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Review article

Interventions to Improve Adolescent Nutrition: A Systematic Review and Meta-Analysis

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A B S T R A C T

Adequate adolescent nutrition is an important step for optimal growth and development. In this article, we systematically reviewed published studies till December 2014 to ascertain the effectiveness of interventions to improve adolescent nutrition. We found one existing systematic review on interventions to prevent obesity which we updated and conducted de novo reviews for micronutrient supplementation and nutrition interventions for pregnant adolescents. Our review findings suggest that micronutrient supplementation among adolescents (predominantly females) can significantly decrease anemia prevalence (relative risk [RR]: .69; 95% confidence interval [CI]: .62–.76) while interventions to improve nutritional status among "pregnant adolescents" showed statistically significant improved birth weight (standard mean difference: .25; 95% CI: .08–.41), decreased low birth weight (RR: .70; 95% CI: .57–.84), and preterm birth (RR: .73; 95% CI: .57–.95). Interventions to promote nutrition and prevent obesity had a marginal impact on reducing body mass index (standard mean difference: −.08; 95% CI: −.17 to .01). However, these findings should be interpreted with caution due to significant statistical heterogeneity.

Adolescent nutrition is crucial for proper growth and development and a prerequisite for achieving full developmental potential. Suboptimal nutrition may contribute to delayed and stunted growth [1] as well as impaired development. As adolescents undergo a period of rapid growth and development, adequate nutrient intake (of both macro and micronutrients) is critical. Many of the risk factors that impact maternal and newborn health exist right from adolescence, including nutritional deficiencies. Prepregnancy wasting in adolescents is usually reflected as low body mass index (BMI $<$ 18.5). Low BMI significantly increases perinatal risks including stillbirths, preterm births, small for gestational age, and low birth weight (LBW) babies [2]. Iron deficiency anemia is among the top 10 causes of disability-adjusted life years lost among adolescents [2]. Concern is especially warranted for adolescent girls because their iron requirements are relatively high (due to growth spurts, sexual maturation, and menstrual losses) and because they may be on the cusp of motherhood. While most programs are targeted at pregnant women, the depletion of iron stores in women starts during adolescence

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with the onset of menstruation. More recently, there has been a growing interest in adolescent girls' nutrition as a means to improve the health of women and children. Each year around 16 million babies are born to adolescent girls between the ages of 15 and 19 years, accounting for over 10% of the total births each year [3]. Pregnancy in adolescence is associated with greater risk to the mother and newborn—including anemia, mortality, stillbirths, and prematurity—especially since the adolescent girls are not physically mature themselves [3]. Adolescent girls are two to five times more likely to die from pregnancy-related causes than women aged 20–29 years [3]. Girls younger than 19 years have a 50% increased risk of stillbirths and neonatal deaths, as well as an increased risk for preterm birth, LBW, and asphyxia [3]. These health risks further increase for girls who become pregnant earlier than 15 years and are somewhat reduced for older adolescents aged 18–19 years.

Over the last two decades, increasing rates of overweight and obesity among children and adolescents have been observed in many countries [4,5]. Many low- and middle-income countries (LMICs) now bear a double burden of nutritional disorders due to the emerging issue of overweight and obesity along with the existing high rates of stunting and other micronutrient deficiencies [6,7]. Childhood overweight is associated with multiple immediate and long-term risks including raised cholesterol, raised triglycerides, type 2 diabetes, high blood pressure, adult obesity, and its associated consequences [8,9]. Prepregnancy overweight has been linked to two of the foremost causes of maternal mortality (hypertensive disorders of pregnancy and gestational diabetes mellitus) [10–13] as well as other adverse pregnancy outcomes, including poor lactation practices [14,15], obstetric anesthesia–related complications [16], prolonged gestation [17,18], maternal infectious morbidity [19], and decreased success with trials of labor.

This article is part of a series of reviews conducted to evaluate the effectiveness of potential interventions for adolescent health and well-being. Detailed framework, methodology, and other potential interventions have been discussed in separate articles [20–26]. In this article, we systematically reviewed published literature to ascertain the effectiveness of interventions to promote nutrition among adolescents comprising of micronutrient supplementation, nutrition interventions for pregnant adolescents, and interventions to prevent obesity.

Methods

For the purpose of this review, the adolescent population was defined as aged 11–19 years; however, since many studies targeted youth (aged 15–24 years) along with adolescents, exceptions were made to include studies targeting adolescents and youth. Studies were excluded if they targeted age groups other than adolescents and youth or did not report segregated data for the age group of interest. Searches were conducted till December 2014, and we did not apply any limitations on the start search date or geographical settings. Outcomes were not prespecified, and we included all the outcomes reported by the study authors. We searched systematically for existing reviews and took a systematic approach to consolidate the existing evidence through the following methodologies:

1. De novo review: For interventions where no reviews existed, we conducted a new review; and
2. Updating existing reviews: We updated the existing systematic reviews only if the existing review included evidence before 2011.

Methodology for de novo reviews

For de novo reviews, our priority was to select existing randomized, quasi-randomized and before/after studies, in which the intervention was directed toward the adolescent age group and related to nutritional outcomes. A separate search strategy was developed for each aspect using appropriate keywords, Medical Subject Heading, and free text terms. The following principal sources of electronic reference libraries were searched to access the available data: The Cochrane Library, Medline, PubMed, Popline, LILACS, CINAHL, EMBASE, World Bank's Jolis search engine, CAB Abstracts, British Library for Development Studies at Institute of Development Studies, the World Health Organization regional databases, Google, and Google Scholar. The titles and abstracts of all studies identified were screened independently by two reviewers for relevance and matched. Any disagreements on selection of studies between these two primary abstractors were resolved by the third reviewer. After retrieval of the full texts of all the studies that met the inclusion/exclusion criteria, data from each study were abstracted independently and in duplicate into a standardized form. Quality assessment of the included randomized controlled trials (RCTs) was done according to the Cochrane risk of bias assessment tool. We conducted meta-analysis for individual studies using the software Review Manager, version 5.3 (Cochrane Collaboration, London, United Kingdom). Pooled statistics were reported as the relative risk (RR) for categorical variables and standard mean difference (SMD) for continuous variables between the experimental and control groups with 95% confidence intervals (CIs). A grade of "high," "moderate," "low," and "very low" was used for grading the overall evidence indicating the strength of an effect on specific health outcome according to the Grading of Recommendations Assessment, Development and Evaluation criteria [27].

Methodology for updated reviews

We updated the existing systematic reviews only if the most recent review on a specific intervention was conducted before December 2011. For updating the existing reviews, we adopted the same methodology and search strategy mentioned in the existing review to update the search and find all the relevant studies after the last search date of the existing review. After retrieval of the full texts of all the articles that met the inclusion/exclusion criteria, data from each study were abstracted independently and in duplicate into a standardized form. Information was extracted on study design, geographical setting, intervention type and description, mode of delivery, and outcomes assessed. We then updated the estimates of reported outcomes by pooling the evidence from the new studies identified in the updated search and reported new effect size for the outcomes of interest with 95% CIs. We then assessed and reported the quality of included reviews using the 11-point assessment of the methodological quality of systematic reviews criteria [28].