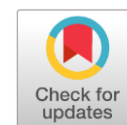


Assessing the Impact of Early Childhood Intervention Programs on Obesity Prevention: A Comparative Study

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ABSTRACT

Background: Childhood obesity is a major global health concern with long-term implications. Early intervention programs (EIPs) have been developed to address this problem, emphasizing nutrition, physical activity, and behavior change. However, the comparative effectiveness of different types of EIPs remains unclear.

Objectives: The aim of this study was to compare the effectiveness of several EIPs to reduce Body Mass Index (BMI), improve dietary habits, and increase physical activity among children 4 to 12 years of age.

Methods: This comparative study was conducted in schools and pediatric clinics in Lahore, Pakistan from February 2022 to June 2023. The current study included 550 children diagnosed with obesity who were selected using stratified random sampling. Participants had different types of EIPs including nutrition education, physical activities and behavioral counseling. Data on BMI, dietary habits and physical activity were collected before and after the interventions. SPSS version 27.0 was employed, Paired t tests, ANOVA and logistic regression were used to control for confounding variables, such as age and socioeconomic status.

Results: Mean BMI was significantly reduced in all groups and had the largest reductions in programs exceeding 16 weeks (mean reduction of 1.4 units, $p < 0.001$). Change in behavioral included increased fruit and vegetable intake (from 38% to 74%, $p < 0.01$) and reduced sugary beverage uptake (from 58% to 35%, $p < 0.01$). Program duration and parental involvement were significant predictors of success.

Conclusions: Early intervention programs effectively reduce obesity metrics among children, with longer duration and parental involvement being key factors for success. These findings highlight the need for sustained, comprehensive programs to combat childhood obesity.

Keywords: Childhood obesity, early intervention, comparative study, BMI reduction, nutrition education, physical activity, parental involvement, obesity prevention.



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INTRODUCTION

Obesity is one of the biggest childhood disease, which has recently increased dramatically on a global level, has a catastrophic impact on the health of millions of children,

and causes a great burden to healthcare services[1]. Childhood obesity has more than tripled in many countries since 1975 and current figures indicate that more than 340 million children and adolescents are overweight or obese[2]. This disturbing development has significant

implications on the future prevalence of chronic diseases such as type 2 diabetes, cardiovascular diseases and numerous types of cancer, which are emerging in younger generations. Childhood obesity is a complex, multifactorial condition influenced by genetic, environmental, and behavioral factors [3]. Some of the known contributors are: low physical activity, high caloric intake, socio-economic constraints that define food choices and accessibility to physical activity. Obesity during childhood results in health problems other than physical including psychological health, academic performance, and social life. Obese children are more likely to be bullied, develop low self-esteem, and be depressed because of their obesity, which make them adopt unhealthy lifestyle and gain more weight[4]. In response to this growing crisis, early intervention programs have been established for dealing with obesity factors in children. They are commonly based on the principles of nutrition education and behavior change for enhancing healthier diet, physical activity and other aspects of life[5]. The underlying assumption is that, if a child is supported and directed during the critical periods of his or her life, obesity will not develop together with its detrimental effects on health. However, the efficacy of these interventions has remained questionable and inconclusive in the literature[6, 7]. A few of these researches have shown that EIPs can reduce BMI and other health related aspects to great improvements while other researches have only shown small or short-term improvements. Such differences could be as a result of variations in the type of programs that were implemented, the duration of the programs and the intensity of the programs among other factors and differences in the population samples that were used in the studies[8]. Also, the issue of sustainability of the benefits that stem from these programs remains paramount since the kids usually gain weight back as soon as the program was over[9]. The objective of the current study was to expand the existing knowledge on childhood obesity by assessing the effectiveness of early intervention programs (EIPs) in real-world practice settings. Specifically, the study aimed to compare the effectiveness of various EIPs in reducing Body Mass Index (BMI), improving dietary habits, and increasing physical activity among children aged 4 to 12 years. The findings of this study were intended to inform future public health initiatives, guiding the development of interventions targeting childhood obesity and promoting better health outcomes for affected children[10].

MATERIALS AND METHODS

The study employed a comparative design and was conducted across various schools and paediatric clinics in Lahore, Pakistan, from February 2022 to June 2023. A total of 550 children, aged 4-12 years, participated in the study. The primary aim was to assess the efficacy of different early intervention programs (EIPs) in childhood obesity by comparing changes in Body Mass Index (BMI),

dietary habits, and physical activity across groups receiving various types of interventions. Ethical approval was obtained from the institutional research committee (ERC/15A/2023), ensuring adherence to all ethical guidelines throughout the study. Stratified random sampling was used to select participants, which included children who had undergone various types of EIPs designed to prevent obesity. They included components of nutrition education, physical activities and behavioral counseling. Inclusion criteria were participants between 4 and 12 years of age, obese, and without any chronic disease. Children who had not reached the age range specified, who were on medication that might affect their weight, or who had previously had weight loss surgery were excluded from the study. For this, data were collected over 16 months where participants were measured for their BMI, dietary habit and physical activity level before and after the intervention. Self-administered questionnaires were completed by participants either at program center or online. Demographic information, details on duration, frequency, and components of the intervention programs were collected from the questionnaire, along with comparative pre- and post-intervention data for BMI, diet and physical activity. Participants self-reported their height and weight and their BMI was calculated from those self-reported heights and weights which were cross checked against available medical records if possible. A power analysis was carried out to ascertain sample size, which would give the study sufficient power to detect differences in BMI and other outcomes between groups. For power of 0.80, effect size of 0.3 and alpha of 0.05, the minimum sample size was calculated to be approximately 500 participants. The study exceeded this requirement, with 550 participants enrolled such that there would be adequate statistical power to detect meaningful differences in the target variables, in particular BMI. SPSS version 27.0 was used for statistical analysis. Demographic data and baseline characteristics were summarized using descriptive statistics (frequencies and percentages). Paired t tests and ANOVA were conducted to assess changes in BMI before and after the intervention by group and to assess differences in effectiveness between types of EIPs. Confounding variables such as age, gender, socioeconomic status, and family history of obesity were adjusted for by logistic regression analysis. All analyses were set at statistical significance $p < 0.05$. Behavioural changes, such as increased fruit and vegetable intake, decreased consumption of sugary beverages, and enhanced physical activity levels, were also compared pre- and post-intervention across groups.

RESULTS

A total of 550 participants completed the study, with a response rate of 91.7%. After excluding incomplete or inconsistent responses, the final sample consisted of 280 males (50.9%) and 270 females (49.1%) with a mean age

of 8.3 years (SD = 2.4). Participants were equally divided between urban (54%) and rural areas (46%). The baseline characteristics of the participants, including age distribution, gender, and region, are summarized in table-1.

Paired t-tests indicated a significant reduction in mean BMI following the intervention. The overall mean BMI decreased from 23.8 (SD = 3.4) to 22.7 (SD = 3.2) ($p < 0.01$). The extent of BMI reduction was closely related to the duration of the programs, as illustrated in table-2. Mixed model ANOVA confirmed that longer program durations led to more substantial BMI reductions ($F = 9.45$, $p < 0.001$), with the greatest reductions seen in programs lasting over 16 weeks.

The intervention also resulted in significant improvements in participants' dietary habits and physical activity levels. Behavioural changes were assessed through self-reported surveys, and the results are summarized in

Table-3. There was a significant increase in the proportion of participants consuming more fruits and vegetables (from 38% to 74%, $p < 0.01$) and a substantial decrease in the intake of sugary beverages (from 58% to 35%, $p < 0.01$). Similarly, physical activity levels improved, with 83% of participants reporting increased physical activity post-intervention compared to 42% before ($p < 0.001$).

Logistic regression was used to adjust for potential confounding variables, such as age, gender, socioeconomic status, and family history of obesity as shown in table-4. The analysis identified program duration (OR = 1.47, $p < 0.01$) and parental involvement (OR = 1.35, $p = 0.03$) as significant predictors of successful BMI reduction. Participants involved in longer-duration programs and those with greater parental engagement were more likely to experience significant reductions in BMI and improved lifestyle behaviours.

Table-1: Baseline characteristics of participants by age, gender, and region.

Variable	N (%)	Mean Age (SD)	Mean BMI (SD)
Total Participants	550 (100%)	8.3 (2.4)	23.8 (3.4)
Age Group (years)			
- 4-6	110 (20%)	5.2 (0.7)	23.5 (3.2)
- 7-9	220 (40%)	8.1 (0.6)	23.7 (3.3)
- 10-12	220 (40%)	11.1 (0.7)	24.1 (3.6)
Gender			
- Male	280 (50.9%)	8.2 (2.3)	23.7 (3.3)
- Female	270 (49.1%)	8.4 (2.5)	23.9 (3.5)
Region			
- Urban	297 (54%)	8.4 (2.3)	23.6 (3.2)
- Rural	253 (46%)	8.2 (2.5)	24.0 (3.6)

Table-2: BMI changes by program duration.

Program Duration	Pre-Intervention BMI (Mean \pm SD)	Post-Intervention BMI (Mean \pm SD)	Mean BMI Change	p-value
< 12 weeks	23.9 \pm 3.5	23.6 \pm 3.3	-0.3	0.12
12-16 weeks	23.7 \pm 3.3	22.9 \pm 3.1	-0.8	<0.01
> 16 weeks	23.8 \pm 3.4	22.4 \pm 3.0	-1.4	<0.001

Table-3: Behavioural changes pre- and post-intervention.

Behavioural Changes	Pre-Intervention (%)	Post-Intervention (%)	p-value
Increased Fruit/Vegetable Intake	38%	74%	<0.01
Decreased Sugary Beverage Intake	58%	35%	<0.01
Increased Physical Activity	42%	83%	<0.001

Table-4: Logistic regression analysis for predictors of BMI reduction.

Predictor Variable	Odds Ratio (OR)	95% Confidence Interval (CI)	p-value
Program Duration	1.47	1.20 - 1.75	<0.01
Parental Involvement	1.35	1.05 - 1.82	0.03
Age	0.98	0.90 - 1.05	0.23
Socioeconomic Status	1.12	0.95 - 1.30	0.15
Family History of Obesity	1.20	0.98 - 1.45	0.08

The results of this study suggest that early childhood intervention programs significantly reduce BMI and improve dietary and physical activity behaviours among children aged 4-12. The most pronounced improvements were observed in longer-duration programs (>16 weeks) and those involving higher levels of parental participation. The findings emphasize the importance of program length

and intensity in achieving meaningful and sustained changes in childhood obesity prevention efforts.

DISCUSSION

The results of the present study support the use of early intervention in childhood obesity, suggesting that such programmes may help make a significant difference in BMI, food selection and physical activity[11]. The drastic

decrease in BMI as witnessed in the current study affirms the hypothesis that structured and consistent behavior change may reduce obesity and complications that are related to it[12]. It is for this reason that longer and more intensive programs are more effective; the public must maintain the commitment to dietary and exercise modification. It is also very encouraging to note the changes in dietary behavior and exercise which are key determinants in obesity prevention and control[13]. The decrease in the intake of sugary beverages and the increase in the consumption of fruits and vegetables are in concordance with goals of most health enhancement programs for children that seek to improve the dietary habits of the young population. Moreover, the trend of physical activity levels is in a line with the existing literature showing the relationship between physical exercise and weight control and health promoting behaviors among children[14]. Parental involvement as being a significant predictor to success therefore, underline the importance of family-based intervention in obesity prevention. Parents and caregivers are influential in children's eating and physical activity behaviours and their engagement in intervention programs is a factor that may increase the effectiveness of interventions[15]. This implies that future interventions should include activities that will encourage parents to be involved and well informed so that they can support the children to adopt and sustain healthy behaviors. Nevertheless, the results of this study suggest several important considerations which have to be discussed due to the limitations of the present research. The use of self-reported data for BMI and behavioral measures may therefore be prone to reporting bias albeit the objective nature of the data was confirmed[16, 17]. Furthermore, the cross-sectional study design also has its drawbacks in that it cannot allow the establishment of causality between the intervention and the outcomes that were noted. Further research in form of longitudinal studies that use randomized controlled designs are required to validate these observations and, in addition, to determine the durability of the effects[18]. Thus, the findings of the present research offer strong evidence for the utility of early intervention programmes in preventing childhood obesity. These results support the necessity for such programs to be extended to more schools, with a focus paid to the length of the program, its intensity and the role of parents[19]. Due to the persisting problem of childhood obesity, these findings provide relevant information to inform future public policies strategies for coping with the problem, for health care workers, and teachers to help children change their lifestyle for the better[20].

CONCLUSION

The findings of this research strongly support the effectiveness of early childhood intervention programs (EIPs) in addressing obesity among children. The results highlight the importance of implementing these programs

on a larger scale, with a particular focus on program duration, frequency, and active parental involvement, which were identified as key factors for success. Given the persistent nature of childhood obesity and its implications for long-term health, these findings emphasize the need for sustained, comprehensive interventions. Expanding the reach of such programs can provide significant benefits, informing future public health strategies and guiding policymakers, healthcare professionals, educators, and parents in their efforts to combat childhood obesity.

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Data Availability: The datasets generated and analyzed during the study are available from the corresponding author on reasonable request.

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