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The Effectiveness of a Family-Centered Behavioral Modification Package in Improving the Eating Behavior, Bmi Percentile and Abdominal Circumference of Obese School-Age Girls: A Randomized Controlled Trial

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Abstract

Background: Childhood obesity is widely recognized as a prominent challenge in the 21st century. The family holds considerable potential in effectively managing this concern, by incorporating behavioral modifications into the child's dietary patterns and physical activity engagement. The aim of this study was to determine the effectiveness of a family-centered, behavioral modifications package in improving the eating behavior, BMI percentile, and abdominal circumference of obese school-age girls.

Methods: A randomized clinical trial was conducted on a cohort of 80 obese female students aged 7-12 in Mashhad between 2020 and 2021. Data was collected using a demographic information Questionnaire and the Children's Eating Behavior Questionnaire (CEBQ). Following a 3D body scanning procedure, a seven-session intervention program was implemented. Six months later, a reassessment was carried out, encompassing the evaluation of BMI percentile, 3D body scanning, and re-administration of the questionnaires. Data was analyzed through SPSS version 24, utilizing paired t-tests, independent t-tests, and multivariate analysis of variance.

Results: Following the intervention, significant increases were observed in scores for enjoyment of food, satiety responsiveness, and slowness in eating. Conversely, scores for food responsiveness, emotional overeating, emotional undereating, and food fussiness displayed a decrease. However, the differences did not reach statistical significance following the intervention ($p>0.05$). Notably, changes in BMI percentile and abdominal circumference displayed a statistically significant difference between the two groups after the intervention ($p<0.05$).

Conclusion: The family-centered behavioral modification program represents an appropriate approach for modifying child's eating behavior, resulting in a success rate exceeding 10% in weight reduction.

Key Words: Family-centered behavioral modification, Child's eating behavior, BMI, Obesity, School-age girls.

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1- INTRODUCTION

Obesity is an alarming global concern that has received sustained attention for an extensive period of time. Currently, there is a notable surge in its prevalence across all countries, including both developed and developing nations, as well as low-income communities. Of particular concern is the escalating rate of obesity among children (1). The onset of the obesity and overweight epidemic can be traced back to 1980, prompting the World Health Organization to acknowledge it as a significant public health issue in 1997 (2). Efforts to combat childhood obesity gained significant momentum, with the goal of reducing its prevalence by 2010 becoming a pivotal objective in public health (3). However, progress in addressing this issue has been sluggish and insufficient (4), as supported by recent data demonstrating a tenfold increase in childhood and adolescent obesity worldwide (1). The most recent statistics from the Centers for Disease Control and Prevention (CDC) reveal that between 2017 and 2020, the prevalence of obesity among American children aged 2-19 years stood at 19.7%, affecting an estimated 14.7 million children and adolescents (5).

Obesity is widely recognized as a chronic condition that poses significant risks to children's health and serves as a precursor to its occurrence in adulthood (6). It is associated with a variety of ailments, including diabetes, cancer, respiratory issues (such as asthma and nocturnal apnea attacks), arthritis, liver complications, digestive disorders, premature puberty, and multiple musculoskeletal disorders like flat feet. Additionally, psychological and social problems such as depression, anxiety, diminished self-confidence and social isolation are non-communicable conditions posing further threats to the health of children affected by obesity (7). Consequently, the early identification, diagnosis, and management of childhood obesity (as a form of secondary prevention) has a critical importance in mitigating the burden of chronic diseases and disabilities in adulthood (6).

When evaluating various treatments for overweight and obesity, substantial research supports the efficacy of comprehensive lifestyle interventions encompassing nutritional recommendations, physical activity prescriptions, and behavior modification (8). The objective behind rectifying obesity-related behaviors is to eliminate the behaviors that contribute to childhood obesity. This includes goal setting, responsibility assignment, nutritional planning, self-monitoring of food intake, weight and activity tracking, stimulus control, problem-solving (addressing challenges in specific eating situations), managing emotional eating, and relapse prevention. Altering children's behaviors regarding food consumption and physical activity relies on enhancing parents' knowledge, self-efficacy, adoption of healthy practices, improvement of parenting skills, and creating an environment that facilitates behavioral change while promoting healthy behaviors in children (9).

Evidence indicates that children and adolescents' nutritional behaviors stem from their parents' nutritional behaviors, thus rendering parents a crucial factor in bringing about changes and modifications in children's behavior (10). Therefore, family-centered programs are deemed suitable for overweight management (11). Bandura's social cognitive theory, a widely recognized theory of behavior change, asserts that behavior observation facilitates learning. Thus, parents' obesity-related behaviors can significantly impact the management of childhood obesity. If these behaviors align with self-management, they can encourage children to manage their obesity. Conversely, if parents overlook their child's obesity, it can have

detrimental effects on the child's condition (12, 13).

In Berry et al.'s review of evidence on family-centered interventions, it was observed that behavior modification interventions targeting children and parents either jointly or separately have been successful in weight reduction for both parents and children. Moreover, problem-solving interventions focused on parents had a weight reduction effect on children. However, interventions involving parents and children together or individual interventions solely focused on children did not result in weight reduction (14).

Due to the current environmental factors, such as energy intake imbalance, the high prevalence of sedentary behaviors, reduced physical activity, and increased immobility, children are at risk of developing obesity. Consequently, interventions are necessary to modify children's behavior with the objectives of improving food consumption, increasing physical activity, and reducing sedentary behaviors. These interventions have the potential to effectively address obesity in children. Recognizing the significance of managing obesity in children and acknowledging the essential role of the family, the purpose of this study was to investigate the effectiveness of a family-centered educational package, incorporating behavioral modifications, on eating behavior, BMI percentile, and abdominal circumference of obese school-age girls.

2- MATERIALS AND METHODS

This study presents a randomized controlled trial conducted in Mashhad between 2019 and 2020. The sample size was estimated at 35 individuals per group based on mean and standard deviation values derived from the previous research conducted by Bocca et al. (15).

However, to ensure the validity and generalizability of the results, a sample size of 40 children per group was calculated, considering a 20% attrition rate. The confidence level was set at 95% with a power of 80%. The research samples were selected through simple random sampling without replacement, utilizing envelopes. From a selection of 10 randomly chosen schools across 7 districts of Mashhad, 2 schools were allocated to the intervention group, and 2 schools to the control group. The assignment to these groups was determined by the first and third choices for the intervention group and the second and fourth choices for the control group. Within these schools, 80 obese girls aged 7-12 years with a BMI percentile exceeding 85% were selected using the convenience sampling method.

2-1. Inclusion and exclusion criteria

The inclusion criteria for this study encompassed the following: children classified as obese according to the international definition (BMI percentile over 85%), aged between 7 and 12 years, mothers attending meetings, non-participation in weight control programs, parent literacy, willingness to participate, and living with both parents. Exclusion criteria included communication difficulties, psychiatric disorders, heart disease or exercise-induced shortness of breath, medical conditions or use of weight-reducing medications, refusal to continue participation, absence of more than one session by the mother or child, and reaching puberty age.

The data collection tools utilized in this study included a checklist for selecting participants, an informed consent form for study participation, and a children's eating behavior questionnaire.

The Children's Eating Behavior Questionnaire, developed by Wardle et al. (16) in England, consists of 35 items that assess children's eating behavior across eight subscales. These subscales measure food responsiveness (5 items), enjoyment

of food (4 items), emotional overeating (4 items), desire to drink (3 items), satiety responsiveness (5 items), slowness in eating (4 items), food fussiness (6 items), and emotional undereating (4 items).

Emotional overeating and emotional undereating reflect emotionally reactive eating behaviors, while the desire to drink indicates interest in sugary beverages, and satiety responsiveness, slowness in eating, and food fussiness reflect avoidance behaviors. The validity and reliability of this tool have been confirmed, with a Cronbach's alpha range of 0.72-0.91 for reliability and test-retest reliability showing correlation coefficients ranging from 0.52-0.87 (17).

2-2. Procedure

Once individuals meeting all the inclusion criteria were selected as research participants, a comprehensive explanation regarding the research objectives, methodology, anticipated benefits, and potential risks was provided to them in an understandable manner. Upon their agreement to participate, written informed consent was obtained from each participant.

In the intervention group, the researchers introduced themselves to the parents and children at the beginning of the intervention sessions, reiterating the research objectives and procedures. Additionally, a 3D body scanning procedure was administered using a 3D scanner (PT-3D FIT) under the supervision of one of the researchers. The intervention group's BMI and corresponding percentile were measured and documented. Subsequently, an educational package incorporating family-centered behavioral modifications, designed by the researcher, was delivered to both the child and mother over a one-month period, consisting of seven 45-minute sessions.

The initial briefing session focused exclusively on parents and covered the introduction of the researcher, the importance of parents' involvement in the study, and the family's role in the development and prevention of obesity.

The second session focused on children, recording their perspectives on obesity and their personal roles in the development and prevention of obesity. Subsequent sessions (third to seventh) were devoted to distributing educational booklets to the participants and delivering relevant training on obesity-related topics, including associated complications and problems, individual and environmental factors influencing obesity, stimulus control, motivation enhancement, and behavior modification techniques. Further details on the assigned behavior modification methods can be found in **Table 1**.

Table-1: The educational package of family-centered behavioral modifications for the intervention group

Sessions	Objectives	Teaching method
First (parent)	Introducing the researcher and providing a comprehensive overview of the researcher role and methodology, providing information about parents' participation in the research, recording parents' opinions on obesity, and discussing the family' role in both the development and prevention of obesity.	Face-to-face training and use of audio-visual equipment
Second (child)	Introducing the researcher and providing a comprehensive overview of the researcher's role and methodology, providing information about the child's participation in the research, recording the child's opinions on obesity, and discussing the	Face-to-face training and use of audio-visual equipment

	child's role in the development and prevention of obesity.	
Third (common)	Providing information about the definition of obesity, complications and problems caused by obesity, the goals of obesity treatment, handing out educational booklets to parents	Face-to-face training and the use of audio-visual equipment.
Fourth (child)	Discussing individual and environmental factors affecting obesity in children, and the prevention of obesity	Face-to-face training and use of audio-visual equipment
Fifth (child)	Discussing individual control and stimulus control strategies in relation to managing obesity	Face-to-face training and use of audio-visual equipment
Sixth (common)	Motivating, reinforcing, and encouraging the use of the star chart	Face-to-face training and use of audio-visual equipment
Seventh (common)	Providing skills utilizing behavior modification techniques	Face-to-face training and use of audio-visual equipment

A six-month follow-up period was conducted after the intervention, utilizing phone calls and WhatsApp as communication channels. At the beginning of the initial session and at the end of the sixth month, participants from both the intervention and control groups completed the Children's Eating Behavior Questionnaire. Moreover, the child's body scan was conducted before and after the intervention, enabling the calculation and recording of BMI and its percentile.

The control group underwent the same procedures as the intervention group, except for the implementation of the behavior modification package. However, in adherence to ethical principles, the educational content and training booklet provided to the intervention group were also given to the control group upon completion of the study.

2-3. Data analysis

Data collected from both groups before and after the intervention were subjected to analysis employing SPSS version 24. The analyses involved multivariate covariance analysis, chi-square tests, Fisher's exact tests, and independent t-tests.

3- RESULTS

The study findings revealed that the mean age of girls in the intervention group was 10.8 ± 1.5 years, whereas in the control group, it was 10.5 ± 1.5 years. Furthermore, there were no significant differences between the two groups in the mean and standard deviation of the child's height and weight indices, parents' BMI, child's birth rank, parents' opinion about the child's obesity, and the family's history of certain diseases (P>0.05) (**Table 2)**.

Table-2: The demographic characteristics of the participants

Variable	Group, Mean ± SD Median (Q1, Q3)		The test result
	Intervention	Control	
Child's age (year)	10.8±1.5 12.0 (10.0, 12.0)	10.5±1.5 11.0 (9.0, 12.0)	Z=-1.0 P=0.337 Mann–Whitney

Child's weight (kg)		52.5±10.5 52.0 (46.0, 58.0)	54.0±11.4 51.0 (41.5, 58.5)	t=0.8 df= 69.0 p=0.407 Independent t
Child's height (cm)		146.0±8.7 147.5 (139.5, 151.0)	143.9±10.9 143.0 (135.0, 151.0)	t=0.9 df= 69.0 p=0.375 Independent t
Mother's BMI (kg/m2)		33.8±5.1 33.4 (30.7, 36.4)	36.3±10.0 34.8 (27.5, 43.5)	Z=-0.7 P=0.501 Mann–Whitney
Father's BMI (kg/m2)		27.5±3.4 26.8 (25.4, 29.4)	26.2±3.0 26.0 (24.1, 27.5)	Z=-1.6 P=0.121 Mann–Whitney
Variable		Intervention N (%)	Control N (%)	The test result
Child's birth rank	First	10 (31.2)	18 (48.6)	Chi2=5.3 df=2.0 p=0.072 Chi-square
	Second	13 (46.0)	16 (43.2)	
	Third or more	9 (28.1)	3 (8.1)	
The parents' opinion about the child's obesity	Not obese	2 (6.1)	1 (2.7)	P=0.849 Fisher's exact test
	Overweight	14 (42.4)	16 (43.2)	
	Obese	17 (51.5)	20 (54.1)	
Family history of certain diseases	Diabetes	4 (28.6)	1 (14.3)	P=0.582 Fisher's exact test
	Thyroid disorder	1 (7.1)	1 (14.3)	
	Heart disease	0 (0.0)	1 (14.3)	
	Other	9 (64.3)	4 (57.1)	

To assess the influence of the family-centered behavioral modification program on the eating behavior of school-age girls, a multivariate covariance analysis was conducted. The results revealed that the implementation of the family-centered behavioral modification program had a significant effect on changing the combination of variables encompassing food responsiveness, enjoyment of food, satiety responsiveness, and slowness in eating, food fussiness, emotional overeating, emotional undereating, and desire to drink. Additionally, the covariance analysis demonstrated significant differences in all subscales of children's eating behavior within the intervention group compared to the control group. However, despite the fact that the scores of food fussiness and emotional undereating after the intervention decreased in the intervention group compared to the control group, this difference was not statistically significant (P>0.05). These findings are summarized in **Table 3**.

Table-3: The effect of family-centered behavioral modification program on the eating behavior of obese school-age girls

The eating behavior dimensions	Leven's test			ANCOVA			
	F	P	SS	MS	F	P	R
Food responsiveness	0.052	0.820	43.893	43.893	6.863	0.011	0.090
Enjoyment of food	2.411	0.125	368.109	368.109	28.359	0.000	0.291
Emotional overeating	2.640	0.109	47.419	47.419	5.659	0.020	0.076
Desire to drink	4.802	0.032	58.508	58.508	10.877	0.002	0.136
Satiety responsiveness	11.870	0.10	62.146	62.146	9.753	0.003	0.124
Slowness in eating	0.000	0.986	58.867	58.867	4.169	0.045	0.057
Food fussiness	1.848	0.178	20.254	20.254	2.716	0.104	0.038
Emotional undereating	0.230	0.633	0.226	0.226	0.037	0.848	0.001

In terms of the impact of the family-centered behavioral modification program on the BMI percentile of obese school-age girls, Fisher's exact test revealed that changes in BMI percentile were statistically significant between the two groups after the intervention (P=0.003) (**Table 4**).

Table-4: The BMI percentile of girls in the two groups before and after the intervention

BMI percentile		Groups, N (%)		The test result
		Intervention	Control	
Before the intervention	85-95 percentile	16 (47.1)	16 (43.2)	Chi2=0.1 df=1.0 p=0.747 Chi-square
	> 95 percentile	18 (52.9)	21 (56.8)	
	Total	34 (100.0)	37 (100.0)	
After the intervention	5-85 percentile	8 (23.5)	1 (2.7)	p=0.003 Fisher's exact test
	85-95 percentile	16 (47.1)	12 (32.4)	
	> 95 percentile	10 (29.4)	24 (64.9)	
	Total	34 (100.0)	37 (100.0)	

Regarding the effect of the family-centered behavioral modification program on the abdominal circumference of obese school-age girls, the results indicated that after the intervention, the girls in the intervention group experienced a decrease of 2.2 ± 6.3 in abdominal circumference, while those in the control group showed an increase of 2.9 ± 6.2. This difference was determined to be significant through an independent t-test (P=0.004) (**Table 5**).

Table-5: Mean and standard deviation of the abdominal circumference of the girls in the two groups before and after the intervention

Abdominal circumference	Groups, Mean ± SD Median (Q1, Q3)		The test result
	Intervention	Control	
Before the intervention	9.10±89.0 90.2 (81.5, 95.1)	9.30±89.8 89.8 (84.0, 95.8)	t=0.3 df= 53.0 p=0.753 Independent t
After the intervention	86.8±8.20	92.6±7.80	t=2.7

	86.0 (81.9, 93.2)	92.4 (86.7, 97.3)	df= 53.0
	16 (47.1)	12 (32.4)	p=0.010 Independent t

4- DISCUSSION

The current research was conducted to investigate the impact of a family-centered behavioral modification program on the eating behavior, BMI percentile, and abdominal circumference of obese school-age girls in selected schools of Mashhad during the period of 2019-2020. The findings of the study indicated an improvement in the eating behavior of the participants following the intervention. Therefore, it can be concluded that the implementation of family-centered behavioral modification programs contributed to enhancing children's response to eating behavior and overall eating habits. This aligns with the study conducted by Taveras et al. (11), emphasizing the significance of modifying children's behavior and eating habits within the context of obesity control. Additionally, Sadeghi et al. (18) highlighted the importance of behavioral modifications targeting dietary patterns and eating habits in the management of childhood obesity.

In the current study, one aspect of behavioral modifications focused on regulating food consumption, physical activity, and emotional eating, which is consistent with the findings of previous studies (19, 20). Noohi's study involved comprehensive training in health-based parenting skills for mothers, which effectively enhanced their children's eating behaviors (20). Although the intervention in our study targeted both children and parents and employed a different approach, it produced similar outcomes.

Moreover, the current study observed a decrease in children's desire for sweet drinks following behavioral modification training. This finding aligns with Wright's research on evaluating parental self-efficacy for obesity prevention related behaviors, which demonstrated the positive influence of parents on health weight behaviors in children, such as reducing the consumption of sweet drinks, increasing fruit and vegetable intake, and promoting physical activity (21). Notwithstanding differences in the intervention type and target population between our study and Wright's study, the results underscore the beneficial role of parents in modifying obesity-related behaviors and subsequently reducing children's weight.

The current study brings attention to the efficacy of enhancing parents' and children's awareness regarding proper nutritional behaviors in improving children's behavior and potentially leading to weight reduction. This finding is consistent with those of Viana et al. (22), who emphasized that increasing self-awareness about children's eating patterns and subsequent changes in their eating behavior plays a crucial role in managing childhood obesity and controlling children's weight. Similarly, Ruebel et al. (23) demonstrated in their study that dietary awareness, encompassing information on reading food labels, portion sizes, and modified guidelines to enhance children's understanding of nutrition and lifestyle habits, can effectively address obesity. Bocca et al. (15) also confirm that raising children's awareness can modify their behavior and eating habits, including consistent breakfast consumption, avoiding sugary beverages, and incorporating three daily snacks, as essential components in the management of obesity. These studies collectively emphasize the necessity of behavioral and dietary changes, as well as the adoption of a healthy lifestyle, for the

management and prevention of childhood obesity, underscoring the importance of education and raising awareness. The present study successfully addressed behavioral modification and obesity management by providing children and parents with information about unhealthy dietary behaviors and physical activity. The educational package implemented in the study focused on various areas, including enjoyment of food, satiety responsiveness and slowness in eating, food fussiness, emotional overeating, emotional undereating, and the desire for sweet drinks.

Considering the persistent influence of behavioral factors, cultural norms, familial practices, and eating habits across generations (24), the family-centered nature of obesity interventions is further supported. In the present study, the implementation of a family-centered training package effectively improved the eating behavior of the participants, affirming the positive impact of family-centered interventions on children's behavioral modifications in regard to their eating habits. A meta-analysis conducted by Smith et al. (10) demonstrated the crucial role of a family-centered approach in managing childhood obesity. They, specifically, discussed that when parents actively participate in program sessions, better outcomes are observed in terms of lifestyle improvement and modification. Razi et al. (25) identified parents' challenges in managing childhood obesity during the COVID-19 pandemic, underscoring the significant role of the parents in controlling childhood obesity.

Family participation, particularly involving mothers, played a significant role in the design of the behavioral modification program. Bocca et al. (15) emphasized the influence of parents in shaping the child's attitudes regarding the implementation of healthy incentives from the household to eliminate unhealthy food. They further highlighted the necessity of teaching parents how to model a healthy lifestyle for effective obesity management. Ahmad et al. (26) employed the REDUCE program, which incorporated social cognitive theory and targeted diet, physical activity, behavior change techniques, and parenting skills. The utilization of this program by parents, focusing on nutrition, physical activity, behavior modification techniques, and parenting skills, demonstrated effectiveness in improving children's health behaviors. Taveras et al. (11) supported these findings by affirming the crucial role of parents in childhood obesity interventions and emphasizing the need for family-centered approaches. Weight management interventions that leverage parental abilities have been proven to be more successful in controlling the weight of obese children.

The study results indicated that the family-centered behavioral modification program, successfully, reduced the BMI percentile and abdominal circumference of the girls in the study. Notably, the program achieved a weight reduction success rate exceeding 10 percent among the participants. These results are in line with the findings of Noohi et al. (20), who implemented an intervention targeting the eating behavior of overweight and obese children through comprehensive training on health-oriented parenting skills for mothers, resulting in a significant reduction in children's BMI.

5- CONCLUSION

Considering the importance of modifying eating behaviors for the management of childhood obesity and acknowledging the crucial role of families in this context, the current research successfully enhanced children's eating behavior through the implementation of a family-centered behavioral modification program. This intervention serves as an initial and impactful measure in reducing children's weight, resulting in a decrease in

BMI percentile and abdominal circumference among the participants. Importantly, no complications or issues arose for the children and families involved in the research, underscoring the safety and feasibility of the intervention. Based on these findings, it is recommended that community health nurses and school nurses, who often serve as the primary point of contact for children and families, provide necessary training and raise awareness to empower them and effectively contribute to the efforts of reducing overweight and obesity among children.

6- ETHICAL CONSIDERATIONS

Prior to participation, detailed information regarding project implementation, information confidentiality, and the purpose of the study was provided to the research groups. It is important to note that all participants voluntarily agreed to participate and provided written consent. This study has received approval from the Ethics Committee of Mashhad University of Medical Sciences (ID: IR.MUMS.NURSE.REC.1398.075) and has been registered with the Clinical Trial Center of Iran (IRCT20191203045584N1).

7- CONFLICT OF INTEREST

None.

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