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### Original Article

# The risk of developing disordered eating following a family-based program among children with overweight and obesity and their siblings: Retrospective and prospective analyses

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### ABSTRACT

**Background:** Studies have raised the concern that dieting and weight-loss programs may be a potential risk factor for developing eating disorders, and may have a potential to affect siblings as well. This study assessed the long-term risk of developing disordered eating among children with overweight and obesity and their siblings as well as the change in the obesogenic environment following a family-based intervention program.

**Methods:** In a 30-month retrospective follow-up study ( $n = 18$  families in intervention group,  $n = 26$  families in control group, total of 81 children and siblings) and a 14-month prospective follow-up study ( $n = 42$  families, 78 children and siblings), families with one or more children with overweight or obesity ages 8–14 years participated in a multidisciplinary parent-child program called “Maccabi Active”. Children’s version of the eating-attitude-test (ChEAT) questionnaire, family eating-and-activity-habits questionnaire (FEAHQ) and BMI z-score were measured.

**Results:** in the retrospective study, no difference between groups with respect to ChEAT scores in children and siblings was found. In the prospective study, the FEAHQ score significantly decreased after completion of the program ( $\Delta\text{FEAHQ} = -16.2 \pm 4.9$ ,  $p = 0.001$ ) and continued to decrease in the 8-month follow-up ( $\Delta\text{FEAHQ} = -23.2 \pm 5.7$ ,  $p = 0.001$ ). BMI z-scores decreased after 6 months ( $\Delta\text{BMI z-score} = -0.3 \pm 0.1$ ,  $p = 0.014$ ), and did not increase in the 8-month follow-up.

**Conclusions:** Our findings suggest no exacerbation in disordered eating behaviors among children with overweight or obesity or their siblings, thus alleviating concerns surrounding the development of disordered eating after participating in a family-based intervention. Moreover, improvement in obesogenic environment suggests potential benefits to the entire family.

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### Introduction

The rising prevalence of obesity has led to an excessive preoccupation with dieting and body image, which in turn may increase the risk of developing eating disorders or disordered eating [1]. Disordered eating refers to a wide range of abnormal eating behaviors,

many of which are shared with diagnosed eating disorders. The main factor differentiating disordered eating from eating disorder is the level of severity and frequency of these behaviors [2,3].

Preoccupation with dieting has been established as a significant predictive factor for developing eating disorders among 14-year-old girls [4]. Adolescent girls who frequently reported on dieting showed a 3.6-fold higher rate of eating disorders compared to non-dieting girls [5]. Neumark-Sztainer et al. found a higher risk of developing eating disorders among females who reported on dieting compared with non-dieters after 5 years. Dieting was significantly associated with binge eating and loss of control among adolescent boys and girls (OR = 1.87 for girls, OR = 3.37 for boys) [6]. Finally, in a study of 496 middle-school female adolescents (mean age = 13.5, SD = 0.7) [4], dieting was found to be one of six potential risk factors for developing eating disorders.

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Treating and preventing obesity is of great importance, since childhood obesity increases the risk of metabolic and mental illnesses [7–9]. However, unwanted implications of weight loss programs for children and adolescents could increase the risk of developing eating disorders and constitute a major challenge in treating childhood obesity. Research findings reflect this challenge and present conflicting results; some studies report on an increased risk of developing eating disorders following dieting, [1,10] while others do not [11–13].

The gold standard of childhood obesity treatments is family-based intervention program in which the agents of change may be solely the parents or parents with their children [14,15]. Most of these intervention programs focus on promoting a healthy lifestyle, as opposed to a focus on dieting and weight loss [16]. Family-based intervention programs are likely to affect not only the child with obesity but also his or her siblings. Studies show that treatment of one sibling indirectly affects siblings too [17,18]. Only a handful of studies addressed the effect of weight-loss interventions on the siblings. Berge et al. claimed that weight-related behaviors mutually affect adolescent siblings and identified three variables as having significant intra-sibling influence: eating breakfast, eating fast food, and sedentary behavior [19]. A review of 16 children obesity programs examined family members in one program only and referenced only anthropometric measurements of the siblings [20]. Data on the effect of childhood obesity treatments on eating behaviors of siblings are lacking.

Moreover, In light of the fact that symptoms of eating disorders may develop or diagnosed long after the treatment has ended [21], there is very little research on long-term effects of intervention programs on the development of disordered eating and obesogenic environments among children and their siblings.

The goals of the following studies were to assess the risk of developing disordered eating among children with overweight and obesity and their siblings following family-based intervention programs using two research approaches: long term retrospective follow up (30-month) and prospective follow up (14-month), as well as, a prospective assessment of the change in the family's obesogenic environment following family-based intervention programs. Indeed, this approach is unconventional, but given the challenge of recognizing disordered eating long after the end of treatments, we have selected to conduct these two consecutive studies.

## Methods

To examine a family-based intervention's effect on the development of disordered eating, and to examine different program aspects, such as long-term efficacy of the intervention and short-term changes in the obesogenic environment, two studies have been conducted: a retrospective follow-up study and a prospective follow-up study.

### Study 1 – The retrospective follow-up study

#### Design

A retrospective follow-up study of families with a child with overweight or obesity who participated in “Maccabi Active” – a Health Maintenance Organization (HMO) based intervention program – during 2012–2013 (intervention) and families with a child with overweight or obesity who did not participate in the intervention program nor treated by a clinical dietitian on more than two occasions until follow-up (control). Program participants were referred to the program by a pediatrician or responded to invitations posted on the HMO's bulletin board in their local branch. The

study was conducted in 2015. The study's measures and procedures are described in Table 1S.

#### Participants

Participants were 44 families (81 children and siblings) with one or more children coping with overweight or obesity between the ages 8–14 years, as described in Fig. 1S.

All participants were members in the northern region of Maccabi health maintenance organization. Each family received leisure coupons for every family member who attended. The study was conducted in Hebrew. All parents signed an inform consent form. Children signed a modified version of the consent statement as required by the Helsinki committee. The study was approved by the ethics committee at Assuta Hospital's Helsinki Committee (Ministry of Health approval number 2015036) and was registered at [www.clinicaltrials.gov](http://www.clinicaltrials.gov) as NCT02624713.

Inclusion criterion for the intervention group was at least 70% participation rate in meetings during 2012–2013 and for the control group, families with a child coping with overweight or obesity during 2012–2013.

Weight status was defined by BMI curves according to the Center for Disease Control and Prevention. Overweight was defined as the 85th–94th percentiles, and obesity was defined as  $\geq 95$ th percentile. Siblings' age range was 8–18 years.

Exclusion criterion was children with obesity or overweight diagnosed with one or more psychiatric disorders.

#### The Intervention – “Maccabi Active” program

Participants in the intervention group received an active lifestyle program; an intensive multidisciplinary parent-child intervention program called “Maccabi Active,” which was previously described [22]. In brief, “Maccabi Active” is a 6-month multi-disciplinary parent-child intervention consisting of parents' education groups, parent-child individual therapy sessions, as well as physical activity groups for the children. The program focus is on lifestyle modification and encouraging physical activity. Parents' education groups for nutrition and healthy behaviors were held with a dietician and a social worker every two weeks for six months, for a total of 12 meetings. Children's intervention consisted of six individual meetings with a family physician, a pediatric physical therapist and a dietician. In addition, the children participated in physical activity groups with a fitness trainer, twice a week for six months.

#### Measurements

A demographic questionnaire was used to collect basic demographic information on each participant (i.e. age, gender, number of children in the family, family status, and religious affiliation of the entire family).

#### ChEAT-26 questionnaire: Children Eating Attitude Test

Children with obesity and overweight and their siblings were asked to complete this questionnaire for collecting data on disordered eating attitudes and behaviors. The ChEAT questionnaire is a 26-item self-report inventory that measures dieting behaviors, preoccupation with food, bulimia, and concerns about being overweight. The ChEAT is Maloney et al.'s modification and adaptation of Garner and Garfinkle's Eating Attitudes Test (EAT) for children [23,24].

A score above 20 is considered pathological and indicates on a high level of disordered eating attitudes and behaviors. Mean Cronbach's alpha was 0.76 [25].

#### Anthropometric measurements

Height and weight of the children and their siblings were measured by the clinical dietician during the program's meetings.

z-scores by age and sex were calculated for each BMI measurement. Participants (child with obesity and sibling/s) were measured at one set time.

#### Statistical methods

Independent sample *t*-tests or chi-square tests were used to describe the differences between the intervention and the control groups. Logistic regression models were used to test the effects of participants/siblings, gender, BMI status, parents' marital status and the number of children in the family on the risk of developing disordered eating (ChEAT score > 20). IBM SPSS Statistics version 19 and STATA version 14 were used to conduct these analyses.

#### Study 2- The prospective follow-up study

##### Design

A prospective follow-up study of families who participated in "Maccabi Active" intervention program in 2015 at Maccabi HMO, an Israeli healthcare provider. The study's measures and procedures are described in Table 2S.

##### Participants

Participants were 42 families (78 children and siblings) with one or more children with overweight or obesity (Fig. 2S). This study included only an intervention group. Each family received leisure coupons for every family member who attended. The study was conducted in Hebrew. All parents signed an inform consent form. Children signed a modified version of the consent statement as required by the Helsinki committee. The study was approved by the ethics committee at Assuta Hospital's Helsinki Committee (Ministry of Health approval number 2015036) and was registered at [www.clinicaltrials.gov](http://www.clinicaltrials.gov) as NCT02624713.

Inclusion criteria were participation in at least 70% of the meetings in 2015 and completing at least two questionnaires on three possible occasions.

Weight status was defined by BMI curves according to the Center for Disease Control and Prevention. Overweight was defined as the 85th–94th percentiles, and obesity was defined as  $\geq 95$ th percentile. Siblings' age range was 8–18 years.

Exclusion criterion was children with obesity or overweight diagnosed with one or more psychiatric disorders.

##### The intervention

Participants in the prospective study took part in the same intervention program ("Maccabi Active") used in the above described retrospective study.

##### Measurements

Four different measurements were used to collect data on participants in this study. Of these, demographic and ChEAT-26 were the same as in the above described retrospective study. Anthropometric measurements were taken on three time points: at baseline, at the end of the program and 8 months after completing the program as described above. In addition, a FEAHQ-32 (Family Eating and Activity Habits Questionnaire) was completed.

##### FEAHQ-32: Family Eating and Activity Habits Questionnaire

This questionnaire was completed by the parents and designed to measure obesogenic factors in the environment (8 items), physical activity (4 items), the relationship between eating and hunger (4 items), and eating habits of children with obesity, their siblings and their parents (13 items) [26]. A higher FEAHQ-32 score reflects a greater obesogenic load in the home environment. The questionnaire was validated in Hebrew for families with children 6–12 years of age from different ethnic backgrounds. The questionnaire presented very good internal consistency (average  $\alpha = 0.90$ ) [27].

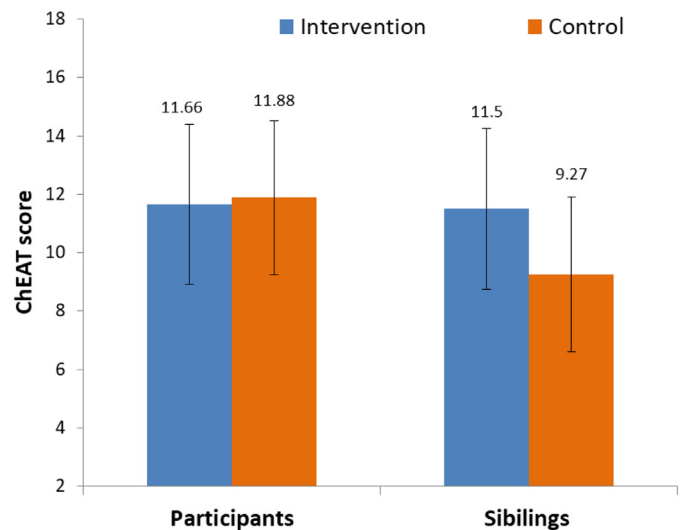


Fig. 1. ChEAT scores across groups 30 months after the intervention program (mean  $\pm$  se).

One parent from each family completed the questionnaire for the whole family (the spouse, the child with overweight or obesity and siblings between the ages 8–18). To avoid bias, we assured that the same parent completed the questionnaire at all data collection points.

##### Statistical methods

Participants' characteristics were summarized by means and standard deviations or percentage as appropriate. Linear mixed models were created to test the different values of variables ChEAT score and BMI z-score among the children with overweight and their siblings at baseline, after 6 months of intervention and after 14 months. The different obesogenic total score (FEAHQ score) values among the families at the three data collection time points were also tested by these models. IBM SPSS Statistics version 19 and STATA version 14 were used to conduct these analyses.

## Results

### Study 1: The retrospective follow-up

The retrospective study included 44 families with 45 participants and 36 siblings with an average 30-month follow-up (range 24–36 months). Thirty (30) months after the intervention, the mean BMI z-score difference between siblings and participants with overweight or obesity was 0.9 in the intervention group and 1.8 in the control group ( $p = 0.001$ ). No significant difference was found between the intervention and the control group in gender distribution, age, BMI z-score and ChEAT score. Family status, the number of children per family and religious affiliation were statistically different between the groups (Table 1a).

### ChEAT score

Mean ChEAT scores were similar in both groups. Although lower ChEAT scores in the control group's siblings were found (19%), this trend was not significant (Fig. 1).

Results of several logistic regression models that were ran on the data suggest that only gender was associated with the risk of developing disordered eating following the intervention program: girls had a 7-fold increased risk of developing disordered eating,  $p = 0.011$  (Fig. 2), compared to boys. Participating in the program did not increase the risk of developing disordered eating.

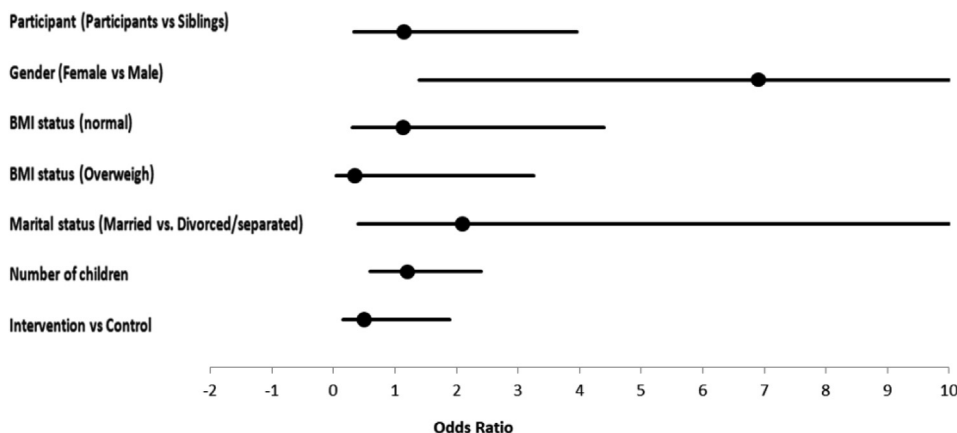
**Table 1**  
Participants baseline characteristics: the retrospective follow-up (1a) and the prospective follow-up study (1b).

		1a. Retrospective			1b. Prospective
		Intervention	control	<i>p</i> <sup>b</sup>	
Overweight or obese children	<i>N</i>	18	27		48
	Age <sup>a</sup> (mean ± sd), years	12.5 ± 1.8	12.1 ± 2.1	0.476	9.9 ± 1.9
	Gender (% girls, ( <i>n</i> ))	44.4% (8)	70.4% (19)	0.082	66.7
	Cheat (mean ± sd)	11.66 ± 7.57	11.88 ± 8.97	0.935	11.79 ± 7.42
Siblings	BMI z-score <sup>a</sup> (mean ± sd)	1.7 ± 1.3	2.0 ± 1.1	0.41	2.6 ± 0.5
	<i>n</i>	6	30		30
	Age <sup>a</sup> (mean ± sd), years	10.1 ± 2.9	12.6 ± 2.8	0.061	12.2 ± 2.9
	Gender (% girls, ( <i>n</i> ))	50% (3)	30% (9)	0.343	56.7% (17)
Family	BMI z-score <sup>a</sup> (mean ± sd)	0.8 ± 1.7	0.2 ± 1.3	0.523	1.0 ± 0.5
	Cheat (mean ± sd)	11.5 ± 8.09	9.27 ± 7.01	0.344	12.68 ± 9.53
	Family status, (%married, ( <i>n</i> ))	72.2% (13)	96.3% (26)	<b>0.02*</b>	NA
	Number of children (mean ± sd)	1.9 ± 0.9	2.7 ± 0.9	<b>0.006*</b>	2.17 ± 0.8
	Religiousness (% Secular, ( <i>n</i> ))	94.4% (17)	55.6% (15)	<b>0.005*</b>	NA
	BMI father (mean ± sd)	31.3 ± 5.3	29.6 ± 5.8	0.714	30.4 ± 5.8
	BMI mother (mean ± sd)	27.6 ± 4.1	27.1 ± 4.2	0.378	27.9 ± 4.5

\* significant differences.

<sup>a</sup> At recruitment.

<sup>b</sup> *t*-test or chi-square (as appropriate) *p* value (intervention vs. control).



**Fig. 2.** Risk of developing disordered eating (ChEAT score >20) 30 months post intervention. Participants; overweight or obese vs. siblings, controlled for gender and intervention. Gender: Female vs. Male, controlled for intervention. Parents' status; married vs. other, controlled for gender and intervention. The number of children in the family; controlled for intervention. Intervention vs. control; controlled for gender.

**Study 2: The prospective follow up**

The prospective follow-up study included 42 families with 48 participants and 30 siblings. At baseline, the mean BMI z-score between siblings and participants with overweight or obesity was 1.6 ± 0.5 (Table 1b).

**ChEAT score**

After the 6-month intervention, the mean ChEAT score decreased by 3.7 points (31%) among participants with overweight or obesity but increased again in the 8-month follow-up after the program ending. The decrease in ChEAT scores among siblings was not statistically significant (Fig. 3).

**Differences between BMI, ChEAT and FEAHQ in the follow-up**

BMI and ChEAT scores decreased following the intervention among both participants with overweight or obesity and their siblings, however, the difference was statistically significant only in the participants group.

In the follow-up, ChEAT scores reverted close to baseline, while BMI scores did not increase significantly. A significant improvement was detected in total FEAHQ scores, indicating a reduction in the obesogenic load in the family (Fig. 4).

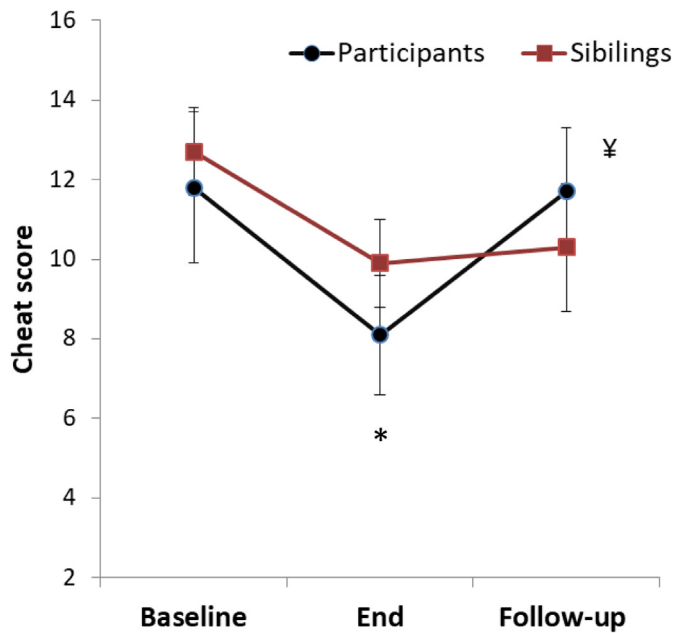
**Discussion**

This study reports on two studies with a total of 89 families and 159 children ages 8–18 years, 93 of whom were participants with overweight or obesity and 66 siblings. Two methodologies were used: a retrospective follow-up and a prospective follow-up. No difference in disordered eating attitudes and behaviors was found between the intervention and control groups among both children and siblings 30 months after the program ending. In addition, in the prospective follow-up study, the obesogenic environment significantly decreased up to 8 months after the program ending.

**Risk of developing disordered eating**

Gender was the only variable that significantly affected the development of disordered eating behaviors 30 months after the intervention ended: the likelihood of developing disordered eating behaviors was 7 times greater for girls than for boys. Participating in the program did not increase the risk of developing disordered eating.

Higher vulnerability to eating disorders among girls was found in previous studies, irrespective of intervention programs: a study of Israeli adolescents with a mean age of 14.4 years reported that the risk of developing disordered eating is 3 times higher among girls – 8.2% compared with 2.8% among boys [28]. Similar prevalence of



**Fig. 3.** ChEAT scores at the beginning and end of the intervention (6 months) and at the follow-up visit, mean  $\pm$  sd. Paired *t*-test end vs. baseline and follow up vs. end. \* *p* = 0.006 for the difference between the end of program compare with baseline. ¥ *p* = 0.037 for the difference between follow up compared with the end of the program.

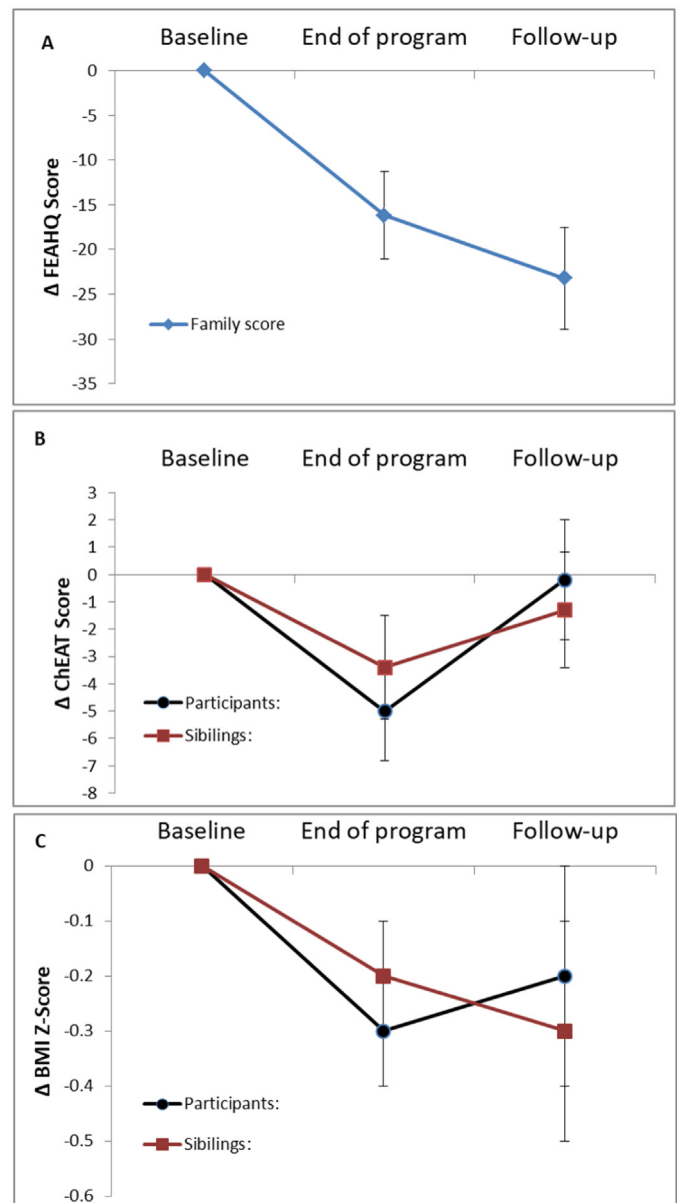
eating disorder (meeting DSM-5 criteria (was found by Allen et al. in Australia – 8.5% among girls compared to 1.2% among boys [29].

In the prospective follow-up, an improvement in the disordered eating score (ChEAT questionnaire) was found at the end of the program, which was not sustained 8 months after the program ending. However, this change did not exceed baseline. Similar to our findings, Follansbee-Junger et al. found no differences between the intervention and control groups in the ChEAT 26 questionnaire score in an intervention for parents only versus parents and their children [30]. Moreover, a meta-analysis of nine intervention studies found no change from baseline in the risk of developing post-intervention eating disorders in an average follow-up of 4.6 years. Furthermore, the combined effect of six studies presented a reduction in the risk of developing eating disorders [13].

### Obesogenic environment

Continual improvement in obesogenic load over time was established, reflecting an improvement in family members' eating and activity habits and a reduction in obesogenic factors in the home environment.

This improvement is expected with this kind of intervention, which focuses on the parents as the main agents of change and aims to benefit all the members of the household. Robertson et al. also found a reduction in obesogenic load in a family-based program that included parents and children with obesity over a three-month period. A 17.6-point decrease was found after 3 months and a 16.7-point decrease after 9 months [31]. Similarly, a decrease of 16.2 points was found in our study after 6 months, and even an additional decrease after another 8 months, totaling in a decrease of 23.2 points. It is important to note that the original FEAHQ [26,27] included questions for the children and their parents, whereas we have examined the obesogenic load among the siblings too, which enabled us a more robust understanding of the family's obesogenic environment.



**Fig. 4.** Differences in FEAHQ, ChEAT and BMI z-scores at the end of the intervention (6 months) and at the follow-up visit.

### BMI z-score

The mean change in BMI z-score at the end of the 6-month intervention (i.e., -0.3) correlates with the mean change reported by Endevelt et al. who conducted a follow-up on 100 children with overweight 6 months after the end of the program and found a decrease of 0.33 in BMI z-score. A decrease in BMI z-score that was sustained even after nearly 4 years [22]. In a review of 42 intervention programs that included 875 adolescent participants, the mean decrease in BMI z-score was between 0.05 and 0.34 [32]. The “Maccabi Active” program appears to achieve weight reduction within this range. Although this change in BMI z-score may not be clinically significant for a child with overweight, it may, however, have long term significance if the weight remains stable as the child grows taller.

### The effect of family-based intervention on siblings

Berge et al. premised that there is a mutual influence between adolescent siblings concerning weight and eating behaviors, irre-

spective of weight status [19]. We have demonstrated a positive effect of family-based intervention on siblings and no effect on disordered eating behaviors. As far as we know, this is the first study that examined the long-term effect of family-based intervention on the risk of developing disordered eating behaviors among siblings of children with overweight or obesity. It is expected that improvement in the obesogenic environment would lead to a lower risk of developing overweight and obesity in the family [26]. In our study, the prevalence of overweight or obese status among siblings was 37% and a small improvement of BMI z-score was found among siblings after 14 months. Only a handful of studies examined the effect of an intervention on siblings [19], and most of them focused only on the weight status [17]. Epstein et al. examined the effect of a weight-loss oriented family intervention program on siblings in which the weight of the siblings was reported by the parents. Findings of this study suggest that a child who participated in the program and his or her siblings had similar chances for weight loss (23.62 versus 21.6) [17].

#### *Different approaches to family-based intervention:*

Some studies have raised the concern that dieting may be a potential risk factor for eating disorders. Our intervention, which was not dieting alone, but rather a family-based intervention centered on lifestyle modification, was effective and did not increase the risk of developing disordered eating. Whereas, the increased gender-related risk is a known independent risk factor [29].

Golan and Crow recommended treating children with overweight or obesity without involving the children and addressing the parents as the exclusive agents of change [33,34]. Follansbee-Junger et al. found no difference in ChEAT scores in interventions with parents only versus ones with parents and children [30]. In both intervention approaches, parents' compliance with the treatment is an important determinant of success. Based on our past experience with these kinds of intervention programs, parents' compliance is lower when the children are not part of the active process. In "Maccabi Active", children who participate in the program benefit from organized physical activity, and their active participation often "attracts" the parents to participate as well, and apparently serving as an effective way to reduce dropout. Although "Maccabi Active" offers a parent-only option, in most cases the parents prefer to include their child in the program.

The USPSTF's 2017 guidelines for treatment of children and adolescents with obesity age 6 and above include a recommendation on interventions for healthy lifestyle oriented behavioral change. The recommendation calls for an intervention program that includes more than 26 h over a period of two to twelve months. The recommended programs target both parents and children with varied activities – separately, together or both and recommend utilizing a multidisciplinary team [32]. The "Maccabi Active" program for treatment of childhood obesity is a healthy lifestyle oriented program that meets the above recommendations and is distinct from dieting alone.

Our study is not without limitations. Although the use of two research methodologies may seem unconventional, this approach was used in other studies for resolving challenging research goals [35,36]. Furthermore, each study presents specific limitation: in the prospective study, no control group was used. However, the main comparison was before and after the intervention, and the main outcome was increased risk of developing disordered eating following the intervention. Therefore, a control group was less significant in this case. In the retrospective study, the control group had a higher rate of religious families, married parents, as well as a higher number of children in the family than in the intervention group. These demographic differences between the groups may have affected the results; however, the model was adjusted to reli-

gious status for controlling the effect of the difference between the groups.

Strengths of this study include the use of two methodologies that enabled independent long-term follow-ups. Furthermore, this study examined the treatment effect on the entire family – not only in terms of weight status, but also in terms of the obesogenic environment and disordered eating. To the best of our knowledge, there are limited studies that examined the effects on siblings, let alone studies that measured the siblings directly as we did in this study.

#### **Conclusions**

Our findings suggest no difference or exacerbation in disordered eating behaviors among children with overweight or obesity or their siblings in a family-based intervention, thus supporting evidence in favor of family-based intervention. Moreover, continuous improvement in the obesogenic environment was found even after the end of the program, with potential benefits to the entire family. However, to further understand the risk of developing disordered eating, future studies should continue to explore the effect of Family-based interventions on siblings and include a matched control group and a longer prospective follow-up (>14 months).

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None declared.

#### **Author's contribution**

Batya Shaharabany: investigation, project administration, writing – original draft.

Sigal Tepper: formal analysis, visualization; writing – original draft.

Suzana Berman: supervision, writing – review & editing.

Moria Golan: conceptualization, methodology, writing – review & editing.

#### **Ethical statement**

We have read and have abided by the statement of ethical standards for manuscripts submitted to the Obesity Research & Clinical Practice.

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#### **Appendix A. Supplementary data**

Supplementary data associated with this article can be found, in the online version, at <https://doi.org/10.1016/j.orcp.2020.04.007>.

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