Orginal Article Open Access
Iranian Journal of Diabetes and Obesity (IJDO)

Effect of Resistance and Interval Training on Serum Melatonin and Expression of Its Receptors (MTNR1A and MTNR1B) in the Pancreas Tissue of Diabetic Rats

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Abstract

Objective: This study aimed to examine the association between depression and quality of life in patients with diabetes at risk of diabulimia, with a particular focus on the mediating role of illness perception.

Materials and Methods: This descriptive-correlational study was conducted among patients with diabetes attending specialized diabetes clinics in Shiraz, Iran, between July and October 2025. Using convenience sampling, 161 eligible participants were recruited. Data were collected using the Beck Depression Inventory-II (BDI-II), the Brief Illness Perception Questionnaire (B-IPQ), and the World Health Organization Quality of Life-BREF (WHOQOL-BREF). Data were analyzed using SPSS version 27 and SmartPLS version 4. Structural equation modeling was applied to test the hypothesized direct and indirect relationships among depression, illness perception, and quality of life.

Results: The findings showed that depression had a significant negative direct effect on illness perception ($P< 0.001$) and quality of life ($P< 0.001$). Illness perception had a significant positive effect on quality of life ($P< 0.001$). In addition, the indirect effect of depression on quality of life through illness perception was significant ($P< 0.001$), indicating the mediating role of illness perception.

Conclusion: Depression was associated with poorer quality of life among patients with diabetes at risk of diabulimia, both directly and indirectly through illness perception. These findings highlight the importance of psychological interventions that address depressive symptoms and illness-related perceptions to improve quality of life in this population.

Keywords: Depression, Illness perception, Quality of life, Diabulimia

QR Code:

Citation: Jahandarpour S, Keykhosravani M, Pouladi Rishehri A, Rafiee Dehbidi V. Effect of Resistance and Interval Training on Serum Melatonin and Expression of Its Receptors (MTNR1A and MTNR1B) in the Pancreas Tissue of Diabetic Rats. IJDO 2026; 18 (3) :190-199

URL: http://ijdo.ssu.ac.ir/article-1-1060-en.html

10.18502/ijdo.v18i3.22376

Article info:
Received: 16 November 2025
Accepted: 28 July 2026
Published in August 2026

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[DOI: 10.18502/ijdo.v18i3.22376]

Introduction

Type 1 diabetes mellitus (T1DM) is a chronic autoimmune disease that requires lifelong management through intensive insulin therapy to maintain optimal glycemic control and prevent metabolic complications. Standard treatment typically involves multiple daily insulin injections or continuous insulin infusion through insulin pumps. Although these strategies are essential for maintaining normoglycemia, some individuals with T1DM develop maladaptive behaviors related to insulin use. One of the most concerning behaviors is diabulimia, a condition characterized by the intentional restriction or omission of insulin doses for weight control purposes (1,2). Because insulin omission may lead to rapid weight loss, some individuals with diabetes deliberately manipulate insulin therapy despite being aware of the serious medical consequences. Such behaviors can result in severe metabolic complications including recurrent diabetic ketoacidosis, poor glycemic control, neuropathy, retinopathy, kidney disease and increased risk of hospitalization (1,3).

Recent research suggests that diabulimia represents a complex phenomenon influenced by biological, psychological, and sociocultural factors. Individuals with diabetes often face body image concerns, weight-related stigma, and pressure to maintain a particular body shape, which may contribute to insulin manipulation behaviors (4). Adolescents and young adults with T1DM are particularly vulnerable to these risks due to developmental, psychological, and social challenges associated with chronic illness management. Studies have shown that poor diet quality, body dissatisfaction, and inadequate nutritional status may increase the likelihood of diabulimia behaviors among individuals with diabetes (1). In addition, qualitative research indicates that individuals who engage in insulin restriction frequently experience psychological distress, feelings of guilt and shame, and a sense of loss of control over their illness (5). These findings highlight the multifaceted nature of diabulimia and underscore the importance of examining psychological determinants of the disorder.

Among the psychological factors associated with diabulimia, depression and diabetes-related emotional distress appear to play a significant role. Managing diabetes requires constant monitoring, dietary regulation, and insulin administration, which can create substantial psychological burden. Previous studies have reported that a considerable proportion of individuals with diabetes experience emotional distress, depressive symptoms, and anxiety related to disease management (6,7). Depression may reduce motivation for effective self-care behaviors and increase the likelihood of maladaptive coping strategies such as insulin omission. Evidence suggests that adolescents with T1DM who experience depression, anxiety, or eating-related problems have a significantly higher risk of developing diabulimia behaviors (8). Furthermore, diabetes-related distress has been identified as an important psychological factor that may exacerbate disordered eating behaviors and negatively affect metabolic control and overall well-being (6).

Beyond psychological distress, individuals' perceptions of their illness play a crucial role in shaping health behaviors and disease management strategies. Illness perception refers to the cognitive and emotional representations individuals form about their illness, including beliefs about its causes, consequences, duration, controllability, and associated symptoms. According to the Common-Sense Model of Self-Regulation, these cognitive and emotional representations influence coping responses and treatment behaviors (9). Empirical studies have demonstrated that negative illness perceptions are associated with poorer treatment adherence, increased psychological distress, and reduced quality of life in patients with chronic illnesses (10,11). Conversely, stronger beliefs in

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personal and treatment control are linked to better health outcomes and improved psychological adjustment.

In individuals with diabetes, illness perceptions may significantly influence how patients interpret their condition, adhere to insulin therapy and engage in self-management behaviors. Patients who perceive diabetes as highly threatening or uncontrollable may experience greater psychological distress and reduced motivation to follow treatment recommendations. Previous research indicates that perceptions of disease severity, risk

and consequences can influence health behaviors and coping strategies among individuals with chronic diseases (12,13). These perceptions may also affect emotional responses to illness and ultimately influence patients' overall well-being and health outcomes. Quality of life is a key outcome indicator in chronic disease management and reflects individuals' physical, psychological, and social well-being (14). In patients with diabetes, quality of life is influenced by multiple factors including disease complications, psychological distress, self-care behaviors and social support (15). Individuals who experience higher levels of emotional distress or negative illness perceptions are more likely to report poorer quality of life and reduced well-being (16). Given the psychological and behavioral complexities associated with diabulimia, understanding the mechanisms through which psychological factors influence quality of life is essential for developing effective prevention and intervention strategies.

Despite the growing body of research on diabulimia, several important gaps remain in the literature. Many previous studies have primarily focused on the prevalence, behavioral characteristics, or clinical complications of diabulimia, while fewer studies have examined the psychological mechanisms that explain how emotional factors influence health outcomes in this population. In particular, the potential mediating role of illness perception in the relationship between depression and quality of life among individuals with diabulimia has received limited empirical attention. Therefore, the present study aimed to investigate the relationship between depression and quality of life in individuals with diabulimia, with illness perception as a mediating variable. By examining these relationships within a structural model, this study seeks to contribute to a deeper understanding of the psychological processes underlying health outcomes in patients with diabetes and to provide evidence that may inform more effective psychological and clinical interventions.

Material and methods

Research method

Study design

The present study used a cross-sectional descriptive-correlational design and was applied in terms of its purpose. The study aimed to investigate the structural associations among depression, illness perception and quality of life in patients with diabetes who were at risk of diabulimia. Within the proposed conceptual framework, depression was specified as the predictor variable, quality of life as the outcome variable and illness perception as the mediating variable. The hypothesized relationships among these constructs were tested using structural equation modeling.

Population and sampling

The target population included patients with diabetes who attended specialized diabetes clinics in Shiraz from July to October 2025. Among diabetes care centers in Shiraz, three clinics, namely Shahraraz, Milad and Pardis, were selected because of their accessibility and their willingness to cooperate with the research process. Eligible patients who visited these clinics during the data collection period were invited to participate through convenience sampling.

A total of approximately 200 questionnaires were distributed among patients who met the preliminary eligibility criteria. After the returned questionnaires were screened for completeness and eligibility, questionnaires

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with substantial missing data or failure to meet the inclusion criteria were removed from the dataset. Finally, data from 161 participants were retained for statistical analysis.

Sample size determination

The sample size was determined based on statistical power requirements for structural equation modeling. Following Cohen's recommendations for detecting a medium effect size, with an effect size of= 0.30, a significance level of 0.05 and statistical power of 0.80, a minimum sample of approximately 150 participants was considered sufficient for examining the proposed relationships among the study variables. Therefore, the final sample of 161 participants was regarded as adequate for conducting the planned SEM analyses.

Inclusion and exclusion criteria

Participants were included if they were between 30 and 55 years of age, had an active medical record at one of the selected diabetes clinics, were willing to participate voluntarily, provided informed consent and were able to read and understand the questionnaire items. Participants were excluded if they withdrew from the study at any point, had severe physical or psychological conditions that interfered with questionnaire completion, or left more than seven questionnaire items unanswered.

Procedure

After receiving the required approvals from the researcher's university and coordinating with the administrators of the selected clinics, data collection was carried out in cooperation with clinic staff. Because some patients had limited access to the internet or were less familiar with online forms, the questionnaires were administered in paper-and-pencil format.

Before completing the questionnaires, participants were informed about the purpose of the study, the voluntary nature of participation, and the general instructions for responding to the items. Additional clarification was provided when necessary to ensure that participants understood the questions; however, all responses were completed by the participants themselves. The average time required to complete the questionnaires was approximately 20 to 30 minutes.

Completed questionnaires were collected by the researcher and reviewed for missing or invalid responses. Data collection took place over a four-month period from July to October 2025. Prior to participation, informed consent was obtained from all participants. They were assured that their personal information would remain confidential and that the findings would be reported only in aggregate form, without identifying any individual participant.

Data collection instruments

Beck Depression Inventory-II: Depression was assessed using the Beck Depression Inventory-II, developed by Beck et al. in 1996 to measure the severity of depressive symptoms (17). The BDI-II consists of 21 items, each scored on a four-point scale from 0 to 3. The total score ranges from 0 to 63, with higher scores indicating more severe depressive symptoms. Scores of 0–13 indicate minimal depression, 14–19 mild depression, 20–28 moderate depression and 29–63 severe depression. Beck et al. reported acceptable psychometric properties for the instrument, including concurrent validity of 0.79 and test-retest reliability of 0.67. Previous validation studies of the Persian version have also supported the reliability and validity of the scale (17). In the present study, Cronbach's alpha for the BDI-II was 0.811.

Brief Illness Perception Questionnaire: Illness perception was measured using the Brief Illness Perception Questionnaire, developed by Broadbent et al. in 2006(19). This instrument is designed to assess patients' cognitive and emotional representations of their illness. It includes items related to perceived consequences, timeline, personal control, treatment control, identity, concern, illness understanding and emotional response. The ninth item is open-ended and asks respondents to identify the main perceived causes of their illness; however, this item was not included in

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the quantitative analyses of the present study. Previous studies have reported acceptable reliability for the B-IPQ, with test-retest reliability coefficients ranging from 0.48 to 0.73 across items. The Persian version has also demonstrated satisfactory psychometric properties, with Cronbach's alpha reported as 0.90 (20). In the present study, Cronbach's alpha for this scale was 0.723.

World Health Organization Quality of Life-BREF**:** Quality of life was assessed using the World Health Organization Quality of Life-BREF questionnaire (21). The WHOQOL-BREF contains 26 items and evaluates four domains of quality of life: physical health, psychological health, social relationships, and environmental health. In addition, two general items assess overall quality of life and general health perception. Responses are rated on a Likert-type scale, with higher scores reflecting better perceived quality of life. Previous Iranian studies have reported acceptable internal consistency for the WHOQOL-BREF, with reliability coefficients generally above 0.70 (22). In the present study, the scale demonstrated good internal consistency, with Cronbach's alpha of 0.884.

Data analysis method

Data analysis was conducted using SPSS version 27 and SmartPLS version 4. SPSS was applied to generate descriptive indices and to calculate Spearman's correlation coefficients, whereas SmartPLS was used to test the proposed path model. The distributional properties of the study variables were examined through the Shapiro–Wilk test. As the normality test produced significant results, the assumption of normal distribution was not supported; therefore, the partial least squares structural equation modeling approach was considered appropriate for the analysis. Statistical significance was evaluated at the 0.05 level. In addition, bootstrapping procedures were performed to assess the significance of the indirect paths and to determine the mediating effect within the model.

Ethical considerations

Ethical approval was obtained by Research Ethics Committees of Bushehr province university of medical sciences, Iran (ethical code: IR.BPUMS.REC.1404.310).

Results

Descriptive statistics for the demographic characteristics of the participants were presented in a separate table. In terms of age, patients with diabulimia were classified into three groups: 30-40 years (49.7%), 40-50 years (43.5%) and 50-55 years (6.8%). Regarding gender, 24.2% of the participants were male and 75.8% were female. With respect to marital status, 76.4% were married and 23.6% were single. In addition, participants were grouped by educational level as middle school (14.9%), high school (59.0%) and academic education (26.1%) (Table 1).

According to table 2, the variable quality of life had a significant positive relationship with the variable perception of illness (r= 0.650, *P*< 0.001). However, the variable quality of life

Table 1. Description of the demographic variables

variables	Groups	Frequency	Percent
Gender	Male	39	24.2
	Female	122	75.8
Age	30-40	80	49.7
	40-50	70	43.5
	50-55	11	6.8
Marital status	Married	123	76.4
	Single	38	23.6
Education	Elementary	24	14.9
	High school	95	59.0
	Academic	42	26.1

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had a significant negative relationship with the variable depression (r= -0.591, *P*< 0.001).

Additionally, the variable perception of illness had a significant negative relationship with the variable depression (r= -0.438, *P*< 0.001).

Based on the results shown in table 3, depression had a significant negative direct effect on illness perception (β= -0.493, t= 9.204, *P*< 0.001, 95% CI [-0.591, -0.381]) and quality of life (β= -0.340, t= 6.226, *P*< 0.001, 95% CI [-0.445, -0.230]). Illness perception had a significant positive direct effect on quality of life (β= 0.524, t= 8.609, *P*< 0.001, 95% CI [0.400, 0.640]). Moreover, the indirect effect of depression on quality of life through illness perception was significant (β= -0.259, t= 6.376, *P*< 0.001, 95% CI [-0.343, -0.181]), indicating that illness perception significantly mediated this relationship.

As presented in table 4, all constructs demonstrated acceptable reliability and convergent validity, with AVE values ranging from 0.502 to 0.571, composite reliability coefficients between 0.810 and 0.892 and Cronbach's alpha values from 0.811 to 0.884. Discriminant validity was supported based on the Fornell-Larcker criterion, as the square roots of AVE (0.737 for illness perception, 0.755 for depression and 0.708 for quality of life) exceeded the corresponding inter-construct correlations. Model fit indices indicated an acceptable fit (SRMR= 0.054 for the estimated model; 0.051 for the saturated model), although the NFI values (0.715 and 0.708) reflected a moderate fit; additionally, the

Table2. Spearman's correlations

Variable	1	2	3
Perception of illness	-		
Depression	-0.438***	-	
Quality of life	0.650***	-0.591***	-

Table 3. Indirect and direct effects

	Path coefficient	Estimate	STDEV	t-value	*P*-value	95% Confidence interval	
						2.5%	97.5%
	Depression -> Perception of illness	-0.493	0.054	9.204	*P*< 0.001	-0.591	**-0.381**
Direct effects	Depression -> Quality of life	-0.340	0.055	6.226	*P*< 0.001	-0.445	**-0.230**
	Perception of illness -> Quality of life	0.524	0.061	8.609	*P*< 0.001	0.400	**0.640**
Indirect effects	Depression -> Perception of illness -> Quality of life	-0.259	0.041	6.376	*P*< 0.001	-0.343	**-0.181**

Table 4. Reliability and validity of the model and model fit

Variables	Cronbach's Alpha	Composite Reliability	AVE
Perception of illness	0.859	0.892	**0.544**
Depression	0.811	0.869	**0.571**
Quality of life	0.884	0.810	**0.502**
Fornell- larcker criterion discriminant validity			
Perception of illness	0.737		
Depression	-0.438	0.755	
Quality of life	0.650	-0.591	**0.708**
Assessment of model fit statistics			
	Saturated model	**Estimated model**	
SRMR	0.051	**0.054**	
NFI	0.708	**0.715**	
Predictive communication Q^2			
Variable	**SSO**	**SSE**	**Q^2(= 1-SSE/SSO)**
Perception of illness	161.000	122.302	**0.240**
Quality of life	161.000	70.615	**0.561**
Coefficient of determination of the model			
Variables	**R-square**	**R-square adjusted**	
Perception of illness	0.243	**0.238**	
Quality of life	0.566	**0.561**	

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model demonstrated satisfactory predictive relevance (Q^2= 0.240 for illness perception and 0.561 for quality of life) and explained 24.3% and 56.6% of the variance in illness perception and quality of life, respectively (R^2= 0.243 and 0.566).

Discussion

The present study examined a structural pathway linking depression, illness perception, and quality of life in individuals with diabulimia. Although the negative association between depression and quality of life may appear expected, the present findings extend prior research by demonstrating that illness perception operates as a mediating cognitive mechanism, rather than depression functioning solely as an independent predictor.

Depression in the context of type 1 diabetes is not merely a comorbid condition; it may alter the cognitive schema through which patients interpret their illness. According to the Common-Sense Model of Self-Regulation, illness perceptions shape coping responses and health behaviors. When depressive symptoms are elevated, patients may perceive diabetes as less controllable, more threatening, and more burdensome. Such maladaptive cognitive representations can weaken engagement in adaptive self-management behaviors and increase vulnerability to insulin omission. Evidence suggests that distorted illness perceptions are associated with poorer medication adherence and adverse psychological outcomes in diabetes populations (9,11). The current findings indicate that this mechanism may be particularly relevant in individuals at risk of diabulimia.

Importantly, insulin restriction in diabulimia may function as a maladaptive emotion-regulation strategy. Qualitative syntheses show that individuals describe insulin omission as a means of coping with body dissatisfaction, perceived loss of control, and psychological distress (5,15). Depression may intensify these experiences by increasing hopelessness and self-criticism, thereby reinforcing harmful compensatory behaviors. Case–control evidence further supports the strong co-occurrence of depression, anxiety, eating problems and diabulimia risk in adolescents with type 1 diabetes (8). Thus, rather than viewing depression and diabulimia as parallel phenomena, the present findings support a dynamic interaction in which depressive symptoms shape illness beliefs, which in turn influence behavioral risk patterns. The positive association between illness perception and quality of life requires nuanced interpretation. Adaptive illness perceptions-characterized by greater perceived control and illness coherence have been linked to better treatment adherence and improved psychosocial functioning in chronic conditions (9,10). In diabetes populations, stronger health literacy and reduced diabetes-related distress are associated with improved quality of life through enhanced cognitive appraisal of the disease (16). Therefore, the mediating pathway observed in this study suggests that cognitive representations may buffer or amplify the impact of depressive symptoms on overall well-being.

Furthermore, diabetes-related distress appears to play a central role in the psychological burden associated with diabulimia. Emotional exhaustion related to glucose monitoring, dietary restrictions and fear of complications has been identified as a key contributor to maladaptive coping behaviors, including insulin restriction (2). Persistent distress may gradually erode perceived self-efficacy, thereby reshaping illness perceptions and lowering quality of life. This aligns with evidence indicating that body-related concerns and sociocultural pressures uniquely affect women with diabetes, increasing vulnerability to disordered eating patterns (7).

Taken together, the present findings move beyond the well-established association between depression and reduced quality of life by identifying illness perception as a cognitive intermediary within this pathway. This integrative perspective contributes theoretically by situating diabulimia within a broader

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cognitive–affective regulatory model, rather than conceptualizing it solely as a behavioral eating disturbance (23).

Limitations

Diabulimia is increasingly recognized as a serious concern in diabetes care, as it may compromise both metabolic management and psychological quality of life. Nevertheless, conclusions drawn from the current literature should be approached cautiously due to several methodological shortcomings. One of the most important limitations is the predominance of cross-sectional research designs. Such designs provide evidence of association but do not allow researchers to establish temporal ordering or causal pathways between psychological vulnerabilities and insulin restriction behaviors.

The validity of existing findings is also influenced by the frequent use of self-report instruments. While self-report measures are valuable for capturing subjective psychological experiences, they are vulnerable to response biases, including recall bias, minimization of symptoms, and socially desirable responding. These concerns are especially important in the study of diabulimia, because insulin omission and eating-related difficulties are often associated with shame, secrecy and perceived stigma. Accordingly, participants may not fully disclose their experiences, which may lead to underestimation of the prevalence and severity of the problem.

Moreover, the representativeness of samples remains a challenge. A substantial number of studies have relied on convenience or volunteer samples, which may introduce selection bias. Individuals who participate in research on sensitive health-related behaviors may differ systematically from those who do not participate, particularly in terms of distress level, treatment history, health literacy, and readiness to discuss diabetes-related difficulties. This limits the extent to which findings can be generalized to the wider population of people living with diabetes.

Another methodological issue concerns the inconsistent adjustment for potential confounding variables. Clinical indicators such as duration of diabetes, HbA1c, insulin treatment characteristics, body mass index, prior eating disorder history, and psychiatric comorbidities may influence both psychological functioning and insulin restriction. When these variables are not adequately measured or statistically controlled, the observed associations may reflect unmeasured clinical or demographic influences rather than direct psychological mechanisms.

Finally, small sample sizes, the scarcity of longitudinal studies, and insufficient consideration of cultural variability further constrain the interpretation of existing findings. These limitations reduce statistical power, limit the ability to examine developmental trajectories and restrict the applicability of results across different social and cultural contexts. Future research would benefit from prospective designs, larger and more diverse samples, clinical verification of diabetes-related variables, and integration of both quantitative and qualitative methods to provide a more comprehensive understanding of diabulimia.

To improve the situation regarding diabulimia, several suggestions can help reduce the prevalence of this disorder and enhance patients' quality of life. First, conducting multi-faceted research with an emphasis on cultural and social diversity can help identify differences and similarities between various communities. Second, employing longitudinal study designs can facilitate a better understanding of the relationships between variables and identify changes over time. Third, increasing public awareness and educating patients about the risks of diabulimia and its effects on mental and physical health can help mitigate this disorder. Additionally, providing psychological support and counseling to patients with diabulimia can alleviate their stress and anxiety, improving their quality of life. Finally, developing and validating appropriate assessment tools for identifying

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diabulimia and evaluating the factors influencing it can assist researchers and practitioners in identifying and managing this disorder. Overall, considering the existing limitations in current research and the need for new approaches, the proposed suggestions could enhance understanding and management of diabulimia, leading to a reduction in its prevalence and an improvement in patients' quality of life.

Conclusion

The relationships between diabulimia and various factors such as social pressure, stress, misconceptions about illness, and mental health history are intricately intertwined. These relationships indicate that diabulimia is not only an eating disorder but is also significantly influenced by psychological, social, and cultural factors. Effective management of this disorder requires multi-dimensional and comprehensive approaches that support patients psychologically and educationally.

In conclusion, diabulimia presents a serious challenge in diabetes management, profoundly impacting depression, illness perception, and quality of life. These complex relationships require special attention, and since diabulimia can severely affect patients' mental and physical health, there is a need for comprehensive approaches in diabetes management and psychological support for patients. Given that diabulimia is recognized as a multi-faceted problem, it is essential to conduct further research and interventions in this area to help improve patients' quality of life.

Acknowledgments

This research was conducted as part of a Ph.D. thesis in psychology at Islamic Azad University of Bushehr. We are grateful for the participation of all the research subjects.

Funding

This study did not receive any funding.

Conflict of Interest

The writers do not have any competing interests.

Authors' contributions

S.J, M.K: writing- original draft and analyzing data. A.PR supervision and conceptualization, S.J, M.K.: collecting the data and Conceptualization, V.RD: Supervision and methodological contributions. All the authors critically revised the manuscript, agree to be fully accountable for the integrity and accuracy of the study and read and approved the final manuscript.

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[DOI: 10.18502/ijdo.v18i3.22376]

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