

ARTICULO DE REVISION

Fitness to improve the nutritional status of schoolchildren: A Review Acondicionamiento físico para mejorar el estado nutricional de escolares: Revisión

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RESUMEN

Según el Índice de Masa Corporal, el sobrepeso y la obesidad en adolescentes ha aumentado. Revisión de ensayos clínicos para determinar el efecto en el índice de masa corporal de los adolescentes con doce semanas de ejercicio en comparación con un grupo de control. Las fuentes de datos PUBMED, WOS, SCOPUS, BEIC, JSTOR y SCIELO. Criterios de inclusión: 1. Población adolescente; 2. Resultados del índice de masa corporal; 3. Ensayos clínicos; 4. grupos con ejercicio y control; 5. español, inglés y portugués; 6. Publicaciones hasta febrero de 2021; Palabras clave: Adolescentes, Índice de Masa Corporal, Ejercicio y Ensayo Clínico. Extracción de datos: efecto en el índice de masa corporal y su desviación estándar. 8 estudios (N: 761). El ejercicio redujo significativamente el índice de masa corporal de los adolescentes - 0,57 Kg/m² (-0,7 a -0,5) p < 0,01. Heterogeneidad estadística (I²: 89%). 12 semanas de ejercicio son eficaces para disminuir el índice de masa corporal en adolescentes.

Palabras Clave: Índice de masa corporal, actividad física, sobrepeso, joven.

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ABSTRACT

According to the Body Mass Index, overweight and obesity in adolescents has increased. Review of clinical trials to determine the effect on adolescents' Body mass index with twelve weeks of exercise compared to a control group. PUBMED, WOS, SCOPUS, BEIC, JSTOR, and SCIELO data sources. Inclusion criteria: 1. Adolescent population; 2. Body mass index results; 3. Clinical trials; 4. groups with exercise and control; 5. Spanish, English, and Portuguese language; 6. Publications up to February 2021; Keywords: Adolescents, Body Mass Index, Exercise and Clinical Trial. Data extraction: effect on the Body mass index and its standard deviation. 8 studies (N: 761). Exercise significantly reduced the Body mass index of adolescents - 0.57 Kg/m² (-0.7 to -0.5) p < 0.01. Statistical heterogeneity (I²: 89%). 12 weeks of exercise are effective at decreasing Body mass index in adolescents.

Keywords: Body mass index, physical activity, overweight, young.

INTRODUCTION

Obesity is a global public health problem, with high prevalence rates and rapid growth at all ages, resulting from a positive imbalance between intake and energy expenditure. Despite being modifiable risk factors, overweight and obesity remain a global public health problem. The prevalence of obesity has doubled since 1980, with more than 1.9 billion and 39% overweight adults. By 2025, global obesity is estimated to reach 18% in men and exceed 21%. In Latin America, an estimated 58% of the population (about 360 million people) are overweight and 23% (140 million) obese. Also, 50% of men and 60% of women are expected to be overweight or obese by 2030 (1,2). In clinical practice and research, the anthropometric method is used to diagnose an adolescent, and the most commonly used indicator is body mass index (BMI) (3,4). A teenager is overweight in the 85th – 95th percentile and obese in the 95th (5). In Chile, 25% of adolescents are overweight and 20% obese. However, in Spain, obesity exceeds 12.6%, and overweight 26.0% (6,7). Anzolina et al. (2016) assessed BMI cut-off points' sensitivity and specificity to predict overweight/obesity according to DEXA estimated body fat values in adolescents. BMI showed a good deal with DEXA, sensitive and specific in identifying overweight and obesity (8).

Obesity alone does not increase cardiovascular risk. Subcutaneous fat has a greater cardiovascular risk for a centripetal android pattern associated with visceral fat. For example, some obese people do not develop insulin resistance or other cardiovascular risk factors related to metabolic syndrome. For this reason, BMI does not always predict cardiovascular risk. Overweight or obese children who become obese adults have an increased risk of type 2 diabetes, hypertension, dyslipidemia, and atherosclerosis (9).

Regular physical activity reduces myocardial oxygen demand and increases cardiorespiratory capacity, with lower coronary risks. Physical activity also reduces systolic and diastolic pressure, improves insulin sensitivity and blood glucose control, reduces glycosylated hemoglobin, and improves dyslipidemia. Physical activity also controls body weight and fat levels. Arango et al. (2020) found an association between high blood pressure, overweight and low cardiorespiratory physical condition (10).

Biological, social, and behavioral changes arise in adolescence, critical to adopting a healthy lifestyle, where exercise levels decrease (11). Lifestyle depends on social and environmental influences, which have

transformed adolescents' attitudes, with an intake of low-cost unhealthy foods and reduced exercise (12). In addition, globalized societies evolve into a sedentary lifestyle, fostering a teen's passive attitude, a digital native and full-time computer user, television, remote control, and video games (13). The recommended level is 60 minutes daily of moderate to vigorous aerobic activity, incorporating strengthening three times per week.

Inadequate feeding practices are observed in adolescence (14). Obesity in youth is associated with asthma, sleep disorders, exercise intolerance, hypertension, and negative self-image (15). Obesity in adolescence is an independent risk factor for adult obesity (16). Intervening early, preventing, and controlling obesity is essential to reduce these negative consequences (17). To obesity, it is necessary to improve dietary intake, increase exercise, reduce sedentary lifestyles, and promote healthy lifestyles (18). Therefore, it is relevant to execute strategies in adolescents with lifestyle changes, healthy diet, and daily exercises to improve their nutritional status (19).

Schools are ideal for teenagers because they spend most of their time in school having access to sports facilities for exercise. However, Dobbins et al. in 2013 report that school interventions do not increase physical activity rates in adolescents, nor do they reduce BMI (20). By contrast, Waters et al. in 2011 indicate that exercise effectively reduces body fat (21). On the other hand, Peirson et al. (2015) suggest that behavioral interventions for obesity in young people moderate BMI (22). These authors used different criteria for the type and combination of exercise, intervention time, and age of the participants when obtaining their conclusions.

Several authors have studied the effect of exercise. Kelley et al. (2014) value studies from 4 to 26 weeks in overweight and obese children and adolescents with a change of -0.06 kg/m^2 (23); Lavelle et al. (2012) study changes in children under 18 years of age with interventions of 2 to 72 months with a change

of -0.1 kg/m^2 (24); Metcalf et al. (2012) study children and adolescents with interventions of 4 to 140 weeks with a change of 0.1 kg/m^2 (25). However, all these researches were conducted with different criteria to analyze the results and unequal age limits, heterogeneous treatment times, and various intervention types.

Because of the above, the following question arises: What is the effect of physical exercise for 12 weeks on adolescents' nutritional status? It is objective: To determine the impact of training on adolescents' nutritional status in clinical trials for twelve weeks compared to a control group. This systematic review focuses on health promotion actions that develop personal skills or behaviors, effectively reducing adolescent obesity.

MATERIALS AND METHODS

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RESULTS

Characteristics of the studies: 740 articles were identified, applying the selection criteria. Of these, eight studies (26-33) were analyzed (n: 761). Figure 1 presents the flowchart and the selection of tasks. Table 1 shows the risk assessment of the studies' bias, offering a low risk of bias and high methodological quality (PEDRO: 8.6 ± 1.5).

Study	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	
Ansari 2010	+	+	-	+	-	-	-	+	+	+	+	7
Lee 2012	+	+	+	+	+	+	+	+	+	+	+	11
Lee 2013	+	+	+	+	+	+	+	+	+	+	+	11
Park 2012	+	+	+	+	+	-	-	+	+	+	+	9
Plavsic 2019	+	+	+	+	-	-	-	+	+	+	+	8
Robbins 2018	+	+	-	+	-	-	-	+	+	+	+	7
Sigal 2014	+	+	+	+	+	-	-	-	+	+	+	8
Suh 2011	+	+	+	+	+	-	-	-	+	+	+	8

1. eligibility criteria were specified.
2. subjects were randomly allocated to groups (in a crossover study, subjects were randomly allocated an order in which treatments were received).
3. allocation was concealed.
4. the groups were similar at baseline regarding the most important prognostic indicators.
5. there was blinding of all subjects.
6. there was blinding of all therapists who administered the therapy.
7. there was blinding of all assessors who measured at least one key outcome.
8. measures of at least one key outcome were obtained from more than 85% of the subjects initially allocated to groups.
9. all subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analyzed by "intention to treat".
10. the results of between-group statistical comparisons are reported for at least one key outcome.
11. the study provides both point measures and measures of variability for at least one key outcome.

Table 1. Quality assessment.

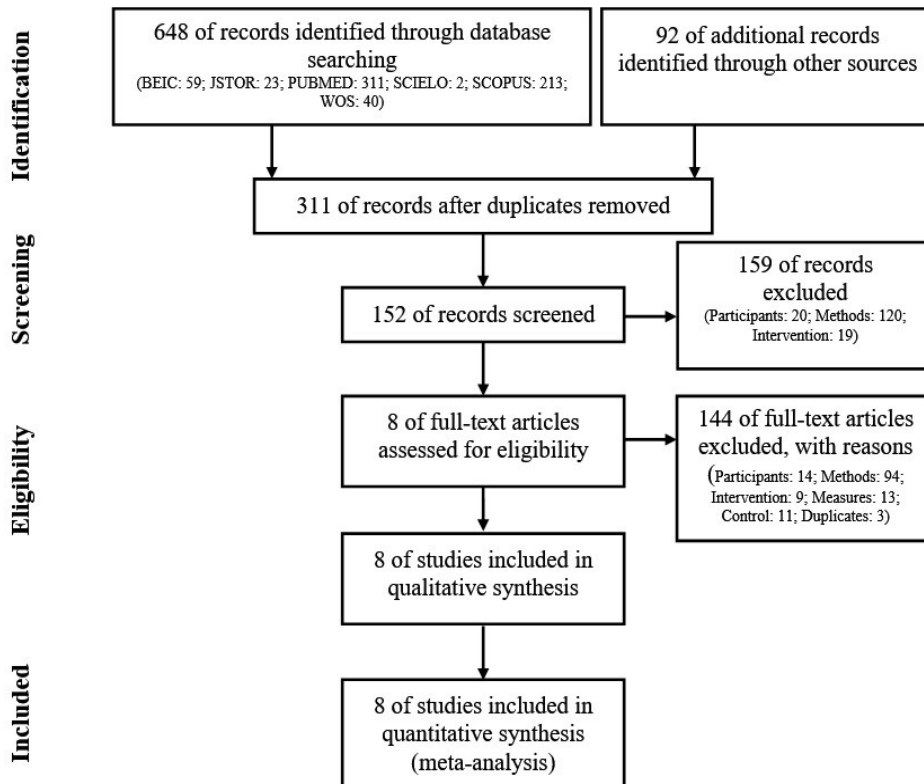


Figure 1. Flowchart.

Study	Intervention	Results
Ansari et al. 2010 Egypt	Aerobic exercise (men and women), 1 hour of moderate exercise, three times a week, the intensity of 60% to 80% of the maximum heart rate.	Blood pressure (mmHg): Men -11.4; Women -12.3.
Lee et al. 2012 USA	Aerobic exercise 3 times a week for 60 min/session (5 minutes of heating and 5 minutes cooling) with treadmills, ellipticals, or stationary bikes. 40 min to 50% VO ₂ peak, up to 60 min to 60-75% VO ₂ peak.	VO ₂ peak (ml/kg/min): +9.1 ± 0.9.
Lee et al. 2012 USA	Resistance exercises one series of 10 total-body exercises, three times per week, 60 min/session. Leg press, leg extension, leg flexion, chest press, pull down, sitting oar, bicep flexion, and triceps extension. One series of push-ups and abs. The first four weeks, 1 or 2 series of 8–12 repetitions at 60% of the maximum repetition. Weeks 4–12, 2 series of 8–12 repetitions to fatigue. 1–2 min break between series.	Muscular strength index: +1.0 ± 0.2
Lee et al. 2013 USA	Aerobic exercise 3 times per week for 60 min/session (5 min heating and 5 min cooling) using treadmills or ellipticals. 40 min to 50% VO ₂ peak and up to 60 min to 60-75% VO ₂ peak.	VO ₂ peak (ml/kg/min): +4.91 ± 1.82
Lee et al. 2013 USA	Resistance Exercise: 1 series of 10 full-body exercises, three times a week, 60 min/session. Leg press, leg extension, leg flexion, chest press, pulley pull, sitting rowing, bicep flexion, and triceps extension. One series of push-ups and extensions. The first four weeks, 1-2 series of 8 to 12 repetitions at 60% maximum repetition. Weeks 4–12, 2 series from 8 to 12 repetitions until fatigue.	Muscular strength index: +0.45 ± 0.11
Park et al. 2012 Korea	Combined exercise 3 days of aerobic exercise and endurance per week (Monday, Wednesday, and Friday). Eighty minutes (10 minutes of heating and 10 minutes of cooling). Aerobic exercise 30 minutes on the treadmill at 50-70% of the heart rate reserve. Weeks from 1 – 6, 30 minutes to 50-60% of the FCR. Weeks 6 – 12, 60-70% of the FCR for 30 minutes. Resistance Exercise: 2 series of seven dynamic exercise circuits with less than 30 seconds of rest between exercises. Bench presses, bicep push-ups, triceps extensions, leg presses, leg extensions, leg flexion, and leg raises. At 60% of its maximum resistance. 8-12 repetitions.	Maximal oxygen Uptake (ml/kg/min): +3.7 ± 2.1
Plavsic et al. 2019 Serbia	HIIT walks or runs uphill on a treadmill in small groups (3-5 participants) 2 days a week (Wednesday and Saturday). Heating 10 minutes to 60-70% MAX FC before performing 4x4 minute intervals at 85-90% MAX HR with an active recovery of 3 minutes to 70% MAX HR between each interval, and a cooling period of 5 minutes, a total of 43 minutes.	Workload (watts): +14 ± 9.8
Robbins et al. 2018 USA	Fifty minutes: 5 minutes of warm-up/stretching; 20 min of building sports skills; 15 minutes of fun games or games to apply learned sports skills; 5 min stretch time.	Autonomous motivation (0 – 4): +0.3 ± 1.7
Sigal et al. 2015 Canada	Aerobic exercise: treadmills, elliptical machines, or bike ergometers (20 to 45 minutes) and intensity (65% to 85% of maximum heart rate).	Systolic blood pressure mmHg): -5 (-7 a -2)
Sigal et al. 2015 Canada	Resistance exercises: 7 exercises with weight machines or free weights, progressing from 2 sets of 15 repetitions to moderate intensity to 3 series of 8 repetitions at the maximum resistance that could be moved eight times (8-RM).	Systolic blood pressure mmHg): -4 (-6 a -1)
Sigal et al. 2015 Canada	Combined exercise of aerobic training plus resistance training during each session.	Systolic blood pressure (mmHg): -1 (-3 a 2)
Suh et al. 2011 Korea	Aerobic exercise 3 days a week. Gymnastics every day during the 2nd and 3rd months of the program. Jump rope, walk or run on a treadmill, and stationary cycling. Forty minutes, 5-minute warm-up, and a stretched cooling period. 60% to 70% of maximum oxygen consumption (60%, 1st month; 65%, 2nd month; 70%, 3rd month). 300 to 400 kcal/session (300 kcal, 1st month; 350 kcal, 2nd month; 400 kcal, 3rd month)	Insulin sensitivity index: +0.04 ± 0.04
Suh et al. 2011 Korea	Resistance exercise 3 days a week. Warm-up of 15 minutes of jogging, gymnastics, and stretching (5 minutes for each type of exercise). 60% of 1RM. Squats, leg extension, leg flexion, military press, leg press, side pulls, bench press, push-ups, leg extension, and deadweight lift-series (2 to 3) from 10 to 12 repetitions. Rest for 1 to 1.5 minutes between series. Sixty minutes, final cooling of 5 minutes.	Insulin sensitivity index: +0.01 ± 0.01

Table 2. Characteristics of studies.

Characteristics of the participants: Table 2 presents the eight studies, which included the following countries: Egypt, the USA, South Korea, Serbia, and Canada, with 761 participants. The initial mean BMI was 29.9 ± 3 kg/m².

Characteristics of the interventions: the intervention with exercise was for twelve weeks and produced different physiological,

functional, and structural improvements in adolescents.

Estimates of the effect of exercise interventions on BMI: Figure 2 shows the eight studies included in the meta-analysis. The random-effects model found that exercise significantly reduced adolescents' BMI by -0.57 Kg/m² (-0.68 to -0.47) < 0.01 . Statistical heterogeneity (I²: 89 %).

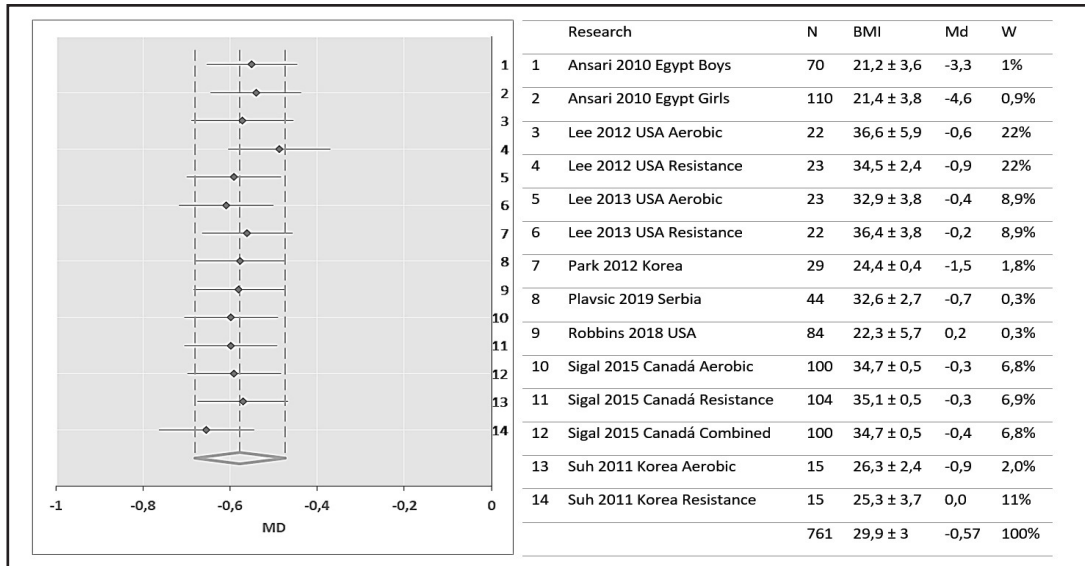


Figure 2. Effectiveness of twelve weeks of exercise in adolescent BMI.

The results of each study for this age group are presented in Table 2. Of the eight included studies targeting adolescents, these provided appropriate BMI data for inclusion in the meta-analysis. Of those included in the meta-analysis, a standardized difference in BMI change from the beginning to the end of the intervention between the intervention and control groups was -0.57 Kg/m² (95% CI -0.68 to -0.47). This result is statistically significant but presents a high heterogeneity in the studies. Thus, the small number of studies and the heterogeneity observed from the plans in the meta-analysis limit our ability to determine the effectiveness of interventions in adolescents confidently. However, these results are promising for promoting physical activity in overweight adolescents, for improving their nutritional status and physical health.

Physical activity outcomes were measured in all studies, and all eight studies report an indicator of the positive impact of physical activity intervention in adolescents (Table 2). Ansari et al. (2010), with an aerobic exercise intervention three times a week with an intensity of 60% to 80% of the maximum heart rate, improved systolic pressure. On the other hand, Lee et al. (2012), with aerobic exercise 3 times a week, improved the VO₂ peak. Moreover, resistance exercises with two sets of 8–12 repetitions until fatigue improved the muscle strength index. In another study, Lee et al. (2013), with the anaerobic intervention of 60 min, improved the VO₂ peak and with resistance exercises of 2 sets of 8 to 12 repetitions until fatigue, improved the muscular strength index. Park et al. (2012), with a mixed intervention of 3 days of aerobic exercise and treadmill resistance at 50-70% of the heart rate

reserve and resistance of 2 sets at 60% of their maximum resistance with 8-12 repetitions, improved the maximal oxygen uptake. Plavsic et al. (2019), with 4x4 minute intervals at 85-90% of the maximum heart rate, improved the workload (watts). Robbins et al. (2018), with 20 min of building sports skills, 15 minutes of fun games, improved autonomous motivation. Sigal et al. (2015), with aerobic training of 20 to 45 minutes at 65% at 85% of the maximum heart rate and resistance exercises of 3 sets of 8 repetitions at maximum resistance (8-RM), improved systolic blood pressure. Suh et al. (2011), with aerobic exercise 3 days a week, from 60% to 70% of maximum oxygen consumption and resistance three days a week, to 60% of 1RM, with 2 – 3 Series of 10 12 repetitions, improved the Insulin sensitivity index.

DISCUSSION

Several interventions reduce obesity, and it is necessary to know which specific components are most effective, affordable and cost-effective, for use in schools. Amini et al. (2015) indicate that dietary strategies, exercise, or reduced sedentary lifestyles impact fat decline. George et al. (2017) suggest that for adolescent obesity, an increase in physical activity should be emphasized rather than a change in diet due to the possible adverse effects of inappropriate eating patterns that may develop in adolescents (34). Teenagers enjoy activities such as hiking, ice skating, or swimming. Sharma et al. (2006) indicate that schools are essential for implementing exercise programs with adolescents (35). On the other hand, Dobbins et al. (2013) show that adolescents have limited capacity to adopt new behaviors and knowledge.

Although BMI does not measure body composition (36), it has widespread use in epidemiological studies due to its ease of measurement, high data availability, and its relationship to morbidity and mortality (37). Possibly, the outcome of this review seems imperceptible, but it generates changes in

body composition that are not identified with BMI and improves health-related quality of life in adolescents.

Unfortunately, BMI does not distinguish between fat mass and lean mass (38). For this, the BMI can be supplemented with the abdominal perimeter, waist-to-hip ratio, or waist-to-height ratio (39). Another option is the measurement of skin folds in adolescents to diagnose and analyze body composition changes during the treatment of childhood obesity (40). Obesity is multifactorial; therefore, exercise interventions can enhance their effectiveness, in the long run, to decrease obesity in adolescents.

A limitation of our research is language due to the lack of an accurate translation that allows us to evaluate and analyze other analyses. Also, this would influence the ability of the team to analyze other databases, to avoid publication bias. Another limitation is the body mass index which does not evaluate changes in body composition but is widely used in research and clinical evaluation of adolescents. We propose using different anthropometric methodologies (4) to assess body composition in adolescents, which are low-cost using field tools, which would allow obtaining better clinical results in the adolescents intervened. In addition, in this review, we also used a qualitative analysis, due to the heterogeneity of the studies, to evaluate the effectiveness of exercise in modifying the nutritional status of adolescents after 12 weeks of intervention.

CONCLUSION

Exercise effectively decreases BMI in adolescents after twelve weeks. Moreover, it can be implemented in schools, fostering positive attitudes towards training, guiding it according to the development level, seeking satisfaction, improving the quality of life-related to health, self-esteem, and extracurricular activities.

While it is necessary to use multiple strategies to decrease obesity, our review indicates that exercise for twelve weeks effectively

reduces BMI in adolescents. However, from a clinical point of view, twelve-week exercise interventions may not effectively change adolescents' nutritional status with obesity. Exercise supplemented with healthy dietary habits throughout the school period could have more significant effects.

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CONFLICT OF INTEREST AND FINANCING

No conflict or funding.

STATEMENT

I certify that I have contributed directly to the intellectual content of this manuscript, to the genesis and analysis of its data, for which I am in a position to I am publicly responsible for it and I accept that my name appears on the list of authors. I certify that this work (or important parts of it) is unpublished and will not be sent to other journals. I certify that have met the ethical control requirements.

In the column "Participation codes" I personally write down all the code letters that designate / identify my participation in this work, chosen from the following table:

- a) Conception and design of the work g Contribution of patients or study material
- b) Gathering / obtaining results h Obtaining financing
- c) Analysis and interpretation of data i Statistical advice
- d) Drafting of the manuscript j Technical or administrative advice
- e) Critical revision of the manuscript k Other contributions (define)
- f) Approval of its final version

Conflict of interest: There is no possible conflict

of interest in this manuscript. If it'd exist, will be declared in this document and / or explained on the title page, by identifying the sources of financing.

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