Research Paper

Effectiveness of Family-based Sensory Diet in Symptoms of Students With Attention-deficit/Hyperactivity Disorder

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ABSTRACT

Objectives: This study aims to evaluate the effect of a family-based sensory diet on the symptoms of attention-deficit/hyperactivity disorder (ADHD) in students.

Methods: This study was conducted using a quasi-experimental method with a control group and a pre-test and post-test design. The statistical population included all children with ADHD between the ages of 6 and 12 years who were referred to the Hasti, Bahar, and Masir Sabz clinics in Tehran City, Iran in 2021. Using the convenience sampling technique, 30 kids were selected and randomly divided into the experimental and control groups. The Wilbarger sensory protocol was used in the experimental group, which underwent a family-based sensory diet intervention (3 times a week, 45 minutes per session). The Conners' parent form scale and the Wechsler intelligence scale for children 4th edition (WISC-IV) were used to measure the study variables. The SPSS software, version 20 was used to conduct the statistical tests, which included the analysis of covariance.

Results: The results of the covariance analysis showed that the family-based sensory diet program had a substantial impact on the mean post-test scores for the two groups (P=0.001).

Discussion: For students with attention deficit, hyperactivity disorder, and impulsivity caused by ADHD, implementing a family-based sensory diet can be useful in lowering these symptoms.

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Highlights

• A sensory diet can offer the right kind of sensory stimulation to improve overall health and functional outcomes.

• Include play and exercise in your daily routine.

• Balance and sensory environments in the classroom help improve focus, memory, and concentration.

• A sensory diet helps reduce the difficulties associated with attention-deficit hyperactivity disorder (ADHD) while fostering creativity, social skills, and problem-solving abilities.

Plain Language Summary

A sensory diet is an activity program, tailored to each person that helps them adjust their level of 'arousal', and is a daily routine that includes relaxing during the day and organizing activities. Sensory diet intervention is a new and effective intervention in children with attention deficit hyperactivity disorder (ADHD) and improves the performance of these children in different social situations and can be used in Iran as a new, practical, and free method.

Introduction

Children with attention-deficit/hyperactivity disorder (ADHD) may have trouble participating in a range of activities at school, play, home, or in other social settings. ADHD is a relatively prevalent childhood disorder [1]. Its global prevalence is 5% and it is 3%-6% in Iran [2]. Its main symptoms include inattention, hyperactivity, and impulsive behaviors. It is also associated with specific internalized cognitive symptoms, including restlessness and emotion. The impulsivity of this disorder is recognized as a lifelong illness and can be diagnosed with different types. Unique cognitive phenomena in addition to emotional symptoms often ignored by people. Difficulties with time perception have been reported in people diagnosed with ADHD [3]. These issues often cause learning difficulties, especially in reading. In addition, other problems, such as aggression, social maladaptation, and antisocial behaviors are often secondarily observed with ADHD [4].

The central and peripheral nervous systems are responsible for controlling sensory information that has been received during the process of sensory processing. Receiving, adapting, integrating, and organizing sensory stimuli are all part of this management [5].

Approximately 40% to 80% of children with disabilities and 5% to 10% of typical children have sensory processing deficits [6]. These kids have hyperactive behaviors, lack concentration, and are impulsive primarily due to impaired sensory processing [7]. Consistent with the research results, these children are sensitive to sensory stimuli. In infancy, they are easily disturbed by environmental changes. In addition, in the process of sensory adjustment, behavioral problems manifest as sensory overexpression [8]. Yochman's investigation revealed that ADHD children are significantly different from healthy children in terms of responding to sensory stimuli, most likely due to deficits in sensory processing ability [9]. In multiple studies on children with ADHD, sensory processing disorder has been detected and reported that under sensory processing disorder, problems pertinent to attention and behavior management will appear [10].

Sensory integration is defined as a neurophysiological process that determines the role of the central nervous system in organizing, interpreting, processing, and modulating information from sensory systems. The sensory systems include sight, smell, taste, touch, hearing, vestibule, and proprioception, all of which are associated with learning and previous memories stored in the brain. From the integration of these systems, we can respond appropriately to daily stimuli and situations. However, when this sensory processing is not done properly, the condition is known as sensory processing disorder (SPD) [11].

A sensory diet is one of the sensory integration interventions based on the theory that controlled sensory inputs can improve performance abilities [12].

The term "sensory diet" describes a variety of activities that are particularly added to children's daily schedules to aid in enhancing their focus, curiosity, and adaptive responses. The selection of activities is performed according to the needs of the child and the principle of sensory integration. They are used at various times throughout the day to assist in regulating the brain's degree of alertness and attentiveness. Depending on the nature and intensity of the stimulation, these substances can be released for up to two hours. Planning the sensory diet during the day is crucial to sustaining these neurochemicals in the brain [13].

According to the results of Ghanizadeh's study [14], sensory issues and hyperactivity interact, and sensory processing programs are effective in easing the symptoms of anxiety and oppositional disorders. Additionally, the results of Ebrahimi et al.'s study [15] demonstrated that sensory integration, particularly proprioception and vestibular senses affect how well adolescents with ADHD perform in the classroom.

According to the results of Dehghan et al.'s study [16], behavioral issues in children with ADHD worsen as sensory disorders do. According to statistics of Molagholamreza Tabasi et al. [5], some behavioral symptoms of ADHD in children may be caused by sensory processing problems. Additionally, Rathod et al.'s study [17] found that sensory integration therapy alone or in combination with cognitive-behavioral therapy significantly decreased ADHD symptoms as measured by the Conners' scale.

In a study, Ebrahimi et al. [15] assessed the effectiveness of motor-sensory integration activities on ADHD symptoms, which improved impulsivity, attention deficit, and hyperactivity in studied subjects.

Considering the high prevalence of attention deficit hyperactivity disorder in school children, the many issues these children face in different areas of their personal and social lives, the importance of early intervention and the evidence supporting the effectiveness of sensory integration therapy. In this study, we attempted to use the family-based sensory diet, which is one of the sensory integration interventions, to improve different behavioral, motor, educational, and language functions of patients with other childhood disorders. Only a few studies have been conducted on the impact of sensory diet therapy on improving the symptoms of patients with attention deficit hyperactivity disorder. We made an effort to give the youngster the right amount of family-based integrated sensations to reduce their ADHD symptoms [12]. The present study sought to answer whether implementing a family-based sensory diet program can improve attention deficit, hyperactivity, and impulsivity problems in children.

Materials and Methods

The current study was applied objectively and technically with a pre-test and post-test design and a control group. The study samples consisted of 30 children with ADHD aged 6-12 years living in Tehran City, Iran. They were randomly selected by convenience sampling method from children with ADHD (combined type, inattention, and hyperactivity/impulsivity) referring to Hasti, Bahar, and Masir Sabz clinics. We used the Wechsler Intelligence Scale for children fourth edition (WISC-IV) to assess children's intelligence and Conners parent form to measure ADHD. Then, the children were randomly split into two groups of 15 (intervention and control). The inclusion criteria included a diagnosis of ADHD by a pediatric psychiatry specialist, no mental disability based on children's Wechsler test, lack of vision and hearing problems, epilepsy, and seizures. The exclusion criteria included non-cooperation to attend the sensory diet program at any study stage.

The intervention group underwent 12 sessions of a family-centered sensory diet program based on the Wilbarger sensory protocol (3 sessions per week; each session lasted 45 minutes). The control group just received standard occupational therapy interventions. The goal of the intervention's first session was to acquaint the family and the child with it. This was done by looking at the child's sensory status, discussing how to correct environmental stimuli, looking at the child's workplace, planning and scheduling the sensory diet, etc. During the subsequent intervention sessions, some education was taught to the parents to adjust sensory inputs, such as increasing self-regulation and the level of consciousness, raising the level of attention using vestibular and proprioceptive stimuli, and using proper and controlled watching and hearing. It should be mentioned that each therapy session included 5 to 6 exercises, and the activities either got harder or changed in future sessions depending on the children's performance. In the seventh session, the sensory diet process was evaluated to ensure the proper functioning of the family and the effectiveness of the exercises. In the last treatment session, the Conners' test, the parent form, was performed on both groups again to evaluate the process of the sensory diet program and conduct the post-test. The statistical tests, including analysis of covariance, were performed via SPSS software, version 20.

Family-based sensory diet

This program is a thorough sensory approach to addressing sensory processing issues and is derived from Wilbarger's (2018) therapy protocol. The deep pressure, proprioception, and oral tactile technique, as this idea is officially termed, aids in organizing the mind, brain, and body. The technique improves body self-regulation, reduces tactile defensiveness, and increases attention and engagement in daily tasks. Three steps make up this protocol, a sensory diet, compression of the joints, and body brushing with a sensory brush. The sensory diet consists of a series of sensory inputs and activities given to the body and neurological system to keep alertness levels as high as possible. Activities are selected according to the needs of the individuals and are included in their daily schedules. These activities increase the level of consciousness, promote the body's awareness about himself/herself, the environment, and others, encourage to attend activities, improve learning, play, and sleep, interact with peers, and raise productivity and functionality [6].

The summary of sensory diet exercises utilized for the intervention group is presented in Table 1.

Wechsler's intelligence scale for children (WISC-IV)

In the present study, the fourth edition of Wechsler's intelligence scale for children (WISC-IV), published in 2003, was utilized. The fourth edition of this scale calculates total intelligence and four types of intelligence, verbal comprehension (similarities, vocabulary, comprehension, general information, and verbal reasoning), perceptual reasoning (block design, picture concepts, picture reasoning, and picture completion), working memory (digit span, letter-number sequencing, and arithmetic) and processing speed (coding, symbol search, and cancellation). In their study, Sadeghi et al. [18] examined the reliability and validity of WISC-IV. The validity results between this scale and Raven progressive matrices revealed a significant correlation between the two scales. The reliability of the test was calculated via two methods of split-half and test re-test. The subscales re-test reliability was obtained from 0.80 to 0.88, and the split-half reliability coefficient was from 0.83 to 0.91.

Table 1. Objectives and content of the educational program

Session	Educational Program
1	Getting acquainted with families, assessing the sensory status of children, introducing the program and the conditions of the child's training area, scheduling the program
2	Vestibular and proprioceptive stimulations, Deep massage, walking on slippery surfaces before class, sitting in a rocking chair with a heavy vest or hat during class.
3	Vision and vestibular stimulations, jumping on the spot before homework, talking while sitting on a yoga ball, spinning in circles, and playing in the sand
4	Vision and vestibular stimulations, listening to music with headphones, chewing gum while doing homework, sitting on a ball chair, and memorizing lessons
5	Proprioceptive stimulation and increase of tolerance, leaning and sitting behind a desk longer, squeezing a jelly ball during class, sleeping in a sleeping bag, and playing on a cloud mattress
6	Proprioceptive stimulation, doing heavy physical activity, playing skateboarding, and moving objects
7	Measuring progress, re-assessing performance and sensory diet
8	Proprioceptive stimulation, dancing, drawing growing circles, squeezing the sponge into the water and jumping on the cloud mattress
9	Vestibular stimulation and interaction between brain nuclei, crawling, ladder climbing, memoir repetition, listening to lessons with headphones, and walking in a straight line
10	Visual and vestibular stimulations, Swedish swimming, wall ball, a structural puzzle game, a swing game, lesson review
11	Proprioceptive and balance stimulation, bike riding, cutting paper into thin strips, playing with ropes
12	Reassessment and summarization

Conners questionnaire

This scale measures attention deficit, hyperactivity, and impulsivity and is one of the common tools to measure children's behavior based on a dimensional classification system. It includes several behavioral questionnaires for children. In 1973, Conners introduced the 93-item scale, which was inclusive for parents. Then, Goethe, Conners, and Alvich devised the short form of this scale (48 items) in 1978. The Conners' scale was initially created to assess how stimulant medication affected children with ADHD and to set them apart from other children. Children with ADHD are now diagnosed using a modified questionnaire with 27 items. It has four cognitive subscales, attention deficit (with 6 questions), hyperactivity (with 6 questions), confrontational disobedience (with 6 questions), and index (with 9 questions). Each question is scored from 0 to 3 (0=not true at all, never; 1=only slightly true, occasionally; 2=relatively true, often; 3=absolutely true, very much). They get a score of 3. According to the number of test questions, the total test score ranges from 0 to 81. In this test, obtaining a cutoff score of 1.5 or more for each question indicates the presence of ADHD.

The reliability coefficient of the re-test for the total score is 0.58, and the Cronbach α coefficient for the total score is 0.73, and its validity is 0.84 [19]. In this study, we used the attention deficit, hyperactivity, and coping subscales of the Conners' questionnaire. Beik et al. [20] found a high correlation between the subscales of the Conners' scale and the cognitive-motor function test in children with ADHD.

Results

Thirty children with comorbid ADHD (mean age= 9.56±4.38 years; 11 girls (36.6%); 19 boys (63.3%)) and their moms (mean age=34.23±6.9 years) participated in the study. Table 2 presents the list of demographic and clinical characteristics of the subjects.

According to the results obtained for the pre-test and post-test variables of sensory diet and occupational therapy, the significant value of the test is greater than 0.05 (P=0.107), the assumption of variance equality in the two groups cannot be rejected and the pre-test and post-test mean of the two groups can be compared (Table 3). Therefore, we utilized the first row related to establishing the assumption of the equality of variance. Com-

Table 2. Demographic characteristics of subjects in terms of mothers' education and employment and age of students

Characteristics		No. (%)/Mean
Gender	Female	11(36.6)
	Male	19(36.3)
Children's age	6-8	9(30)
	8.1-10	11(37.7)
	10.1-12	10(33.3)
Mean intelligence score	Female	104.01
	Male	103.84
Mother's education	Associate degree or lower	9(30)
	Bachelor's degree	14(47.7)
	Master's degree or higher	7(23.3)
Mother's occupation	Employed	16(53.3)
	Housewife	14(47.7)
Type of ADHD	Mixed (inattention and hyperactivity/impulsivity are present at the same time)	

ADHD: Attention-deficit/hyperactivity disorder.

paring the pre-test and post-test mean of a sensory diet and occupational therapy between the two groups, the t statistics was 3.550, and the corresponding significant value was less than 0.05 (P=0.001) (Table 4). Therefore, the pre-test and post-test mean scores of the sensory diet and occupational therapy in students who received sensory diet in addition to occupational therapy are significantly higher than those who were only treated with occupational therapy (Table 5).

Discussion

This study was conducted to assess the performance of a sensory diet program for ADHD kids in families. The results of the study demonstrated that the family-based sensory diet program lowers impulsivity, hyperactivity, and attention deficit in students with ADHD.

The results of this study are consistent with the results of Peterson et al.'s study [21]. They showed that a sensory diet has beneficial impacts on lowering aberrant behaviors, and boosting attention span and memory retention in kids with ADHD. Senapati and Kumari Sahoo also [22] studied how a sensory diet affects the functional behaviors of children with ADHD. In this study, 28 children aged 6-12 diagnosed with ADHD were selected and assigned to two intervention and control groups. Sensory diet interventions were given to the intervention group for two months, and during that time, improvements in self-control and functional behaviors in the family, classroom, and community were observed. To explain these results, we may claim that the prefrontal cortex has a specific purpose in linking the extensive network of the brain's motor, perceptual, and limbic regions. Extensive projectiles reach from most areas of parietal, temporal, and occipital lobes to the prefrontal cortex. Subcortical structures, including the basal ganglia, cerebellum, and various brainstem nuclei send signals to the prefrontal cortex indirectly and through a few links. Numerous relationships exist between the prefrontal cortex and the majority of the brain's regions. It also plays a part in the coordination and executive functions of the brain due to its extensive connections [23]. In addition to improving prefrontal cortex performance, the sensory diet affects the thalamus and cortex due to the interaction between the subcortical and cortical areas, particularly the prefrontal area.

Pingale et al. [6] assessed the success of the sensory diet in three experiments as part of a review of research, and the results were satisfactory. To treat abnormalities in sensory processing, he advised the use of a sensory diet. Pingale et al. [6] studied the impact of a sensory diet on three autistic children in a different trial. Their sensory processing issues, social skills, and behavior control in the classroom all showed considerable improvement. Hare [24] assessed the efficiency of sensory processing therapy in lowering impulsivity and anxiety

Table 3. Descriptive data of attention deficit, hyperactivity, and impulsivity variables of students in pre-test and post-test stages

Variables	Stage	Group	Mean±SD	Min	Max	No.
Attention deficit	Pre-test	Intervention	39.47±5.18	31	47	15
		Control	39.47±4.97	31	47	15
	Post-test	Intervention	35.40±5.46	27	44	15
		Control	39.0±4.71	30	46	15
Hyperactivity	Pre-test	Intervention	16.87±2.20	12	20	15
		Control	16.8±1.74	14	19	15
	Post-test	Intervention	11.8±2.11	7	14	15
		Control	16.0±2.0	12	20	15
Impulsivity	Pre-test	Intervention	30.93±3.81	24	36	15
		Control	30.67±2.89	25	36	15
	Post-test	Intervention	24.0±3.047	20	28	15
		Control	30.47±2.85	24	35	15

Table 4. Univariate covariance analysis to assess the impact of family-based sensory diet program on ADHD and impulsivity in students with ADHD

Variable to Assess the Impact of Family-based Sensory Diet Program on	Source of Variation	Sum of Squares	df	Mean of Squares	F	Sig.	Effect Size
Attention deficit in students with ADHD	Pre-test	681.503	1	681.503	399.168	0.000	0.937
	Group	97.200	1	97.200	56.932	0.000	0.678
	Error	46.097	27	1.707			
	Total	42340	30				
Hyperactivity in students with ADHD	Pre-test	61.950	1	61.950	29.631	0.000	0.523
	Group	135.428	1	135.428	64.775	0.000	0.706
	Error	56.450	27	2.091			
	Total	6047	30				
Impulsivity in students with AHDH	Pre-test	200.389	1	200.389	124.825	0.000	0.822
	Group	333.872	1	333.872	207.973	0.000	0.885
	Error	22807	27	1.605			
	Total	557.367	30				

ADHD: Attention-deficit/hyperactivity disorder.

in 18 to 26-year-olds with ADHD and found that these individuals' anxiety and impulsive control were significantly affected. Sheikhtaheri et al. conducted a study titled "developing a mobile phone-based application to educate parents of children with ADHD" [12]. The results showed that sensory diet programs helped youngsters with ADHD by reducing their symptoms. These results are explained by the idea that a sensory diet can help these kids' symptoms by improving the way their central nervous systems receive information. Additionally, treating this disease with an early diagnosis and effective intervention techniques may greatly minimize the symptoms [25]. Additionally, the sensory diet based on the principle of sensory integration helps the children be more organized in their responses to sensory stimuli and greater interaction with their environment [21] by transcending the senses of the environment and raising their level of consciousness.

For children with ADHD aged 5 to 12 years old, Hemant and Ferzandi studied sensory integration therapy [10]. According to the study's results, these children's sensory processing problems were influenced by their treatment for sensory integration.

The results of this investigation are consistent with the results of Niklasson et al. [26] and VandenBerg [27]. They evaluated how the use of sensory stimulation affects the cognitive abilities of kids with ADHD. Moreover, the above study's results are consistent with the results of Salamati et al., who examined the effect of vestibular sensory stimulation on children with ADHD. They confirmed the effectiveness of this diet on the attention and auditory perception of these children [28].

To explain these results, the problems associated with ADHD, including motor skills impairment, attention

Table 5. The t-test for means equality between pre-test and post-test regarding sensory diet and occupational therapy

Variables	F	Sig.	df	Sig.	t
Assumption of variance equality	2.674	0.107	58	0.001	3.550
Assumption of variance inequality			54.076	0.001	3.550

deficit, learning disability, aggression, academic issues, stimulation, and motor restlessness, are very significant [16, 29]. Problems with sensory integration, such as poor posture, inadequate visual response, and abnormal muscle tone, impact body scheme, and the reciprocal and coordinated use of body organs are due to poor processing and data integration from the vestibular and proprioceptive senses. This deficiency in information processing can lead to disgust or fear of movement, decreased range of motion, reduced attention, emotional instability, and so on. In addition, there may be issues with people's tactile systems. The consequence of all these problems is the reactions that we encounter at the outset of the treatment session: low concentration, irritability, unmotivated, and unorganized behavior [30].

According to the results of Omaran's [31] dissertation titled "the effectiveness of sensory integration on the executive activities of children with ADHD", children in the intervention group performed significantly better in response inhibition, sustained attention, and working memory when compared to children in the control group. Furthermore, sensory integration treatment caused effective and lasting changes in participants' performance in the components of executive functions. The results of this study indicated that sensory integration can be used as a practical treatment approach for children with ADHD.

Majorek et al. [32] also assessed the impact of rhythmic movements (a type of movement therapy) on the behavioral functions of children with ADHD and the reported positive effects of movement programs on attention span, concentration, work rhythm, and skills such as agility coordination and social behavior. These results are consistent with the results of the present study on improving attention. Dehghan et al. also investigated the effect of perceptual-motor training on the behavioral abnormalities of 5-8-year-old children with ADHD. Behavioral issues, such as anxiety, attention, aggression, and social problems also showed improvement [16]. In addition, Kao et al. [33] stated that the high physical fitness level of kids induced after motor exercises is related to the parameters of attention, working memory, and speed of response, which also confirms the results of the present study.

The impact of using sensory integration therapy in improving ADHD in children is inconsistent with the study of Gharebaghi et al. [34], who examined the effectiveness of sensory stimulation on the attention performance of children with learning disabilities. The difference may be because, in the above study, proprioceptive stimulation was utilized only with a vest and saddle during routine occupational therapy sessions. Therefore, this effect was not confirmed because the fundamental principles of sensory integration comprised the combination of three proximal sensory systems. Moreover, the small number of samples in their study is likely a reason to disprove their effectiveness.

Chu and Reynolds used Bhatara's research that examined how well sensory stimulation can reduce the symptoms of ADHD in their investigation and reported that the three primary symptoms of ADHD were significantly affected by sensory stimulation [35]. These results are also consistent with the results of Ebrahimi [15] on the effectiveness of sensory integration treatment and impulsivity in children with ADHD.

Niklasson et al. [26] evaluated the impact of vestibular stimulation on children with ADHD, learning disabilities, and developmental speech delays. The children improved in concentration problems, social skills development, relaxation, and hyperactivity control. In another study conducted by these two researchers, 20 children with attention deficit hyperactivity disorder received vestibular and auditory stimuli. The reports by teachers and parents demonstrated positive and significant impacts in the areas of behavior, concentration, hyperactivity, and attention disorders. Improvement was more in younger kids than in older children.

In a study titled "the effectiveness of group integration interventions on attention, hyperactivity, and impulsivity of elementary school students with hyperactivity disorder", [36, 37] found that sensory integration significantly reduced the experimental group's impulsivity, hyperactivity, and attention deficit disorders.

The therapeutic approach used in this study differs from the therapeutic approach used in previous investigations. In this study, parents gave their kids sensory diet plans and exercises, which they helped them complete. In recent years, ample discussions have been raised concerning various exercise methods suitable for children with ADHD, but few have been conducted on the interaction between parents and children. It is well recognized that parents are the main providers of their children's daily requirements. As a result, parents were used in this study because they are the most reliable sources of assistance for kids. Each coach-centered or parent-centered intervention method has unique characteristics, with both training methods having positive effects on motor performance. The parent-centered approach appears to have been successful in influencing psychologi-

cal traits, including a sense of community and belonging, motivation, increased confidence, etc. Also, according to the study results, a sensory diet is suitable for utilization as a treatment for children with ADHD or at least as a complementary method, and in combination with other available tools. Therefore, psychologists, educators, teachers, and parents are recommended to employ the results of this study to increase the attention of children with ADHD.

Conclusion

The results of the above study show that sensory diet intervention is an effective and new intervention in treating children with ADHD and improves their performance at home, school, and society/community. Since this approach is applicable, family-based, free, and accessible, especially during the current COVID-19 pandemic (where people may not want to take their children to a medical facility), it is a practical and appropriate alternative solution for multiple groups of society. Although sensory processing defects are apparent in numerous childhood disorders, and considering the available evidence, the sensory diet approach has neither been implemented as a separate therapeutic intervention nor researched or studied in Iran. Thus, the sensory diet approach can be utilized for such disorders with other treatments.

Ethical Considerations

Compliance with ethical guidelines

Approval was obtained from the Ethics Committee of Science and Research Branch of Islamic Azad University (Code: IR.IAU.SRB.REC.1400.155). Before the study, written and verbal consent was obtained from the participants and the confidentiality of their information was ensured.

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Authors' contributions

All authors equally contributed to preparing this article.

Conflict of interest

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