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RESEARCH ARTICLE

The role of food program to overcome obesity, overweight, and underweight among autistic children

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Abstract

This research aims to explore the impact of a specially tailored food program on the weight changes experienced by children with autism. This food program was implemented both within specialized centers and under direct maternal supervision at home. The intervention spanned two months and consisted of three main meals and two snacks daily for the children with autism. Prior to the program's initiation, an assessment of the children's weight status revealed a spectrum ranging from extremely underweight to underweight, with only a small fraction of the sample exhibiting normal weight and one child falling into the obese category. The study findings indicated that a diet free from gluten, casein, sugar, and monosodium glutamate proved beneficial for children with autism. Notably, the results demonstrated a positive trend in weight among underweight children, with weight gains ranging from 1 to 3 kilograms, contingent upon age. The research also highlighted that younger participants tended to exhibit a more pronounced response to the program. Moreover, the program exhibited success in reducing obesity, with a notable 4-kilogram reduction in weight observed among obese children. Based on the outcomes, it is suggested that programs of this nature should be consistently implemented within specialized centers. This study's keywords encompass autism children, overweight, underweight, and normal body weight.

Keywords: Autism children, Overweight, Underweight, Normal body weight.

Introduction

The dietary patterns of individuals with autism often diverge from those of typically developing individuals. Children with autism tend to exhibit specific and repetitive food preferences, which, over time, can result in nutritional deficiencies and subsequent health issues (Diolordi *et al.*, 2014). Notably, Schreck *et al.* (2004) conducted a comparative study between neurotypical children and those with autism, revealing distinct differences in eating habits. The latter group exhibited a consistent preference for the same foods and beverages across meals, a phenomenon supported by various other investigations (Cermak *et al.*, 2010; Mayes & Zickgraf, 2019; Sharp *et al.*, 2013; Solmi *et al.*, 2021). The concern surrounding the adequacy of dietary choices of children with autism has recently gained traction (Herndon *et al.*, 2009).

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This focus on the dietary habits of children with autism has spurred interest in understanding the potential impact of these habits on their health, behavior, and the manifestation of autism-related disorders (Bener *et al.*, 2013; Cornish, 2002; Duan *et al.*, 2013; Mostafa & AL-Ayadhi, 2012). Certain studies have also linked these dietary habits to deficiencies in essential nutrients like folate, elevated levels of homocysteine (Ranjan & Nasser, 2015), and diet-induced nutritional imbalances (Al-Farsi *et al.*, 2013). Many instances of nutritional deficiencies in children with autism stem from their distinct food preferences.

Inadequate consumption of nutritious foods can impede the growth of children with autism, resulting in various growth disorders, including overweight (Broder-Fingert *et al.*, 2014; Chen *et al.*, 2010; Croen *et al.*, 2015; Curtin *et al.*, 2010; Evans *et al.*, 2012; Healy *et al.*, 2020; Must & Anderson, 2003; Shedlock *et al.*, 2016). Overweight tendencies among these children have been attributed to the consumption of calorie-rich and overly-sweetened beverages (Evans *et al.*, 2012). Overall, a consensus among several studies attributes the onset of obesity in children with autism to their eating behaviors (Cermak *et al.*, 2010; Mayes & Zickgraf, 2019; Sharp *et al.*, 2013). Moreover, some researchers have linked obesity in this population to low levels of physical activity (Healy *et al.*, 2019; McCoy *et al.*, 2016; McCoy & Morgan, 2020), leading to

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interventions aimed at improving fitness through increased physical activity (Dickinson & Place, 2014; Ferreira *et al.*, 2019; Howells *et al.*, 2019). Age has also been explored as a contributing factor to obesity, with suggestions that reduced physical activity as children with autism grow older may play a role (Healy *et al.*, 2020; Jones *et al.*, 2017). Sleep patterns have additionally been investigated, as some authors hypothesize that increased sleep duration in children with autism may contribute to obesity (Zuckerman *et al.*, 2014).

However, the dietary challenges faced by children with autism extend beyond obesity, encompassing instances of underweight as well (Li *et al.*, 2020). Research indicates that underweight cases constitute a significant portion of this population (Li *et al.*, 2020; Sedgewick *et al.*, 2020; Wang *et al.*, 2016). Bolte *et al.* (2002) have highlighted that underweight conditions among children with autism arise from a combination of factors, including reduced absorption of nutrients due to dietary choices and high levels of activity. Interestingly, some authors have revealed the complexity of weight gain in children with autism, citing physiological complications that can hinder weight gain (Haelle, 2021). This study is dedicated to exploring the potential efficacy of a specialized food program in improving the weight status of children with autism.

Materials and Methods

This study employed a cohort quantitative design to investigate the impact of a food program on the health of children with autism. A total of 21 children with autism (comprising 3 females and 18 males) participated in the study. Their ages ranged from 3 to 9 years. At the outset of the program, measurements of the children's weight and height were taken. The food program was meticulously designed to exclude items containing gluten, casein, caffeine, monosodium glutamate, and sugar. Instead, the program integrated alternative food options such as camel milk, organic products, herbicides, flax seeds, sesame, corn and rice bread, rice, almond and coconut milk, gluten-free and casein-free chips and biscuits, dried fruits, palm products, eggs, legumes, meat, chicken, raisins, olive oil, and walnuts. The program encompassed the provision of three main meals and two snacks daily, spanning a duration of two months. Implementation occurred both within the research center (for 9 children) and in the participants' homes (for 12 children). To ensure proper execution, the researcher conducted home visits, offered mothers guidance, and oversaw the program's progress. Additionally, training sessions were conducted for both center staff and mothers, enhancing their comprehension of the program and enabling effective execution in both settings.

Research Ethics

The ethical considerations of this study were diligently addressed, with direct communication established with the parents of the participating children with autism. Comprehensive explanations were provided to parents, outlining the food program's composition and implementation details (Figure 1). Specifically, parents were informed about the specific food types to be eliminated and the corresponding viable substitutes for each category. Furthermore, technical procedures were clarified, encompassing the pre- and post-program measurements of the children's weight and height. To ensure transparency and informed participation, consent forms were signed by the parents of the children with autism, underscoring their understanding and approval of their child's involvement in the study.

Results

The research was conducted within a specialized center that provided dedicated services for children with autism. A significant proportion of these children (42.9%) received care through regular visits to the center, while the remaining participants (57.1%) received care services within their homes. Gender distribution among the center's visitors or program participants skewed predominantly towards males, accounting for 85.7% of the cohort. The remaining 14.3% constituted females.

Regarding age distribution, the participants were divided into two distinct groups. The larger subset (61.9%) fell into the age bracket of less than 7 years, while the remaining portion (38.1%) belonged to the age group of 7 years or older. The geographical representation of participants encompassed various governorates, with the highest proportion hailing from Amman, the capital city (38.1%). Other represented areas included Al Balqa, located approximately 40 km away from the capital (42.9%). Zarqa is about 20 km from the capital (9.5%), and Jerash is roughly 40 km from the capital (9.5%).

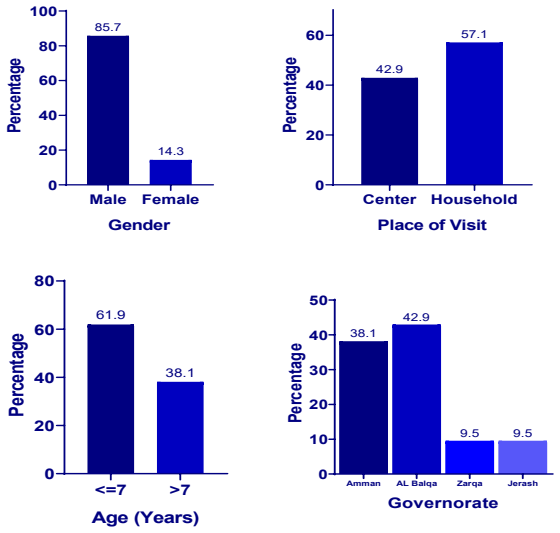

Figure 1: Demographic characteristics of autism children included in the food program.

Most of the children with autism who participated in the program were initially classified as underweight (85.7%). The segment of participants with normal weight constituted a smaller portion, accounting for 9.5% of the sample, whereas only 4.8% fell into the obese category. Specifically, the sample encompassed 11 children with autism who were underweight and aged 7 years or younger. Within the same age category, merely two children with autism were categorized as having a normal weight, with no instances of obesity observed. In the age category of over 7 years, there were seven children with autism classified as underweight, while none were deemed to have a normal weight. Within this age bracket, a singular child with autism was categorized as obese. The distribution of these weight categories across different age groups will provide valuable insights into assessing the potential impact of age on the response to the food program. For a graphical representation of this distribution, please refer to Figure 2.

In Figure 3, the weight distribution among the children with autism prior to their participation in the food program is presented. The data indicates that children within the normal weight range were observed at ages 4 and 5, weighing 30 and 20 kg, respectively. The sole instance of obesity was identified in a 9-year-old child with a weight of 69 kg.

The distribution of weights exhibits a diverse range, with the lowest recorded weight at 9.0 kg, seen in a 5-year-old child, indicating a case of severe underweight. Conversely, the highest weight recorded was 31 kg, corresponding to a 9-year-old child classified as underweight. This weight distribution variation across different ages among children with autism underscores the significance of tailored care interventions required to enhance their physical well-being and overall fitness.

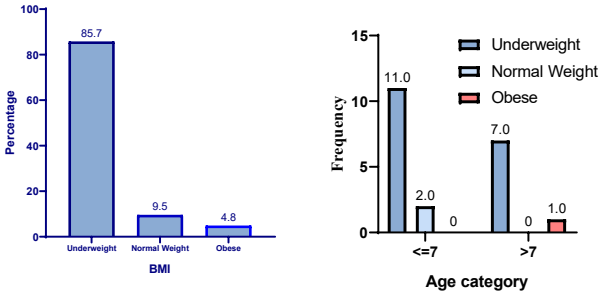

Figure 2: The starting BMI of the sample and its distribution over age category

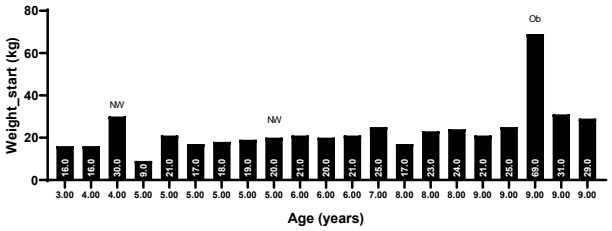

Figure 3: The distribution of weight among autism children before receiving the food program.

The utilized metric system formula calculates body mass index (BMI) as weight (kg) divided by the square of height (m) (M. D. S. V. M. V. R. M. M. P. M. M. P. S. S. A., 2015). This formula provides insights into the children's body composition and aids in understanding the relationship between weight and height in the context of their health status.

The study outcomes revealed a favorable impact resulting from implementing the food program for children with autism. Specifically, the results indicated that children with autism who initially had a normal weight were able to maintain their normal weight throughout the course of the applied food program.

Furthermore, a notable positive trend was observed among children who were initially classified as underweight. This subset displayed weight gains ranging from 1 to 3 kg, exemplifying the program's efficacy in fostering healthier weight levels.

Conversely, a child who was initially categorized as obese experienced a weight reduction of approximately 4 kg due to the influence of the food program. These outcomes collectively underscore the significant effectiveness of the applied food program in enhancing the physical well-being and fitness of children with autism.

For a graphical representation illustrating these results, please refer to Figure 4.

The reaction of children with autism to the food program exhibited variations dependent on their age. The findings highlighted a noteworthy distinction in the response among underweight children with autism. Notably, younger children exhibited a more pronounced response to the food program, registering an average weight gain of one kilogram over the duration of the program. Conversely, as age increased, the number of children displaying a positive response to the food program decreased.

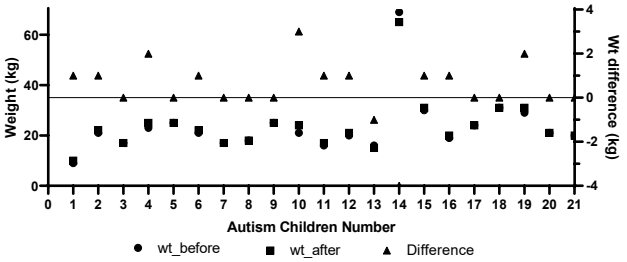

Figure 4: The comparison of children's weights before and after receiving the food program

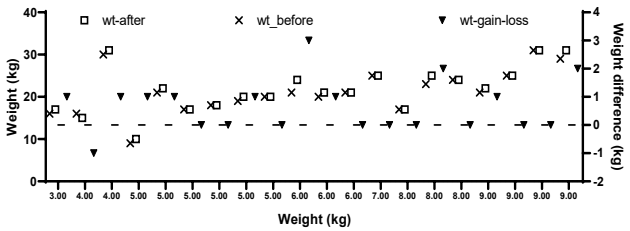

Figure 5: The weight gain of underweight autism children according to age

For a visual depiction of this age-dependent response, kindly refer to Figure 5. This distribution underscores the influence of age on the degree of response to the food program among children with autism who were initially classified as underweight.

The outcomes of the study indicated that the location where the food program was administered, whether at a specialized center or within households, had a discernible impact on the weight gain experienced by both underweight and normal-weight children with autism. Statistical analysis revealed a significant association ($t = 3.29$, $p = 0.002$) between the program's location and the weight changes observed.

The mean weight for children with autism who received the program at the specialized center was 24.81 kg, whereas those who participated in the program at home exhibited a mean weight of 19.25 kg.

When the program was conducted within households, six children with autism demonstrated weight gains ranging from 1 to 2 kg. Among this group, 4 children displayed no discernible weight change, while 1 child experienced a weight loss of 1 kg.

In contrast, children with autism who participated in the program at the specialized center exhibited a distinct pattern. One child achieved a weight increase of 3 kg through the program, while another child experienced a weight gain of 2 kgs. Furthermore, two children at the center registered weight gains of 1 kg each. Interestingly, 4 children at the center did not manifest any significant weight change before and after the program.

To visualize these findings, please refer to Figure 6. The data underscores the noteworthy influence of the program's location on the weight changes experienced by children with autism, thereby emphasizing the multifaceted nature of the program's impact.

The findings revealed notable shifts in BMI among the participants. Among the 21 children with autism, 10 displayed an increase in BMI following the food program. Conversely, seven children exhibited consistent and stable BMI values before and after the implementation of the program. It's worth noting that this group included children with a normal BMI at the outset. Furthermore, four children experienced a decrease in BMI, which notably encompassed

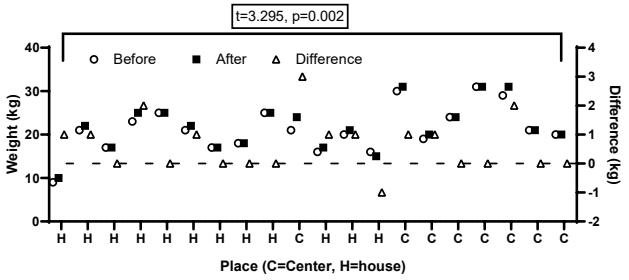

Figure 6: The effect of place of receiving the food program on weight change of autistic children.

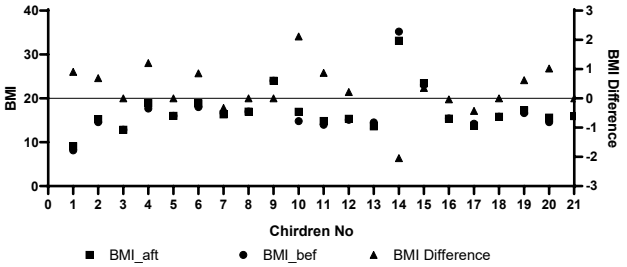

Figure 7: The effect of food program on BMI of autistic children

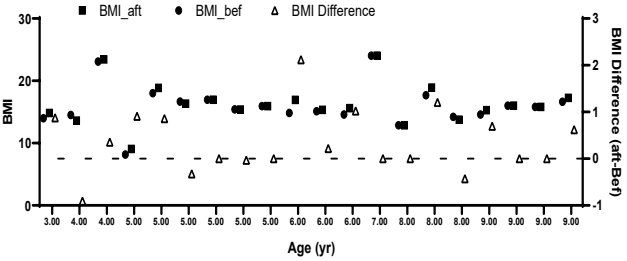

Figure 8: The effect of food program on BMI of autistic children according to age

the child initially categorized as obese.

For a graphical representation depicting these changes, kindly refer to Figure 7. These BMI variations further underline the diverse responses observed among children with autism following their participation in the food program.

Among the children with autism, a discernible trend emerged with regard to the effect of age on changes in Body Mass Index (BMI). Specifically, younger children exhibited a more pronounced increase in BMI when compared to their older counterparts.

Within the subset of children aged less than 7 years, a total of seven children experienced an elevation in their BMI values. Concurrently, four children within this age range displayed a consistent and unaltered BMI before and after the program. Remarkably, only one child in this age group demonstrated a decreased BMI.

These age-related variations in BMI response are visually depicted in Figure 8. The data accentuates the influence of age on the changes in BMI among children with autism who participated in the food program.

Discussion

The primary aim of this research was to investigate the impact of a carefully designed food program on weight gain among children with autism. This program was meticulously constructed to exclude components such as gluten, casein, caffeine, monosodium glutamate, and sugar products. A wealth of existing research supports the notion that gluten-free diets can enhance digestion and absorption in children with autism and that casein consumption can impact gastrointestinal symptoms (Berding & Donovan, 2018; Cornish, 2002; Diolordi *et al.*, 2014; Hill *et al.*, 2015; Horvath & Perman, 2002; Onaolapo & Onaolapo, 2018; Ranjan &

Nasser, 2015; Sanctuary *et al*., 2018; Weir *et al*., 2021). The exclusion of calcium from the program aimed to mitigate potential digestive issues (Sanctuary *et al*., 2018), while the replacement of sugar with natural sweetening alternatives, such as honey, was considered for its potential benefits (Hill *et al*., 2015; Sanctuary *et al*., 2018; Weir *et al*., 2021).

The food program was devised not only to meet the nutritional needs of children with autism but also to replace less favored components with more acceptable alternatives. Implementation occurred both within the specialized center and households, with significant effort invested in ensuring accurate execution and adherence to the program. The findings revealed that the program exhibited heightened responsiveness among those children with intensive underweight, leading to improved physical fitness. This positive outcome could be attributed to the program's potential to enhance food metabolism and alleviate extreme gastrointestinal symptoms (Weir *et al*., 2021). The evidence of weight increase observed in more than half of the children within the program after a span of two months corroborated their positive response to the food program.

An intriguing observation emerged from the results: the weight improvement among children who received the program within the specialized center exceeded that of children who participated from their homes. This could potentially be linked to the rigorous and direct supervision within the center, which facilitated the optimal execution of the program. Specifically, weight gains of up to 3 kg were recorded for children within the center.

Moreover, the findings underscored the age-related aspect of the children's response. Participants below 7 years exhibited a greater response to the program than their older counterparts, highlighting the varying responsiveness of different age groups.

Importantly, the program demonstrated efficacy even in cases of obesity, as evidenced by a weight reduction of 4 kg observed over two months. This suggests that continuous monitoring and implementation of the program could potentially lead to normalization of body mass index (BMI) for children previously categorized as obese.

Notably, the program succeeded in maintaining the normal weight of children who already had a normal BMI, reaffirming its ability to cater to a diverse range of needs.

These findings collectively emphasize the potential of tailored food programs to address malnutrition concerns and enhance various aspects of the lives of children with autism. The outcomes contribute to the growing body of knowledge surrounding effective interventions for this unique population.

Conclusion

In conclusion, the primary objective of this research was to explore the impact of a carefully structured food program on enhancing the physical well-being of children with autism. The program was successfully administered to 21 children, encompassing a specialized center and home environments. Stringent training was provided to the program's supervisors and implementers to ensure its precise execution. Over a duration of two months, the program's effects were assessed.

The outcomes highlighted several key findings. Notably, the program exhibited its greatest efficacy in underweight children, resulting in weight gain, weight loss in the case of obesity, and the maintenance of weight for children with normal BMI. However, a significant distinction was observed between the outcomes derived from the specialized center and those from household implementation. The program's impact was notably more pronounced within the center, potentially due to heightened supervision and adherence to the program's guidelines.

Furthermore, the response to the program demonstrated an age-related trend. Younger children exhibited a more substantial response to the food program in comparison to older children. This suggests that the timing of interventions is crucial in eliciting positive outcomes.

Overall, the results emphasized the importance of direct and continuous observation in successfully implementing such programs for children with autism.

Recommendations

Based on the findings of this study, several recommendations can be made:

- Specialized Center Execution: Given the more pronounced response observed within the specialized center, it's advisable to prioritize this setting for executing food programs. The heightened supervision and structured environment likely contribute to better outcomes.
- Early Intervention: The study's outcomes suggest that interventions targeting younger children with autism are likely to yield more significant improvements in physical fitness. Tailoring programs to cater to this age group could enhance effectiveness.
- Comprehensive Training: Ensuring that supervisors and implementers of the program receive intensive and comprehensive training is essential for successful execution. Their understanding of the program's intricacies and guidelines significantly contributes to its impact.
- Continued Monitoring: The positive impact of the food program underscores the importance of sustained monitoring and follow-up. Regular assessment and adjustments can help maintain the achieved results and further improve the physical health of children with autism.

In conclusion, this study sheds light on the potential of tailored food programs to enhance the well-being of

children with autism. The findings and recommendations contribute to the development of effective strategies for addressing the unique nutritional needs of this population.

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