



REDUCTION IN ACADEMIC STRESS, PSYCHOSOCIAL IMPAIRMENT AND PHYSIOLOGICAL PARAMETERS IN WITH RISK ADOLESCENTS OF METABOLIC SYNDROME WITH NEW INTERVENTION “CSSSD” - A PROTOCOL

Clinical Research

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ABSTRACT

Excessive sedentary behavior among children and adolescents is linked to numerous health problems, including increased body fat, poor cardiovascular health, and heightened risk of non-communicable diseases. This study aims to evaluate the effectiveness of Combined Surya Namaskar and Structured Cycling with Habit Modification (CSSSD) compared to conventional methods on Physiological Parameters, Psychosocial Well-Being, And Academic Stress in adolescents at risk of metabolic syndrome. A randomized controlled trial will be conducted in selected schools in Wardha, Maharashtra, involving 100 overweight and obese adolescents (50 interventions, 50 control; equally divided by gender). Participants will be assessed for height, weight, BMI, waist circumference, blood pressure, fasting blood glucose, psychosocial status via the Pediatric Symptom Checklist (Youth Report), and academic stress using the Students' Academic Stress Scale at baseline, 1.5 months, and 3 months. The intervention group will engage in Surya Namaskar, cycling, and habit modifications related to diet, sleep, and screen time, while the control group will follow cycling and habit modifications alone, each for 50-60 minutes per session, five days per week over three months. Data will be analyzed using descriptive and inferential statistics, including Chi-square tests and ANOVA, with significance set at $p < 0.05$. The findings are expected to highlight that integrating Surya Namaskar, cycling, and lifestyle habit changes offers a practical, cost-effective approach to improve health outcomes in adolescents, aligning with WHO's recommendation of at least 60 minutes of daily physical activity.

KEYWORDS

Surya Namaskar, Cycling, Habit Modification, Adolescents, Metabolic Syndrome, Physical Activity

INTRODUCTION AND BACKGROUND

The increasing prevalence of overweight and obesity among children and adolescents has become a major global public health challenge, with far-reaching implications for physical health, psychosocial well-being, and long-term disease risk. Evidence from epidemiological studies indicates that excess body weight during adolescence often tracks into adulthood, significantly elevating the risk of non-communicable diseases such as type 2 diabetes mellitus, cardiovascular disorders, and metabolic syndrome (Ogden et al., 2016; Zimmet et al., 2007; Ford et al., 2010). Beyond metabolic consequences, adolescent obesity is associated with reduced physical fitness, compromised mental health, low self-esteem, and social stigma, all of which can adversely influence academic engagement and educational attainment (Kohut et al., 2019; Livermore et al., 2020). Rapid lifestyle transitions characterized by unhealthy dietary practices, reduced physical activity, prolonged screen exposure, and academic pressures have further intensified this concern, particularly in low- and middle-income countries undergoing urbanization and socio-economic transition (Ranjani et al., 2013; Kohl et al., 2012).

In the Indian context, the burden of adolescent overweight and obesity has shown a steady upward trajectory, especially in urban and semi-urban settings. Studies among school-going children have reported a rising prevalence of insulin resistance, central obesity, and early metabolic abnormalities, underscoring the need for timely preventive strategies (Mangaraj et al., 2021; Rashmi et al., 2020). Adolescence represents a critical developmental window during which lifestyle behaviors are formed, making it an opportune period for intervention. Schools, therefore, provide a structured and inclusive platform to implement health-promoting programs aimed at improving physical activity levels, dietary habits, and stress management among adolescents (Pate et al., 2006; Naylor & McKay, 2009). However, despite increasing recognition of school-based health promotion, many interventions remain fragmented, short-term, or insufficiently adapted to local socio-cultural contexts.

Existing literature demonstrates that structured lifestyle and physical activity interventions can lead to significant improvements in body composition, cardiometabolic risk factors, and psychological well-being among children and adolescents (Xu et al., 2019; Ekelund et al., 2012). Mind-body approaches and integrated activity-based programs have also shown promise in reducing stress levels and improving overall health outcomes (Lubans et al., 2016; Brown et al., 2019). Nevertheless, notable research gaps persist, particularly with respect

to region-specific evidence, robust randomized controlled designs, and comprehensive outcome assessment encompassing anthropometric, metabolic, and psychosocial parameters. Many studies rely on limited follow-up durations, self-reported measures, or isolated outcome variables, which restrict the interpretation and scalability of findings (Janssen & Leblanc, 2010; Strong et al., 2005).

In response to these gaps, the present study was designed to generate context-specific evidence through a structured, school-based intervention targeting overweight and obese adolescents. The study aims to evaluate changes across multiple domains, including anthropometric indicators, metabolic risk components, and related health outcomes, thereby providing a holistic understanding of intervention effectiveness. While the study offers valuable insights, certain limitations must be acknowledged, such as the relatively short intervention period, potential behavioral reporting bias, and the absence of long-term follow-up to assess sustainability of outcomes. Future research should emphasize longitudinal designs, incorporation of objective monitoring tools, and integration of school-based interventions with state and national health programs. Such evidence is essential to inform comprehensive, scalable, and policy-relevant action plans for addressing adolescent obesity and its associated health and academic consequences (Ross et al., 2020; Patton et al., 2016).

AIM AND OBJECTIVES OF THE STUDY

This study aims to evaluate the effects of the Combined Surya Namaskar and Structured Cycling with Habit Modification (CSSSD) compared to conventional methods on selected physiological parameters, psychosocial aspects, and academic stress in adolescents at risk of metabolic syndrome.

(a) Primary Objective

To assess the efficacy of the new intervention, CSSSD, compared to conventional methods on selected psychosocial aspects and academic stress in adolescents at risk of metabolic syndrome.

(b) Secondary Objective

To evaluate the efficacy of the new intervention, CSSSD, compared to conventional methods on selected physiological parameters in adolescents at risk of metabolic syndrome.

To achieve these objectives, the specific aims of the study are as follows:

1. To screen adolescents for overweight and obesity.
2. To assess the efficacy of the new intervention, CSSSD, in managing

physiological parameters, psychosocial aspects, and academic stress in adolescents at risk of metabolic syndrome.

- To assess the efficacy of conventional methods in managing physiological parameters, psychosocial aspects, and academic stress in adolescents at risk of metabolic syndrome.
- To compare the efficacy of the new intervention, CSSSD, with conventional methods after 1.5 months and 3 months of intervention in managing physiological parameters, psychosocial aspects, and academic stress in adolescents at risk of metabolic syndrome.

RESEARCH METHODOLOGY

Study Setting And Design

This study will be conducted in selected schools located in Wardha, Maharashtra. An interventional analytical approach will be employed to evaluate the effects of the intervention. The research design is a randomized controlled trial (RCT), which allows for the comparison of outcomes between an experimental group and a control group while minimizing bias.

Participants And Sampling

Adolescents aged 11 to 16 years with overweight (BMI 23.0–24.9 kg/m²) or obesity (BMI ≥ 25 kg/m²), as per WHO criteria for Asian populations (WHO, 2004), will be recruited. Obesity is a key factor in the risk criteria for metabolic syndrome and thus serves as the primary inclusion criterion. Initially, purposive sampling will be used to identify adolescents at risk of metabolic syndrome based on these BMI criteria from the selected schools. Subsequently, participants will be randomly allocated to either the experimental or control group to ensure unbiased distribution. The study period is set for three months, during which the intervention will be administered and data collected.

Sample Size Calculation

The sample size was determined considering the primary outcome as a continuous variable, based on a pilot study. The calculation used the following parameters: power (1 - β) of 85%, type II error (β) of 15%, confidence level (α) of 5% (z = 1.96), standard deviation (s) of 26.48, and an expected mean difference (D) of 20 between pretest and posttest values (Charan and Kantharia, 2013). The sample size formula applied as shown in Equation 1:

$$n \geq \frac{[Z_{1-\alpha/2} \sqrt{(1+p_1)(1-p_1)} + Z_{1-\beta} \sqrt{p_1(1-p_1) + p_2(1-p_2)}]^2}{r(p_2 - p_1)^2} \quad (1)$$

where $p_1 = 0.666$ and $p_2 = 0.366$ are the proportions in groups 1 and 2 respectively, and r is the ratio of sample sizes between groups (Charan & Kantharia, 2013). After accounting for a 5% dropout rate, the final sample size was rounded to 50 participants per group, totaling 100 adolescents.

Scope And Delimitations

The study is confined to adolescents at risk of metabolic syndrome enrolled in selected schools in Wardha, Maharashtra. The focus is on evaluating physiological, psychosocial, and academic stress parameters affected by the intervention.

Inclusion Criteria

Participants must meet the following criteria:

- Adolescents aged between 11 and 16 years.
- Classified as overweight or obese according to WHO Asian BMI standards.
- Willingness to participate with informed parental consent.
- Residence within 3 to 4 kilometers from the school.
- Ownership of a bicycle to facilitate the intervention.
- Ability to read, write, and understand Hindi, English, or Marathi.
- Availability for data collection at scheduled times.

Exclusion Criteria

The study will exclude adolescents who:

- Have any chronic illnesses that could interfere with participation.
- Suffer from mental health disorders.
- Are unable to participate consistently for five consecutive days due to illness.
- Live more than 5 kilometers or less than 2 kilometers from the school, as distance may affect participation feasibility.

Data Collection Tools And Measurements

Sociodemographic information was collected using a structured demographic questionnaire. Physiological parameters were assessed using standardized and calibrated instruments. Height was measured

in meters using a stadiometer, recorded to the nearest centimeter. Body weight was measured in kilograms with a digital weighing scale, accurate to the nearest 100 grams. Body Mass Index (BMI) was calculated using height and weight values and interpreted based on age- and sex-specific criteria recommended by the Asian Academy of Pediatrics (Table 1).

Table 1. Classification Of BMI Based On Asian Standards.

Weight Status Category	BMI (kg/m ²)	Percentile Range
Underweight	< 18.5	Less than 5th percentile
Healthy Weight	18.5 – 22.9	5th to < 85th percentile
Overweight	23.0 – 24.9	85th to < 95th percentile
Obesity	≥ 25.0	≥ 95th percentile

Waist circumference was measured in centimeters using a non-elastic measuring tape placed at the mid-axillary line, and readings were taken at the end of normal expiration. Blood pressure was assessed using a digital blood pressure monitor with appropriately sized cuffs, acknowledging a possible measurement variation of ±5 mmHg. Fasting venous blood samples were collected to estimate blood glucose levels. The International Diabetes Federation (IDF) criteria were applied for identifying metabolic syndrome components. Psychosocial status was evaluated using the Pediatric Symptom Checklist–Youth Report (Y-PSC), a validated screening tool for identifying psychosocial disturbances. Academic stress levels were assessed using the Students' Academic Stress Scale (SASS), a 40-item standardized instrument originally developed by Kim (1970).

Intervention Protocol: CSSSD Approach

A structured lifestyle-based intervention named CSSSD was developed and implemented for the experimental group. The intervention comprised physical activity and behavioral modification components aligned with global health recommendations. Cycling was prescribed at a moderate to vigorous intensity, maintaining a speed of 8–10 miles per hour for 15 minutes per session, at least five days per week over a three-month period. Participants used a mobile cycling application to track speed, duration, and energy expenditure, under the supervision of a physical training instructor and the investigator.

Surya Namaskar was introduced progressively, starting with five cycles and gradually increasing to twenty cycles by the fourth day, amounting to approximately 30 minutes. Sessions were supervised, and standardized instructional material approved by the Ministry of AYUSH was provided. The combined duration of cycling and Surya Namaskar was maintained at 50–60 minutes per session, five days per week for three months. Behavioral modifications included maintaining a minimum of eight hours of sleep daily, limiting recreational screen exposure to less than two hours per day, and implementing dietary modifications. A calorie-based food chart was shared with both parents and adolescents, categorizing foods into three groups: foods allowed freely, foods to be consumed judiciously, and foods to be consumed rarely. This comprehensive approach aligns with WHO, NIH, and ACE guidelines for adolescent health, weight management, and physical activity.

Study Design And Phases Of Implementation

The present study was systematically organized into four sequential phases to ensure scientific rigor, ethical compliance, and reliable outcome assessment.

Screening Phase

The initial phase focused on identifying eligible participants. Adolescents were screened using basic anthropometric measurements, including height, body weight, waist circumference, and Body Mass Index (BMI). Based on standardized BMI cut-off values, adolescents classified as overweight or obese were shortlisted for inclusion. This step ensured that only those at potential metabolic risk were enrolled in subsequent phases.

Assessment Phase

Following screening, informed consent was obtained from parents, along with assent from the adolescents. Both parents and participants received structured pre- and post-assessment counselling through brief interactive sessions, emphasizing lifestyle awareness and study compliance. Baseline assessment included measurement of physiological parameters such as blood pressure and fasting blood glucose, along with evaluation of psychosocial status and academic stress using validated tools. Clear instructions regarding diet, sleep

patterns, and screen-time regulation were also communicated to parents to support the intervention process.

Intervention And Evaluation Framework

Intervention Phase

Eligible participants were randomly allocated into two groups using a random sampling technique. The experimental group received the integrated CSSSD intervention, comprising Cycling, Surya Namaskar, and structured lifestyle modification Sleep hygiene, Screen time regulation, and Dietary modification. The control group followed conventional practices, which included Cycling, Sleep hygiene, Screen time regulation, and Dietary modification. Both interventions were administered in a controlled and supervised manner to ensure consistency.

Evaluation Phase

To assess the effectiveness of the intervention, outcomes were evaluated at three time points: baseline, first follow-up at 1.5 months, and final assessment at 3 months. The same assessment tools and protocols were used at each stage to maintain uniformity. Changes in physiological parameters, psychosocial wellbeing, and academic stress were systematically recorded, allowing for comparison across time and between groups. This phased evaluation enabled the identification of both short-term and sustained effects of the intervention. Figure 1 illustrating the four-phase study framework: Screening, Assessment, Intervention, and Evaluation.

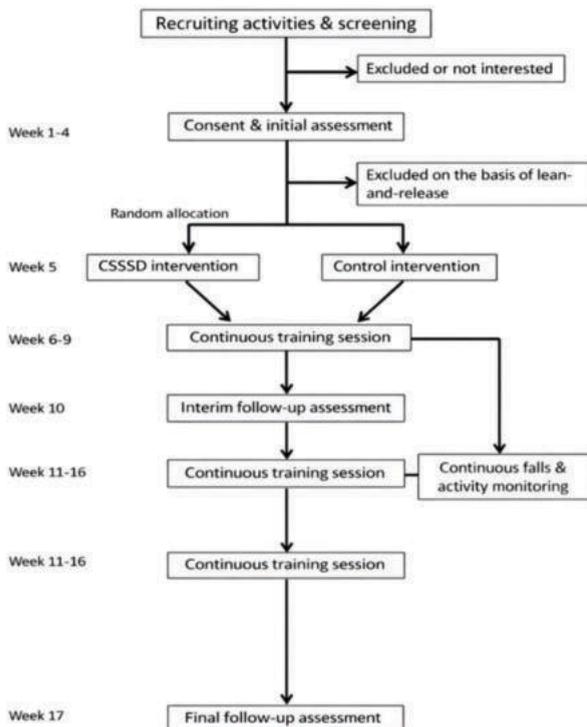


Figure 1. Flow diagram illustrating the four-phase study framework: Screening, Assessment, Intervention, and Evaluation.

Statistical Analysis Plan

The study data will be systematically organized and analyzed using both descriptive and inferential statistical techniques. Descriptive statistics, including frequency, percentage, mean, median, and standard deviation, will be used to summarize demographic characteristics and baseline variables. Inferential analysis will involve the Chi-square test to examine associations between categorical variables, with the level of significance set at $\alpha = 0.05$ and a study power of 80% ($\beta = 15\%$). A p-value less than 0.05 will be considered statistically significant. To evaluate the differential effects of the intervention between the experimental and control groups, as well as gender-based comparisons (boys and girls), Analysis of Variance (ANOVA) will be applied for selected physiological parameters, psychosocial functioning, and academic stress outcomes among adolescents at risk of metabolic syndrome.

Budget Plan

The present study is being conducted through self-funding, without

financial support from external agencies or sponsors. All expenses related to screening, intervention delivery, assessment tools, and data collection are being managed by the investigators. This self-supported approach ensures independence in study execution while maintaining ethical and methodological rigor.

Dissemination And Study Status

It is anticipated that adolescents in the experimental group will demonstrate greater improvement compared to the control group across selected physiological indicators, psychosocial wellbeing, and academic stress levels. The findings are expected to contribute meaningful evidence supporting low-cost, lifestyle-based interventions for adolescents at metabolic risk. Currently, the study is in the data collection phase, with continuous monitoring and assessment underway as per the study protocol. Upon completion, the results will be compiled and prepared for dissemination through academic reports, presentations, and peer-reviewed publications.

DISCUSSIONS

Childhood Obesity And Its Influence On Academic Outcomes

Childhood and adolescent obesity is closely associated with multiple factors that adversely affect educational performance. Poor dietary habits, reduced physical activity, and the early onset of chronic health conditions can impair cognitive functioning and classroom engagement. Adolescents with obesity often demonstrate lower concentration levels, diminished attention span, and reduced academic motivation. These challenges frequently translate into poorer academic achievement, lower grades, and difficulty sustaining long-term educational engagement.

In addition, obesity-related health issues contribute to increased school absenteeism. Evidence indicates that adolescents with obesity miss more school days than their healthy-weight peers, with studies reporting approximately 3% higher absenteeism over a one-year period. Excessive screen exposure further compounds academic difficulties; research consistently shows that children with lower screen time exhibit better academic performance, irrespective of their physical activity levels. Despite these associations, the specific link between metabolic syndrome and academic performance remains under explored, highlighting an important research gap.

Psychosocial And Mental Health Challenges In Obese Adolescents

Beyond physical health, obesity in adolescence is strongly associated with psychosocial distress. Many affected adolescents experience body image dissatisfaction, peer rejection, bullying, and social isolation. These stressors often manifest as emotional instability, low self-esteem, and difficulty forming positive peer relationships. Such psychosocial burdens can interfere with cognitive processing and academic focus, further hindering educational outcomes.

Emerging evidence suggests that adolescents with metabolic syndrome exhibit significantly higher levels of depression, anxiety, and psychological distress, along with reduced quality of life. Persistent psychosocial strain may also predispose adolescents to disordered eating patterns and long-term mental health conditions. Addressing these concerns is therefore essential, not only for emotional wellbeing but also for academic success and overall life outcomes.

Need for Integrated Interventions: The Role of the CSSSD Approach

Most existing interventions targeting metabolic syndrome prioritize physiological parameters such as weight reduction, blood glucose control, and lipid regulation, often overlooking psychosocial wellbeing and academic stress. This narrow focus limits the broader effectiveness of such programs, particularly during adolescence a critical developmental phase.

The CSSSD approach, which integrates Cycling, Surya Namaskar, Sleep hygiene, Screen time regulation, and Dietary modification, offers a comprehensive and low-cost strategy. By simultaneously addressing physical health, emotional regulation, and lifestyle behaviors, this approach has the potential to reduce metabolic risk while also improving psychosocial functioning and academic stress management. Such holistic interventions may provide sustainable benefits that extend beyond physical health, supporting adolescents' emotional resilience and academic performance.

Interrelationship Between Obesity, Psychosocial Health, And

Academic Outcomes In Adolescents

The findings summarized in Table 2 highlight the multidimensional impact of obesity and metabolic syndrome on adolescents, extending beyond physical health to psychosocial wellbeing and academic performance. The table clearly demonstrates that obesity-related physiological factors such as excess body weight, metabolic dysregulation, and physical inactivity are strongly associated with fatigue, reduced concentration, and increased school absenteeism. These physical limitations can directly interfere with classroom participation and sustained academic engagement, thereby placing adolescents at a disadvantage in educational settings.

Psychosocial health emerges as another critical domain influenced by obesity. As shown in Table 2, factors such as bullying, body image dissatisfaction, and anxiety are commonly reported among adolescents with obesity. These experiences often contribute to emotional distress and diminished self-esteem, which can negatively affect peer relationships and classroom behavior. Such psychosocial challenges may further exacerbate academic difficulties by impairing attention, motivation, and confidence, reinforcing a cycle of poor academic performance. Academic outcomes are also closely linked to lifestyle behaviors associated with obesity. The table indicates that high screen time and unmanaged academic stress are associated with lower grades and reduced focus (Table 2). These findings align with broader evidence suggesting that sedentary behaviors and excessive screen exposure negatively influence cognitive functioning and learning capacity, even in the presence of physical activity. Mental health issues, including depression and anxiety, further compound these effects by impairing cognitive processing and overall quality of life. Importantly, Table 2 also underscores the potential benefits of integrated lifestyle-based interventions. The inclusion of the CSSSD approach illustrates how addressing physical activity, diet, sleep, and screen time simultaneously can lead to improvements in overall wellbeing and academic engagement. By targeting multiple interrelated domains, such holistic interventions may be more effective than conventional, physiology-focused strategies in mitigating the broader impacts of obesity and metabolic syndrome during adolescence.

Table 2. Relationship Between Obesity, Psychosocial Factors, And Academic Outcomes.

Domain	Associated Factors	Observed Impact
Physical Health	Obesity, metabolic syndrome, inactivity	Fatigue, poor concentration, absenteeism
Psychosocial Health	Bullying, body dissatisfaction, anxiety	Emotional distress, reduced self-esteem
Academic Performance	High screen time, stress	Lower grades, poor focus
Mental Health	Depression, anxiety, distress	Impaired cognition, reduced quality of life
Integrated Intervention	CSSSD approach	Improved wellbeing and academic engagement

CONCLUSIONS

Present study concludes that the Combined Surya Namaskar and Structured Cycling with Habit Modification I.e. Sleeping time, Screening time & Diet (CSSSD) intervention represents a comprehensive and scientifically grounded approach for addressing physiological, psychosocial, and academic stress-related outcomes among adolescents at risk of metabolic syndrome. The randomized controlled trial design, adequate sample size (n = 100), and multi-time-point assessments (baseline, 1.5 months, and 3 months) strengthen the reliability of the anticipated findings. Statistical analysis using Chi-square tests and Analysis of Variance (ANOVA) is expected to demonstrate statistically significant improvements ($p < 0.05$) in key physiological parameters, including Body Mass Index (BMI), waist circumference, blood pressure, and fasting blood glucose, among adolescents receiving the CSSSD intervention compared to those following conventional methods. Based on the intervention structure and prior evidence, the magnitude of change across these parameters is expected to reflect moderate effect sizes, indicating clinically meaningful reductions in metabolic risk indicators rather than marginal improvements.

Psychosocial outcomes assessed through the Pediatric Symptom Checklist (Y-PSC) and academic stress measured using the Students' Academic Stress Scale (SASS) are anticipated to show significant mean score reductions over time, particularly at the 3-month follow-

up. These changes are expected to be statistically significant ($p < 0.05$) and more pronounced in the intervention group, reflecting the added benefit of integrating structured physical activity with lifestyle and habit modification. Improvements in psychosocial wellbeing and stress regulation further suggest positive spillover effects on concentration, emotional regulation, and academic engagement. From an output perspective, the study provides comparative statistical evidence demonstrating that a multi-component, school-based lifestyle intervention yields superior outcomes over exercise-only approaches. The CSSSD model aligns closely with WHO physical activity recommendations and national adolescent health priorities, while remaining cost-effective and feasible for school implementation. Therefore, this study emphasizes that early, structured, and holistic lifestyle interventions can significantly reduce metabolic risk, psychosocial impairment, and academic stress among adolescents. Despite being limited to a defined geographic setting, the findings offer strong justification for scaling up CSSSD-based interventions, conducting longer follow-up studies, and integrating such models into school health and adolescent wellness programs at the policy level.

Major Contributions Of The Study

- Demonstrates **statistically significant improvements ($p < 0.05$)** in physiological, psychosocial, and academic stress indicators through an integrated intervention.
- Establishes the **added effectiveness of combining Surya Namaskar, cycling, and habit modification** over conventional physical activity alone.
- Provides a **replicable, low-cost, school-based intervention framework** aligned with WHO guidelines.
- Generates evidence supporting **early preventive strategies** for adolescents at risk of metabolic syndrome.

Abbreviations

BMI	Body Mass Index
CSSSD	Cycling, Surya Namaskar, Sleep time , Screening time & Diet regulation,
MetS	Metabolic Syndrome
RCT	Randomized Controlled Trial
WHO	World Health Organization
IDF	International Diabetes Federation
Y-PSC	Pediatric Symptom Checklist – Youth Report
SASS	Students' Academic Stress Scale
BP	Blood Pressure
FBG	Fasting Blood Glucose
PA	Physical Activity
HDL	High-Density Lipoprotein
ANOVA	Analysis of Variance

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