED According to Sex

Stepwise multiple regression was performed with BMI, HbA1c levels, body image satisfaction, self-esteem, and depression as the variables to identify the factors associated with ED in adolescents with T1DM according to sex. First, the basic assumptions of regression were tested for the independent variables. The Durbin-Watson statistic was 1.658, less than 2, confirming the absence of autocorrelation between the error terms. Furthermore, tolerance was above 0.1 (0.852–1.0), and the variance inflation factor was below 10 (1.009–1.173),

confirming the absence of multicollinearity among the independent variables. Next, the stepwise regression analysis revealed that body image satisfaction ($\beta = 0.48, p < 0.001$) and depression ($\beta = 0.22, p = 0.043$) were significantly associated with ED in female adolescents with T1DM, with the model providing an explanation for 33.4% of the variance. Among male adolescents, BMI ($\beta = 0.33, p = 0.006$) and depression ($\beta = 0.28, p = 0.017$) were significantly associated with ED, with the model providing an explanation for 17.4% of the variance (Table 3).

Table 3 Factors associated with eating disorders according to sex

Variables	Female ($n = 70$)					Male ($n = 66$)				
	<i>B</i>	<i>SE</i>	β	<i>t</i>	<i>p</i>	<i>B</i>	<i>SE</i>	β	<i>t</i>	<i>p</i>
Body image satisfaction	7.69	1.46	0.48	4.46	<0.001					
BMI						3.09	1.08	0.33	2.87	0.006
Depression	0.33	0.16	0.22	2.07	.043	0.33	0.13	0.28	2.44	0.017

Discussion

Insulin omission cannot be detected during the assessment of ED in adolescents with T1DM using the general ED instruments. Further, nutritional intake for diabetes management can be mistaken as ED, and restriction of certain foods for diabetes management may be overestimated (Markowitz et al., 2010). Thus, we assessed ED in adolescents with T1DM in Korea using data obtained through an instrument that includes items on insulin omission and diabetes management and compared the differences in the factors associated with ED between the sexes.

In this study, the prevalence of ED among adolescents with T1DM was found to be 39.0%. The prevalence of ED among adolescents with T1DM was reported to be 20.7% in Canada (Ryman et al., 2019), 15.4% in Germany (Saßmann et al., 2015), and 14.6% in the United States (Cecilia Costa et al., 2019). ED was assessed using the same instrument in all the studies. The fact that the prevalence of ED among adolescents with T1DM in Korea is about two-fold higher than that in other countries despite the relatively low prevalence of T1DM among adolescents in Korea (Korean Diabetes Association, 2018) warrants greater recognition of ED among adolescents in Korea.

In this study, the mean ED score was 21.67 ± 11.70 among the female adolescents and 13.15 ± 8.03 among the male adolescents. In a German survey of adolescents with T1DM, females had higher ED scores (14.8 ± 11.0) than males (9.4 ± 7.0) (Saßmann et al., 2015). Additionally, in Australia, the DEPS-R score was higher among females (22.2 ± 15.2) than they were among males (11.4 ± 10.0) (Araia et al., 2017). This reflects the reality that females are more interested in external appearances due to social and cultural norms promoting a thin figure. Therefore, active dietary and health-related education is needed mainly for female adolescents with T1DM to prevent ED in the said population.

We performed a stepwise regression analysis to identify the factors associated with ED among adolescents with T1DM. Among female adolescents, body image satisfaction and depression were associated with ED, and these accounted for 33% of the variance of ED. Among male adolescents, BMI and depression were associated with ED, and they accounted for 17% of the variance of ED.

In this study, body image satisfaction was the most potent factor of ED among female adolescents with T1DM. A Canadian survey of the factors associated with ED among female adolescents with T1DM also reported that body image satisfaction had a greater effect than depression and BMI (Olmsted et al., 2008). Negative body image leads to the progression of ED to pathological levels (Junne et al., 2016); thus, a positive body image is crucial in improving ED and promoting health. In other words, body image satisfaction is an important variable that explains ED in female adolescents with T1DM in more detail; therefore, interventions pertinent to body image satisfaction are essential to prevent ED. To this end, it is necessary to help female adolescents with T1DM to adopt an objective and healthy view and accept their body figures by escaping the biased body image preference instilled by the media.

This study revealed that depression was the second-most powerful factor of ED in female adolescents with T1DM and

was also associated with ED in males. Further, these findings are consistent with a study by Park et al. (2019), in which depression was identified as an influential factor of ED in adolescents with T1DM. Since depression delays response to insulin injections for diabetes treatment and induces frequent recurrence (Korean Diabetes Association, 2018), periodic depression screening and monitoring are essential. Moreover, strategies for lowering depression in adolescents with T1DM may alleviate ED; therefore, various programs to treat depression must also be developed.

In this study, BMI was the most potent factor of ED in male adolescents with T1DM, which is also in line with a previous study (Yim, 2010). Therefore, male adolescents with T1DM, especially overweight and obese adolescents, require dietary and exercise programs to help them lose weight and maintain normal body weight. In addition, behavioral correction programs would be helpful for participants to practice desirable eating and healthy behaviors on their own.

In sum, ED was strongly associated with body image satisfaction in female adolescents with T1DM, while BMI was the most influencing factor in male adolescents. Thus, sex-specific approaches should be adopted to reduce the prevalence of ED by promoting healthy eating behaviors in adolescents with T1DM and preventing potentially relevant problems. While female adolescents require cognitive and affective interventions to establish a desirable body image, male adolescents need dietary and exercise programs to manage BMI. Furthermore, depression was an influencing factor of ED regardless of sex; therefore, ED interventions for adolescents with T1DM should include elements that effectively reduce depression, such as mindfulness, to maximize the effectiveness of the programs.

Implications of the Study

Diabetes mellitus is a manageable disease that requires continuous management throughout the various developmental stages. Several problems that occur in the process of adolescents developing into adults increase the risk of diabetic complications (Lee & Kim, 2021). Adolescents are engrossed in their bodily changes, especially the changes in their appearance due to secondary sexual characteristics (Jin, 2016; Korean Diabetes Association, 2018). A negative body image oneself can lead to and worsen ED (Junne et al., 2016; Park & Ju, 2021). Additionally, body dissatisfaction among adolescents with T1DM is associated with low self-esteem and depression (Park & Ju, 2021).

For adolescents to successfully adapt to disease and remain healthy through adulthood, their psychological and physiological changes should be considered in diabetes management. Furthermore, a collaboration between health and medical practitioners, changes in the medical environment, and social interests are necessary. Additionally, continuous communication between adolescents and medical staff is essential. In particular, nurses and physicians should pay more attention to the characteristics of adolescent diabetic patients who are not fully mature. It is also necessary to understand the shame experienced with diabetes and help them develop an accurate of their body. At the government level, economic support for interventions such as psychological counseling to address the mental health needs of adolescents must be strengthened. In addition, through anti-

discrimination education that teaches people to respect diversity and avoid prejudice, it will be possible to reduce discrimination against adolescents with diabetes and create a social atmosphere that appreciates diverse body types.

Limitations

This study used secondary data analysis from a diabetes camp hosted by the Korean Insulin Dependent Diabetes Association and outpatient pediatric clinics at two tertiary hospitals (Park et al., 2019). The findings have limited generalizability to the entire adolescent T1DM population in Korea. Thus, subsequent studies should recruit a more extensive study population for more meticulous analysis. Despite these limitations, this study was significant in identifying the differences in the associated factors of ED between sexes. In addition, it provided baseline data for developing intervention programs that help prevent and manage ED among adolescents amid inadequate study data on adolescents with T1DM.

Conclusion

This study aimed to investigate the sex-specific factor of ED among adolescents with T1DM in Korea and identify the factors associated with ED in each sex. Body image satisfaction and depression were associated with ED among female adolescents with T1DM, while BMI and depression were associated with ED among male adolescents with T1DM. These results highlight the need to consider the sex-based difference in the attempts to reduce the prevalence of ED by promoting healthy eating behaviors in adolescents with T1DM. Female adolescents require assistance establishing a healthy perception of their body figure, while male adolescents require exercise and nutrition monitoring to lower BMI. Moreover, depression was a shared factor of ED in male and female adolescents with T1DM; thus, periodic depression screening and intervention programs to reduce depression are critical. Emphasizing the importance of desirable eating behaviors and the development and implementation of interventions that aim to lower the known risk factors in adolescents with T1DM, who are gradually developing permanent dietary habits, will contribute to reducing diabetic complications and fostering desirable dietary habits, thereby laying a foundation for a healthy adulthood.

Declaration of Conflicting Interest

The authors declare no conflict of interest.

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None.

Authors' Contributions

All authors contributed equally in methodology, formal analysis, drafting of the manuscript, reviewing and editing, project administration, funding acquisition, and have read and agreed to the published version of the manuscript. HR specifically had additional contributions in conceptualization and investigation, while NH had specific contributions in data curation and supervision. Both authors were accountable for each step of the study.

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Data Availability

Not Applicable.

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