

Pythagorean Self-Awareness Intervention Promoted Healthy Dietary Patterns, Controlled Body Mass Index, and Reduced Self-Reported Stress Levels of Primary School Children: A One-Arm Pilot Study

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Abstract

Stress is common in childhood and an important factor that affects behavior later in adulthood. The aim of this study was to assess the effects of the Pythagorean Self-Awareness Intervention (PSAI), a holistic “cognitive reconstruction” technique to assess primary school children’s stress levels, adherence to the Mediterranean diet, and body mass index. Secondary outcome measures included relations with peers, sleep, and hair cortisol concentrations. This one-arm pilot study took place in a primary school, from February to

June 2019. Participants were 32 pupils attending the second grade of primary school who received the 8-week PSAI to adopt healthy behaviors and lifestyle. Self-report measures were applied for the evaluation of various variables at the beginning and the end of the eight-week intervention. There were statistically significant reductions in stress levels ($p = 0.00$), nightmares’ frequency ($p = 0.00$), body mass index ($p = 0.03$), and bully scale ($p = 0.00$), and improvement in Mediterranean diet quality ($p = 0.00$). Hair cortisol concentrations increased ($p = 0.02$). The social scale significantly increased. Bedtime remained the

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same after the intervention. This pilot trial showed that the PSAI promoted healthy dietary patterns, controlled children's body mass index, and reduced their self-reported stress levels. Further research on the implementation of this holistic program on children is suggested, in well-powered randomized controlled trials.

Keywords

Body mass index · BMI · Intervention · Pythagorean self-awareness · Stress · Healthy lifestyle · Bullying · Children · Students · Mediterranean diet

2.1 Introduction

Research on stress demonstrates that it can have both beneficial and harmful effects on health, wellbeing, and performance [1]. In fact, stress experienced by children each day can influence a plethora of complex and interacting physiological reactions. These reactions affect many organ systems within the body. For instance, emotional stress can stimulate the autonomic nervous system, mainly the sympathetic branch, and alter heart rhythm patterns, ultimately altering the activity pattern in the afferent neurological information transmitted from the heart to the brain. Matthews, Gump, Block, and Allen [2] also found that children with significant sources of ongoing stress in their lives exhibited increased physiological activation in response to acute laboratory stressors. Negative affect was also found to be linked to increased resting blood pressure levels in adolescents [3]. Similarly, Matthews

et al. found that children who had chronic or ongoing stressors present in their lives exhibited higher diastolic blood pressure responses to acute laboratory stress tasks when compared to children with less background stress in their lives.

Exposure to chronic and acute life stressors can disrupt the neuroendocrine stress regulation system. The increased production of cortisol can result in epigenetic changes in the structure of regions of the brain responsible for emotion regulation and other important functions, and promote obesogenic eating behavior and dietary patterns, as well as lifestyle factors (e.g., disturbance in daily routine, poor sleep, low physical activity) that may increase obesity risk [4–7].

One step further, it has been reported that overweight or obese children are more likely to experience bullying victimization in school settings across different countries [8]. On the other hand, it has been reported that bullied children exhibit a greater risk of becoming overweight or obese [9], while obesity has been found to be associated with psychosocial maladjustment including increased anxiety, depressive feelings, loneliness, lowered self-esteem, and behavior problems.

The above data support the notion that ongoing stress and improper management not only affects a child's health status in the present but also may have cumulative and long-term effects. In examining the present effects of stress, research has also supported the idea that the presence of stress in children can impair cognitive processes involved in learning [10] as well as appropriate social interactions with others.

Parents, on the other hand, may not be able to identify children's stress and its impact on their children, as it is suggested by Breiner et al. [11],

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and it has also been suggested that many parents believe that the child is seeking attention or being difficult, rather than recognize their behaviors as a result of stress.

School settings with the collaboration of parents, teachers, and health professionals can ideally be used for the implementation of health promotion programs to primarily manage stress and prevent its adverse effects on children. Traditionally, school-based programs for overweight and obese children have focused only on the training of healthy eating and increase in physical activity [12]. However, there is a need for school-based intervention programs to reduce stress and its effects. Multicomponent school-based interventions promoting adherence to the Mediterranean diet (MD) have the potential to combat obesity [13].

Based on the aforementioned, we present the effects of the Pythagorean Self-Awareness Intervention (PSAI), a novel holistic stress management program that combines evidence-based lifestyle recommendations (Mediterranean diet, sleep routine, physical activity, limited use of screens, etc.) and cognitive reconstruction based on the teaching of the ancient Greek philosopher, Pythagoras.

The PSAI has demonstrated favorable physical, metabolic, and mental health outcomes in children and adults in Greece. In the school setting, Kalogiratos et al. [14] found that PSAI decreased emotional eating and promoted well-being in third grade primary school children. PSAI has also demonstrated amelioration of stress and aging biomarkers in a sample of type II diabetes mellitus and healthy adults [15]. In addition, the PSAI showed positive results in decrease in weight in a sample of obese adults as well as in a community sample [16, 17]. Furthermore, the implementation of PSAI had positive outcomes in a sample of patients with major depression [18].

The primary aim of the study was to investigate the effects of the PSAI on primary school students' stress levels, adherence to the Mediterranean diet, and body mass index (BMI). Secondary outcome measures included relations

with peers, sleep, and hair cortisol concentration (HCC).

2.2 Subjects and Methods

2.2.1 Study Design

A one-arm pilot study took place at the 4th Primary School of Chalandri, Municipality of Attica Province (Greece), from February to June 2019. The program received ethics approval by the Ministry of Education Φ.2.1/ΣΔ/43813/Δ7 for the academic year 2019–2020.

2.2.2 Participants

Pupils attending the second grade of primary school with good comprehension of the Greek language were eligible to participate in the study intervention for eight weeks. Children were excluded from the study if they practiced other stress management techniques. Written consent forms were obtained from children's parents before inclusion in the study.

2.2.3 Measurements

2.2.3.1 Socio-demographic Data

Sex, age, family members, and siblings were recorded for each study participant. Measurements took place in the classroom after completion of school's schedule.

Measurements were performed by a health professional trained in the science of stress. Children completed the questionnaires on their own in the presence of the stress scientists in case they had any queries. The following measures were assessed at baseline and after the intervention.

2.2.3.2 Anthropometric Data

Body weight and height were measured at school with the use of a calibrated digital scale and a stadiometer, in the minimum clothing possible. Body mass index (BMI) was estimated.

2.2.3.3 Hair Cortisol

A sample of hair (3 cm) was obtained from each participant for measurement of hair cortisol concentration (HCC). A lock of hair as thick as a pencil was cut by scissors from the posterior vertex as close as possible to the scalp. As hair has a predictable growth rate of about 1 cm/month, the closest part of 1 cm to the scalp approaches the production of last month's cortisol. Hair samples were stored in paper envelopes at room temperature pending analysis. The first three centimeters of hair proximal to the scalp were cut and pulverized with a ball mill. Cortisol was extracted into methanol. Hair cortisol analysis took place at the Choremeio Research Laboratory, Unit of Clinical and Translational Research in Endocrinology of the First Department of Pediatrics, School of Medicine, National and Kapodistrian University of Athens, Greece. Physiological mean concentration of hair cortisol in healthy children aged eight to nine years has been reported to be 6.7 pg/mg [19].

Stress in Children Questionnaire (SIC): The Stress in Children Questionnaire consists of 21 questions that examine the stress that children may encounter in many aspects of their life and has been used with children aged between 8 and 12 years. Higher scores indicate higher levels of stress [20].

KIDMED Index: The Mediterranean Diet Quality Index for Children and Adolescents (KIDMED) is based on the principles of Mediterranean dietary patterns and comprises 16 “yes” or “no” questions that could be self-administered or conducted by interview. Overall score ranges from 0 to 12 and it is derived from the summation of the values, which is classified into three levels: (1) >8 , optimal adherence to Mediterranean Diet; (2) 4–7, improvement needed to adjust intake to Mediterranean patterns; and (3) ≤ 3 , very low diet quality. The instrument has been used in children and adolescents aged 3–18 years [21].

Peer Relation Questionnaire for Children (PRQ): The Peer Relation Questionnaire (short form) for children measures the bullying phenomenon consisting of 12 items with 3 subscales (tendency to bully others, tendency to be victim-

ized by others, and tend to act in a pro-social or cooperative manner). The instrument has been validated in children and adolescents aged 8–14 years [22].

Sleep: A series of questions were asked to measure the bedtime and the frequency of nightmares. Mean scores were calculated.

2.2.4 Pythagorean Self-Awareness Intervention for Children and Adolescents

Pythagorean Self-Awareness Intervention for Children and Adolescents (PSAI-CA) is a holistic “cognitive reconstruction” technique of stress management and improvement in the quality of life, sleep, and memory. The technique was developed by the Medical School of Athens at National and Kapodistrian University based on the new concept of Evidence-Based Lifestyle Medicine [23] and World Health Organization (WHO) data for adolescents [9]. The technique relied on the philosophy of an ancient Greek philosopher Pythagoras of Samos (c. 570 e.c. 495 BCE) [24]. As Pythagoras stated, self-awareness and eudemonia are achieved through constant introspection and self-control. The purpose of the technique is to increase self-awareness using a moral reference for this critical appraisal. The analysis of the neurophysiology of the technique refers to the activation of the Default Mode Network (DMN), a large-scale functional brain network. The DMN is activated when the individual focuses on internal self-relevant mental processes such as memory retrieval of autobiographical events, envisioning future actions, and being aware of the perspectives of others [25, 26].

The technique of PSAI-CA is mainly practiced shortly before night sleep and the individual must follow three cognitive processes. A rule referred to “The Twelve Virtues” has been developed as a moral reference to accomplish the children's self-awareness by following five simple steps, which are presented in Table 2.1. Pythagorean virtues are: (1) fairness, (2) truthfulness, (3) charity and spirituality, (4) decent

behavior, (5) discipline and respect for the law, (6) order and accuracy, (7) industriousness, (8) cooperation, (9) contribution to the general good, (10) courage, (11) cleanliness and perfect appearance, and (12) temperance. Events or choices of personal relationships are judged freely by the individual since the primary goal is to enhance self-awareness and not to criticize them [27].

2.2.4.1 PSAI-CA Implementation

Eight sessions were part of the program and numerous pieces of advice were included about healthy nutrition, sleep, physical activity, bullying, and screens (mobile-tablet-PC). Sessions were held once per week (90 min) over eight weeks. The first session included information about the stress system, symptoms, and effects. Students were trained individually in diaphragm breathing using the Biofeedback software. The five tricks were presented to the students. Pedometers were provided as a motivation for exercising. In the second session, participants received instructions on the practice of Pythagorean Self-Awareness and the 12 virtues were taught. In the following sessions guidelines and advice on the Mediterranean diet, physical activity, sleep, use of screens, and bullying were given to the students. During sessions, they were encouraged to discuss practical issues or ideas

that might have emerged during the previous days. In each session, a weekly activity logbook (self-report measure of compliance to the PSAI), reading materials, and homework assignments were provided.

2.2.5 Statistical Methods

The data were analyzed by non-parametric tests due to the small study sample. Adjusted means were calculated through paired sample *t*-test. The level of significance was set at 0.05. BMI was calculated as the ratio of body weight to the square of height (kg/m²). BMI *z*-scores were calculated based on World Health Organization (WHO) growth charts. The SPSS statistical software version 22.0 for Windows was used to perform statistical analyses (SPSS Inc., Chicago, IL). The sample size was not calculated prior to the intervention. However, post-hoc power analysis was performed. Power exceeded 90% based on calculations performed in R software using the *pwr* package [28].

Table 2.1 The five steps of PSAI-CA applied daily for 30 minutes by each participant

1st	Before night sleep sitting on a chair, breathe diaphragmatically for 10 min
2nd	Read the 12 virtues then turn your attention inwards and assume the role of the observer
3rd	Recall every event of the day in the exact time sequence it happened
4th	Observe your day like a video timeline
	Choose the events that seem important to you and assess your actions (reward, detest) using 3 questions based on the 12 virtues and the instructions for a healthy lifestyle you were taught:
	<i>What have I done right?</i>
	<i>What have I done wrong?</i>
5th	<i>What have I omitted that I ought to have done?</i>
	The next day make a quick review of the previous day and set your new goals

2.3 Results

A total of 32 pupils participated in the study and there was one dropout due to change of school. The flowchart of study participants is depicted in Fig. 2.1.

Full participation in all sessions and full compliance with PSAI were assessed in the weekly diaries. The mean age of the participants was 8 years, with 53.1% of participants being girls, 46.9% boys, and 84.4% had siblings, while most of the participants' families had 4 members. Finally, BMI *z*-scores of the participants were within normal range. Descriptive statistics are presented in Table 2.2.

Table 2.3, presents the study's results. There was a statistically significant reduction in stress levels (SIC, *p* = 0.00), nightmares (*p* = 0.00), BMI *z*-scores (*p* = 0.02), and HCC (*p* = 0.02). Adherence to Mediterranean diet was also found to have statistical improvement; KIDMED (*p* = 0.00) was also improved after

Fig. 2.1 Flowchart of the study participants

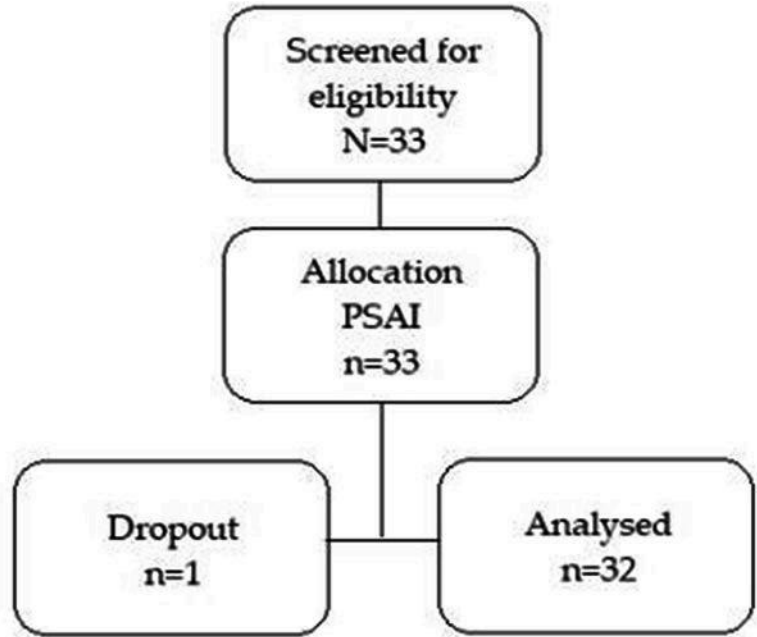


Table 2.2 Baseline socio-demographic and anthropometric characteristics of study's participants

Referential measurements	N = 32
Sex	
Boys	15 (46.9%)
Girls	17 (53.1%)
Mean age in years (SD)	8.03 (0.18)
Min-max age range in years	8–9
Siblings	
Yes	27 (84.4%)
No	5 (15.6%)
Family members	
3	3 (9.4%)
4	25 (78.1%)
5+	4 (12.5%)
Anthropometric measures	
Median weight in kilograms (iqr)	26.90 (6.05)
Mean height in cm (SD)	1.24 (0.06)
BMI z-score	0.94 ± 0.64
Descriptive statistics of the study's participants	

BMI body mass index, *iqr* interquartile range, *SD* standard deviation

the intervention program. Hair cortisol concentrations statistically increased (HCC, $p = 0.02$). Statistical decrease was also noticed in the Bully scale of the bullying questionnaire (PRQ-Bully, $p = 0.00$) while the social scale was statistically increased (PRQ-Presocial, $p = 0.00$). No statistically significant changes

were observed in the PRQ-Victim scale ($p = 0.11$) and bedtime ($p = 0.82$).

Table 2.3 Baseline and post-intervention measurements of the study participants

Measurements	Pre-intervention <i>N</i> = 32	Post-intervention <i>N</i> = 32	<i>p</i> -Value
Primary outcomes			
SIC	2.29 ± 0.70	1.40 ± 0.49	<0.001*
KIDMED	6.41 ± 1.87	10.61 ± 1.39	<0.001*
BMI <i>z</i> -scores	0.94 ± 0.64	0.60 ± 0.81	<0.05
Secondary outcomes			
Bedtime	21.03 ± 1.75	21.30 ± 0.54	0.82
Nightmares	1.33 ± 1.16	0.52 ± 0.90	<0.001
PRQ-Bully	8.15 ± 2.55	8 ± 2.62	<0.001
PRQ-Presocial	12.6 ± 1.96	13.81 ± 2.03	<0.001
PRQ-Victim	8.45 ± 2.31	7.42 ± 1.62	0.11
HCC	4.22 ± 1.98	5.68 ± 3.18	<0.05

SIC Stress in Children Questionnaire, *KIDMED* Mediterranean Diet Quality Index for Children and Adolescents, *PRQ* Peer Relations Questionnaire for Children, *HCC* Hair Cortisol Concentrations, *BMI* Body Mass Index
Measurements are presented in mean ± standard deviation. *Level of significance: $p < 0.05$

2.4 Discussion

The study aimed to assess the effectiveness of a novel holistic cognitive stress management program, PSIA-CA, which included consults of stress, quality of life, sleep, eating behavior, and bullying behavior of children. The hypothesis that PSIA-CA is effective to reduce stress and adopt a healthy lifestyle has been confirmed. After the intervention program, stress levels, nightmares, and BMI were statistically reduced. In the bullying scale, the bully, which represents the physical and psychological maltreatment of one child from another, was diminished. The social scale was increased as well as hair cortisol concentration. Bedtime and PRQ-Victim scale were still the same after the intervention program.

The reduction in stress levels can be explained by the fact that the participants were able to control any stressful factor applying the PSIA technique. The program reduced stress levels and negative emotions and favored a less reward-seeking behavior (e.g., recreational habits) and more healthy choices daily [29–32]. Study participants changed their BMI because of the nutrition guidelines based on the Mediterranean diet, which is considered one of the healthiest dietary models. Kalogiratou et al. found that the implementation of the PSIA had positive effects on a sample of primary school attendants’ emotional

eating and psychological state [14]. In recent studies, the Mediterranean diet had a beneficial effect on certain body systems [33–35]. Children and adolescents may be the age groups with the most unfavorable Mediterranean diet profile [36]. The PSIA has also been used in overweight/obese adults as an effective method for reduction in BMI, body fat, emotional and external eating behavior, as well as adverse metabolic indices [16].

The main reason behind bullying’s reduction is the full compliance of children with PSIA, an item of which was the Pythagorean Virtues. While finding more ways to cooperate, children managed to decrease conflicts. Anger’s control was managed through the virtue of temperance. Instead of counting on conflicts, they solved their disputes through dialogue and mutual understanding. Many anti-bullying programs are effective, because intervention programs reduced peer victimization and increased school safety in 14 schools [34, 37, 38]. Therefore, anti-bullying programs appeared to be substantial in encouraging children to change their behavior for the better [39, 40].

As per the study’s results, the social scale was increased, which means that peer relations were improved among children. Social skills were also improved by supporting each other. The relationships between them ameliorated and they became more cooperative.

The elementary students who suffered constant nightmares have reported a decrease in them. Even though our sample was not obese, this finding is similar to the study of Mazurak et al. [41] who compared sleep quality of children and adolescents with obesity versus a healthy sample and suggested that sleep hygiene education, as part of weight-loss therapy, may provide both physical and psychological benefits to this population. The effectiveness of the PSAI has been confirmed by the reduction in anxiety and an improvement in sleep, diet, and exercise [42].

Our results are consistent with cognitive behavioural therapy (CBT) studies that also improved sleep and reduced insomnia [43–45].

Cortisol is a measure of stress as an end-product of the hypothalamic-pituitary-adrenal (HPA) axis. Hair cortisol is considered superior to the serum and urine cortisol for the evaluation of chronic stress, as it reflects cortisol aggregation over the previous months. Hair cortisol has been associated with physical and mental illnesses in children and adolescents [46]. In our study hair cortisol concentrations were increased, which could indicate the activation of HPA axis [47]. This could be explained by increasing attention and emotional effort through cognitive reappraisal [29]. The frontal lobe can be activated via gnostic reconstruction. The technique was effective using the moral reference and critical appraisal whereas most intervention programs use a specific technique. Pupils embraced the 12 virtues and learned how to evaluate themselves, discerning what is right and what is wrong. They acquired self-control, self-discipline, and restraint. The role of the observer gives the possibility of self-review and self-evaluation [30]. The children were equipped with skills such as self-discipline and self-control and are now capable of using them for their benefit on their way to development. Those skills will also assist them in spiritual improvement, academic performance, and wellness, which in turn lead to social wellbeing [32].

Besides that, to reduce stress and obesity mindfulness interventions have been implemented. When children received mindfulness

training, they reported lower stress [48] and positive results [49]. Furthermore, intervention programs showed that BMI had a significant beneficial alteration [50–53]. A meta-analysis of 19 studies (total participants = 4063) of educational interventions in children and adolescents evaluating social-emotional training, relaxation programs, problem-solving, and stress management showed a positive effect on reducing the symptoms of stress and strengthening coping skills [54]. Environmental, cognitive, and behavioral factors work together to influence children's knowledge of nutrition, self-efficacy, and healthy behavior choices. Both have been shown to contribute to children's eating behavior [36]. However, this study faces some limitations including small and random sample size, lack of control group and short follow-up, small duration of the intervention, and lack of other age groups. Furthermore, compliance to the intervention was assessed by children's self-reports without parental reassurance that all recommendations were followed. Thus, the results of the study cannot be generalized.

2.5 Conclusions

This pilot study showed that the PSAI-CA reduced stress levels and established healthy behaviors and lifestyle in a sample of second grade primary school students. Further research on the implementation of the PSAI on school children is needed to verify these findings, through a well-powered randomized controlled trial.

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