



Diet and physical exercises for preschoolers with ADHD and their mothers: An intervention study

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ARTICLE INFO

Keywords:

Preschooler
ADHD symptoms
Nutrition
Physical exercise

ABSTRACT

Background: Attention deficit hyperactivity disorder (ADHD) is a serious public health problem. Diet-focused approaches and physical exercise can be used to complement other ADHD management techniques.

Objective: To determine the prevalence of ADHD symptoms among preschoolers in nursery schools and to evaluate the educational interventions toward nutrition and physical exercise in mothers and their preschoolers with ADHD symptoms.

Research methodology: A two-phase sampling method was employed. First, a cross-sectional survey was conducted to determine the prevalence of ADHD symptoms in four nursery schools (400 preschoolers aged between 3 and 6 years). Second, an intervention study (a quasi-experimental research design with one group completing the pre-test and the post-test) was performed on 36 preschoolers having ADHD symptoms and their mothers by using the educational intervention for mothers and photos and games about nutrition and physical exercise for the preschoolers with ADHD; mothers of four children out of the 40 refused to participate in the study. Data were analyzed using SPSS version 20. The paired t-test was used to determine significant differences between the groups. Differences were considered significant at $P < 0.05$.

Results: Of the 400 preschoolers, 10% had high ADHD symptoms. The mean score of mothers' knowledge of nutrition and physical exercise improved after the implementation of the program ($p = 0.01$). In addition, preschoolers with ADHD enjoyed the session with photos and games ($p = 0.01$).

Conclusions and Implications: Educational intervention significantly improved the knowledge of the mothers. Moreover, preschoolers with ADHD symptoms enjoyed the session with photos and games. This intervention appears to be feasible and promising for further investigation of its effects.

1. Background

Attention deficit hyperactivity disorder (ADHD) is a serious public health problem, and it is one of the most common neurodevelopmental disorders in childhood.¹ It is characterized by inattentive, impulsive, and hyperactive behaviors. Globally, it affects 2.2% of school-aged children.^{2,3} A systematic review of studies conducted in Arab

countries reported that the prevalence of ADHD ranged from 1.3% to 16%.^{2,4} In a study conducted in Iran that employed the same questionnaire in both teachers and parents to assess ADHD behavior,⁵ 25.8% and 17% of preschoolers were identified as having ADHD symptoms according to their parents' and teachers evaluations, respectively. Moreover, a study conducted in Menoufia Governorate, Egypt, reported that 9.3% of preschoolers were diagnosed with ADHD.⁶

Abbreviations: ADHD, Attention deficit hyperactivity disorder.

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<https://doi.org/10.1016/j.ctim.2022.102826>

Received 20 February 2021; Received in revised form 23 March 2022; Accepted 24 March 2022

Available online 26 March 2022

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The symptoms of ADHD vary from one child to another, from predominant poor attention to predominant hyperactivity and impulsivity, or a combination of both.^{7,9} The causes of ADHD are also unclear. Some causes include genetic factors, exposure to environmental toxins, and gestational factors including smoking, alcohol consumption, severe stress, and exposure to lead during pregnancy.^{6,10,11}

ADHD has traditionally been managed with medication. The recommended drugs prescribed for children with ADHD have various potential adverse side effects.^{12–15} Therefore, parents and practitioners are seeking alternative treatments. In addition to medication, the multimodal treatment of ADHD comprises non-medical treatments that include trainings for parents and healthcare providers.⁹ Behavioral management programs are available to help children function better in their home and school environments. Additionally, nutrition and physical exercise can be used to complement these management techniques.^{13,14}

Non-medical treatments include dietary approaches that develop healthy eating habits including consuming plenty of fruits, vegetables, and whole grains, choosing lean protein sources, and eliminating unhealthy foods and additives.^{16–20} Many trials, including those addressing colorings-free, gluten-free, and low-sugar diets, have investigated the effects of diet on ADHD symptoms, these diets showed statistically significant and clinically relevant positive effects on ADHD.^{18–20} Other interventions include daily physical activity according to age,¹⁵ including mind/body practices, and brain training programs.²¹ Several review articles have focused on the role and efficiency of physical activity interventions for ADHD. Acute and regular physical activity triggers a wide array of physiological events. These can lead to improvements in physical and psychological well-being as well as in cognitive functions, including memory.^{11,22,23}

Harazni and Alkaissi²⁴ stated that there were clear defects in the knowledge and services provided to children with ADHD and the available support for caregivers. Therefore, increasing the awareness about ADHD by health care providers such as school nurses, athletes, and dietitians is the key to improving service delivery for affected children and their families.^{25,26} The objective of this study was to evaluate the educational approaches and enjoyment regarding nutrition and physical exercise for mothers and their preschoolers with heightened ADHD symptoms, which will help in caring for them.

2. Methods

2.1. Aim of the study

This study aimed to determine the prevalence of ADHD symptoms among preschoolers in nursery schools and to evaluate the educational approaches toward nutrition and physical exercise in mothers and their preschoolers with ADHD symptoms.

2.2. Research design

A two-phase sampling method was used in this study. First, a cross-sectional survey was conducted to determine the prevalence of ADHD across four nursery schools (400 preschoolers aged between 3 and 6 years). Second, an intervention study (a quasi-experimental research design with one group completing the pre-test and the post-test) was performed on 36 preschoolers having high ADHD symptoms and on their mothers by using educational approaches for mothers and photos and games about nutrition and physical exercise for their preschoolers with ADHD symptoms.

2.3. Study population and sampling technique

The sample size was calculated based on the prevalence of ADHD among preschool children in Menoufia Governorate, Egypt, where 9.30% of them were diagnosed with ADHD.⁶ The sample was calculated

using Open Epi, version 3.01 (www.OpenEpi.com), with a confidence level of 99.9%. The sample size was originally 353, but it was increased by 10% to safeguard against non-responders and dropouts; therefore, the sample size became 400.

A two-phase sampling method was used to select participants. In phase one, four nursery schools were selected randomly from 38 nursery schools in Elehsaa Governorate, Saudi Arabia. In phase two, a survey was conducted on 400 mothers and their children who were not previously diagnosed by a physician or a mental health provider (aged three–six years) in the selected nursery schools to determine the prevalence of ADHD symptoms. All the participants completed the screening questionnaire in the pre-test. From the total sample, 40 preschoolers scored above the cutoff for ADHD symptoms. The mothers of four of the 40 children refused to complete the study. The total number of children who completed the intervention study was 36, and their mothers were aged from 20 to 28 years. Mothers' education levels ranged from secondary to university education.

2.3.1. Ethical consideration

The present study was approved by the Institutional Ethical Review Board of King Faisal University. Written consent was obtained from the mothers. Confidentiality was assured to all the participants. They had the right to terminate participation in any phase without any consequences. Mothers of preschoolers with high ADHD symptoms were informed and referred to a specialist or a mental health provider to receive treatment and follow-up. [Fig. 1.](#)

3. Measurement instruments

3.1. The questionnaire was divided into four parts

3.1.1. Part one

The ADHD rating scale (Arabic version)²⁷ was used to identify children with ADHD symptoms with age range from 3 to 13 years. The rating scale contained 14 items, each of which had a four-point scale (0–3) as follows: not at all, just a little, pretty much, and very much. The time provided for completing the rating scale was five minutes. The total scores on the rating scale ranged from zero to 42.²⁸ Cronbach's alpha coefficient was computed to estimate the internal consistency of the scale, and it was 0.70. ADHD cutoff points were obtained for male (23.5) and female (22.5) children.²⁸ The receiver operating characteristic (ROC) curve is used to determine the cutoff points, including sensitivity and specificity measures, depending on the scale's grand total score. The ADHD rating scale was only used to identify the preschoolers with ADHD symptoms, and their mothers were advised to follow them up with a specialist or a mental health provider.

3.1.2. Part two

It measured the knowledge of mothers on specific nutrition and physical exercises related to the management of ADHD before and after implementing the educational program. The knowledge portion contained 59 statements distributed across the two axes. The first included nutritional awareness related to the management of ADHD and consisted of 34 phrases. The second axis consisted of 25 statements on physical exercise awareness. Questions were scored as one mark per correct answer and no marks for wrong answers, no answer, and refusal to answer. The internal consistency for the knowledge portion containing 59 statements was 0.89.

3.1.3. Part three

It assessed the knowledge of mothers regarding proper and general nutrition for preschoolers. This part consisted of 60 questions, including 17 phrases on nutrition (Cronbach's α coefficient = 0.85); six questions, vegetables (Cronbach's α coefficient = 0.81); 11 questions, fruit (Cronbach's α coefficient = 0.88); and, nine questions, drinks and liquids (Cronbach's α coefficient = 0.89). There were 17 questions

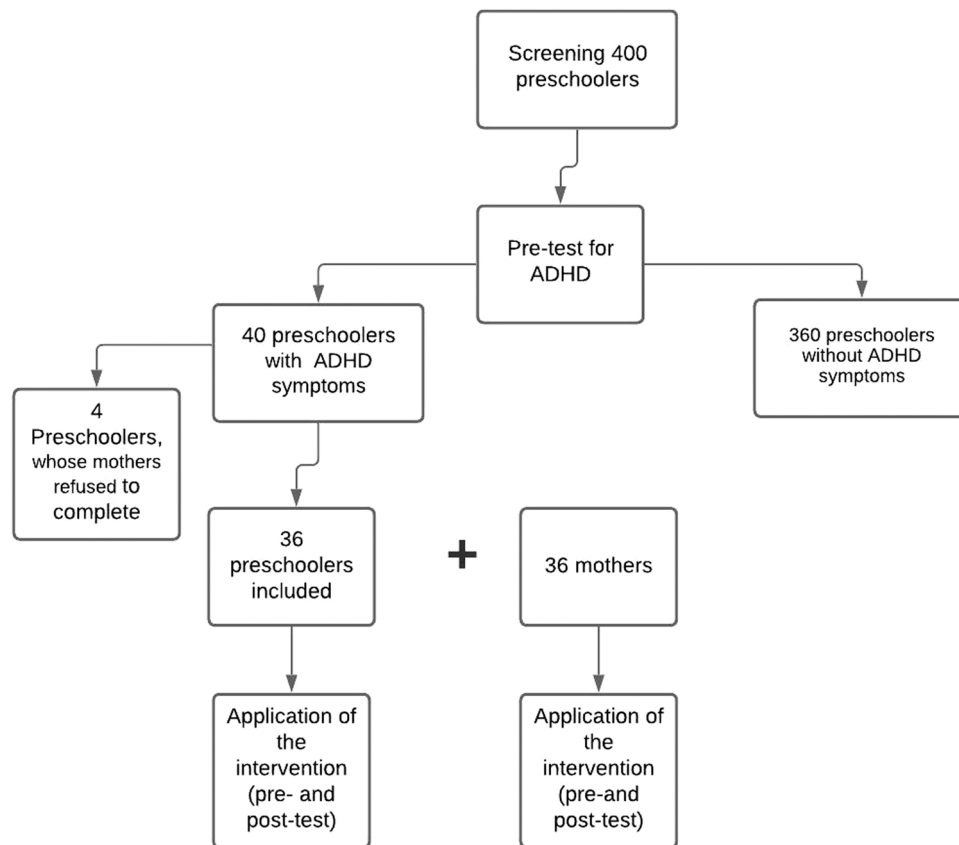


Fig. 1. Flow chart of the sampling technique.

(Cronbach's α coefficient = 0.92) on dietary requirements. Questions were scored as one mark per correct answer and no marks for wrong answers, no answer, and refusal to answer. The higher the mean score, the more knowledge they had.

3.1.4. Part four

It assessed the enjoyment experienced from physical exercise and nutrition education by using photos and games among preschoolers with ADHD symptoms. This part consisted of 40 photos including 22 about nutrition and 18 designed for the behavior of preschoolers with ADHD symptoms. Additionally, part four involved physical exercise for preschoolers with ADHD symptoms. The researchers incorporated physical exercise by using photos and games as it is more enjoyable to preschoolers. Questions regarding nutrition education were scored as one mark per love it and no marks for not at all. Also, physical exercise was scored as one for done and zero for not done. The internal consistency of the responses for the total tool was calculated using Cronbach's α coefficient, and it was 0.75.

The questionnaire was examined and reappraised by three specialists in the field of public health and preventive medicine and a specialist in physical education. They reviewed the instruments for clarity, relevance, comprehensiveness, understanding, and applicability.

The mothers and their children were divided into groups, and each group received a total of three 1-hour sessions within a week. The session included 15 min of exercise.

3.2. Baseline measurement

To test the clarity of the tools and to determine the time required to complete the questionnaire, the tool was pre-tested on 30 children of the same age without ADHD symptoms and their mothers before starting the data collection. The questionnaire required approximately 45 min to

complete and did not require any modification. These children were not included in the statistical analyses.

4. Intervention

4.1. The educational program was conducted in the following four stages

I-Assessment stage: The researchers determined the prevalence of ADHD symptoms among preschoolers using a questionnaire that was completed by their mothers. The assessment was conducted from August 2019 to September 30, 2019, with approximately 25 questionnaires per day, two days per week.

4.2. II-Planning stage

4.2.1. Contents of the program

4.2.1.1. Theory. It included the definition, types, and importance of nutrition and the components of a balanced diet for the child, as well as the definition of hyperactivity disorder and the types of foods that can decrease the symptoms of ADHD.

4.2.1.2. Practical. It comprised physical games and the display of photos that decrease the symptoms of ADHD (imitating some movements, kinetic stories, and identifying the foods that prevent hyperactivity disorder through games such as collecting protein products, and healthy food products). The preschoolers were taught about unhealthy drinks through photos of soft drinks.

4.2.1.3. Program arrangement. The researchers prepared lectures, meetings, and brochures. The lectures and meetings were conducted at the nursery schools. The time of the education session was determined

based on the that which was suitable for the participants and via coordination between the researchers and mothers. Media handouts regarding ADHD were provided to all the participants at the end of the session.

III-Implementation stage: During the meeting, the researchers in Saudi Arabia illustrated the goal of the research to all the mothers. A baseline measurement was performed prior to the meeting to evaluate the participants' knowledge. The time provided to complete the pre-test was approximately 45 min. The mothers and their children were divided into four groups of nine. Each group received three one hour-long sessions to complete the program. Each day, the researchers conducted two physical activity sessions. The sessions included 15 min of exercise and emphasized that the mothers should make the preschoolers perform these exercises every day. This study was conducted from October 1, 2019, to December 2019.

IV-Evaluation stage: The evaluation was conducted by the post-test immediately after implementing and completing the course to assess the mothers' level of knowledge. The post-test was implemented by repeating the same pre-test to determine the effect of the educational program.

5. Statistical analysis

Data entry, cleaning, coding, and recording were performed. Categorical variables are described as numbers and percentages (N, %), whereas continuous variables are described as mean \pm SD. The chi-square test and Fisher's exact test were used to compare the frequencies, whereas a paired t-test was used to compare continuous variables ($p < 0.05$). All data management procedures were performed using IBM SPSS 20.0.

6. Results

Table 1 shows that the mean age of the children was 4.87 ± 0.87 , and more than half of them were girls. The mothers' ages ranged from 20 to 28 years, with more than half of them working and having high education levels (part 1 in questionnaire).

Table 2 reveals that the mean scores of the mothers' knowledge about nutrition, vegetables, fruits, and drinks for ADHD management improved after the educational intervention, with statistically significant differences (Part 3 in the questionnaire).

Table 3 shows that the mean scores of the mothers' knowledge related to all the nutrition and physical exercise variables studied in the pre-test increased over the study period with statistically significant differences (P -value = 0.01) (part 2 in questionnaire).

Table 4 presents the mean scores for the enjoyment of nutrition-related photos and games for preschoolers with ADHD symptoms. It shows that the total mean scores increased after the application of designated exercise and nutritional education by using photos and

Table 1
Personal data of preschoolers with ADHD symptoms and their mothers.

Personal data	No. (36)	%
Preschoolers' ADHD symptoms (Mean \pm SD) range	24.92 \pm 1.42 ²³⁻²⁸	
Preschoolers' age (y) (Mean \pm SD)	4.87 \pm 0.87	
Gender		
Male	17	47.2
Female	19	52.8
Mothers' age		
20 to < 24 y	14	38.9
24-28 y	22	61.1
Mothers' education		
Middle (secondary)	20	44.4
High (university)	16	55.6
Mothers' occupation		
Working	16	55.6
Housewife	20	44.4

games, with statistically significant differences ($P = 0.01$) (part 4 in questionnaire).

7. Discussion

The study concluded that 10% preschoolers had ADHD symptoms. The mean scores of mothers' knowledge of nutrition and physical exercise improved after the program ($p = 0.01$). In addition, preschoolers with ADHD symptoms enjoyed the sessions with photos and games ($p = 0.01$).

The present study reported that 10% of the preschoolers screened by the ADHD rating scale had high levels of ADHD symptoms. The prevalence of ADHD was slightly higher in this study than that in a study conducted in Menoufia Governorate, Egypt, by Mahrous et al.⁶ They reported that the prevalence of ADHD among preschool children was 9.3%.

Another study conducted among preschoolers in mainland China by Cao et al.²⁹ reported that 8.6% of preschoolers had high levels of ADHD symptoms. Moreover, the present study showed a higher prevalence than the other two studies conducted in China on Chinese children by Wang et al.³⁰ and Liu et al.³¹ They reported that the prevalence of ADHD was 6.26%. We believe that the differences in ADHD symptom prevalence across these studies may be due to racial/ethnic disparities and differences in the diagnostic tools used. In our study, we used a validated scale for children in the Arabic language, which is a language we are comfortable with. This scale was selected because it provides a direct rating of the essential symptoms of the disorder according to the diagnostic criteria of the Diagnostic and Statistical Manual (Version 3, revised [DSM-III-R]).²⁷

The mean score of mothers' knowledge about nutrition, vegetables, fruits, and drinks for ADHD was improved. Additionally, the mean score of mothers' knowledge related to nutrition and physical exercise in the pre-test was low, whereas it improved significantly after the educational intervention ($P = 0.01$).

This study is in line with that of Abd-Elkader et al.,⁷ who concluded that most of the mothers studied had a poor level of knowledge about the nutritional needs of their children.

In the present study, the mean score for the enjoyment of the nutrition-related photos and games and physical exercise by preschoolers who suffered from ADHD was low in the pre-test. However, after the intervention, the mean score improved with statistically significant differences ($P = 0.01$).

The present study conformed to a study conducted by Taylor et al.³² They confirmed that physical activity sessions specifically designed with the help of children with ADHD can be acceptable and enjoyable. The results also correspond with Phillips,¹³ who reported that the use of strategies involving grocery store games with a child with ADHD can help him/her. Our opinion was that all children like games and photos, and games and photos can help preschoolers with ADHD focus on the task at hand.

Regarding physical activity, similar results were obtained in a study conducted by Zang.²² An evidence-based meta-analysis determined that physical exercise contributes majorly to children suffering from ADHD. In addition, the results obtained by Miklós et al.⁹ were in line with those of the present study. They highlighted that physical activity had a significantly positive impact on children with ADHD.

The strengths and limitations of this study should be noted. First, this study was cross-sectional and did not permit causation or the relationships to be determined. However, a cross-sectional study is the most suitable method for determining prevalence. Quasi-experimental research is more feasible to enable the measurement of the effect of intervention programs. In addition, a limited study was conducted to determine the prevalence of ADHD symptoms and apply the intervention among preschoolers. Early detection and intervention may lead to more effective, successful, and shorter treatments. The ADHD rating scale (Arabic version) was selected because it provides a direct rating of

Table 2
Mothers' knowledge about proper nutrition for preschoolers in the pre- and post-test.

Topics	Test	Mean \pm SD	DF	T value	P-value	Eta ²	D- value
IntroductionAbout nutrition	Pre	2.74 \pm 26.05	35	31.97	0.01	0.97	10.81
	Post	46.91 \pm 2.01					
Vegetables	Pre	1.73 \pm 9.72	35	18.44	0.01	0.91	6.23
	Post	15.44 \pm 1.22					
Fruits	Pre	15.44 \pm 3.58	35	20.77	0.01	0.92	7.02
	Post	1.77 \pm 29.75					
Drinks	Pre	13.80 \pm 2.36	35	24.55	0.01	0.95	8.30
	Post	1.52 \pm 24.16					
Dietary requirements	Pre	17.69 \pm 2.58	35	23.86	0.01	0.94	8.07
	Post	31.83 \pm 2.19					

Table 3
Knowledge of mothers regarding nutrition and physical exercise related to the management of ADHD in the pre- and post-test.

Knowledge	Test	Mean \pm SD	DF	T value	P-value	Eta ²	D-value
Nutrition-related to ADHD	Pre	54.80 \pm 7.39	35	19.75	0.01	0.92	6.68
	Post	91.50 \pm 7.04					
Physical exercise	Pre	45.83 \pm 4.08	35	24.94	0.01	0.95	8.43
	Post	68.16 \pm 4.02					
Total	Pre	100.63 \pm 8.28	35	29.83	0.01	0.96	10.08
	Post	159.66 \pm 7.71					

Table 4
Enjoyment of preschoolers with ADHD symptoms from nutrition-related photos and games and physical exercises in the pre- and post-test.

Topics	Test	Mean \pm SD	DF	T value	P-value	Eta ²	D-value
Nutritional photos	Pre	7.27 \pm 1.51	35	25.73	0.01	0.95	8.70
	Post	16.52 \pm 2.01					
Physical exercise	Pre	5.83 \pm 1.18	35	20.34	0.01	0.92	6.88
	Post	9.47 \pm 0.91					
The behavior of preschoolers with ADHD	Pre	7.52 \pm 1.29	35	32.37	0.01	0.97	10.94
	Post	15.47 \pm 1.18					
Total	Pre	20.63 \pm 2.54	35	50.67	0.01	0.99	17.13
	Post	41.47 \pm 2.97					

the essential symptoms of the disorder according to the diagnostic criteria of the Diagnostic and Statistical Manual (Version 3, revised [DSM-III-R]).

However, it is not a randomized controlled trial (RCT), which is the gold standard for interventions. In addition, no measures of actual behavioral changes in mothers or children were considered. Finally, a follow-up measure, which could provide information on whether the effects of the trial were long-lasting or not, was not applied after the intervention. Future studies may be necessary to investigate whether nutrition and physical exercise in preschoolers can alleviate ADHD symptoms at a later age.

8. Conclusions and future research

These results constitute a strong basis for the development of an RCT in which behavioral outcomes (nutrition and exercise, as well as ADHD symptoms) are investigated after delivering the intervention. In addition, it would be beneficial to carry out such studies in larger populations that are followed up for a longer period.

9. Implications for practice

The favorable effects of physical exercise and diet using photos and games appear to be feasible and promising for further investigation into its effects. Mothers may prefer alternative treatment choices, such as diet and physical activity that will relieve their child's symptoms without putting their health at risk. In addition, mothers' knowledge may be beneficial in decreasing the symptoms in preschoolers with ADHD. Furthermore, future studies should be conducted with a larger sample and at a later age to confirm this hypothesis.

Ethics approval and consent to participate

The present study was approved by the Institutional Ethical Review Board of King Faisal University. Written consent was obtained from the mothers. Confidentiality was assured to all participants.

Funding

No funding was received.

CRediT authorship contribution statement

Marwa M. Hassan: Conceptualization, Methodology, Software, analysis and interpretation, and the final draft. **Anwar Al Nuaim:** Analysis and interpretation, Writing – original draft preparation, Conceptualization, Methodology and the final draft. **Safaa R. Osman:** Visualization, Investigation, the final draft, Conceptualization, Methodology, and analysis and interpretation. **Mohamed D. Hassan:** Supervision, software, conceptualization, methodology, analysis and interpretation, and the final draft. **Taghreed M. Ismail:** Writing – reviewing and editing, conceptualization, methodology, analysis and interpretation, and the final draft.

Declaration of Competing Interest

None declared.

Acknowledgements

The study supported by the deanship of scientific research at King Faisal University, Saudi Arabia under the annual research project (Grant N 122).

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