The McGovern-Dole International Food for Education and Child Nutrition Program

Nutrition Interventions and their Educational and Nutrition Outcomes for Pre-School and Primary-School-Age Children in Developing Countries: A Systematic Review and Meta-Analysis

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1.0. Introduction

1.1. Background

The McGovern – Dole International Food for Education and Child Nutrition Program (MGD), one of the Foreign Agricultural Service's leading food assistance programs, helps support education, child development and food security in low-income, food-deficit countries throughout the world. The program is named in honor of former Ambassador and U.S. Senator George McGovern and former U.S. Senator Robert Dole for their efforts to encourage a global commitment to school feeding and child nutrition.

The key objective of the MGD program is to improve literacy of primary school-age children, especially for girls. By providing school meals, teacher training and related support, MGD projects help enhance school enrollment and academic performance. The program also funds supplementary activities that promote children's health and nutrition in an effort to further support children's school enrollment, attendance, and capacity to benefit from the educational instruction received.

The MGD program was first authorized in the Farm Security and Rural Investment Act of 2002 (P.L. 107-171). The 2014 Farm Bill reauthorized the program through 2018. USDA is currently funding 45 McGovern-Dole projects in 27 low-income, food-deficit countries throughout the world. McGovern-Dole projects are implemented by non-profit charitable organizations, cooperatives, the United Nations World Food Program and other international organizations.

The present study is part of a broader evaluation and research effort to: (1) support the MGD program's ability to use rigorous evidence, evaluation and research in strategic decision-making to improve program outcomes; and (2) help the program identify key gaps in the knowledge base on what interventions are successful in improving literacy and reducing hunger. This study builds on three research efforts: a thorough intervention mapping analysis of the MGD program over a five-year period (2009-2013); a comprehensive annotated bibliography of the programmatic and policy topics of relevance to MGD program interventions; a proposal for selecting research topics for three systematic reviews of the international literature on the impact of education program interventions in developing countries with particular relevance to the MGD program.

1.2. Rationale for Selection

1.2.1. Nutrition in the MGD framework and Nutrition Interventions in the MGD program

The first two topics selected for a systematic review and meta-analysis in support of the MGD program were school feeding and educational outcomes, and health interventions and their educational and health outcomes. The rationale for selecting the present topic on nutrition interventions and educational and nutrition outcomes is five fold. First, a primary MGD objective is "improved…student health and nutrition" (see "MGD Results Framework" Annex 2). Second, increased use of health and dietary practices is the highest result of the second component of the MGD results framework. It is also a necessary condition to improved literacy of school-age children, the highest result in the overall MGD literacy results framework: Increased use of health and dietary practices affects improved literacy of school-age children through reduced health-related absences and therefore improved literacy of school age children via improved student attendance.

Third, the 2009-2013 MGD intervention mapping analysis indicates that nearly one-half of all programs implemented nutrition activities in 2011-2013. The average number of those activities almost tripled in recent years (from 10 in 2009-2010 to 26 in 2011-2013). These included distributing of de-worming medication, vitamins & minerals; providing nutrition education, establishing school gardens; and monitoring children's growth. Fourth, the literature on nutrition offers experimental and quasi-experimental evidence from which it is possible to draw conclusions about what programs are likely to work, as measured by their impact on educational and nutrition outcomes. Fifth, from this growing body of literature, it is possible to sketch a reasonable consensus on some of these outcomes, draw some lessons learned and their policy implications, and identify areas for further investigation to help close the knowledge gap.

1.2.2. Nutrition Interventions Considered: Causal Pathways and Outcomes

1.2.2.1. Malnutrition Defined

Malnutrition refers to a variety of nutrition-related factors such as inadequate diets, infections, undernutrition and micronutrients (see, for instance, Shekar et al., 2006; Hoddinott et al., 2012; Bhutta et al., 2013; IFPRI 2014). Undernutrition in children is measured through three common (and normalized) indictors: weight, wasting, and stunting. Micronutrients — or vitamins and minerals — are vital components of good nutrition, improving human health, and advancing physical and intellectual development. Needed only in minuscule amounts, micronutrients enable the body to produce enzymes, hormones and other substances essential for proper growth and development. Micronutrients are required for essential physiological processes but many cannot be produced by the body and must be directly consumed from food sources (or through supplementation) or converted into a usable form from the environment (i.e. sunlight conversion of Vitamin D on the skin) (for a more complete list of malnutrition measures, see Section 1.2.2.5).

Given the importance and ubiquity of nutrition interventions this meta-analysis will closely analyze the effects of common nutrition interventions and corresponding causal pathways.

1.2.2.2. The Copenhagen Consensus and Nutrition Interventions

The Copenhagen Consensus Center is a think tank that researches the smartest solutions for the world's biggest problems by cost-benefit. Its studies are conducted by more than 100 economists from internationally renowned institutions, including seven Nobel Laureates, to advise policymakers and philanthropists how to spend their money most effectively. The goal of the Copenhagen Consensus project is to set priorities among a series of proposals for confronting the greatest global challenges (Copenhagen Consensus, 2004).

The Copenhagen Consensus 2004 assessed the expected rate of return of 17 development investments covering a broad range of initiatives and sectors. The assessment concluded that investment in micronutrients had the highest rate of economic return, just after control of HIV/AIDS — surpassing interventions in many other sectors such as water and sanitation, governance and corruption, and climate change. Three other nutrition interventions ranked among the 13 best interventions.

The Copenhagen Consensus 2008 ranked 30 possible interventions, including education for girls, malaria prevention and treatment, rural water supply, microfinance, and HIV combination prevention. Guided predominantly by consideration of economic costs and benefits, the assessment ranked four nutrition interventions among the most profitable nine interventions. These were micronutrient supplementation for children (vitamin A and zinc), micronutrient fortification (iron and salt iodization), biofortification (the process of breeding food crops that are rich in micronutrients, such as vitamin A, zinc, and iron), deworming and other nutrition programs at school, and community-based nutrition promotion. The 2012 Copenhagen Consensus conference ranked bundled micronutrient interventions the highest priority.

1.2.2.3. Study Focus

Public health interventions to alleviate micronutrient malnutrition in preschool and school-age children include anthelminthic (or parasitic-worm) treatment; the promotion of dietary diversification (increasing both the quantity and the range of micronutrient-rich foods consumed to include foods rich in vitamins and minerals); mass fortification of staple foods or food ingredients (i.e. the addition of micronutrients to flour or salt during manufacturing or processing); home (point of use) fortification of foods;[1] and micronutrient supplementation (the

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[1] Point of use food fortification includes multiple micronutrient powders for home fortification of foods (WHO 2011f) and Sprinkles ™, a product that can be easily mixed into any food prepared at home and does not interact with food components or significantly change the taste, color or texture of the food to which it is added. Micronutrient Powder for School Feeding Programs is specially formulated for school feeding programs (http://hexagonnutrition.com/sprinkles/?gclid=CjwKEAjw67SvBRC1m5zPv4GboAUSJAB6MJlkb6l0DueTO9nP1_TFJX6cj2NVetaeH4wU6Lorr-h7oRoCg6Dw_wcB; accessed 9/7/2015).

provision of relatively large doses of micronutrients, usually in the form of pills, capsules or syrups).[2]

All vitamins and minerals are important, but particular emphasis is given to vitamin A, iodine, iron, zinc, folic acid, and iron, both because the prevalence of deficiency in these micronutrients is high in many populations and because they play pivotal roles in maintaining health and productivity (WHO, 2011a; IFPRI, 2014).

The array of vitamin and micronutrients supplementation interventions is wide and varied. Interventions can include simple, and single micronutrient/vitamin supplementation (i.e. iodized salt) to multiple combinations of micronutrient/vitamin supplementation (i.e. flour fortification with folic acid, iron, and zinc). For example, folic acid supplementation – often dispensed together with iron as a common means for relieving anemia in women of reproductive age (Viteri & Berger, 2005) -- and preventive zinc supplementation among infants, preschoolers, and older pre-pubertal children have been thoroughly analyzed in several studies and systematic reviews (Brown et al., 2009; Imdad et al., 2011; Mayo-Wilson et al., 2014; WHO, 2011g; WHO, 2011h). Those studies have shown that zinc deficiency affects children's physical growth and leads to increased susceptibility to a number of infections, including diarrhea and pneumonia (Brown et al., 2009).

Vitamin A and iodine interventions have been described as having sufficient benefits to support their widespread implementation (Bhutta et al., 2008). Following extensive research on the disease burden[3] of vitamin A deficiency among children, considerable progress has been achieved in scaling up vitamin A supplementation for children between the ages of 6 months and 59 months. When UNICEF first began monitoring global coverage in 1999, only 16 percent of children were fully protected with two annual doses of vitamin A (Dalmiya, & Palmer, 2007). Effective coverage has increased dramatically over the past 15 years. Vitamin A supplementation full coverage[4] in least developed countries was 85 percent in 2013 (UNICEF, 2014).

The causes and consequences of iodine deficiency are well studied. Iodized salt has been shown to correct even severe iodine deficiency among school-age children (Zimmermann et al., 2003). A recent systematic review and a corresponding meta-analysis using available data comparing consumption of, or exposure to, iodized salt on an entire array of iodine deficiency disorders, including goiter, urinary iodine excretion, cretinism, cognitive function and potential adverse

[2] Supplementation has the advantage of supplying an optimal amount of a specific nutrient or nutrients, in a highly absorbable form, and is often the fastest way to control deficiency in individuals or population groups that have been identified as being deficient (Allen et al. 2006).
[3] The burden of disease measures the gap between the actual health of a population and an ideal situation where everyone in the population lives into old age in full health.
[4] Vitamin A supplementation full coverage is the estimated percentage of children aged 6–59 months reached with 2 doses of vitamin A supplements approximately 4-6 months apart in a given calendar year.

effects such as hypothyroidism and hyperthyroidism (Aburto et al., 2014) showed that iodized salt had a large effect on reducing the risk of goiter, cretinism, low cognitive function and iodine deficiency.

As in the case of vitamin A supplementation, considerable progress has been made in salt iodization. The accepted strategy of universal salt iodization to meet the iodine needs of all people, especially women prior to conception remains today the intervention of choice for cost, simplicity, and sustainability reasons (WHO, 2007). Adequately iodized salt consumption[5] in least developed countries was 75 percent in 2009-2013 (UNICEF, 2014). To date, more than 120 countries with all levels of deficiency risk are implementing large-scale salt iodization (WHO, 2014).

This meta-analysis focuses on two common—and important—nutrition interventions: iron supplementation in a single micronutrient form (or often in conjunction with folic acid when dispensed to women of productive age); and multiple micronutrient interventions that include iron.

1.2.2.4. Iron and Multiple Micronutrient Interventions: Causal Pathways and Outcomes

1.2.2.4.1. Iron Deficiency

Iron deficiency, a common form of nutritional deficiency, results from long-term imbalance caused by an inadequate dietary iron intake; poor iron absorption or utilization; increased iron requirements for growth during childhood, adolescence or pregnancy; or chronic blood losses (Moy, 2006; Viteri & Berger, 2005). Anemia is characterized by a reduction in the oxygen-carrying capacity of blood. In addition to iron deficiency, anemia is caused by other vitamin and mineral deficiencies such as folate, vitamin B12 and vitamin A deficiency; parasitic infections; and menstruation, especially when it occurs at an early age and among young women who do not consume sufficient iron (WHO, 2001).

It is estimated that approximately 600 million preschool and school-aged children are anemic worldwide, and it is calculated that at least half of the cases are due to iron deficiency (WHO, 2008). Children who suffer from iron deficiency in the early years may have irreversible deficits in many aspects of development (Pollitt, 1997; Lozoff, 2007). Other studies show that iron deficiency causes cognitive impairment (Tamura et al., 2002; Sandstead et al., 2000; Atamna et al., 2002; Black, 2003). Several studies demonstrated that schoolchildren treated for iron deficiency had reduced lethargy, and improved attention, comprehension and verbal and cognitive performance. Of particular importance was the cognitive–behavioral impact of iron

[5] Adequately iodized salt consumption is the percentage of households consuming adequately iodized salt (15 parts per million or more).

deficiency on girls as they reach puberty (Murray-Kolb, 2011; Sandstead et al., 2000) and iron contributions to the health of those girls (WHO, 2009).

In addition to control of helminthic infection, strategies for anemia control include improved dietary iron by improving dietary diversity or fortification of staple foods and condiments, home-based fortification with multiple micronutrients, and iron supplementation (Parisha et al., 2013). Iron supplementation -- the provision of doses of iron alone or in combination with other micronutrients in the form of tablets, syrups or capsules -- is the most widespread strategy for improving iron status in children worldwide. Daily supplementation provides the highest dose of iron of any non-parenteral approach and is a commonly recommended clinical and public health strategy for the prevention and treatment of anemia (WHO, 2001).

1.2.2.4.2. Multiple Micronutrient Interventions

The past few decades have been called the "micronutrient era" (Jonsson, 2010), during which many studies have examined the benefits of providing micronutrients to improve maternal and child health outcomes as well as preschool and school-age children. Many of these studies examined single nutrients such as vitamin A, zinc, or iron with varying outcomes and results. Over time, there has been increasing recognition that micronutrient deficiencies do not occur in isolation (Dijkhuizen et al., 2001; Black, 2003) and that providing several micronutrients at the same time may be more beneficial and cost-effective than single micronutrient interventions (Ramakrishnan et al., 2011). For instance, zinc combined with other micronutrients may exert a greater influence on cognitive function than when zinc is administered by itself (Benton, 2010). Similarly, since deficiency of several micronutrients has been implicated in impaired cognitive and motor performance and development (Black et al., 2004), correction of a single deficiency may not be enough to substantially improve cognitive performance.[6] Multiple micronutrients usually combine iron, vitamin A, folic acid, zinc, and vitamin C. Commonly used products for this purpose include syrups, tablets, fortified foods -- for example, biscuits (Nga et al., 2009), beverages (Ash et al., 2003), micronutrient powders that can be added to servings of foods in individual doses, and bulk food prepared and consumed in schools (Osei et al., 2008).

1.2.2.5. Outcomes and Indicators Considered

The outcomes and indicators considered for this analysis are based on an annotated bibliography in preparation for the three MGD systematic reviews outlined above and on other systematic

[6] It is also important to note that micronutrients might have antagonistic effects, affecting their bioavailability and their functioning in physiologic processes. For instance, since iron and zinc, as well as copper and manganese, compete for intestinal uptake, a high dose of one of these minerals may limit the absorption of the others (Sandstroem 2001; Allen & Casterline-Sabel 2001).

reviews dealing with educational and nutrition reviews. Outcomes are divided into two broad categories: education, and nutrition. Educational outcomes are as follows:[7]

- School participation
  - Enrollment
  - Attendance/absenteeism
  - Dropout
  - Repetition
- Learning achievement
  - Standardized math and science test scores
  - Standardized language test scores
- Cognitive development
  - Verbal fluency
  - Memory
  - Reasoning
  - Intelligence

Nutritional outcomes and their indicators include the following:[8]

- Most-used anthropometric outcomes:
  - Weight-for-age (underweight)
  - Weight-for-height (wasting)
  - Height-for-age (stunting)
- Other anthropometric outcomes
  - Weight
  - Height
  - Mid-upper arm circumference
  - Skinfold thickness
  - Percent body fat
  - Body mass index (BMI)
- Nutrition biomarkers
  - Hemoglobin
  - Serum ferritin
  - Soluble transferrin receptor
  - Serum retinol
  - Serum retinol binding protein

[7] See, for instance, Adelman et al. 2007; Alderman et al. 2012; Jomaa et al. 2011; Lawson et al. 2012; McEwan 2014.
[8] See, for instance, Taylor-Robinson 201; UN SCN 2010; De-Regil et al. 2011; Low et al. 2013; Cogil 2003; WHO 2001; WHO 2008; WHO 2011c; WHO 2011d.

- Vitamin A biomarkers
- Serum zinc
- Urinary iodine

Health outcomes (such as rates of diarrhea, bacteria contamination, and respiratory infections) were analyzed in a separate meta-analysis and are included in this study.

1.2.2.5.1. Educational Outcomes

A 'high quality' education is typically defined as adequate classrooms staffed with well-trained teachers using appropriate learning materials. However, 'quality education' will not result in effective educational outcomes if children are sick, hungry or malnourished. There is a significant body of evidence (Shekar et al., 2006; Alderman et al., 2008; Bundy, 2011) that malnutrition leads to reduced attendance and poor school performance. Thus the theory of change holds that improved nutrition can reduce morbidity, therefore leading to increased attendance and improved performance.[9]

Nutrients play an important role in cognitive and motor development in children (Black, 2003). Prevalent worldwide (Ramakrishnan, 2002), micronutrient deficiencies can result in delayed physical and cognitive development, preventing children from reaching their full potential (Demment et al., 2003). For instance, children living in areas affected by severe iodine deficiency disorder may have an intelligence quotient well below that of non–iodine-deficient areas (Qian et al., 2005). Iron and zinc deficiency have been associated with impaired psycho-motor development and cognitive function (Politt et al., 2002; Grantham-McGregor, 2001). Zinc deficiency has been linked to low activity and depressed motor development among the most vulnerable children (Black, 2003) and anemia has been linked with lower learning abilities in school-age children (Sangvi et al., 2007).

1.2.2.5.2. Nutrition Outcomes

To understand the ultimate impact of nutritional interventions, it is necessary to consider their effects on the nutritional status of children. Undernutrition refers to three most commonly used normalized anthropometric indictors: underweight, wasting, and stunting. Mild, moderate and severe underweight is a composite measure of short-term and long-term undernutrition, corresponding to less than one, two or three standard deviations from median weight for age (WAZ) of the reference population. Mild, moderate and severe wasting is an indicator for inadequate nutrition in the recent past, corresponding to less than one, two or three standard deviations from median weight for height (WHZ) of the reference population. Mild, moderate and severe stunting is an indicator for chronic undernutrition, corresponding to less than one, two

[9] Morbidity is an incidence of ill health. It is often measured by the probability that a randomly selected individual in a population at some date and location would become seriously ill in some period of time.

or three standard deviations from median height for age (HAZ) of the reference population. Emphasis in nutrition and economic research is more particularly placed on stunting or height for age because children with a healthier start in life come closer to their genetic potential height. There is emerging evidence, both from nutrition and economics, that the average size of children predicts the health of human capital of the next generation (IFPRI, 2014; Behrman et al., 2013; Hoddinott et al., 2013; Hoddinott et al., 2008; Victora et al., 2008; Shekar et al., 2006; Alderman et al., 2006).

Additional measures include weight, height, body mass index (BMI), mean upper-arm circumference (MUAC), mid–upper-arm muscle circumference (MUAMC), and skinfold thickness (see, for instance, Cogil, 2003). BMI, or weight over height squared, measures thinness/fatness and is used for adolescents and adults (and, increasingly, for school-age children). MUAC and MUAMC are measures of body composition. MUAC can detect small changes in fat tissue and muscle mass—an indicator of protein-energy malnutrition. MUAMC is a refined measure used to estimate total body muscle mass and is less sensitive to brief changes in muscle mass that may occur during illness. Skinfold thickness is an anthropometric measurement used to evaluate nutritional status of children by estimating the amount of the subcutaneous adipose tissue. The subcutaneous fat is most frequently measured in five sites, including the upper arm. The values are used in an equation that estimates body fat.

In the context of school feeding and micronutrient interventions, caloric intake can lead to weight gain and, in some circumstances, to height gain. Micronutrients in fortified school meals can contribute to growth and gains in muscle mass. Reducing zinc deficiencies, for example, can help to accelerate growth and improve appetite. Adequate stores of zinc, vitamin A, and iron reduce susceptibility to infection and hence improve growth (Adelman et al., 2008).

Children of school age, especially in economically disadvantaged populations, do not suffer only from observable forms of malnutrition, but also from non-observed micronutrient deficiencies, also referred to as "hidden hunger." For this reason, micronutrient deficiencies are also measured through nutrition biomarkers detected via blood tests, including iron deficiency, iron deficiency anemia, hemoglobin, serum ferritin, soluble transferrin receptor, serum retinol, serum retinol binding protein, and serum zinc. Serum retinol and serum retinol binding protein are two biochemical indicators for determining vitamin A deficiency. Serum zinc or plasma zinc concentration is the most widely used biochemical indicator of zinc status.

In the later stages of iron depletion, the hemoglobin concentration decreases, resulting in a condition known as iron deficiency anemia. Hemoglobin concentrations are used to diagnose anemia, while serum ferritin, an iron storage protein, and serum transferrin, an iron transport protein, are commonly used as indicators of iron status in populations (WHO, 2011c; WHO, 2011d). Children, particularly those younger than five years, are vulnerable to iron deficiency anemia because of their increased needs as a result of rapid growth. It is estimated that approximately 600 million preschool and school-aged children are anemic worldwide, and it is calculated that at least half of the cases are due to iron deficiency (WHO, 2008).

Consequences of iron deficiency anemia during childhood include growth retardation, reduced school achievement, impaired motor and cognitive development, and increased morbidity from a variety of causes including diarrhea and acute respiratory infections (WHO, 2001). Long-term effects of early iron deficiency include decreased work capacity and impaired cognitive and behavioral development (Siddiqui, 2004; Lozoff, 2007). Some of these impairments are thought to be irreversible if they occur at an early age and the consequences may continue even after treatment, reinforcing the importance of prevention.

1.3. Organization of the Report

This report contains five sections, including this introduction. The next section describes the objective of the study and its methodology. Section three presents an in-depth discussion of the empirical evidence derived from the various nutritional interventions conducted in school settings: iron supplementation, and multiple micronutrient supplementation and food fortification with multiple micronutrients. Major findings are followed by summary and conclusions, limitations of the findings, and implications for possible future research. Annex 1 consists of a detailed table summarizing the major characteristics of the study used in the analysis. The MGD results framework is provided as Annex 2. Detailed technical data used to derive findings are provided as Annex 3 and Annex 4.

2.0. Objective and Methodology

2.1. Objective

The objective of the systematic review and meta-analysis is to investigate the likely causal impact of iron and multiple micronutrient interventions on educational and nutrition outcomes for preschool and primary-school children, and implications for possible future research directions.

2.2. Methodology

2.2.1. Geographic Coverage

Only studies of interventions conducted in developing countries are included.[10]

[10] Developing countries are characterized as such based on the classification used in the International Monetary Fund World Economic Outlook for 2014.

2.2.2. Timeframe

The literature search was mainly, but not exclusively, based on studies published between 2000-2015. Studies that were conducted before 2000, but not published until 2000 were included. Earlier studies considered that are considered as 'ground breaking' and/or especially relevant were also considered for inclusion.

2.2.3. Target Groups

Pre-primary and primary-school-age children are the focus of the investigation.

2.2.4. Study Language

Studies are not excluded on the basis of language.

2.2.5. Search Sources

The studies reviewed for the iron and multiple micronutrient meta-analyses were identified through a systematic search. The search covered both general and specialist sources pertaining to education, economics, nutrition and health. They included electronic sources and journals, websites of research centers and gray publications (unpublished studies, including studies found through the World Bank, and the Abdul Latif Jameel Poverty Action Lab at MIT). Citation tracking and examination of the body of work of relevant influential authors were used to identify studies meeting the inclusion criteria used in these reviews. Electronic searches were conducted on papers cited in other papers already included in this review as well as cross-checking of references cited in other meta-analysis papers that included nutrition interventions in school settings. Citation searches were also conducted using Google Scholar for related systematic reviews and relevant impact evaluations. Such impact evaluations and systematic reviews (and the citations therein) were screened for relevance using the screening criteria described below.

2.2.6. Evidence Considered and Estimation Methods

2.2.6.1. Screening Criteria

Only the empirical literature that contains the most rigorous evidence using the strongest methodology for identifying causal impacts was considered. Impact evaluations quantify the effects of programs on individuals, households, and communities. They show whether the changes observed are indeed due to the program intervention and not to other factors (see, for instance, Khandker et al., 2010). Impact evaluations "compare the outcomes of a program against a counterfactual that shows what would have happened to beneficiaries without the program. Unlike other forms of evaluation (such as 'performance evaluations'), they permit the attribution of observed changes in outcomes to the program being evaluated" (World Bank, n.d.).

Attribution is different from association between the intervention and outcomes that may have been affected by other contextual factors. Evaluating the impact of an intervention hinges on a fundamental question: "What would the situation have been if the intervention had not taken place?".

Impact evaluations range from randomized designs to quasi-experimental models. Impact evaluations range from randomized designs to quasi-experimental models. There is consensus that the best evaluation method is the experimental design, in which beneficiaries (called intervention or treatment group) are randomly selected from a set of communities with similar characteristics. Subjects not randomly selected for the intervention form a counterfactual (called comparison or control group). Randomized controlled trials (RCTs), the gold standard by which scientific evidence is evaluated, can be double-blind trials, an experimental procedure in which neither the subjects nor the experimenters know which subjects are in the test and control groups during the actual course of the experiments; single-blind trials, an experimental procedure in which the experimenters but not the subjects know the makeup of the test and control groups during the course of the experiments; or without blinding ("unblinded"). The control may be a standard practice, a placebo, or no intervention at all.

In a perfect study it would be possible to control all variables. In such a controlled experiment, if all the controls work as expected, it is possible to conclude that the results of the experiment are due to the effect of the variable being tested. More generally, experimental design enables the investigator to make claims of the following nature: The two situations were identical until the intervention was introduced. Since the intervention is the only difference between the two situations, the new outcome was caused by that intervention.

Quasi-experimental designs are used when all the necessary requirements to control influences of extraneous variables cannot be met, most particularly when randomization is not possible for political, ethical, or logistical reasons. When the subjects cannot be randomly assigned to either the experimental or the control group, or when the researcher cannot control which group will get the treatment, participants do not all have the same chance of being in the control or the experimental groups, or of receiving or not receiving the treatment. [11]

While RCTs have pre-test and post-test data for randomly assigned intervention and control groups, quasi-experimental design studies develop a counterfactual using a comparison group which has not been created by randomization. To develop the counterfactual, quasi-experimental

[11] Following the literature, the event for which an estimate of the causal effect is sought is called *treatment*. The *outcome* is what will be used to measure the effect of the treatment. The treatment and control groups do not necessarily need to have the same pre-intervention conditions. The two groups may well have different characteristics. However, many of those characteristics can reasonably be assumed to remain constant over time or at least over the course of an evaluation.

studies use statistical techniques to create a comparison group that is matched with the intervention group in socioeconomic and other characteristics, or to adjust for differences between the two groups that might otherwise lead to inaccurate estimates. The goal of such statistical techniques is to simulate a randomized controlled trial.[12] Quasi-experimental methods include the following:

- Difference-in-Difference (or Double Difference): An increasingly popular method to estimate causal relationships, this technique compares the before-and-after difference for a group receiving the intervention to the before-after difference for those who did not.
- Matched comparisons: An analysis in which subjects in a treatment group and a comparison group are made comparable with respect to extraneous factors by individually pairing study subjects with the comparison group subjects.
- Instrumental variables: Have been used primarily in economic research, but have increasingly appeared in epidemiological studies. They are used to control for confounding and measurement error in observational studies, allowing for the possibility of making causal inferences with observational data and can adjust for both observed and unobserved confounding effects.
- Judgmental matching of comparison groups: A statistical method that involves creating a comparison group by finding a match for each person or site in the treatment group based on the researcher's judgement about what variables are important.
- Propensity score matching: Statistically creating comparable groups based on an analysis of the factors that influenced people's propensity to participate in a given program. The most common implementation of propensity score matching is one-to-one or pair matching, in which pairs of treated and untreated subjects are formed, such that matched subjects have similar values of the propensity score.
- Regression discontinuity: An analysis used to estimate program impacts in situations in which candidates are selected for treatment based on whether their value for a numeric rating exceeds a designated threshold or cut-off point. The analysis consists of comparing the outcomes of individuals below the cut-off point with those above the cut-off point.

2.2.6.2. Exclusion Criteria

Studies that did not meet the inclusion criteria listed above (including studies that did not have a control group) were not considered.

2.2.6.3. Statistical Analysis Methodology

[12] For details on all these evaluation methods, see for instance Khandker et al., 2010; and Gertler et al., 2011.

Data in the studies reviewed were analyzed through meta-analysis.[13] Meta-analysis is the statistical combination of results from those separate studies. It can be used to generalize from the sample of studies based on different assumptions about the distribution of effects. Such a combination yields an overall effect size, a statistic (a quantitative measure) that summarizes the effectiveness of the interventions compared with their control interventions.[14]

The Comprehensive Meta-Analysis software, a computer program for meta-analysis, was used to estimate effect sizes. Following the international development meta-analysis literature, the random effects meta-analysis methodology was used to derive estimates. Unlike the fixed-effect meta-analysis, which assumes that the treatment effect is common across all studies and that differences in study findings are due to sampling error, or chance, only (Riley et al., 2011), random-effects meta-analysis estimates the average effect across studies, allowing for differences due to both chance and other factors which affect estimates -- such as study location, characteristics of the target population and length or intensity of the treatment. For this reason, the random-effects confidence interval in random-effects meta-analysis is wider than that estimated in a fixed-effect meta-analysis, reflecting a more conservative estimate as a result of the additional uncertainty around the estimate.

Study weights are also more balanced under the random-effects model than under the fixed-effect model. Under the fixed-effects model, it is assumed that the true effect size for all studies is identical, and the only reason the effect size varies between studies is sampling error (error in estimating the effect size). Therefore, when assigning weights to the different studies under the fixed-effect model it is assumed that we can largely ignore the information in the smaller studies because we have better information about the same effect size in the larger studies. By contrast, our objective under the random-effects model is not to estimate one true ("fixed") effect, but to

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[13] According to the Campbell Collaboration -- an international research network that produces systematic reviews of the effects of social interventions in crime and justice, education, international development, and social welfare -- the objective of a systematic review is to "sum up the best available research on a specific question. This is done by synthesizing the results of several studies. A systematic review uses transparent procedures to find, evaluate and synthesize the results of relevant research. Procedures are explicitly defined in advance, in order to ensure that the exercise is transparent and can be replicated…Studies included in a review are screened for quality, so that the findings of a large number of studies can be combined." (Higgins, 2014). This definition applies to any technical research topic. For instance, the U.S. Department of Health and Human Services defines the systematic review as "a critical assessment and evaluation of all research studies that address a particular clinical issue. The researchers use an organized method of locating, assembling, and evaluating a body of literature on a particular topic using a set of specific criteria." (http://effectivehealthcare.ahrq.gov/index.cfm/glossary-of-terms/?pageaction=showterm&termid=70;; accessed 5/9/2015).

[14] The effect size is a generic term for the estimate of effect of treatment for a study. It is a dimensionless measure of effect that is typically used for continuous data when different scales are used to measure an outcome and is usually defined as the difference in means between the intervention and control groups divided by the standard deviation of the control or both groups, where the standard deviation is defined as the spread or dispersion of a set of observations, calculated as the average difference from the mean value in the sample. (See, for instance, Cochrane Community, http://community.cochrane.org/; accessed 5/9/2015).

estimate the mean of a distribution of effects to ensure that all these effect sizes are represented in the summary estimate.[15]

2.2.6.4. Limitations of the Analysis

2.2.6.4.1. Assessment of Publication Bias

The presence of bias in the extracted data was evaluated graphically by using the funnel plot and Egger's regression tests (Egger et al. 1997). To reduce publication bias (a situation that, for instance, may lead journals to prefer studies with positive effects), every attempt was made to broaden the search to the non-published "grey literature" that included conference proceedings, technical reports, dissertations, and theses. However, no attempt was made to assess publication bias through sensitivity analysis for outliers (defined as any study which differed markedly from the overall pattern) or through imputation of missing studies by using "trim and fill" analysis (Duval & Tweedie, 2000) –a sensitivity analysis method that extends beyond the scope of this study.

Another method of assessing the potential for publication bias is to calculate the "fail-safe N," the number of studies whose effect size is zero or negative that would be needed to increase the P-value for the meta-analysis to above 0.05 (or any other selected threshold). However, the Cochrane Handbook for Systematic Reviews of Interventions notes that "this and other methods are not recommended for use in Cochrane reviews" (Higgins et al., 2014). (For additional information on publication bias, see Annex 3; for detailed funnel plots and Egger's regression texts associated with each pooled effect size, see Annex 4.)

2.2.6.4.2. Assessment of Risk of Bias in Included Studies

The Cochrane Collaboration recommends a specific tool for assessing risk of bias in each included study and across studies. The assessment consists of a judgement and a support for that judgement for each entry in a "risk of bias" table, where each entry addresses a specific feature of the study. The judgement for each entry involves assessing the risk of bias as "low risk," "high risk," or "unclear risk," with the last category indicating either lack of information or uncertainty over the potential for bias. Assessment of risk of bias includes sequence generation (checking for possible selection bias), allocation concealment (checking for possible selection bias), blinding in RCTs (checking for possible performance and detection bias), incomplete

[15] This is equivalent to saying that we cannot discount a small study by giving it a very small weight (the way we would in a fixed-effect analysis). Since our objective is to estimate the mean effect in a range of studies -- and we do not want that overall estimate to be overly influenced by any one of them -- we cannot give too much weight to a very large study (the way we would in a fixed-effect analysis) and give too little weight to the estimate provided by a small study because that estimate contains information about an effect that no other study has estimated (See, for instance, http://www.meta-analysis.com/downloads/Meta-analysis%20Fixed-effect%20vs%20Random-effects%20models.pdf; accessed 6/10/2015).

outcome data (checking for possible attrition bias through withdrawals, dropouts or protocol deviations), selective reporting bias, and other sources of bias.

Due to time constraints, a detailed risk of bias table could not be prepared for each study included in the meta-analysis. Since we did not perform a risk of bias analysis, we could not carry out sensitivity analysis to examine the effects of removing studies at high risk of bias from the analysis. Nor did we conduct an influence analysis -- the effect of omitting one study at a time -- to reveal that no single study has an overwhelming effect on the outcome considered.

2.2.6.4.3. Heterogeneity and Stratified Analysis

We addressed heterogeneity[16] by use of random-effects meta-analysis (see Section 2.2.6.3) and predefined subgroup analyses. We visually examined the forest plots[17] from the meta-analysis to look for any obvious heterogeneity among studies in terms of the size or the direction of treatment effect. We used the I^2 statistic test to quantify the level of heterogeneity among the studies in each analysis. We explored the identified heterogeneity by subgroups of participants, treatments, and outcomes. (Forest plots and I^2statistics for all interventions and outcomes measured can be found in Annex 4.). The stratified analysis focused on individual outcomes by intervention; outcome category and individual outcomes within each category; and gender, when data were available. Further stratified analyses to control for certain treatment sub-categories and experimental samples are beyond the scope of this study. These include the effect of the following moderators [18] and d their impact:

- Study design and quality: RCTs vs. quasi-experimental design; for RCTs, masking of participants and outcome assessors, unit and method of allocation, and exclusion of participants after randomization or proportion of losses after follow-up; working papers

[16] Heterogeneity is used to describe the variation in, or diversity of, participants, interventions, and measurement of outcomes across a set of studies. In a statistical sense, it is used to describe the degree of variation in the effect estimates from a set of studies. It is also used to indicate the presence of variability among studies beyond the amount expected due solely to chance. Heterogeneity in meta-analysis is measured by I^2, a statistical expression of the inconsistency of the results in the studies reviewed. For example, a meta-analysis with $I^2 = 0$ means that all variability in effect size estimates is due to sampling error within studies. On the other hand, a meta-analysis with $I^2 = 50$ means that half of the total variability among effect sizes is caused not by sampling error, but by true heterogeneity between studies. According to the Cochrane Handbook (Higgins, 2014), a rough guide to the interpretation of I^2 is as follows:

0% to 40%: might not be important;
30% to 60%: may represent moderate heterogeneity;
50% to 90%: may represent substantial heterogeneity;
75% to 100%: considerable heterogeneity.

(http://handbook.cochrane.org/chapter_9/9_5_2_identifying_and_measuring_heterogeneity.htm)

[17] A forest plot is a graphical representation of the individual results of each study included in a meta-analysis, together with the combined meta-analysis result. The plot also allows researchers to see the heterogeneity among the results of the studies.

[18] Statistically, a moderating variable is one that affects the direction and/or strength of the relation between dependent and independent variables.

vs. published papers; and quasi-experimental design method (for major quasi-experimental design methods, see Section 2.2.6.1).

- Geographic location of study population
- Rural and urban location
- Socio-economic status as defined in each study
- Age of children
- Grade of children
- Study duration
- Sample size and power analysis
- Anemia biomarker (hemoglobin, serum ferritin, soluble transferrin receptor)
- Dose of iron or multiple micronutrients
- Type of compound and bioavailability of the iron preparation used for supplementation. As pointed out by Allen (2014), fortification with iron has often been ineffective in the past due to the use of poorly absorbable or bioavailable compounds to prevent undesirable sensory changes in the food, leading to revised WHO fortification recommendations in 2010.
- Supplementation regimen for intermittent iron supplementation: one supplement per week; other intermittent regimen
- Supplementation product (syrup, tablet, capsule)
- Fortification vehicle (e.g., drink, seasoning, spread, salt, flour, biscuits)
- Micronutrient composition for iron supplementation (iron alone; iron and folic acid; iron and other micronutrient; iron and multiple micronutrients).
- Number of micronutrients and type of compound
- Cognition test. (Researchers in the studies reviewed were found to use a variety of assessment tests to measure the same domain. Results from such a variety of outcome measures poses a challenge in making comparisons, and the applicability of one result may be limited to populations without a similar deficiency.)

3.0. Empirical Evidence

3.1. Effect of Iron and Multiple Micronutrient Interventions on Educational Outcomes in Preschool and School-Age Children

This section first analyzes the effect of daily and intermittent iron supplementation on educational outcomes. This analysis is followed by an investigation of the effect of multiple micronutrient interventions on those outcomes. Multiple micronutrient interventions are implemented through supplementation or food fortification, the process of adding micronutrients (essential trace elements and vitamins) to food.

As detailed in Section 1.2.2.5, education outcomes are divided into three categories: school participation (enrollment, attendance/absenteeism, dropout, and repetition); learning achievement (standardized math and science test scores, and standardized language test scores); and cognitive development (verbal fluency, memory, reasoning, and intelligence). It should however be noted, as apparent in the tables used for discussion below, that the studies included in the review did not investigate school participation outcomes, and not all learning and cognitive achievement outcomes were examined.

Finding 1: Daily iron supplementation may improve educational outcomes

Daily iron supplementation may improve educational outcomes.[19] However, at a very small level of 0.046 [20] (Table 3.1), this effect size is based on low-quality evidence.[21] The pooled effect is based on six studies[22] that assessed the effect of iron supplementation on intelligence, reasoning, and math & science. The effect on intelligence is based on three studies: two in India (Seshadri & Gopaldas, 1989; Kashyap & Gopaldas, 1987), with a total sample size of 652 divided into three groups of about 215 each; and one in Thailand (Sungthong et al., 2002), with a total sample of 397 school children. Although large (0.922), the effect on reasoning is only based on two studies: one in Indonesia with a sample of 97 school children (Soemantri et al., 1996) showing a 0.250 effect size and one in Thailand (Politt et al., 2002), with a much larger sample of 1,358 showing no effect on reasoning. The effect on math and science is based on a single study, with an effect size of 0.100.

Table 3.1: Mean Effect Size of Daily Iron Supplementation on Educational Outcomes

Outcome	Effect size	Number of effect sizes
Pooled effect	0.0.046 (***)	9
Intelligence	0.922 (***)	6

(***) Significant at 99% level; (**) Significant at 95% level; (*) Significant at 90% level
(#) Effect sizes too few to estimate effect size separately

[19] Studies on intermittent iron supplementation included in the review did not investigate educational outcomes.

[20] Effect size magnitudes are typically interpreted on the basis of rules of thumb suggested by Cohen (1988). According to Cohen, an effect size of about 0.20 is considered “small,” of about 0.50 is considered “medium,” and of about 0.80 is considered “large.” Although these guidelines are broad categorizations, it has become standard practice for researchers to use them when interpreting effect size estimates. Thus, if the means for the treatment and control groups do not differ by 0.2 standard deviations or more, the difference is “trivial” or very small even if it is statistically significant.

[21] The quality of evidence is based on the Grading of Recommendations Assessment, Development and Evaluation (GRADE) Working Group, an informal collaboration of people with an interest in addressing the shortcomings of present grading systems in health care. Using the GRADE system, outcomes may be classified as follows: high quality evidence means iron supplementation improves the outcome under consideration; moderate quality evidence means iron supplementation probably improves the outcome; low quality evidence means iron supplementation may improve the outcome; very low quality evidence means we do not know whether iron supplementation improves the outcome.

[22] The number of effect sizes (9 in this example) is generally higher than the number of studies (6 in this example) because a given study may estimate more than a single effect size.

Finding 2: The effect of multiple micronutrient interventions on educational outcomes is higher for supplementation than for fortification, but their pooled effect size is very small

At 0.092, the pooled effect of multiple micronutrient interventions is very small (Table 3.2). The overall effect size of multiple micronutrient supplementation (0.309) is much higher than the overall effect size for fortification with multiple micronutrient (0.080). The pooled effect size (0.092) is slightly higher than the effect size of fortification (0.082) but is considerably lower than the effect of supplementation (0.309) because the effect of fortification is based on a high number of effect sizes (88), whereas the effect of multiple micronutrient supplementation is based a much lower number of effect sizes (9).

It should also be noted that most of the effect for multiple micronutrient supplementation is based on one major outcome (memory tests) and two minor outcomes, reasoning and intelligence (not shown in Table 3.2), and food fortification is based on 6 outcomes totaling 88 effect sizes.

Table 3.2: Mean Effect Size of Multiple Micronutrient Interventions on Educational Outcomes (a)

Outcome	Effect size	Number of effect sizes
Pooled effect	0.092 (***)	97
Supplementation	0.309 (***)	9
Memory	0.298 (***)	7
Fortification	0.080 (***)	88
Intelligence	0.138 (***)	24
Language	0.027	4
Math & Science	0.005	10
Memory	0.100 (***)	22
Reasoning	0.032 (*)	12
Verbal	0.093 (***)	16

(a) Studies on multiple micronutrient interventions included in the review did not investigate school participation outcomes (enrollment, attendance, dropout and repetition rates). Nor did they investigate educational outcomes by gender.
(***) Significant at 99% level; (**) Significant at 95% level; (*) Significant at 90% level

Finding 3: The effect of food fortification with multiple micronutrients on educational outcomes is driven by three major outcomes

Table 3.2 presents the performance of supplementation/fortification on memory (an overall effect size of 0.100 based on 22 effect sizes), intelligence (an overall effect size of 0.138 based on 24 effect sizes) and verbal test score improvement (an overall effect size of 0.093 based on 16 effect sizes). These three outcomes are major contributors to the overall impact on food fortification using multiple micronutrients. Notably, it was found that fortification has no effect on learning achievement (demonstrated through language, math, and science test scores). There was no statistically significant effect of these interventions on educational outcomes (effect size not statistically significant).

3.2. Effect of Iron and Multiple Micronutrient Interventions on Nutrition Outcomes in Preschool and School-Age Children

This section first analyzes the effect of daily and intermittent iron supplementation on nutrition outcomes. This analysis is followed by an investigation of the effect of multiple micronutrient interventions on those outcomes. Previously detailed in Section 1.2.2.5., nutrition outcomes are typically divided into three categories: common anthropometric outcomes (weight (specifically 'underweight'), wasting, and stunting); other anthropometric outcomes (weight, height, mid-upper arm circumference, skinfold thickness, percent body fat, and body mass index); and nutrition biomarkers (hemoglobin, serum ferritin, soluble transferrin receptor, serum retinol, serum retinol binding protein, vitamin A biomarkers, serum zinc, and urinary iodine). The studies included in the review did not examine all the nutrition outcomes listed above (see tables and discussion below).

Finding 4: Iron supplementation improves nutrition outcomes for preschool and school-age children

As shown in Table 3.3, the pooled effect of daily and intermittent iron supplementation on the nutrition outcomes for preschool and school-age children is estimated at 0.566 based on a large number of effect sizes (82).

Table 3.3: Mean Effect Size of Daily and Intermittent Iron Supplementation on Nutrition Outcomes

Outcome	Effect size	Number of effect sizes
Pooled effect (daily and intermittent supplementation)	0.566 (***)	82
Daily Supplementation	0.277 (***)	31
Stunting	0.261 (**)	10
Underweight	0.390 (**)	10
Wasting	0.414	5
Intermittent Supplementation (all outcomes)	0.602 (***)	45
Anemia (boys & girls)	0.138 (***)	30
Anemia (girls only)	0.630 (***)	15
BMI (girls only)	1.478 (***)	12

(***) Significant at 99% level; (**) Significant at 95% level; (*) Significant at 90% level

Finding 5: The effect of iron supplementation is driven more by intermittent than by daily supplementation

Table 3.3 illustrates that the effects of iron supplementation (0.566) are impacted more by intermittent supplementation (an effect size of 0.602 based on 45 effect sizes) than by daily supplementation (an effect size of 0.277 based on 31 effect sizes).

Finding 6: Daily iron supplementation reduces stunting and underweight and appears to have no effect on wasting

As depicted in Table 3.3, daily iron supplementation reduces stunting (effect size of 0.261) and underweight (effect size of 0.390), but has no effect on wasting (effect size not statistically significant).

Finding 7: Intermittent iron supplementation has a larger effect on girls than on boys as measured by anemia status

Table 3.3 shows that intermittent iron supplementation as measured by 'anemia status'[23] of preschool and school-age children has a larger effect on girls (0.630) than on boys, as indicated by the combined effect on boys and girls (0.138). This finding is important for three reasons. First, children are particularly vulnerable to iron deficiency anemia because of their increased need for iron as a result of rapid growth. Second, anemia status is particularly important for girls of, or near, reproductive age. Third, it is estimated that approximately 600 million preschool and school-aged children are anemic worldwide, and it is calculated that at least half of the cases are due to iron deficiency (WHO, 2008).

Intermittent iron supplementation has an unambiguously large effect (1.478) on BMI improvement for girls, which is the largest nutrition effect size for any outcome in this meta-analysis (no data on the effect on intermittent iron supplementation are available for boys separately or for both boys and girls as a single group).

Finding 8: Multiple micronutrient interventions improves nutrition outcomes for preschool and school-age children

Table 3.4 outlines the pooled effect of multiple micronutrient supplementation and food fortification interventions on nutrition outcomes for preschool and school-age children. The pooled effect is calculated at 0.366 with a large effect size (152).

Finding 9: Both food fortification and micronutrient supplementation play a positive role in improving the nutrition status of preschool and school-age children, but the evidence is stronger for food fortification

The effect size for food fortification (0.360) and micronutrient supplementation (0.427) are nearly equal (Table 3.4). However, the reliability of the results from food fortification is much greater than micronutrient supplementation because the results are derived from large number of effect sizes and outcomes (141 effect sizes and 6 outcomes) than micronutrient supplementation (11 effect sizes and a single outcome).

[23] As detailed in Section 1.2, Iron deficiency anemia is measured by several biomarkers, including hemoglobin concentration, serum ferritin, and serum transferrin, an iron transport protein.

Table 3.4: Mean Effect Size of Multiple Micronutrient Supplementation and Fortification on Nutrition Outcomes		
Outcome	Effect size	Number of effect sizes
Pooled effect (supplementation and fortification)	0.366 (***)	152
Supplementation (all outcomes)	0.427 (**)	11
Anemia (boys & girls)	0.720 (***)	8
Anemia (girls only)	0.718 (**)	4
Fortification (all outcomes)	0.360 (***)	141
Weight	0.192 (***)	16
Height	0.339 (***)	15
MUAC	0.076 (*)	6
Anemia	0.476 (***)	44
Serum zinc	0.197 (***)	11
Vitamin A	0.131(***)	11
(***) Significant at 99% level; (**) Significant at 95% level; (*) Significant at 90% level		

Finding 10: The effect of multiple micronutrient interventions is stronger for anemia than for any other nutrition outcome for both supplementation and food fortification

The effect size of food fortification for reduced anemia (0.476) (see Table 3.4) is higher than any other nutrition outcome, including weight (0.192), height (0.339), MUAC (0.076), Serum zinc (0.197), and vitamin A (0.131). As noted earlier, this is an important finding because children are particularly vulnerable to iron deficiency anemia.

Finding 11: Micronutrient fortification has a positive effect on vitamin A and Zinc deficiency

The effect size for vitamin A status, as measured by serum retinol concentrations (WHO 2011i), is 0.131 (Table 3.4). This positive outcome is particularly important because vitamin A, an essential micronutrient for the immune system, can improve a child's chance of survival by up to 25 percent. In addition, in countries where mortality among young children is high, ensuring that pre-school children receive enough vitamin A may be the single most cost-effective child survival intervention (UNICEF, 2013). The effect size for zinc status, as measured by plasma zinc or serum retinol concentrations (see, for instance, Lowe et al. 2009), is 0.197. Zinc is another essential micronutrient that has an important role in preventing mortality, morbidity, and growth failure in children (Mayo-Wilson et al. 2014; Walker et al. 2010); and treating diarrhea in children (Lazzerini, & Ronfani, 2012; Lamberti et al., 2013).

Finding 12: The effect sizes for nutrition outcomes are stronger than for educational outcomes

The pooled effect sizes for nutrition outcomes (0.366 for micronutrient supplementation and food fortification, and 0.566 for iron supplementation) are higher than for educational outcomes (0.046 for iron supplementation, and 0. 092 for multiple micronutrient supplementation and food fortification). However, this differential is not unexpected because it may take more time to show significant differences in cognitive domains and, more particularly, in acquired skills and knowledge following nutritional interventions than in nutrition biomarkers for at least two reasons. First, environmental factors, such as education, parenting styles, and socioeconomic status may be more important determinants of learning than nutrition. Second, the duration of the trials may have been too short to demonstrate effects. For instance, some of the study periods may be too short for supplementation or fortification to bring about significant differences in acquired skills and knowledge following the nutritional intervention. For example, as suggested by Benton (2001), verbal intelligence comprises the acquired knowledge that might not be affected by nutrition in the shorter term.

3.3. Conclusions, Limitations of the Findings, and Learning Agenda

3.3.1. Summary and Conclusions

3.3.1.1. Major Findings

- Daily iron supplementation and multiple micronutrient interventions have a positive effect on educational outcomes in preschool and school-age children, but their effect size is very small.
- Iron supplementation and multiple micronutrient interventions improve nutrition outcomes for preschool and school-age children. Both food fortification with multiple micronutrients and multiple micronutrient supplementation play a positive role in improving the nutrition status of preschool and school-age children, but the evidence is stronger for food fortification.
- The effect of multiple micronutrient interventions is stronger for anemia than for any other nutrition outcome for both supplementation and food fortification, and intermittent iron supplementation has a larger effect on girls than on boys as measured by anemia status. This is a key finding because all children and most particularly girls are vulnerable to iron deficiency anemia and because millions of preschool and school-aged children are anemic worldwide and more than half of those cases are due to iron deficiency.
- Food fortification with multiple micronutrients has a positive effect on vitamin A and Zinc deficiency, an important result because vitamin A and zinc are two essential micronutrients with proven effectiveness (i.e., they produce the intended outcome) and cost-effectiveness (i.e., they produce the intended outcome at a lower cost than competing interventions).
- The effect sizes for nutrition outcomes are stronger than for educational outcomes. This result may be due to the fact that the duration of the trials may have been too short and it may take more time to show significant differences in cognitive domains and knowledge acquisition than in nutrition biomarkers following nutritional interventions.
- The evidence outlined above comes from a relatively large set of 43 studies conducted in 19 countries dispersed across Africa (8 countries; 12 studies), Asia (7 countries; 26 studies), and Latin America (4 countries; 5 studies). (For details, see Annex 1.)

3.3.1.2. Capitalizing on Early Development Gains

It is now widely accepted (e.g., Shekar et al., 2006; Hoddinott et al., 2012; Bhutta et al., 2013; IFPRI, 2014; UN SCN, 2010) that a critical window of good nutrition is from pregnancy through the first two years of life. Early childhood nutrition depends in a critical way on nutrition of mothers during pregnancy. A second vulnerable period is the first two years of life because it is a period of peak mortality and susceptibility to disease. It is also a period where the nutritional requirements are high because young children are growing fast and their brains are growing most rapidly.

It is also acknowledged (e.g., Bundy, 2011; IFPRI, 2014; Alderman & Bundy, 2011) that while investing in nutrition during the first 1,000 days of life is a priority, addressing the nutrition needs of preschool and school-aged children will help those children capitalize on early development gains from good nutrition in pregnancy and the first 24 months.

Alderman and Bundy posit if food for education is one of the better investments in improving nutrition (Alderman and Bundy, 2011). Despite new evidence indicating favorable externalities to siblings of students, and the clear benefit in addressing hunger in schoolchildren, the answer there is no reliable evidence to prove that nutrition interventions through food for education interventions are the most effective, or provide the best 'value for money', on improving educational outcomes. However, nutrition and health interventions for preschool and school-age children are often part of a continuum of supportive programs of which food for education is just one component. Through a life-cycle approach, from maternal and child health during fetal development and infancy, to early child development, through pre school and school, these combinations of interventions do serve a purpose. There are compelling arguments that school health and nutrition programs should be mainstreamed into education by making school health and nutrition an integral part of a sector-wide education approach.

As evidenced by the results of this meta-analysis, school feeding can be effective in improving the nutrition status of preschool and school children if it is provided alongside nutrition interventions to tackle key micronutrient deficiencies among those children. For instance, fortified in-school meals or take-home rations can ensure appropriate intakes of iron and other key micronutrients.

The provision of school meals, when implemented alongside micronutrient interventions, is even more effective when their equity dimensions are considered. There is substantial evidence (Simeon et al., 1995; Jukes et al., 2006; Simeon & Grantham-McGregor, 1989; Pollitt et al., 1998; Simeon, 1998) that improving health and nutrition has the greatest effects on the poorest and most vulnerable schoolchildren. School health and nutrition programs can also play a key role in promoting gender equity. First, gender-based vulnerability and exclusion in developing countries can place girls at greater risk of ill health, neglect, hunger, and malnutrition. Second, some of the most common health conditions affecting education are more prevalent in girls. For instance, iron supplementation and iron-fortified food offer particular benefits to girls because women and girls are, for physiological reasons, more likely to experience high rates of anemia.

Many of the micronutrient interventions are also cost-effective. The cost-benefit ratio of iron fortification of general food products is 7.8 (Horton et al. 2008). The cost-benefit ratio of wheat flour fortification with iron is calculated to be between 6.7 (Casey et al., 2011) and 9.1 (Horton et al., 2011). The cost-benefit ratio for doubly fortified salt (iodine and iron) is between 2 and 5 (Horton et al. 2011; Rajkumar et al., 2012). The cost-benefit of salt iodization alone is 81 (Rajkumar et al., 2012). The latest cost-benefit ratio for vitamin A supplementation is estimated to be between 4.3 and 250 (Behrman et al., 2004; Horton et al., 2008; Rajkumar et al., 2012), and 2.85 for zinc supplementation (Rajkumar et al., 2012).

3.3.2. Limitations of the Findings

- The evidence used in this meta-analysis is based on a series of studies of an average duration of approximately seven months, several of which were conducted over a period of two months or less. Thus, many of the study periods may be too short for the interventions to bring about significant differences in outcomes, particularly regarding cognitive skills or acquired knowledge. As suggested by Benton (2001), verbal intelligence comprises the acquired knowledge that might not be affected by nutrition in the shorter term. Failure to generate significant changes in the intelligence tests may also be due to the fact that the study children were already performing well and additional micronutrients were not able to stimulate further increases in the IQ tests (Vazir et al., 2006).
- The effect of micronutrient interventions may be contextual. We have limited information on how the study setting influences the effect of those interventions. The magnitude of the effect may depend on the background prevalence of different micronutrient deficiencies and/or infections such as HIV and malaria (Ramakrishnan et al., 2011). For example, there is evidence that the effects of iron supplementation on child health vary by the extent of malaria and iron deficiency (Sazawal et al., 2006; WHO, 2006).
- Due to lack of data, important moderator variables could not be incorporated into the analysis, including effect sizes by age, grade, and pre-school vs. school-age children.
- With the exception of very limited data on a few anemia biomarkers, no data were available to investigate other important biomarkers or anthropometric outcomes by gender.
- We have limited information on indicators of nutritional status at baseline to explore whether malnourished children would benefit more from micronutrients than would well-nourished children.
- Due to data availability, this study provided average effect size estimates without accounting for the resource inputs associated with each program. This is a significant gap because it is misleading to use effect size as the sole criterion for ranking interventions. Some programs may have been on average less effective but more cost-effective than others.

3.3.3. Evidence Gap and Implications for Future Research

- The conclusions and limitations of this meta-analysis have shown that substantial gaps in our knowledge about delivering micronutrients remain. This is in part due to the fact that particular attention to micronutrient interventions has justifiably focused on "the thousand days," which include pregnancy and the infant and young child during the first two-year postpartum period. However, recommendations for older children and school-age girls of reproductive age are yet to be as well developed.
- Given the demonstrated importance of gender in relation to educational and nutritional outcomes, it is clearly essential that future studies of school nutrition interventions ensure that data are disaggregated by sex, and that the presence or absence of a gender role is clearly defined so that gender concerns can better be understood.
- Of particular importance are the contextual factors such as existing levels of infections. From this perspective, future studies should evaluate the effects of micronutrient interventions on child health and development and examine if these vary by the presence of infections such as HIV and malaria.
- More studies of an appropriate duration in different age groups and across all levels of baseline nutrition status are also required.
- A recent analysis of school feeding programs by the World Food Program and the World Bank (World Food Program, 2013) has recommended fortified foods as a routine part of school- based programs. Additional research is needed to address the operational challenges associated with delivering micronutrient programs in school settings. As with any intervention, micronutrient supplementation and food fortification programs must overcome administrative and logistical challenges to ensure that objectives are being met.

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Note: (*) denotes study included in the meta-analysis

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Annexes

Annex 1: Baseline Characteristics of the Studies Included in the Systematic Review and Meta-Analysis

Study	Title	Type of study	Location	Sample and ages	Interventions	Outcomes
Aaron et al. 2011	A Multi-Micronutrient Beverage Enhances the Vitamin A and Zinc Status of Nigerian Primary Schoolchildren	6 months double-blind placebo controlled trial	Nasarawa State, Nigeria	School children participating in pilot school feeding program. 566 children 5-13 years old assigned randomly to micronutrient fortification (n=288) or isoenergetic control beverage (n=278).	Children received 5 days a week during school hours either 250 ml multi-micronutrient beverage including Vit. A, iron, and zinc or an isoenergetic control beverage. After six months, results for 270 children in the micronutrient group and 264 in the control group were used in analysis.	Biochemical and anthropometric indicators of nutritional status. Treatment intervention did not significantly affect hemoglobin or serum ferritin concentrations. Biochemical changes were greater in the micronutrient group for serum retinol and zinc. Efficacy of the fortified beverage on anemia and iron status needs further evaluation.
Abrams et al. 2003	A Multinutrient-Fortified Beverage Enhances the Nutritional Status of Children in Botswana	Experimental control trial. Multivariate analysis to determine effects of fortified beverages.	Gaborone, Botswana	Out of 311 students screened in two public primary schools, 145 children completed taking experimental beverage and 118 a control placebo drink.	Children in one school were given seven 240 ml servings weekly of experimental beverage (ESP) fortified with 12 micronutrients. Children in the control school were given an isoenergetic placebo drink (CON), during 8 week period.	Changes in weight, weight for age, and mid-upper-arm circumference were significantly better in treated group than control group. Ferritin, riboflavin, and folate were significantly better in experimental group than in control, but Vit B12 was not. Plasma retinol did not change. Zinc was significantly higher and transferrin receptors significantly lower in the treated group than in control group.
Aguayo 2000	School-administered weekly iron supplementation–Effect on the growth and hemoglobin status of non-anemic Bolivian school-age children A randomized placebo-controlled trial	Randomized double-blind placebo-controlled trial; 2-arm design with individual randomization	La Paz, Bolivia	6 to 11.9 yr (Mean 9 yr). 73 initial and 64 at follow up. Treatment (37); Placebo (36)	weekly tablets containing iron. Placebo. Duration 18 weeks	Hemoglobin, anemia, anthropometric measurements (weight, height, MUAC) and side effects.

Study	Title	Type of study	Location	Sample and ages	Interventions	Outcomes
Ahmed et al. 2005	Efficacy of twice-weekly multiple micronutrient supplementation for improving the hemoglobin and micronutrient status of anemic adolescent schoolgirls in Bangladesh	Randomized double blind trial	Bangladesh, rural schools in Dhaka district	197 Anemic adolescent schoolgirls aged 14-18 yrs from rural schools	Two groups receiving twice weekly supplements of iron and folic acid (IFA) or multiple micronutrients (including IFA) for 12 weeks.	Baseline and endline tests compare IFA girls group with MMN group for anemia and iron deficiency, vitamins A and C concentrations.
Angeles et al. 1993	Decreased rate of stunting among anemic Indonesian preschool children through iron supplementation	RCT, double blind	Indonesia, Asia	Preschool children (2-5 y): treatment group (n = 39); control group (n = 37)	A treatment group (n = 39) received daily supplements of 30 mg Fe and 20 mg vitamin C, whereas a control group (n = 37) received 20 mg vitamin C only for a period of 2 months.	Hemoglobin and anthropometric measurements
Arcanjo et al. 2011	Weekly Iron Supplementation for the Prevention of Anemia in Pre-school Children: A Randomized, Double-blind, Placebo-controlled Trial	Cluster-randomized, placebo-controlled double-blind trial	Northeast Brazil	The study population comprised pre-school children (n = 135) from one randomly chosen public school	50 mg elemental iron for 14 weeks	Hemoglobin and hematocrit values
Ash et al. 2003	Randomized efficacy trial of a micronutrient-fortified beverage in primary school children in Tanzania	Randomized double blind placebo controlled efficacy trial	Tanzania, Mpwapwa District, on central plateau	841 primary school children aged 6-11 years. Children assigned to two groups: fortified and unfortified beverage group. 774 children of the initially eligible completed the 6 months trial.	Fortified beverage given to children for 6 months; the control group given unfortified beverage. Each group had about 370-380 children subjects (duration: 6 months).	Hematologic and anthropometric measurements: After 6 months children with anemia at the baseline had increased levels of hemoglobin at the end more than children with unfortified drinks. Mean incremental change in weight, height, and BMI were significantly higher among children receiving fortified drink than in the control group with unfortified drinks.
Berger et al. 1997	Weekly iron supplementation is as effective as 5 day per week iron supplementation in Bolivian school children living at high altitude	Double-blind randomized controlled trial. 3-arm design with individual randomization	La Paz, Bolivia	3.3 to 8.3 yr. Total 176: G1 (59); G2 (59); G3 Placebo (58)	G1: Tuesday iron (3-4 mg/kg). G2 iron (3-4 mg/kg) 5 days/week. G3 placebo. Duration 16 weeks	Hemoglobin, anemia, zinc
Chwang et al. 1988	Iron supplementation and physical growth of rural Indonesian children	RCT, double blind	Indonesia, Asia	8.2 to 13.5 yr. Sample 139: Fe (59); placebo (60)	Ferrous sulfate (10 mg) and placebo (duration: 12 weeks)	Cognitive performance. Hemoglobin, serum iron, transferrin, total iron binding capacity, anthropometric measurements.

Study	Title	Type of study	Location	Sample and ages	Interventions	Outcomes
Dalton et al. 2009	A Randomized Control Trial in School Children Showed Improvement in Cognitive Function after Consuming a Bread Spread Containing Fish Flour from a Marine Source	RCT, single blind	Northern Cape province, South Africa.	183 total Grade 2 students 7-9 years old were assigned randomly to fish flour spread treatment (n=91) or control placebo (n=92).	Students received 25 grams fish flour bread spread per day, or a placebo spread. Fish flour spread is rich in n-3 long chain polyunsaturated fatty acids (duration: 6 months)	Plasma and red blood cells fatty acid composition; learning; spelling tests; reading; memory.
Dossa et al. 2001	Impact of iron supplementation and deworming on growth performance in preschool Beninese children	RCT, double blind	Benin, Africa	3 to 5 years. Total 136: Fe (68); Placebo (68)	Oral dose 60 mg/day during 3 months	Hemoglobin, anthropometric measurements
Friis et al. 2003	Effects on hemoglobin of multi-micronutrient supplementation and multi-helminth chemotherapy: a randomized, controlled trial in Kenyan school children	Randomized, placebo control, double blind. Two by two factorial trial.	Kenya, Bondo District, Western Kenya	977 school children 9 to 18 years old in 19 schools	Single treatment of infected children with albendazole for geohelminths and praziquantel for Schistosoma mansoni and daily supplementation with 13 micronutrients. Follow up 8 months later.	Hemoglobin concentration
Gewa et al. 2009	Dietary micronutrients are associated with higher cognitive function gains among primary school children in rural Kenya	Two-year longitudinal, randomized control feeding intervention study. Longitudinal regression analysis	Kenya, Eastern province	Total sample of 554 Grade 1 children, median age 7.4 yr. from 12 selected primary rural schools.	Dietary nutrient values based on monthly and bimonthly 24 hour recall data collected during the study period. Four study groups: control and three supplement snacks: vegetarian (maize, beans and vegetables), milk, and meat (duration: 2 years)	Cognitive test scores based on Raven's Colored Progressive Matrices test for cognitive development.
Hall et al. 2002	A randomized trial in Mali of the effectiveness of weekly iron supplements given by teachers on the hemoglobin concentrations of schoolchildren	Cluster randomized trial. 2-arm design with randomization at school level	Kolondieba district, Mali	60 schools, 30 per arm. 1201 children (1113 followed up) 6 to 19 yr. (Mean 11.4)	Group 1 (551) 65 mg elemental iron and .25 mg folic acid once a week. G2 (562) no intervention (duration: 10 weeks)	Anemia, hemoglobin. Results by gender.
Jinabhai et al. 2001	A randomized controlled trial of the effect of antihelminthic treatment and micronutrient fortification on health status and school performance of rural primary school children.	RCT, double blind	South Africa	Mean age 9.0 yr. N=579	Vitamins (A, B) and minerals (Ca, Fe, Zn) supplementation. 16 weeks duration	Cognitive outcomes, crystallized intelligence.

Study	Title	Type of study	Location	Sample and ages	Interventions	Outcomes
Kashyap et al. 1987	Impact of hematinic supplementation on cognitive function in underprivileged school girls (8–15 yrs of age)	65 pairs of subjects initially matched for age, hemoglobin, individual and total cognitive test scores were randomly assigned to either the treatment or placebo group.	India, Asia	8 to 15 yr. Total 130: Fe (65), Placebo (65)	60 mg elemental iron ($FeSO_4$) for 60 days at a stretch, twice in a school year (duration 8 months)	Cognitive scores, hemoglobin.
Kumar et al. 2008	Trial Using Multiple Micronutrient Food Supplement and its Effect on Cognition	Pre-Posttest design for one year trial.	India, Chenai	7-11 year old school children. Experimental group (n=51) of residential children. Control group (n=72) did not take meals at school.	Multiple micronutrient food supplement. Food in the school kitchen cooked with the supplement for the residential school children for a period of one year. The control group were school children who did not eat at the school.	Test for Hemoglobin, Hematocrit, red blood cells. Battery of cognitive development tests for memory, attentiveness and intelligence
Kumar et al. 2007	Multiple micronutrient fortification of salt and its effect on cognition in Chennai school children	Experimental group of children took one cooked meal at school; control group of pupils did not. Both groups tested at baseline and end of experiment.	India, Chenai	7-11 years old school children. N=63 in experimental group and N=66 in control group.	Multiple micronutrient fortification of salt used for school meals for one year.	A battery of 7 memory tests one test for attention and concentration and one test for intelligence were administered to all the children at baseline and endline. Blood lab tests for anemia related factors.
Latham et al. 1990	Improvements in growth following iron supplementation in young Kenyan school children	Paired groups randomized	Kenya, Africa	Mean = 8 years. Total = 55; FE = 29, Placebo = 26	Oral dose of 80 mg/day during 8 months	Hemoglobin, anthropometric measurements
Lawless et al. 1994	Iron supplementation improves appetite and growth in anemic Kenyan primary school children	Stratified randomization by gender and initial hemoglobin value	Kenya, Africa	6 to 11 years. Total 86: Fe (44); Placebo (42)	Oral dose 60 mg/day during 3 months	Hemoglobin, anthropometric measurements
Manger et al. 2008	A micronutrient-fortified seasoning powder reduces morbidity and improves short-term cognitive function, but has no effect on anthropometric measures in primary school children in northeast Thailand: a randomized controlled trial	RCT	Northeast Thailand, Trakan Phutphon district, Ubon Ratchathani province.	Children aged 5 to 13 from 10 schools stratified within each school into 4 strata: girls grades 1–3, boys grades 1–3, girls grades 4–6, and boys grades 4–6. Fifteen children from each stratum were randomly selected. Total 569 children.	Fortification with 4 micronutrients (iron, zinc, iodine, and Vit A) in seasoning powder added to school lunches, 5 days per week, 31 weeks.	Anthropometric measures; visual effect tests; school grades.

Study	Title	Type of study	Location	Sample and ages	Interventions	Outcomes
Muthayya et al., 2009	Effect of fortification with multiple micronutrients and n23 fatty acids on growth and cognitive performance in Indian schoolchildren: the CHAMPION (Children's Health and Mental Performance Influenced by Optimal Nutrition) Study	RCT, double blind; 2 by 2 factorial	India	598 children 6 to 10 years old school children randomly assignment to four different treatment groups.	Multiple Micro Nutrient fortification: multiple micronutrients and omega 3 fatty acids. Twelve months. A drink was prepared daily, for each child individually, mixing 65 g of the powder in 160 mL boiled water (duration: 12 months).	Anthropometric measurements and cognitive performance (memory, reasoning)
Mwanri et al. 2000	Supplemental vitamin A improves anemia and growth in anemic school children in Tanzania	RCT, double blind	Tanzania, Africa	6 to 12 years. Total 136: Fe (68); Placebo (68)	Oral dose 60 mg/day during 3 months	Hemoglobin, anthropometric measurements
Nga et al. 2011	Decreased Parasite Load and Improved Cognitive Outcomes Caused by Deworming and Consumption of Multi-Micronutrient Fortified Biscuits in Rural Vietnamese Schoolchildren	RCT, double blind, placebo-controlled 2 × 2 factorial trial	Vietnam	Sample of 510 School children 6-8 years old	Combined multiple micronutrient fortified biscuits and deworming (duration: 4 months)	Anthropometric measurements and cognitive development indicators
Osendarp et al. 2007	Effect of a 12-mo micronutrient intervention on learning and memory in well-nourished and marginally nourished school-aged children: 2 parallel, randomized, placebo-controlled studies in Australia and Indonesia	Two 2-by-2 factorial randomized controlled double-blind trials	Indonesia, Asia	Mean age 8.2 yr. Total 384	Vitamins A, B-6, B-12, C, Folate. Minerals: FE, Zn. Duration 52 weeks	Cognitive outcomes, crystallized intelligence.
Pollitt et al. 1989	Iron deficiency and educational achievement in Thailand	RCT, double blind	Thailand, Asia	9 to 11 yr. Total 1358: Fe (679); Placebo (679)	Ferrous sulfate (50 mg/100 mg) + albendazole. 16 weeks duration	Cognitive scores, hemoglobin, ferritin, transferrin saturation.
Richard et al. 2006	Zinc and iron supplementation and malaria, diarrhea, and respiratory infections in children in the Peruvian Amazon	RCT	Peru	0.5 to 15 yr. Total 836: Fe (208); placebo (209); Fe+Zn (210); placebo+ Zn (209)	Ferrous sulfate (15 mg elemental iron) with and without Zn. Duration 7 months	Hemoglobin, zinc, malaria, lower respiratory tract infection, diarrhea. Anthropometric scores.

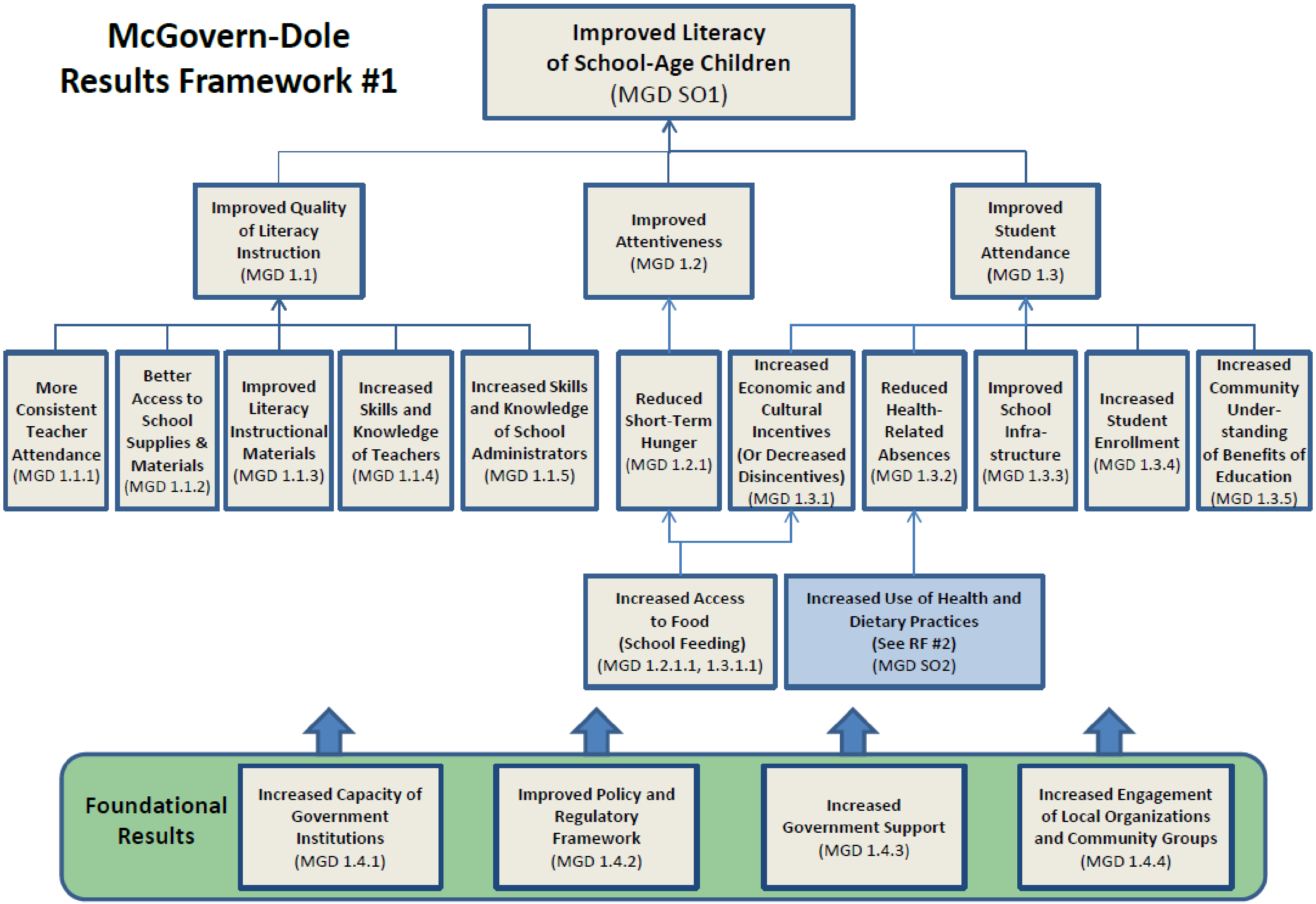
Study	Title	Type of study	Location	Sample and ages	Interventions	Outcomes
Roschnik et al. 2003	The impact of weekly school-based iron supplementation	Cluster randomized trial. 2-arm design with randomization at school level and stratified by sponsorship status	Mangochi District, Malawi	Initially 1160 children 7 to 8 yr and 12 to 14 yr (752 followed up). G1 (20 schools 640 children); G2 (20 schools, 640 children)	G1: 65 mg elemental iron and .25 mg folic acid once per week for 15 weeks. G2 - no intervention). Duration 15 weeks	Hemoglobin concentration, bilharzia infection, school attendance, test scores and dropout and repetition rates at school level.
Roschnik et al. 2004	Weekly iron supplements given by teachers sustain the hemoglobin concentration of schoolchildren in the Philippines	Cluster-randomized trial. 2-arm design with randomization at school level	Guimaras and Iloilo, Philippines	1785 children (1510 followed up) aged 7 to 12 yr. 25 schools Treated and 26 in control group	G1: 25 schools, 108 mg elemental iron. G2 (26 schools) no intervention. Duration 10 weeks	Anemia, hemoglobin.
Sari et al. 2001	Effect of iron-fortified candies on the iron status of children aged 4–6 y in East Jakarta, Indonesia	RCT, double blind placebo-controlled	Jakarta, Indonesia	Children aged 4 to 6 years. 57 assigned to fortified candy group, and 60 to placebo candy group.	Every week for 12 weeks 30 g (10 pieces) candy was given to children. Fortified candy contained 1 mg of Fe and small amounts of vitamins and minerals.	Hemoglobin concentration Serum ferritin
Sen & Kanani 2009	Intermittent Iron Folate Supplementation: Impact on Hematinic Status and Growth of School Girls	DID. Four schools: one control, and 3 treatments: daily, once weekly and twice per week.	India, Vadodara.	254 school girls, 9 to 13 years of age in Grades V and VI in four selected schools.	IFA Tablets (Iron + Folic Acid) supplementation. E1: once weekly, E2: twice weekly; ED Daily dose; CS: control school, no supplementation (duration: 1 year)	Measured outcome: hemoglobin, BMI, height and weight of Anemic and Non-Anemic girls. Results favorable for the IFA treatments.
Sen et al. 2009	Impact of iron-folic acid supplementation on cognitive abilities of school girls in Vadodara	Cluster-randomized controlled trial. 4-arm design with randomization at school level	Vadodara, India	240 school age females, 9 to 13 years. G1 (64); G2 (89); G3 (59); G4 (41).	G1: 100 mg elemental iron and 0.5 mg folic acid, once/week. G2 same but twice/week. G3: same but daily. G4 no supplement. Duration 1 year	Physical work capacity, hemoglobin change and adherence.
Seshadri et al. 1989 (study 1)	Impact of iron supplementation on cognitive functions in preschool and school-aged children: the Indian experience	Schools were selected based on proximity and the teachers' willingness to cooperate. The children were stratified by age, and within each age group every third child was randomly assigned to the control group and the other two, to the experimental group.	India	5 to 8 yr. Total 97: Fe (63); placebo (34)	20 mg elemental iron and folic acid, and placebo (duration: 8 months)	Hemoglobin, IQ (performance, verbal, total)

Study	Title	Type of study	Location	Sample and ages	Interventions	Outcomes
Seshadri et al. 1989 (Study 2)	Impact of iron supplementation on cognitive functions in preschool and school-aged children: the Indian experience	Same as Seshari et al. 1989 (Study 1)	India	5 to 6 yr. Total 28: Fe (14); placebo (14)	40 mg elemental iron plus folic acid and placebo (duration: 8 months)	Hemoglobin, IQ (performance, verbal, total)
Seshadri et al. 1989 (Study 3)	Impact of iron supplementation on cognitive functions in preschool and school-aged children: the Indian experience	Same as Seshari et al. 1989 (Study 1)	India	8 to 15 yr. Total 130: Fe (65), Placebo (65)	60 mg elemental iron and placebo (study duration: 1 year)	Anemia, iron deficiency, hemoglobin, IQ (performance, verbal, total)
Siddiqui et al., 2004	Efficacy of daily vs. weekly supplementation of iron in schoolchildren with low iron status	Randomized controlled trial with 2-arm design with individual randomization	Karachi, Pakistan	60 children aged 5 to 10 years. G1 (30); G2:(30).	G1: 60 mg elemental iron once/week for 8 weeks. G2: same but daily for 56 days	Hemoglobin, hematocrit, serum iron, total iron binding capacity, serum ferritin.
Sinisterra et al. 1997	Effect of supplementation with iron salts and knowledge, attitudes and practices in relation to anemia among schoolchildren in the province of Cocle, Ministry of Health, Republic of Panama (report)	Cluster-randomized trial, 2-arm design with randomization at school level (5 schools)	Anton district, Cocle, Panama	909 children (842 followed up) both sexes, aged 6 to 13 yr. G1 (176); G2 (210); G3 (225); G4 (195)	G1: 60 mg elemental iron and "nutricrema" daily. G2: nutricrema only; G3: 60 mg Fe daily and nutricema once/wk; G4: Milk plus cookie fortified with folic acid. Duration 6 months	Anemia (Hg < 120 g/l), hemoglobin, attitudes, beliefs, growth.
Soemantri et al. 1989	Preliminary findings on iron supplementation and learning achievement of rural Indonesian children	RCT, double blind	Indonesia, Asia	8.1 to 11.6 yr. Total 130: Fe (71); placebo (59)	Ferrous sulfate (10 mg/kg/day) and placebo. Duration 3 months	Hemoglobin, transferrin saturation, cognitive scores
Soemantri et al. 1997	Daily and weekly iron supplementation and physical growth of school age Indonesian children	Randomized controlled trial. 2-arm design with individual randomization	Batang, Indonesia	97 children, both sexes, aged 7 to 11 yr. G1 (52); G2 (45).	G1: Daily dose 3 mg Fe/kg (as ferrous sulfate). G2: Weekly dose 3 mg Fe/kg. Duration 3 months	Anthropometric measurements (weight for age z-scores, height for age z-scores) and hemoglobin.

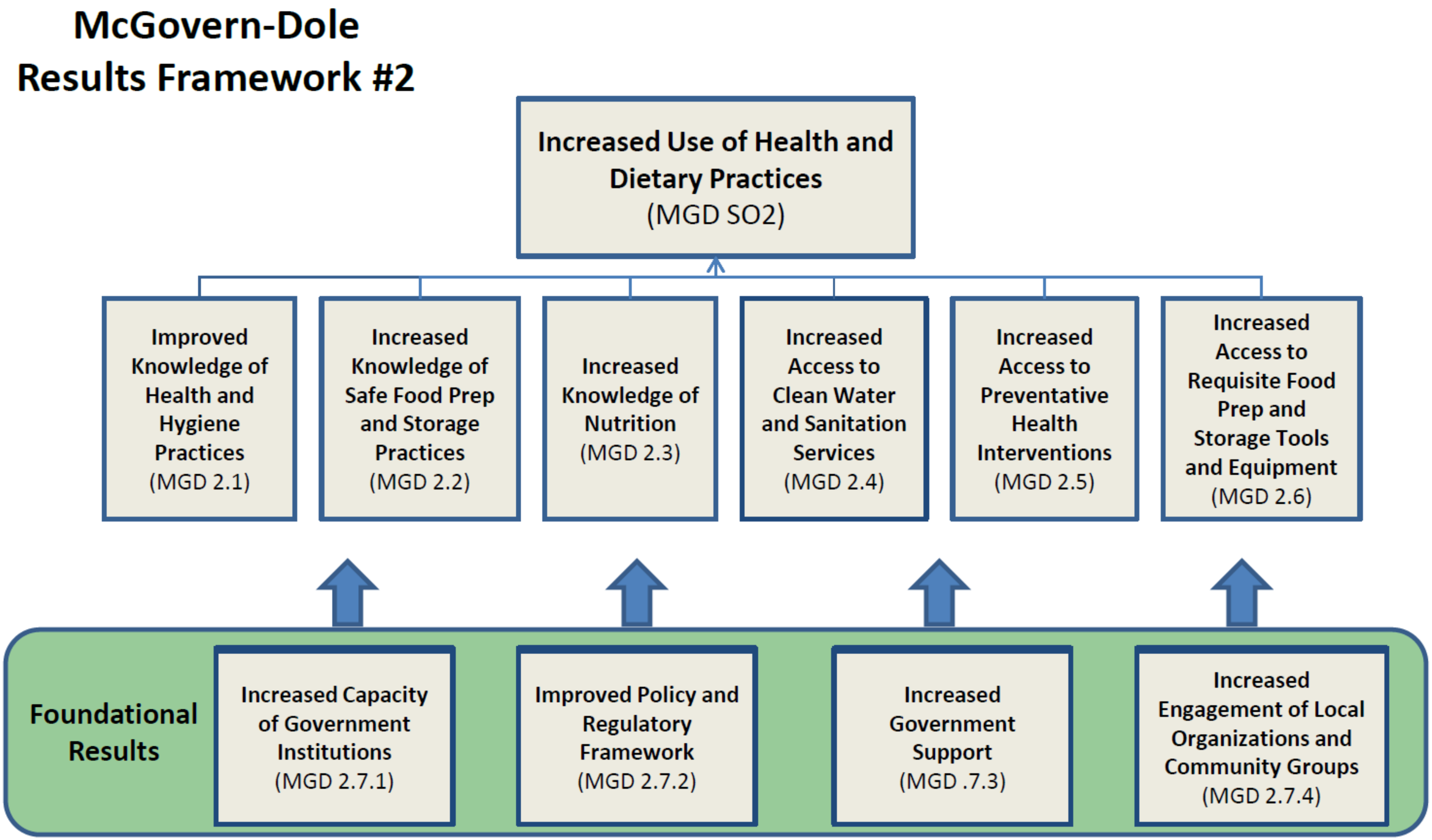
Study	Title	Type of study	Location	Sample and ages	Interventions	Outcomes
Solon et al. 2003 (Study 1)	Effect of a multiple-micronutrient-fortified fruit powder beverage on the nutrition status, physical fitness, and cognitive performance of schoolchildren in the Philippines	Randomized, double blind, placebo-controlled trial	Philippines, Balete in Batangas province	A total of 851 children in grades 1–6 (Mean age 10 years) were enrolled and 808 were subsequently evaluated. Children were recruited from four elementary schools.	Schoolchildren assigned to receive either the fortified or nonfortified beverage with or without anthelmintic therapy. The fruit-flavored beverage contained physiologic levels of 11 micronutrients, including iron, vitamin A, and iodine. The fortification approach delivers highly bioavailable micronutrients.	Data on hemoglobin, urinary iodine excretion (UIE), physical fitness, cognitive performance collected at baseline and at 16 weeks post interventions. Consumption of fortified beverage had significant positive effects on iron status, iodine status, physical fitness, and cognitive performance among iron and iodine deficient schoolchildren. Only subjects who were deficient at baseline showed an increase in either hemoglobin or UIE levels.
Solon et al. 2003 (Study 2)	Effect of a multiple-micronutrient-fortified fruit powder beverage on the nutrition status, physical fitness, and cognitive performance of schoolchildren in the Philippines	Randomized, double blind, placebo-controlled trial	Philippines, Asia	Mean age 9.9 yr. Sample 851 less 13 to attrition	Vitamins A,B-3, B-6, B-12, C, Folate, riboflavin, E. Minerals: Fe, Zn, I. Duration 16 weeks	Cognitive outcomes, crystallized and fluid intelligence.
Sungthong et al. 2002	Once weekly is superior to daily iron supplementation on height gain but not on hematological improvement among schoolchildren in Thailand	Simple random allocation in two selected schools	Thailand, Asia	397 school children, both sexes, in grades 1 through 6 (9.7 years of age average), G1 (134); G2 (140); G3 (123)	All children received Albendazole and then randomly received ferrous sulfate (300 mg/tablet) either daily or weekly, or a placebo for 16 wk.	Hemoglobin, serum ferritin, prevalence of anemia, weight and height
Taylor et al. 2001	The effect of different anthelmintic treatment regimens combined with iron supplementation on the nutritional status of schoolchildren in KwaZulu-Natal, South Africa: a randomized controlled trial	RCT, double blind. Factorial design (6 arms) with individual randomization	Kwa-Zulu Natal, South Africa	425 children, both sexes, aged 6 to 15 years (mean 11.2 yr): G1 (56); G2(60); G3(60); G4(57); G5(101); G6(91).	G1: weekly dose 65 mg Fe, 0.1 mg folic acid, 400 mg albendazole, 40 mg/kg praziquantel. G2: same but placebo for Fe and folic acid. G3: Same as G1 but albendazole 3 times/week; G4: same as G2 but praziquantel 3 times/week; G5: same as G1 but placebo for albendazole and praziquantel. G5 all placebos. Duration 10 weeks with follow up at 6 and 12 months.	Height, weight, presence of malaria parasites, presence of hookworm infection, urine infection or presence of blood in urine.

Study	Title	Type of study	Location	Sample and ages	Interventions	Outcomes
Thankachan et al. 2012	Multiple Micronutrient-Fortified Rice Affects Physical Performance and Plasma Vitamin B-12 and Homocysteine Concentrations of Indian School Children	Randomized, double-blind, controlled trial, 258 children were assigned to 1 of 3 intervention groups.	India, Bangalore	6 to 12 years old, low-income school children. Total sample: 258 children.	Multiple Micronutrient fortified rice. Three groups fed rice-based lunch meals fortified with multiple micronutrients with either low-iron (6.25 mg) or high-iron (12.5 mg) concentrations or identical meals with unfortified rice. Meals served 6 days per week for six months.	Anthropometric, biochemical, physical performance, and cognitive assessments were taken at baseline and endpoint.
Vazir et al. 2006	Effect of micronutrient supplement on health and nutritional status of schoolchildren: mental function	RCT, double blind	India, Asia	Mean age 10.7 yr, sample = 869	Vitamins: A, B-3, B-6, B-12, C, D, folate, thiamine, riboflavin. Minerals: Fe, I, Zn, Ca. (duration: 14 months)	Cognitive outcomes, fluid and crystallized intelligence.
Vinodkumar, 2007	Multiple micronutrient fortification of salt	Pre-posttest design with experimental and control group. Control group: school children who did not eat at the school. (Double-blind placebo-controlled trial not carried out because placebo was not approved for children	Chennai, India	The experimental group consisted of 119 children residing in a residential school. The control group consisted of 126 children who lived in communities nearby and attended the day school. Mean age of the experimental and the control groups was 9.5 and 9.1 years, respectively.	Salt fortified with multiple micronutrients containing chelated ferrous sulfate and microencapsulated vitamins A, B1, B2, B6, B12, folic acid, niacin, calcium pantothenate and iodine. Duration of study: one year.	Hemoglobin, red blood cell count, hematocrit, serum vitamin A and urinary iodine, height
Winichagoon et al. 2006	A Multimicronutrient-Fortified Seasoning Powder Enhances the Hemoglobin, Zinc, and Iodine Status of Primary School Children in North East Thailand: A Randomized Controlled Trial of Efficacy	Randomized control trial	North East Thailand	569 children aged 5.5 to 13.4 years from 10 schools in NE Thailand. Students assigned to receive a seasoning powder fortified with zinc, iron, vit A, and iodine, or not fortified powder. Each group had 260-280 students.	Treated group received school lunch with seasoning powder fortified with zinc, iron, vit A, and iodine and delivered 5 days per week for 31 weeks. Control group lunch seasoned with non-fortified powder.	Baseline and final micronutrient status, hemoglobinopathies were assessed from blood and urine samples. Anemia, based on hemoglobin, no effect was apparent as a result of the intervention. Zinc and urine iodine deficiency were .63 and .52 times those of unfortified group. Fortification had no effect on serum retinol, ferritin, or mean red cell volume (MCV)

Annex 2: The MGD Results Framework



A Note on Foundational Results: These results can feed into one or more higher-level results. Causal relationships sometimes exist between foundational results.



A Note on Foundational Results: These results can feed into one or more higher-level results. Causal relationships sometimes exist between foundational results.

Annex 3: Analysis of Publication Bias

Publication bias refers to the selective publication of studies with a particular outcome --- the greater likelihood that studies with positive results will be published, with the result that most treatments tend to be less effective in practice than the research suggests (see, for instance, Dickersin, 1990 or Ferguson et al., 2012). Small studies are at the greatest risk of being lost because, with small samples, only very large effects are likely to be significant and those with small and moderate effects are likely to be unpublished. Large studies are likely to be published regardless of statistical significance.

Funnel plots and Egger tests (Egger et al., 1997) enable the quantification of publication bias. Funnel plots provide a graphical depiction of publication bias, based on the rationale that small studies are more likely to be unreported than large studies, a phenomenon referred to as the "file drawer problem." The y-axis, showing the standard error corresponding to sample size, is inverted with large studies measured at the top (see funnel plots below). The asymmetry in the plot, as highlighted by the lack of small sample studies which report findings below the average effect at the vertical line, suggests evidence for publication bias.

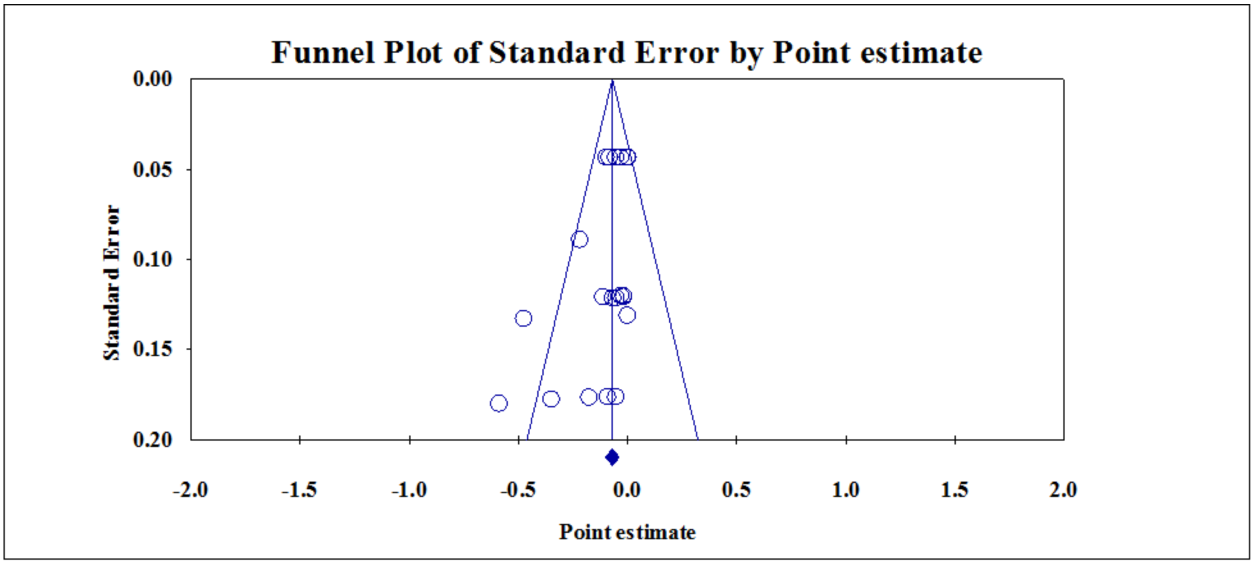
In the absence of publication bias the studies will be distributed symmetrically throughout the scatter plot. In the possible presence of bias, the bottom of the plot would tend to show a higher concentration of studies on one side of the plot than the other. The funnel plot can also be used to identify outliers -- observations that are numerically distant from the rest of the data. Identification of outliers in meta-analysis can be used to conduct sensitivity analysis (with and without outliers).

Given the difficulties in accurately assessing asymmetry by visual inspection, statistical tests are recommended. The most widely used statistical test is Egger's test. Egger's test is based on two variables: (i) normalized effect estimate (meta-analysis estimate divided by its standard error), and (ii) precision (reciprocal of the standard error of the estimate). The test is based on a simple linear regression to test for intercept $\beta 0=0$; i.e., the null hypothesis that intercept $b=0$ (or the null hypothesis that there is no funnel plot asymmetry). In this case the regression line will run through the origin. If the intercept b deviates from zero (the origin), the deviation provides a measure of asymmetry -- the larger the deviation from zero, the larger the asymmetry. (It is for this reason that Egger's test is also referred to as "Egger's test of the intercept.")

The following two plots are from a biased and unbiased analysis, as reflected in their corresponding funnel plots and Egger's test statistics.

Example of a biased analysis (effect of food fortification with multiple micronutrients on memory tests for all children described in this study):

- The 22 effect sizes are not symmetrically distributed
- The Egger's test shows that the intercept (at -1.41074) is statistically different from zero (P-value = 0.00546)

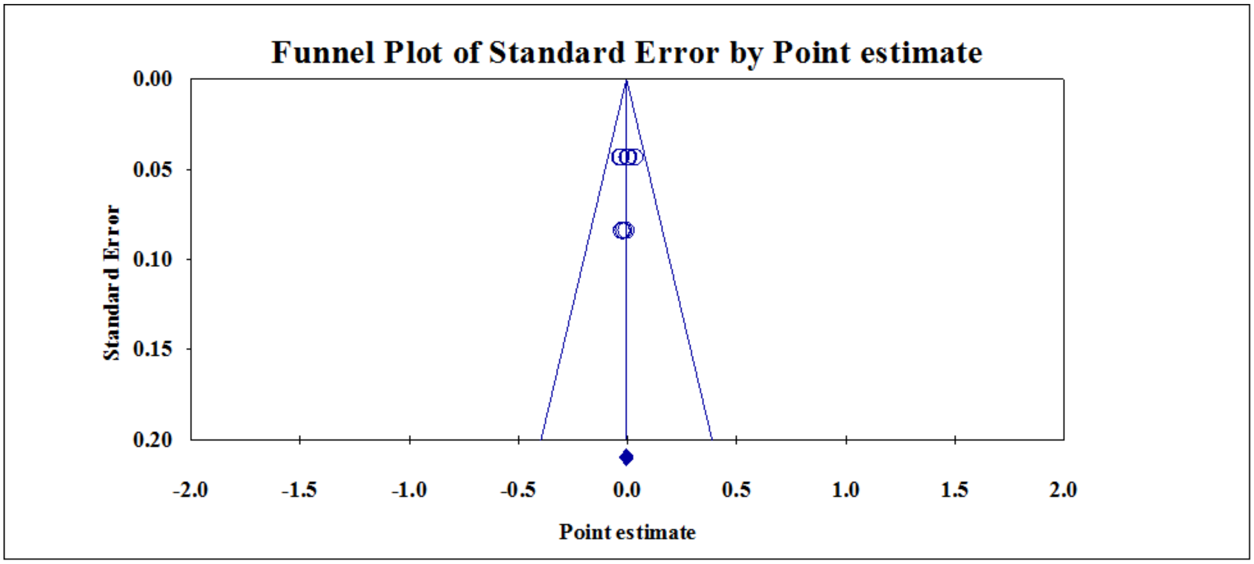


Egger's regression intercept

Intercept	-1.49074
Standard error	0.47860
95% lower limit (2-tailed)	-2.48908
95% upper limit (2-tailed)	-0.49239
t-value	3.11478
df	20.00000
P-value (1-tailed)	0.00273
P-value (2-tailed)	0.00546

Example of an unbiased analysis (effect of food fortification with multiple micronutrients on math and science tests for all children described in this study):

- The 10 effect sizes are symmetrically distributed
- The Egger's test shows that the intercept (at -0.39409) is not statistically different from zero (P-value = 0.46853)



Egger's regression intercept

Intercept	-0.39409
Standard error	0.51790
95% lower limit (2-tailed)	-1.58838
95% upper limit (2-tailed)	0.80020
t-value	0.76093
df	8.00000
P-value (1-tailed)	0.23427
P-value (2-tailed)	0.46853

Assessing publication bias involves: (1) broadening the search to the non-published "grey literature" to reduce the bias; and (2) conducting sensitivity analysis. The present meta-analysis minimized the publication bias by conducting a thorough search for non-published studies that included conference proceedings, technical reports, dissertations, and theses. Despite this effort, the funnel plots and Egger's tests presented in Annex 4 indicate that publication bias could not always be eliminated.

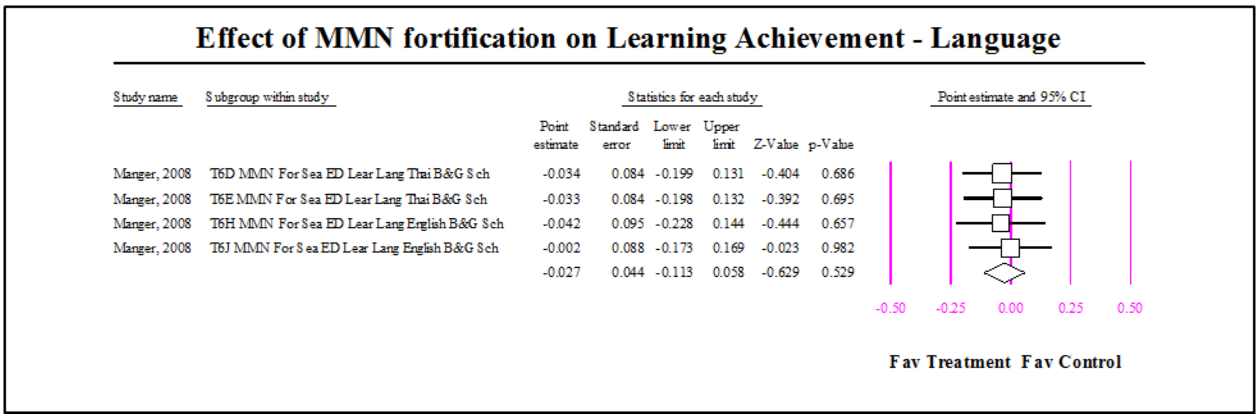
Assessing publication bias can also be conducted through imputation of missing studies by using "trim and fill" analysis -- a sensitivity analysis method that extends beyond the scope of this study. Another method of assessing the potential for publication bias is to calculate the "fail-safe N," the number of studies whose effect size is zero or negative that would be needed to increase the P-value for the meta-analysis to above 0.05. However, the Cochrane Handbook for Systematic Reviews of Interventions notes that "this and other methods are not recommended for use in Cochrane reviews" (Higgins et al. 2014).

It is very important to note, however, that the presence of publication bias means that the pooled effect sizes may be overestimated and the response ratio effect size estimated by trim and fill corresponds to a reduction in average effect size. Since the school feeding effect sizes estimated in this meta-analysis are (when statistically significant) consistently "very small," the trim and fill analysis are expected to make those effect sizes even smaller --- with no major implications on the conclusions and learning agenda presented in this study.

Annex 4: Technical Data Used for Analysis: Forest Plots, Funnel Plots, Egger's Tests and Detailed Statistics

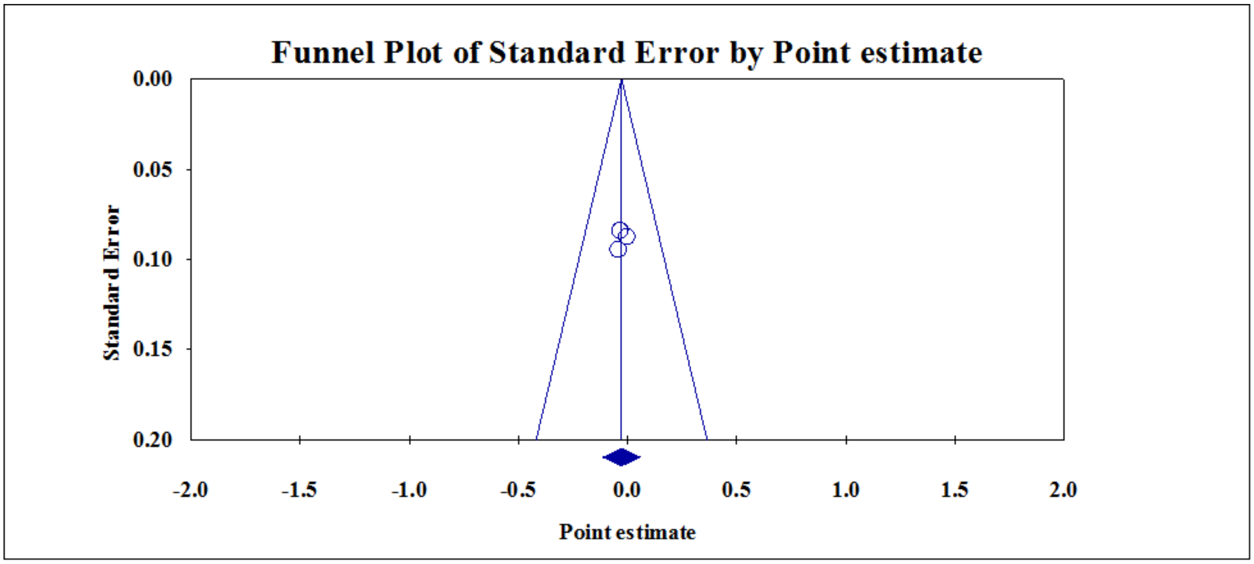
Data in this annex were used to derive the findings in Section 3.0 (empirical evidence) and Annex 3 (analysis of publication bias). The annex, which served as a basis for constructing the tables in Section 3.0, provides detailed statistics of effect sizes, including standard errors, t-values, degrees of freedom, confidence intervals, statistical significance, heterogeneity statistics, funnel plots, and Egger's tests. Number of studies in the statistical tables below refers to the number of effect sizes, not the number of studies themselves.

Effect of food Fortification with Multiple Micronutrients on Learning Achievement (language skills)



Effect size and significance				
Model	Number Studies	Point estimate	Significance	Standard error
Random effects	4.000	(0.027)	-	0.044

Heterogeneity				Tau-squared			
Q-value	df (Q)	P-value	I-squared	Tau Squared	Standard Error	Variance	Tau
0.119	3.000	0.990	-	-	0.006	0.000	-



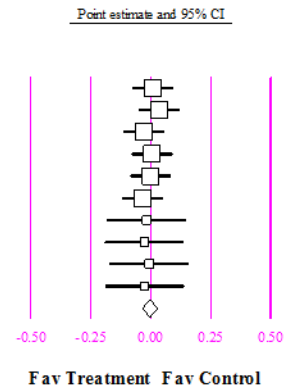
Egger's regression intercept

Intercept	-0.65184
Standard error	2.52523
95% lower limit (2-tailed)	-11.51701
95% upper limit (2-tailed)	10.21332
t-value	0.25813
df	2.00000
P-value (1-tailed)	0.41022
P-value (2-tailed)	0.82044

Effect of food Fortification with Multiple Micronutrients on Learning Achievement (math and science)

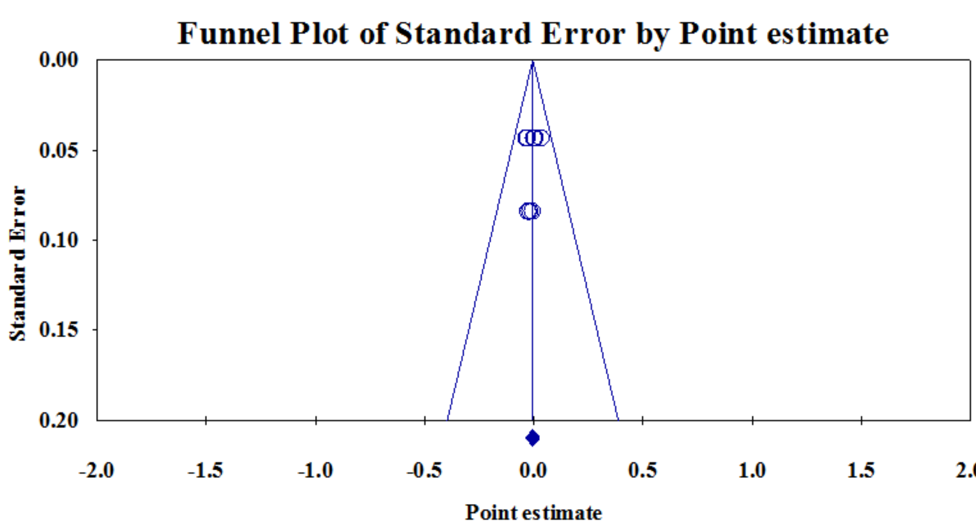
Effect of MMN fortification on Learning Achievement - Math and Science

Study name	Subgroup within study	Point estimate	Standard error	Lower limit	Upper limit	Z-Value	p-Value
Gewan, 2009	T3M MMN For Sna ED Lear M&S Math B&G Sch	0.007	0.044	-0.078	0.092	0.161	0.872
Gewan, 2009	T3N MMN For Sna ED Lear M&S Math B&G Sch	0.034	0.044	-0.051	0.119	0.782	0.434
Gewan, 2009	T3O MMN For Sna ED Lear M&S Math B&G Sch	-0.028	0.044	-0.113	0.057	-0.644	0.520
Gewan, 2009	T3P MMN For Sna ED Lear M&S Math B&G Sch	0.006	0.044	-0.079	0.091	0.138	0.890
Gewan, 2009	T3Q MMN For Sna ED Lear M&S Math B&G Sch	0.000	0.044	-0.085	0.085	0.000	1.000
Gewan, 2009	T3R MMn For Sna ED Lear M&S Math B&G Sch	-0.034	0.044	-0.119	0.051	-0.782	0.434
Manger, 2008	T6F MMN For Sea ED Lear M&S Math B&G Sch	-0.017	0.084	-0.182	0.148	-0.202	0.840
Manger, 2008	T6G MMN For Sea ED Lear M&S Math B&G Sch	-0.026	0.084	-0.191	0.139	-0.309	0.757
Manger, 2008	T6K MMN For Sea ED Lear M&S Science B&G Sch	-0.006	0.084	-0.171	0.159	-0.071	0.943
Manger, 2008	T6L MMN For Sea ED Lear M&S Science B&G Sch	-0.025	0.084	-0.190	0.140	-0.297	0.766
		-0.005	0.016	-0.037	0.027	-0.301	0.764



Effect size and significance				
Model	Number Studies	Point estimate	Significance	Standard error
Random effects	10.000	(0.005)	-	0.016

Heterogeneity				Tau-squared			
Q-value	df (Q)	P-value	I-squared	Tau Squared	Standard Error	Variance	Tau
1.820	9.000	0.994	-	-	0.001	0.000	-



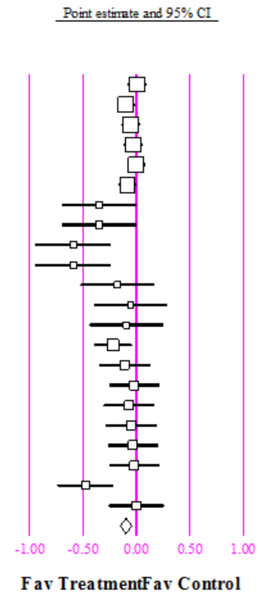
Egger's regression intercept

Intercept	-0.39409
Standard error	0.51790
95% lower limit (2-tailed)	-1.58838
95% upper limit (2-tailed)	0.80020
t-value	0.76093
df	8.00000
P-value (1-tailed)	0.23427
P-value (2-tailed)	0.46853

Effect of food Fortification with Multiple Micronutrients on Cognitive Development (memory)

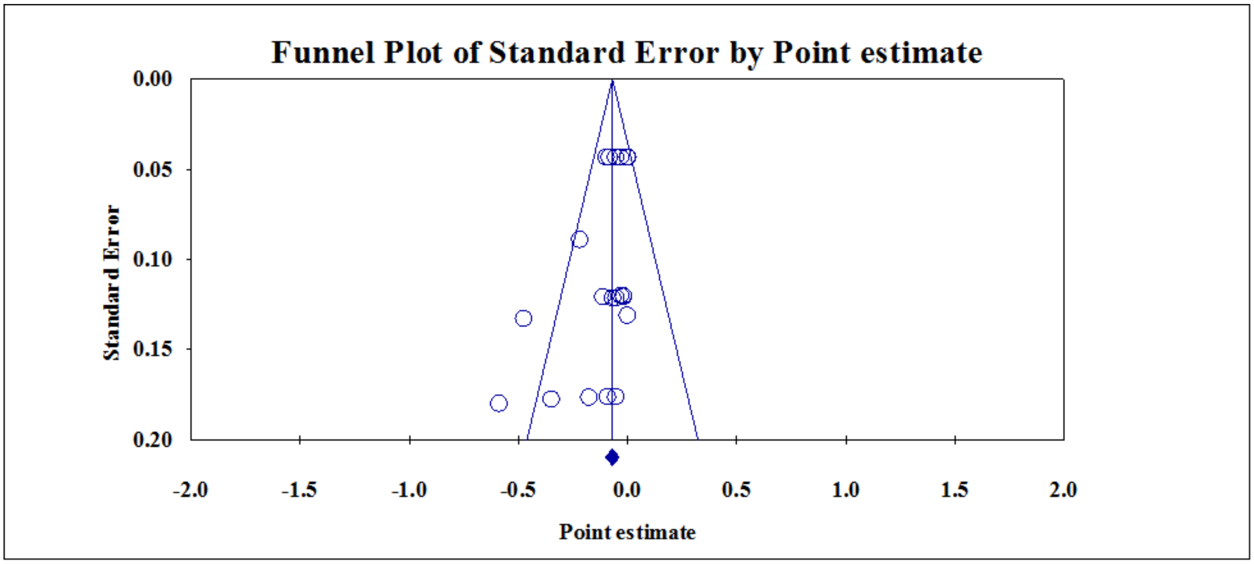
Effect of MMN fortification on Cognitive Development - Memory

Study name	Subgroup within study	Point estimate	Standard error	Lower limit	Upper limit	Z-Value	p-Value
Gewan, 2009	T3S MMN For Sna ED Cogn Memo Fe avail B&G Sch	0.003	0.044	-0.082	0.088	0.069	0.945
Gewan, 2009	T3T MMN For Sna ED Cogn Memo Zn avail B&G Sch	-0.097	0.044	-0.182	-0.012	-2.225	0.026
Gewan, 2009	T3U MMN For Sna ED Cogn Memo B12 Vita B&G Sch	-0.054	0.044	-0.139	0.031	-1.241	0.214
Gewan, 2009	T3V MMN For Sna ED Cogn Memo B6 Vitam B&G Sch	-0.031	0.044	-0.116	0.054	-0.713	0.476
Gewan, 2009	T3W MMN For Sna ED Cogn Memo Folate B&G Sch	0.000	0.044	-0.085	0.085	0.000	1.000
Gewan, 2009	T3X MMN For Sna ED Cogn Memo Riboflav B&G Sch	-0.083	0.044	-0.168	0.002	-1.904	0.057
Kumar, 2009	T3A MMN For Sal ED Cogn Memo Benton B&G Sch	-0.348	0.178	-0.696	-0.000	-1.961	0.050
Kumar, 2009	T3B MMN For Sal ED Cogn Memo Cattell B&G Sch	-0.348	0.178	-0.696	-0.000	-1.961	0.050
Kumar, 2009	T3C MMN For Sal ED Cogn Memo MannSui B&G Sch	-0.588	0.180	-0.941	-0.235	-3.268	0.001
Kumar, 2009	T3D MMN For Sal ED Cogn Memo Delayed B&G Sch	-0.588	0.180	-0.941	-0.235	-3.268	0.001
Kumar, 2009	T3E MMN For Sal ED Cogn Memo Persona B&G Sch	-0.176	0.177	-0.522	0.170	-0.997	0.319
Kumar, 2009	T3F MMN For Sal ED Cogn Memo Digit sp B&G Sch	-0.053	0.176	-0.398	0.292	-0.301	0.764
Kumar, 2009	T3G MMN For Sal ED Cogn Memo Digit sp B&G Sch	-0.091	0.176	-0.436	0.254	-0.516	0.606
Manger, 2008	T6A MMN For Sea ED Cogn Memo Visual r B&G Sch	-0.218	0.089	-0.393	-0.043	-2.447	0.014
Muthayya, 2009	T5B MMN For Dri ED Cogn Memo HI MMN H B&G Sch	-0.112	0.121	-0.349	0.125	-0.928	0.353
Muthayya, 2009	T5D MMN For Dri ED Cogn Memo HI MMN H B&G Sch	-0.017	0.121	-0.253	0.219	-0.141	0.888
Muthayya, 2009	T5G MMN For Dri ED Cogn Memo HI MMN L B&G Sch	-0.067	0.122	-0.305	0.171	-0.551	0.581
Muthayya, 2009	T5I MMN For Dri ED Cogn Memo HI MMN L B&G Sch	-0.052	0.122	-0.290	0.186	-0.428	0.669
Muthayya, 2009	T5L MMN For Dri ED Cogn Memo Lo MMN H B&G Sch	-0.031	0.120	-0.267	0.205	-0.258	0.796
Muthayya, 2009	T5N MMN For Dri ED Cogn Memo Lo MMN H B&G Sch	-0.019	0.120	-0.255	0.217	-0.158	0.874
Nga, 2011	T4C MMN For Bis ED Cogn Memo Digit sp B&G Sch	-0.475	0.133	-0.735	-0.215	-3.574	0.000
Nga, 2011	T4D MMN For Bis ED Cogn Memo Digit sp B&G Sch	0.000	0.131	-0.257	0.257	0.000	1.000
		-0.100	0.026	-0.152	-0.049	-3.796	0.000



Effect size and significance				
Model	Number Studies	Point estimate	Significance	Standard error
Random effects	22.000	(0.100)	***	0.026

Heterogeneity				Tau-squared			
Q-value	df (Q)	P-value	I-squared	Tau Squared	Standard Error	Variance	Tau
41.642	21.000	0.005	49.570	0.006	0.004	0.000	0.076



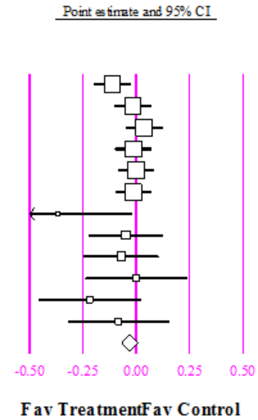
Egger's regression intercept

Intercept	-1.49074
Standard error	0.47860
95% lower limit (2-tailed)	-2.48908
95% upper limit (2-tailed)	-0.49239
t-value	3.11478
df	20.00000
P-value (1-tailed)	0.00273
P-value (2-tailed)	0.00546

Effect of food Fortification with Multiple Micronutrients on Cognitive Development (reasoning)

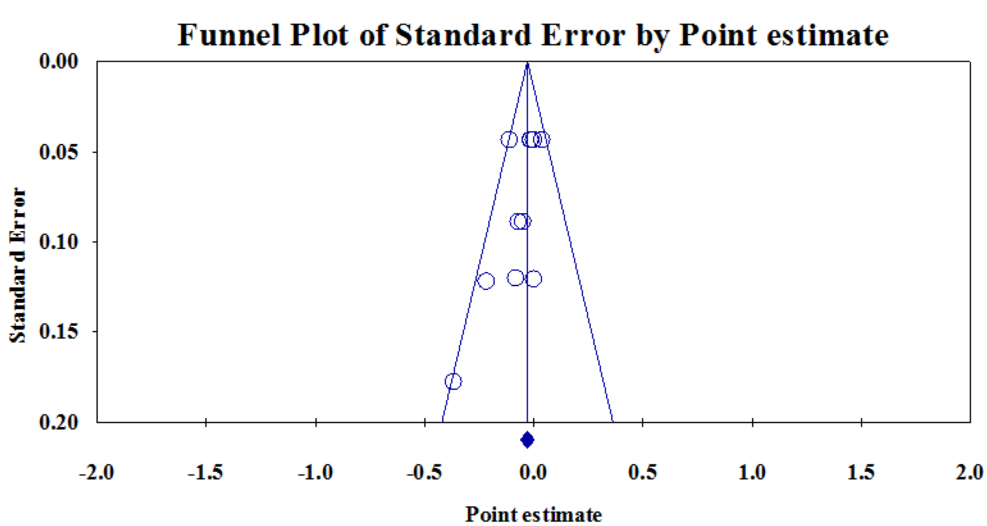
Effect of MMN fortification on Cognitive Development - Reasoning

Study name	Subgroup within study	Point estimate	Standard error	Lower limit	Upper limit	Z-Value	p-Value
Gewan, 2009	T3A MMN For Sna ED Cogn Reas Fe avail B&G Sch	-0.111	0.044	-0.196	-0.026	-2.546	0.011
Gewan, 2009	T3B MMN For Sna ED Cogn Reas Zn avail B&G Sch	-0.015	0.044	-0.100	0.070	-0.345	0.730
Gewan, 2009	T3C MMN For Sna ED Cogn Reas B12 Vita B&G Sch	0.038	0.044	-0.047	0.123	0.874	0.382
Gewan, 2009	T3D MMN For Sna ED Cogn Reas B6 Vitam B&G Sch	-0.014	0.044	-0.099	0.071	-0.322	0.748
Gewan, 2009	T3E MMN For Sna ED Cogn Reas Folate B&G Sch	0.000	0.044	-0.085	0.085	0.000	1.000
Gewan, 2009	T3F MMN For Sna ED Cogn Reas Riboflav B&G Sch	-0.013	0.044	-0.098	0.072	-0.299	0.765
Kumar, 2009	T3H MMN For Sal ED Cogn Reas Letter c B&G Sch	-0.367	0.178	-0.715	-0.019	-2.066	0.039
Manger, 2008	T6B MMN For Sea ED Cogn Reas Digits f B&G Sch	-0.050	0.089	-0.224	0.124	-0.563	0.573
Manger, 2008	T6C MMN For Sea ED Cogn Reas Digits b B&G Sch	-0.070	0.089	-0.244	0.104	-0.787	0.431
Muthayya, 2009	T5C MMN For Dri ED Cogn Reas HI MMN H B&G Sch	0.000	0.121	-0.236	0.236	0.000	1.000
Muthayya, 2009	T5H MMN For Dri ED Cogn Reas HI MMN L B&G Sch	-0.217	0.122	-0.456	0.022	-1.780	0.075
Muthayya, 2009	T5M MMN For Dri ED Cogn Reas Lo MMN H B&G Sch	-0.082	0.120	-0.318	0.154	-0.682	0.495
		-0.032	0.019	-0.069	0.005	-1.689	0.091



Effect size and significance				
Model	Number Studies	Point estimate	Significance	Standard error
Random effects	12.000	(0.032)	*	0.019

Heterogeneity				Tau-squared			
Q-value	df (Q)	P-value	I-squared	Tau Squared	Standard Error	Variance	Tau
13.232	11.000	0.278	16.871	0.001	0.002	0.000	0.026



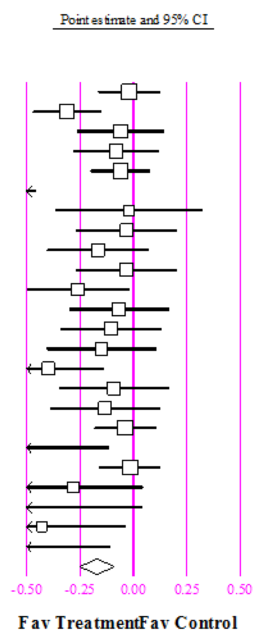
Egger's regression intercept

Intercept	-1.41903
Standard error	0.66728
95% lower limit (2-tailed)	-2.90581
95% upper limit (2-tailed)	0.06776
t-value	2.12660
df	10.00000
P-value (1-tailed)	0.02968
P-value (2-tailed)	0.05936

Effect of food Fortification with Multiple Micronutrients on Cognitive Development (intelligence)

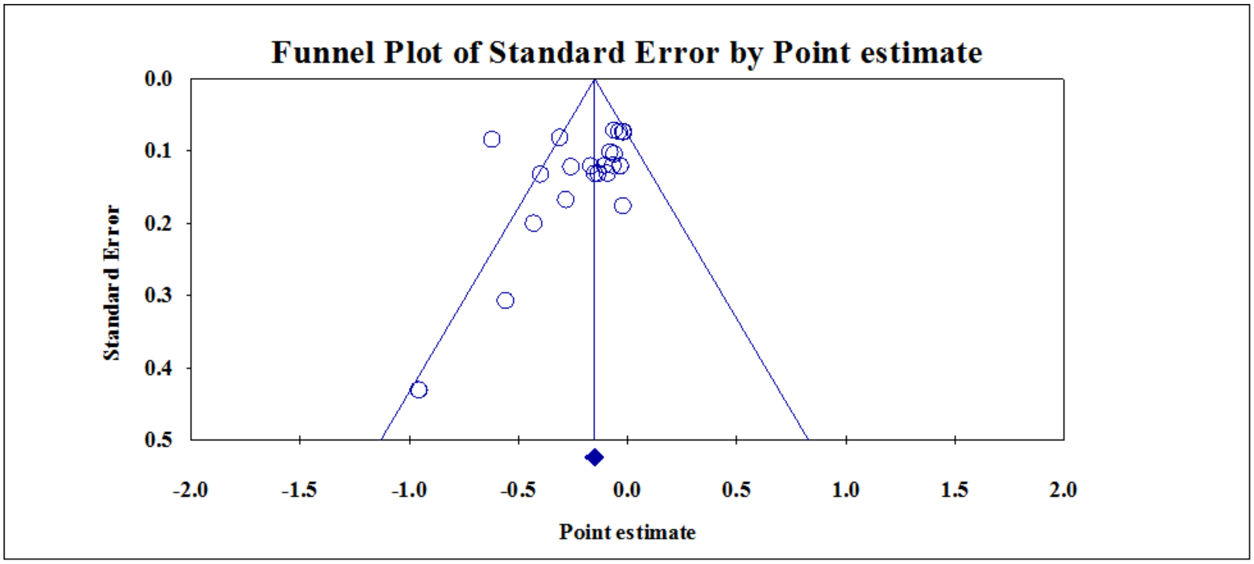
Effect of MMN fortification on Cognitive Development - Intelligence

Study name	Subgroup within study	Point estimate	Standard error	Lower limit	Upper limit	Z-Value	p-Value
Eilander et al.	F3A MMN For MMN ED Cogn Inte Solon 20 B&G Sch	-0.020	0.074	-0.165	0.125	-0.271	0.787
Eilander et al.	F3B MMN For MMN ED Cogn Inte Vazir 20 B&G Sch	-0.310	0.082	-0.470	-0.150	-3.804	0.000
Eilander et al.	F5A MMN For MMN ED Cogn Inte Jinabhai B&G Sch	-0.060	0.104	-0.264	0.144	-0.575	0.565
Eilander et al.	F5B MMN For MMN ED Cogn Inte Osendarp B&G Sch	-0.080	0.102	-0.279	0.119	-0.787	0.432
Eilander et al.	F5C MMN For MMN ED Cogn Inte Solon 20 B&G Sch	-0.060	0.071	-0.200	0.080	-0.842	0.400
Eilander et al.	F5D MMN For MMN ED Cogn Inte Vazir 20 B&G Sch	-0.620	0.084	-0.785	-0.455	-7.372	0.000
Kumar, 2009	T3I MMN For Sal ED Cogn Inte Raven's B&G Sch	-0.020	0.176	-0.365	0.325	-0.114	0.910
Muthayya, 2009	T5A MMN For Dri ED Cogn Inte HI MMN H B&G Sch	-0.032	0.121	-0.268	0.204	-0.265	0.791
Muthayya, 2009	T5E MMN For Dri ED Cogn Inte HI MMN H B&G Sch	-0.167	0.121	-0.404	0.070	-1.382	0.167
Muthayya, 2009	T5F MMN For Dri ED Cogn Inte HI MMN L B&G Sch	-0.032	0.122	-0.270	0.206	-0.263	0.792
Muthayya, 2009	T5J MMN For Dri ED Cogn Inte HI MMN L B&G Sch	-0.258	0.122	-0.497	-0.019	-2.115	0.034
Muthayya, 2009	T5K MMN For Dri ED Cogn Inte Lo MMN H B&G Sch	-0.066	0.120	-0.302	0.170	-0.549	0.583
Muthayya, 2009	T5O MMN For Dri ED Cogn Inte Lo MMN H B&G Sch	-0.104	0.120	-0.340	0.132	-0.865	0.387
Nga, 2011	T4A MMN For Bis ED Cogn Inte Raven's B&G Sch	-0.149	0.131	-0.406	0.108	-1.136	0.256
Nga, 2011	T4B MMN For Bis ED Cogn Inte Raven's B&G Sch	-0.398	0.132	-0.657	-0.139	-3.008	0.003
Nga, 2011	T4E MMN For Bis ED Cogn Inte Block de B&G Sch	-0.091	0.131	-0.348	0.166	-0.694	0.488
Nga, 2011	T4F MMN For Bis ED Cogn Inte B&G Sch	-0.133	0.131	-0.390	0.124	-1.014	0.311
Solon, 2003	T6A MMN For Dri ED Cogn Inte All B&G Sch	-0.038	0.073	-0.182	0.106	-0.518	0.605
Solon, 2003	T6B MMN For Dri ED Cogn Inte Hb<11 UI B&G Sch	-0.957	0.431	-1.802	-0.112	-2.220	0.026
Solon, 2003	T6C MMN For Dri ED Cogn Inte All B&G Sch	-0.016	0.073	-0.160	0.128	-0.218	0.827
Solon, 2003	T6D MMN For Dri ED Cogn Inte Hb<11 B&G Sch	-0.282	0.168	-0.610	0.046	-1.684	0.092
Solon, 2003	T6E MMN For Dri ED Cogn Inte Hb<11 UI B&G Sch	-0.558	0.307	-1.160	0.044	-1.816	0.069
Solon, 2003	T6F MMN For Dri ED Cogn Inte Hb<11 UI B&G Sch	-0.429	0.200	-0.822	-0.036	-2.142	0.032
Solon, 2003	T6G MMN For Dri ED Cogn Inte Hb<11 UI B&G Sch	-0.954	0.431	-1.799	-0.109	-2.214	0.027
		-0.172	0.041	-0.252	-0.092	-4.225	0.000



Effect size and significance				
Model	Number Studies	Point estimate	Significance	Standard error
Random effects	24.000	(0.172)	***	0.041

Heterogeneity				Tau-squared			
Q-value	df (Q)	P-value	I-squared	Tau Squared	Standard Error	Variance	Tau
65.580	23.000	0.000	64.928	0.023	0.011	0.000	0.151



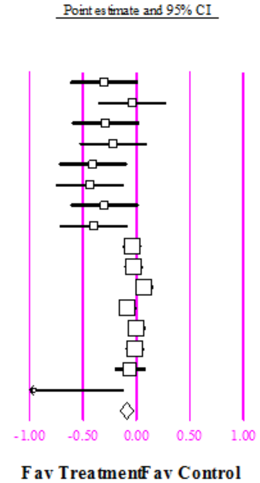
Egger's regression intercept

Intercept	-1.59950
Standard error	0.89139
95% lower limit (2-tailed)	-3.44813
95% upper limit (2-tailed)	0.24913
t-value	1.79439
df	22.00000
P-value (1-tailed)	0.04325
P-value (2-tailed)	0.08651

Effect of food Fortification with Multiple Micronutrients on Cognitive Development (verbal skills)

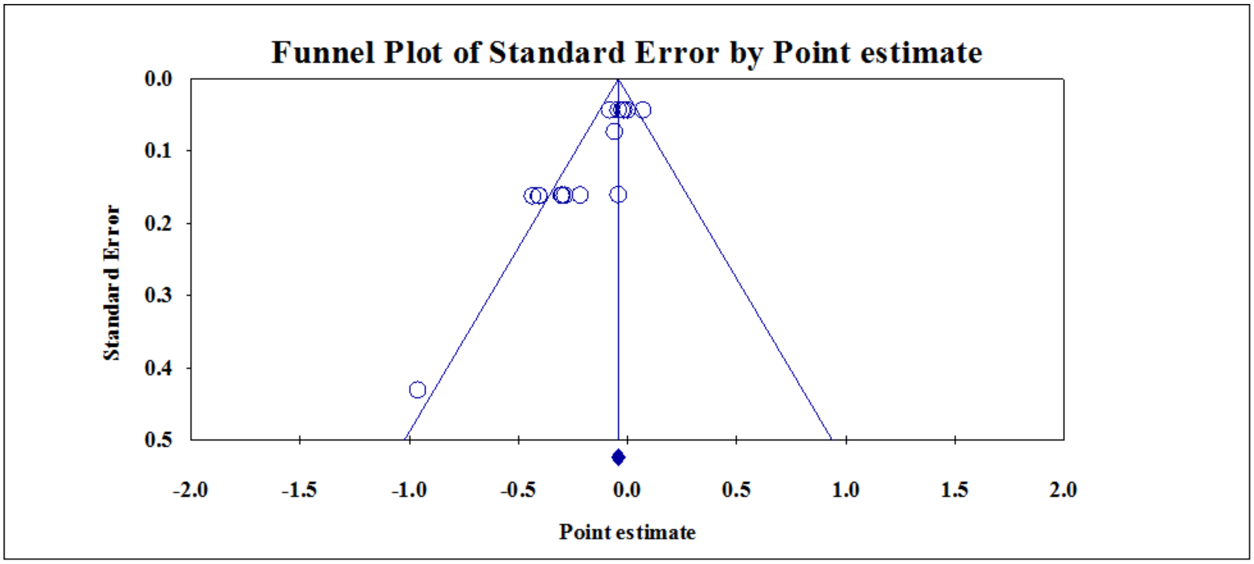
Effect of MMN fortification on Cognitive Development - Verbal

Study name	Subgroup within study	Point estimate	Standard error	Lower limit	Upper limit	Z-Value	p-Value
Dalton, 2009	T4A MMN For Spr ED Cogn Verb HVLT Rec B&G Sch	-0.302	0.162	-0.619	0.015	-1.869	0.062
Dalton, 2009	T4B MMN For Spr ED Cogn Verb HVLT Rec B&G Sch	-0.041	0.161	-0.356	0.274	-0.255	0.799
Dalton, 2009	T4C MMN For Spr ED Cogn Verb HVLT Rec B&G Sch	-0.287	0.162	-0.604	0.030	-1.777	0.076
Dalton, 2009	T4D MMN For Spr ED Cogn Verb HVLT tot B&G Sch	-0.216	0.161	-0.532	0.100	-1.341	0.180
Dalton, 2009	T4E MMN For Spr ED Cogn Verb HVLT Rec B&G Sch	-0.406	0.162	-0.724	-0.088	-2.502	0.012
Dalton, 2009	T4F MMN For Spr ED Cogn Verb HVLT Dis B&G Sch	-0.434	0.163	-0.752	-0.116	-2.671	0.008
Dalton, 2009	T4G MMN For Spr ED Cogn Verb Reading B&G Sch	-0.298	0.162	-0.615	0.019	-1.845	0.065
Dalton, 2009	T4H MMN For Spr ED Cogn Verb Spelling B&G Sch	-0.403	0.162	-0.721	-0.085	-2.483	0.013
Gewan, 2009	T3G MMN For Sna ED Cogn Verb Fe avail B&G Sch	-0.041	0.044	-0.126	0.044	-0.943	0.346
Gewan, 2009	T3H MMN For Sna ED Cogn Verb Zn avail B&G Sch	-0.024	0.044	-0.109	0.061	-0.552	0.581
Gewan, 2009	T3I MMN For Sna ED Cogn Verb B12 Vita B&G Sch	0.072	0.044	-0.013	0.157	1.655	0.098
Gewan, 2009	T3J MMN For Sna ED Cogn Verb B6 Vitam B&G Sch	-0.082	0.044	-0.167	0.003	-1.881	0.060
Gewan, 2009	T3K MMN For Sna ED Cogn Verb Folate B&G Sch	0.000	0.044	-0.085	0.085	0.000	1.000
Gewan, 2009	T3L MMN For Sna ED Cogn Verb Riboflav B&G Sch	-0.015	0.044	-0.100	0.070	-0.345	0.730
Solon, 2003	T6H MMN For Dri ED Cogn Verb All B&G Sch	-0.059	0.073	-0.203	0.085	-0.804	0.422
Solon, 2003	T6J MMN For Dri ED Cogn Verb Hb<11 Ul B&G Sch	-0.960	0.431	-1.805	-0.115	-2.227	0.026
		-0.093	0.032	-0.155	-0.030	-2.900	0.004



Effect size and significance				
Model	Number Studies	Point estimate	Significance	Standard error
Random effects	16.000	(0.093)	***	0.032

Heterogeneity				Tau-squared			
Q-value	df (Q)	P-value	I-squared	Tau Squared	Standard Error	Variance	Tau
38.153	15.000	0.001	60.684	0.007	0.005	0.000	0.085



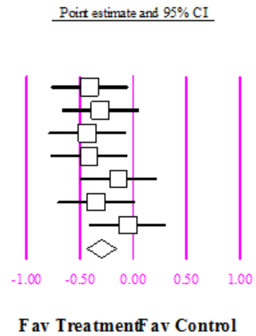
Egger's regression intercept

Intercept	-2.38497
Standard error	0.41302
95% lower limit (2-tailed)	-3.27082
95% upper limit (2-tailed)	-1.49912
t-value	5.77439
df	14.00000
P-value (1-tailed)	0.00002
P-value (2-tailed)	0.00005

Effect of Supplementation with Multiple Micronutrients on Cognitive Development (memory)

Effect of MMN Supplementation on Cognitive Development - Memory

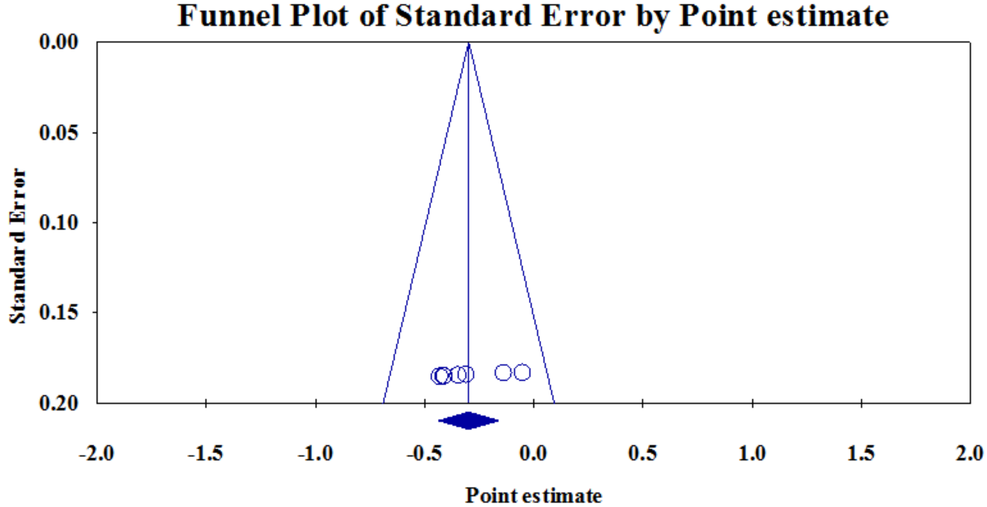
Study name	Subgroup within study	Point estimate	Standard error	Lower limit	Upper limit	Z-Value	p-Value
Kumar, 2008	T4A MMN Sup Cap ED Cogn Memo Red cell B&G Sch	-0.409	0.185	-0.771	-0.047	-2.212	0.027
Kumar, 2008	T4B MMN Sup Cap ED Cogn Memo Cattell B&G Sch	-0.309	0.184	-0.670	0.052	-1.678	0.093
Kumar, 2008	T4C MMN Sup Cap ED Cogn Memo MannSui B&G Sch	-0.430	0.185	-0.793	-0.067	-2.323	0.020
Kumar, 2008	T4D MMN Sup Cap ED Cogn Memo Delayed B&G Sch	-0.413	0.185	-0.775	-0.051	-2.234	0.026
Kumar, 2008	T4E MMN Sup Cap ED Cogn Memo Persona B&G Sch	-0.138	0.183	-0.497	0.221	-0.753	0.451
Kumar, 2008	T4F MMN Sup Cap ED Cogn Memo Digit sp B&G Sch	-0.347	0.184	-0.708	0.014	-1.882	0.060
Kumar, 2008	T4G MMN Sup Cap ED Cogn Memo Digit sp B&G Sch	-0.051	0.183	-0.410	0.308	-0.279	0.781
		-0.298	0.070	-0.435	-0.162	-4.286	0.000



Effect size and significance				
Model	Number Studies	Point estimate	Significance	Standard error
Random effects	7.000	(0.298)	***	0.070

Heterogeneity				Tau-squared			
Q-value	df (Q)	P-value	I-squared	Tau Squared	Standard Error	Variance	Tau
3.912	6.000	0.689	-	-	0.020	0.000	-

Funnel Plot of Standard Error by Point estimate



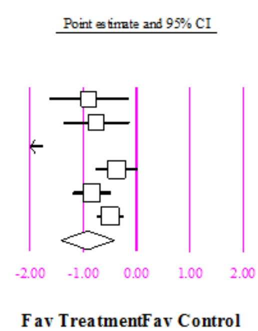
Egger's regression intercept

Intercept	-177.72635
Standard error	15.38768
95% lower limit (2-tailed)	-217.28163
95% upper limit (2-tailed)	-138.17107
t-value	11.54991
df	5.00000
P-value (1-tailed)	0.00004
P-value (2-tailed)	0.00009

Effect of Iron Supplementation on Cognitive Development (intelligence)

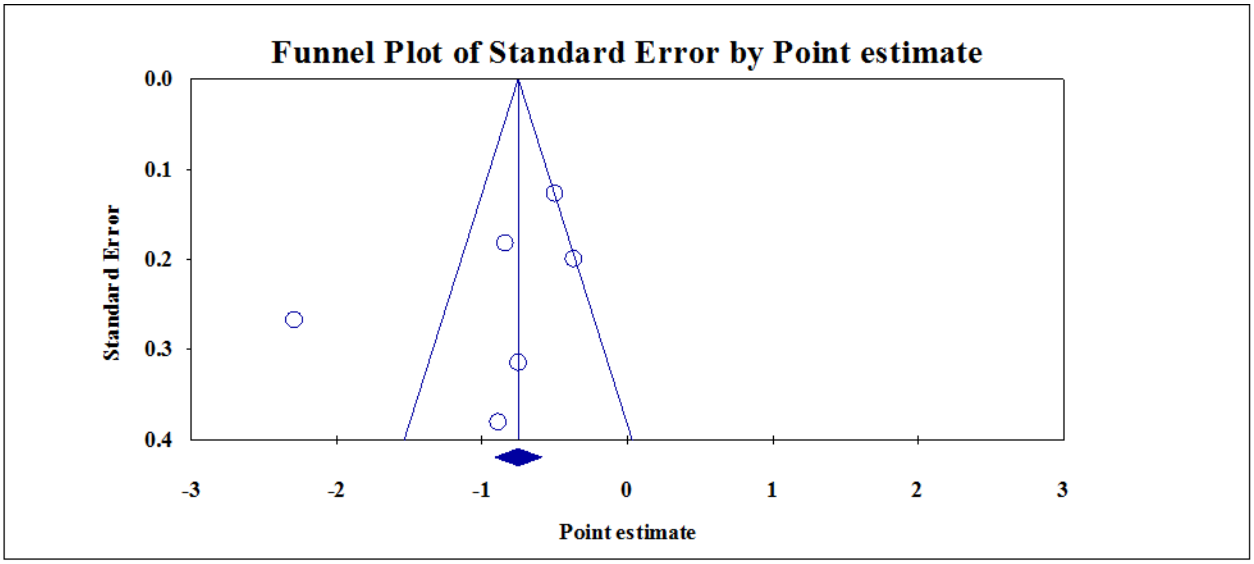
Effect of Iron Supplementation on Cognitive Development - Intelligence

Study name	Subgroup within study	Point estimate	Standard error	Lower limit	Upper limit	Z-Value	p-Value
CMAJ 185(17) 2013	F2A Iron Sup Dai ED Cogn Inte Seshadri B&G Sch	-0.890	0.380	-1.635	-0.145	-2.341	0.019
CMAJ 185(17) 2013	F2B Iron Sup Dai ED Cogn Inte Gopaldas B&G Sch	-0.750	0.315	-1.366	-0.134	-2.385	0.017
CMAJ 185(17) 2013	F2C Iron Sup Dai ED Cogn Inte Seshadri B&G Sch	-2.290	0.267	-2.813	-1.767	-8.577	0.000
CMAJ 185(17) 2013	F2D Iron Sup Dai ED Cogn Inte Seshadri B&G Sch	-0.370	0.200	-0.761	0.021	-1.854	0.064
CMAJ 185(17) 2013	F2E Iron Sup Dai ED Cogn Inte Kashyap B&G Sch	-0.840	0.182	-1.197	-0.483	-4.615	0.000
CMAJ 185(17) 2013	F2H Iron Sup Dai ED Cogn Inte Sungthon B&G Sch	-0.500	0.127	-0.749	-0.251	-3.940	0.000
		-0.922	0.256	-1.423	-0.421	-3.607	0.000



Effect size and significance				
Model	Number Studies	Point estimate	Significance	Standard error
Random effects	6.000	(0.922)	***	0.256

Heterogeneity				Tau-squared			
Q-value	df (Q)	P-value	I-squared	Tau Squared	Standard Error	Variance	Tau
41.153	5.000	0.000	87.850	0.329	0.271	0.074	0.574



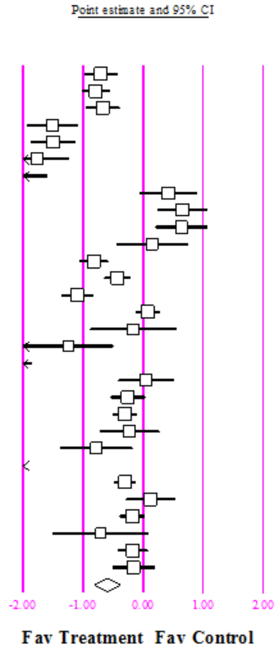
Egger's regression intercept

Intercept	-3.66282
Standard error	3.24492
95% lower limit (2-tailed)	-12.67217
95% upper limit (2-tailed)	5.34653
t-value	1.12878
df	4.00000
P-value (1-tailed)	0.16105
P-value (2-tailed)	0.32210

Effect of Iron Supplementation on Anemia

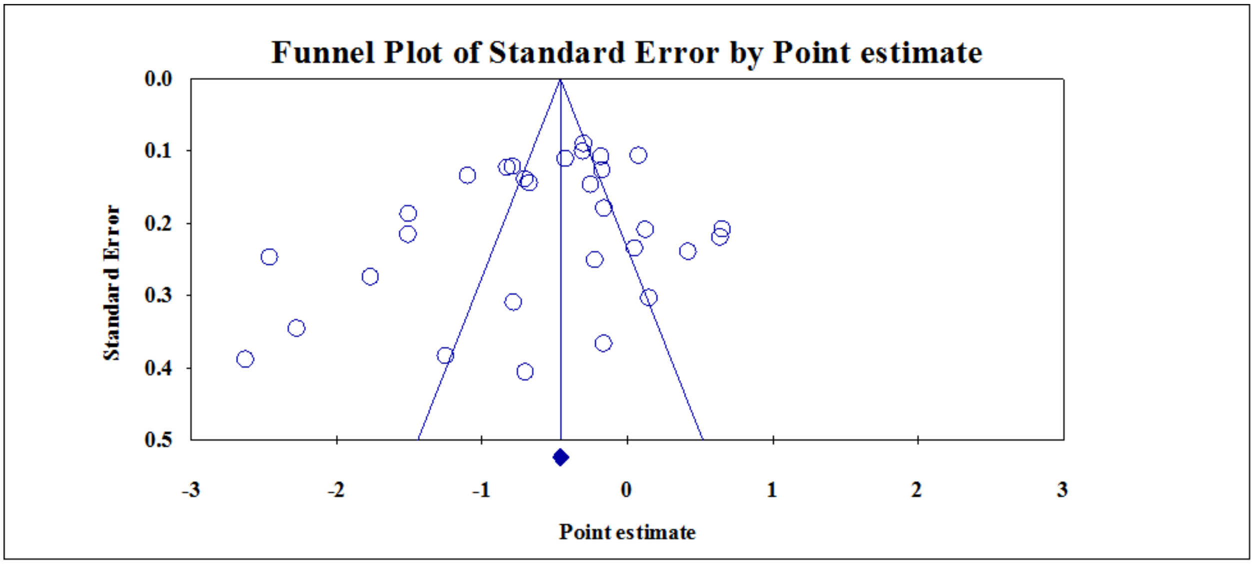
Effect of Iron Supplementation on Nutrition Indicators - Anemia

Study name	Subgroup within study	Point estimate	Standard error	Lower limit	Upper limit	Z-Value	p-Value
Aditi, 2012	T1A Iron Sup Int NUT Biom Anem Hb 1/wk Girls Sch	-0.705	0.139	-0.977	-0.433	-5.087	0.000
Aditi, 2012	T1B Iron Sup Int NUT Biom Anem Hb 2/wk Girls Sch	-0.789	0.121	-1.027	-0.551	-6.499	0.000
Aditi, 2012	T1C Iron Sup Int NUT Biom Anem Hb Daily Girls Sch	-0.674	0.144	-0.957	-0.391	-4.674	0.000
Aditi, 2012	T2A Iron Sup Int NUT Biom Anem Hb 1/wk Girls Sch	-1.508	0.216	-1.930	-1.086	-6.998	0.000
Aditi, 2012	T2B Iron Sup Int NUT Biom Anem Hb 2/wk Girls Sch	-1.505	0.187	-1.872	-1.138	-8.048	0.000
Aditi, 2012	T2C Iron Sup Int NUT Biom Anem Hb Daily Girls Sch	-1.766	0.274	-2.304	-1.228	-6.436	0.000
Aditi, 2012	T2D Iron Sup Int NUT Biom Anem Hb Contr Girls Sch	-2.273	0.346	-2.950	-1.596	-6.577	0.000
Aditi, 2012	T2E Iron Sup Int NUT Biom Anem Hb 1/wk Girls Sch	0.418	0.239	-0.051	0.887	1.747	0.081
Aditi, 2012	T2F Iron Sup Int NUT Biom Anem Hb 2/wk Girls Sch	0.652	0.208	0.244	1.060	3.133	0.002
Aditi, 2012	T2G Iron Sup Int NUT Biom Anem Hb Daily Girls Sch	0.638	0.219	0.208	1.068	2.908	0.004
Aditi, 2012	T2H Iron Sup Int NUT Biom Anem Hb Contr Girls Sch	0.148	0.303	-0.446	0.742	0.488	0.625
Ahmed, 2005	T3A Iron Sup Int NUT Biom Anem Hemoglob Girls Sch	-0.827	0.123	-1.068	-0.586	-6.735	0.000
Ahmed, 2005	T3B Iron Sup Int NUT Biom Anem Hemoglob Girls Sch	-0.426	0.111	-0.643	-0.209	-3.848	0.000
Ahmed, 2005	T3C Iron Sup Int NUT Biom Anem RBC Foli Girls Sch	-1.098	0.134	-1.361	-0.835	-8.182	0.000
Ahmed, 2005	T3D Iron Sup Int NUT Biom Anem Serum V Girls Sch	0.077	0.106	-0.131	0.285	0.725	0.468
Cochrane 2014	F5.1A Iron Sup Int NUT Biom Anem Aguayo 2 B&G Sch	-0.163	0.367	-0.882	0.556	-0.445	0.657
Cochrane 2014	F5.1B Iron Sup Int NUT Biom Anem Arcanjo B&G Sch	-1.249	0.384	-2.001	-0.497	-3.255	0.001
Cochrane 2014	F5.1C Iron Sup Int NUT Biom Anem Berger 1 B&G Sch	-2.625	0.388	-3.386	-1.864	-6.760	0.000
Cochrane 2014	F5.1D Iron Sup Int NUT Biom Anem Roschnik B&G Sch	0.050	0.235	-0.410	0.510	0.213	0.831
Cochrane 2014	F5.1E Iron Sup Int NUT Biom Anem Roschnik B&G Sch	-0.254	0.146	-0.541	0.033	-1.735	0.083
Cochrane 2014	F5.1F Iron Sup Int NUT Biom Anem Hall 200 B&G Sch	-0.308	0.100	-0.505	-0.111	-3.068	0.002
Cochrane 2014	F5.9A Iron Sup Int NUT Biom Anem Aguayo 2 B&G Sch	-0.224	0.251	-0.716	0.268	-0.893	0.372
Cochrane 2014	F5.9B Iron Sup Int NUT Biom Anem Arcanjo B&G Sch	-0.783	0.309	-1.389	-0.177	-2.531	0.011
Cochrane 2014	F5.9C Iron Sup Int NUT Biom Anem Berger 1 B&G Sch	-2.459	0.247	-2.943	-1.975	-9.951	0.000
Cochrane 2014	F5.9D Iron Sup Int NUT Biom Anem Hall 200 B&G Sch	-0.301	0.090	-0.477	-0.125	-3.348	0.001
Cochrane 2014	F5.9E Iron Sup Int NUT Biom Anem Roschnik B&G Sch	0.123	0.209	-0.286	0.532	0.589	0.556
Cochrane 2014	F5.9F Iron Sup Int NUT Biom Anem Roschnik B&G Sch	-0.181	0.108	-0.392	0.030	-1.679	0.093
Cochrane 2014	F5.9G Iron Sup Int NUT Biom Anem Sen 2009 B&G Sch	-0.703	0.406	-1.499	0.093	-1.732	0.083
Cochrane 2014	F5.9H Iron Sup Int NUT Biom Anem Sungthon B&G Sch	-0.174	0.127	-0.422	0.074	-1.374	0.169
Cochrane 2014	F5.9I Iron Sup Int NUT Biom Anem Taylor 2 B&G Sch	-0.161	0.179	-0.512	0.190	-0.898	0.369
		-0.602	0.111	-0.820	-0.383	-5.395	0.000



Effect size and significance				
Model	Number Studies	Point estimate	Significance	Standard error
Random effects	30.000	(0.602)	***	0.111

Heterogeneity				Tau-squared			
Q-value	df (Q)	P-value	I-squared	Tau Squared	Standard Error	Variance	Tau
384.276	29.000	-	92.453	0.323	0.115	0.013	0.569



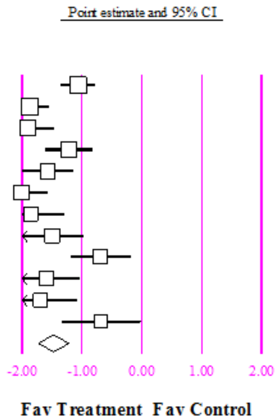
Egger's regression intercept

Intercept	-2.45316
Standard error	1.62012
95% lower limit (2-tailed)	-5.77182
95% upper limit (2-tailed)	0.86551
t-value	1.51418
df	28.00000
P-value (1-tailed)	0.07059
P-value (2-tailed)	0.14119

Effect of Daily Iron Supplementation on BMI

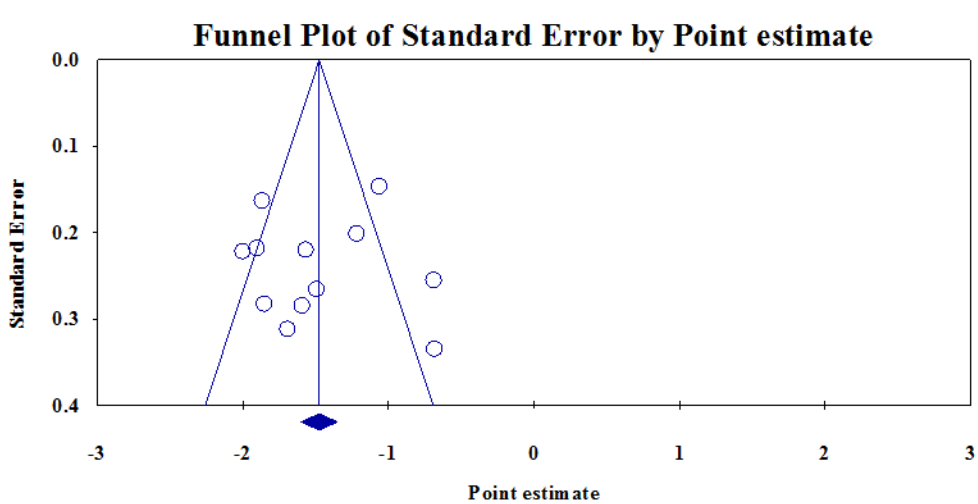
Effects of Iron Supplementation on Nutrition Indicators - BMI

Study name	Subgroup within study	Point estimate	Standard error	Lower limit	Upper limit	Z-Value	p-Value
Aditi, 2012	T3A Iron Sup Int NUT Anth BMI 1/wk Girls Sch	-1.063	0.146	-1.350	-0.776	-7.261	0.000
Aditi, 2012	T3B Iron Sup Int NUT Anth BMI 2/wk Girls Sch	-1.867	0.163	-2.187	-1.547	-11.440	0.000
Aditi, 2012	T3C Iron Sup Int NUT Anth BMI Daily Girls Sch	-1.903	0.218	-2.331	-1.475	-8.721	0.000
Aditi, 2012	T3D Iron Sup Int NUT Anth BMI Control Girls Sch	-1.218	0.201	-1.613	-0.823	-6.051	0.000
Aditi, 2012	T4A Iron Sup Int NUT Anth BMI 1/wk Girls Sch	-1.567	0.220	-1.998	-1.136	-7.123	0.000
Aditi, 2012	T4B Iron Sup Int NUT Anth BMI 2/wk Girls Sch	-2.000	0.222	-2.435	-1.565	-9.017	0.000
Aditi, 2012	T4C Iron Sup Int NUT Anth BMI Daily Girls Sch	-1.852	0.283	-2.406	-1.298	-6.553	0.000
Aditi, 2012	T4D Iron Sup Int NUT Anth BMI Control Girls Sch	-1.494	0.266	-2.015	-0.973	-5.625	0.000
Aditi, 2012	T4E Iron Sup Int NUT Anth BMI 1/wk Girls Sch	-0.687	0.255	-1.187	-0.187	-2.693	0.007
Aditi, 2012	T4F Iron Sup Int NUT Anth BMI 2/wk Girls Sch	-1.593	0.285	-2.151	-1.035	-5.597	0.000
Aditi, 2012	T4G Iron Sup Int NUT Anth BMI Daily Girls Sch	-1.692	0.312	-2.303	-1.081	-5.425	0.000
Aditi, 2012	T4H Iron Sup Int NUT Anth BMI Control Girls Sch	-0.682	0.335	-1.338	-0.026	-2.037	0.042
		-1.478	0.130	-1.733	-1.223	-11.369	0.000



Effect size and significance				
Model	**Number Studies**	**Point estimate**	**Significance**	**Standard error**
Random effects	12.000	(1.478)	***	0.130

Heterogeneity				Tau-squared			
Q-value	**df (Q)**	**P-value**	**I-squared**	**Tau Squared**	**Standard Error**	**Variance**	**Tau**
42.537	11.000	0.000	74.140	0.144	0.089	0.008	0.380



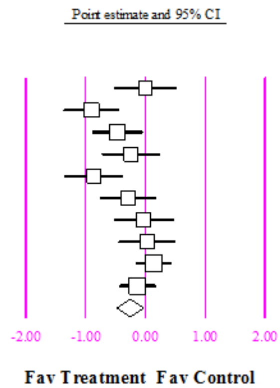
Egger's regression intercept

Intercept	-0.09773
Standard error	2.41506
95% lower limit (2-tailed)	-5.47882
95% upper limit (2-tailed)	5.28336
t-value	0.04047
df	10.00000
P-value (1-tailed)	0.48426
P-value (2-tailed)	0.96852

Effect of Iron Supplementation on Stunting

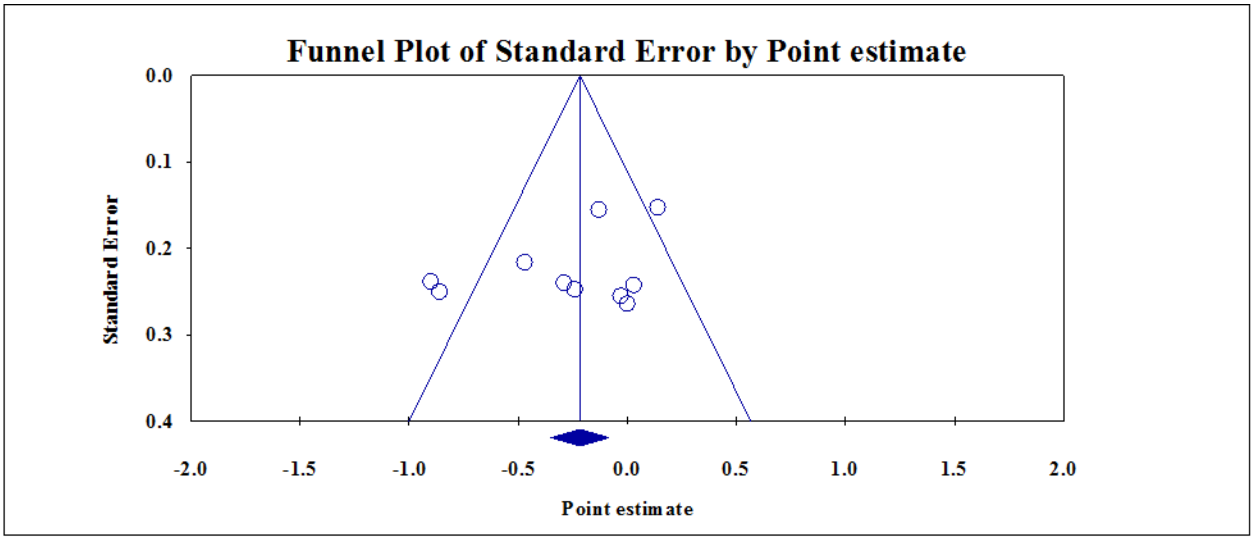
Effects of Iron Supplementation on Nutrition Indicators - Stuntin (School age Boys & Girls)

Study name	Subgroup within study	Point estimate	Standard error	Lower limit	Upper limit	Z-Value	p-Value
Sachdev	F5A Iron Sup dai NUT Anth Stun Lathame B&G Sch	0.000	0.264	-0.518	0.518	0.000	1.000
Sachdev	F5B Iron Sup dai NUT Anth Stun Angeles B&G Pre	-0.900	0.239	-1.368	-0.432	-3.772	0.000
Sachdev	F5C Iron Sup dai NUT Anth Stun Lawless B&G Sch	-0.470	0.216	-0.894	-0.046	-2.173	0.030
Sachdev	F5D Iron Sup dai NUT Anth Stun Aguayo, B&G Sch	-0.240	0.248	-0.725	0.245	-0.969	0.333
Sachdev	F5E Iron Sup dai NUT Anth Stun Mwanri e B&G Sch	-0.860	0.250	-1.351	-0.369	-3.436	0.001
Sachdev	F5F Iron Sup dai NUT Anth Stun Mwanri e B&G Sch	-0.290	0.240	-0.761	0.181	-1.207	0.227
Sachdev	F5G Iron Sup dai NUT Anth Stun Dossa et B&G Pre	-0.030	0.255	-0.530	0.470	-0.118	0.906
Sachdev	F5H Iron Sup dai NUT Anth Stun Dossa et B&G Pre	0.030	0.243	-0.446	0.506	0.124	0.902
Sachdev	F5I Iron Sup dai NUT Anth Stun Sungthon B&G Sch	0.140	0.153	-0.159	0.439	0.917	0.359
Sachdev	F5J Iron Sup dai NUT Anth Stun Sungthon B&G Sch	-0.130	0.155	-0.434	0.174	-0.838	0.402
		-0.261	0.114	-0.484	-0.038	-2.291	0.022



Effect size and significance				
Model	**Number Studies**	**Point estimate**	**Significance**	**Standard error**
Random effects	10.000	(0.261)	**	0.114

Heterogeneity				Tau-squared			
Q-value	**df (Q)**	**P-value**	**I-squared**	**Tau Squared**	**Standard Error**	**Variance**	**Tau**
24.288	9.000	0.004	62.945	0.079	0.061	0.004	0.282



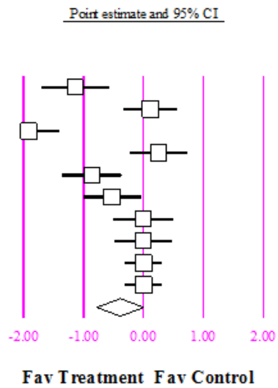
Egger's regression intercept

Intercept	-3.39141
Standard error	2.34663
95% lower limit (2-tailed)	-8.80274
95% upper limit (2-tailed)	2.01993
t-value	1.44523
df	8.00000
P-value (1-tailed)	0.09320
P-value (2-tailed)	0.18640

Effect of Iron Supplementation on Underweight

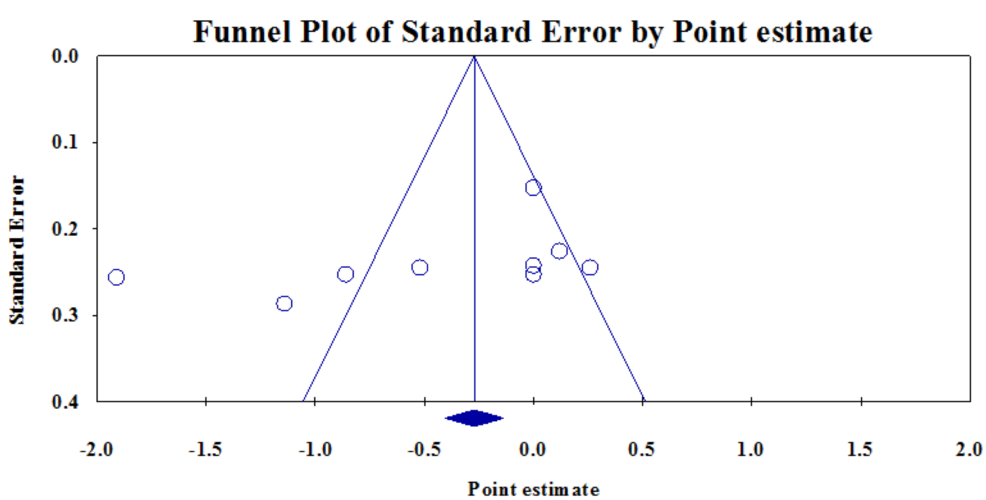
Effects of Iron Supplementation on Nutrition Indicators - Underweight (School age Boys & Girls)

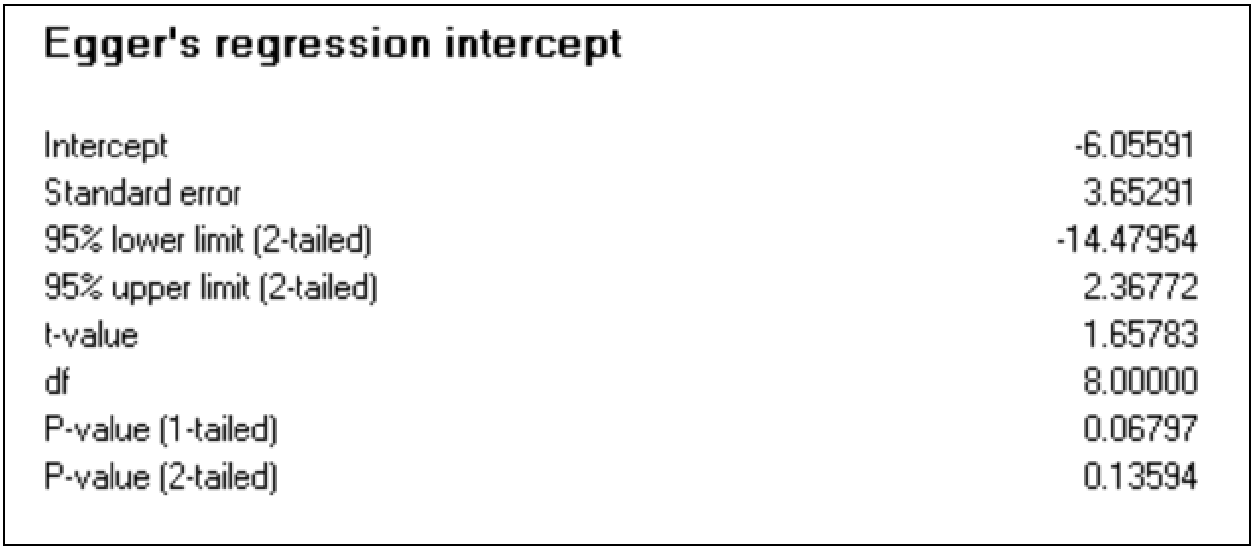
Study name	Subgroup within study	Point estimate	Standard error	Lower limit	Upper limit	Z-Value	p-Value
Sachdev	F3A Iron Sup dai NUT Anth Unde Lathame B&G Sch	-1.140	0.287	-1.702	-0.578	-3.975	0.000
Sachdev	F3B Iron Sup dai NUT Anth Unde Angeles B&G Pre	0.120	0.226	-0.323	0.563	0.531	0.596
Sachdev	F3C Iron Sup dai NUT Anth Unde Lawless B&G Sch	-1.910	0.257	-2.413	-1.407	-7.446	0.000
Sachdev	F3D Iron Sup dai NUT Anth Unde Aguayo, B&G Sch	0.260	0.245	-0.221	0.741	1.060	0.289
Sachdev	F3E Iron Sup dai NUT Anth Unde Mwanri e B&G Sch	-0.860	0.253	-1.355	-0.365	-3.402	0.001
Sachdev	F3F Iron Sup dai NUT Anth Unde Mwanri e B&G Sch	-0.520	0.245	-1.001	-0.039	-2.121	0.034
Sachdev	F3G Iron Sup dai NUT Anth Unde Dossa et B&G Pre	0.000	0.253	-0.495	0.495	0.000	1.000
Sachdev	F3H Iron Sup dai NUT Anth Unde Dossa et B&G Pre	0.000	0.243	-0.476	0.476	0.000	1.000
Sachdev	F3I Iron Sup dai NUT Anth Unde Sungthon B&G Sch	0.000	0.153	-0.299	0.299	0.000	1.000
Sachdev	F3J Iron Sup dai NUT Anth Unde Sungthon B&G Sch	0.000	0.153	-0.299	0.299	0.000	1.000
		-0.390	0.199	-0.779	-0.000	-1.960	0.050



Effect size and significance				
Model	Number Studies	Point estimate	Significance	Standard error
Random effects	10.000	(0.390)	**	0.199

Heterogeneity				Tau-squared			
Q-value	df (Q)	P-value	I-squared	Tau Squared	Standard Error	Variance	Tau
72.846	9.000	0.000	87.645	0.341	0.197	0.039	0.584

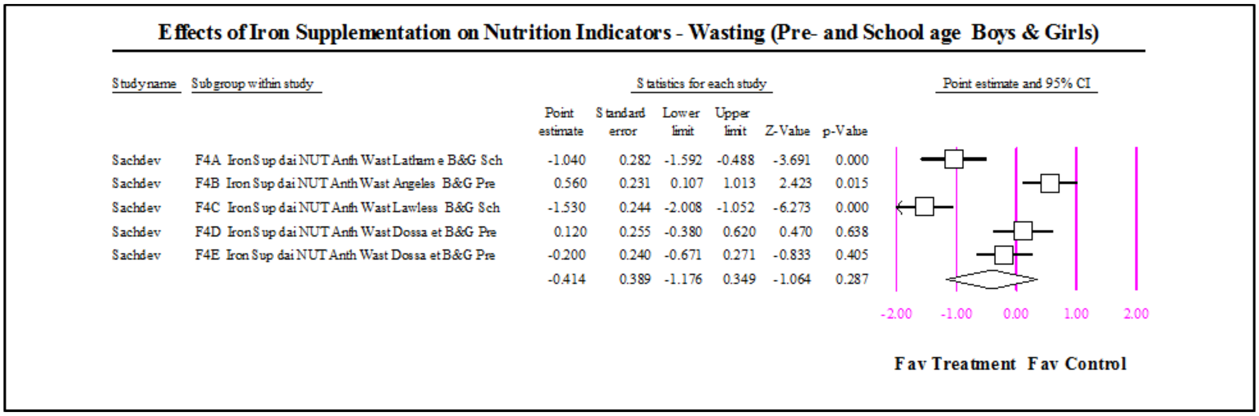




Egger's regression intercept

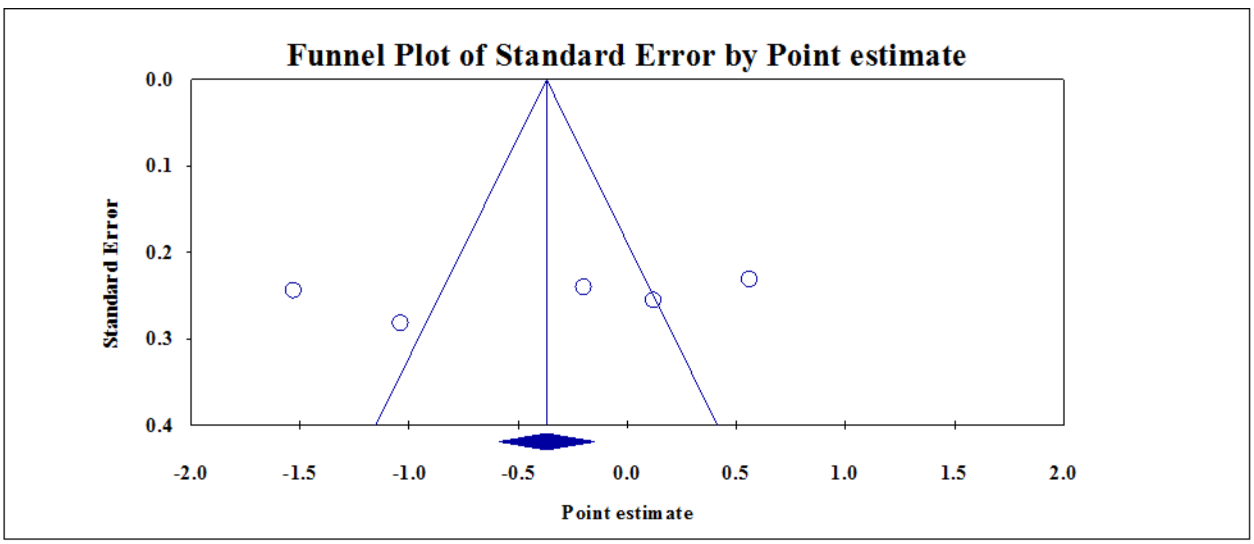
Intercept	-6.05591
Standard error	3.65291
95% lower limit (2-tailed)	-14.47954
95% upper limit (2-tailed)	2.36772
t-value	1.65783
df	8.00000
P-value (1-tailed)	0.06797
P-value (2-tailed)	0.13594

Effect of Iron Supplementation on Wasting



Effect size and significance				
Model	Number Studies	Point estimate	Significance	Standard error
Random effects	5.000	(0.414)	-	0.389

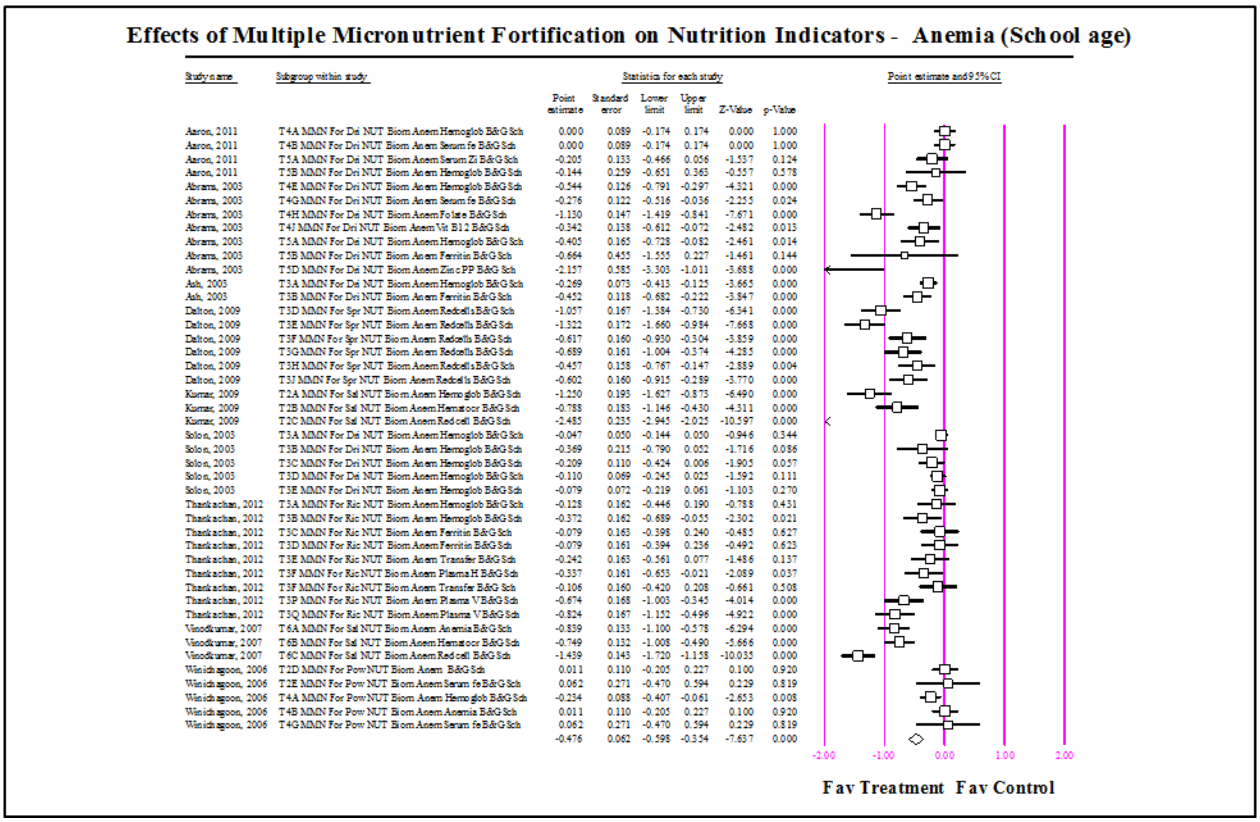
Heterogeneity				Tau-squared			
Q-value	df (Q)	P-value	I-squared	Tau Squared	Standard Error	Variance	Tau
48.652	4.000	0.000	91.778	0.694	0.537	0.289	0.833



Egger's regression intercept

Intercept	-21.36599
Standard error	24.26618
95% lower limit (2-tailed)	-98.59186
95% upper limit (2-tailed)	55.85989
t-value	0.88048
df	3.00000
P-value (1-tailed)	0.22171
P-value (2-tailed)	0.44343

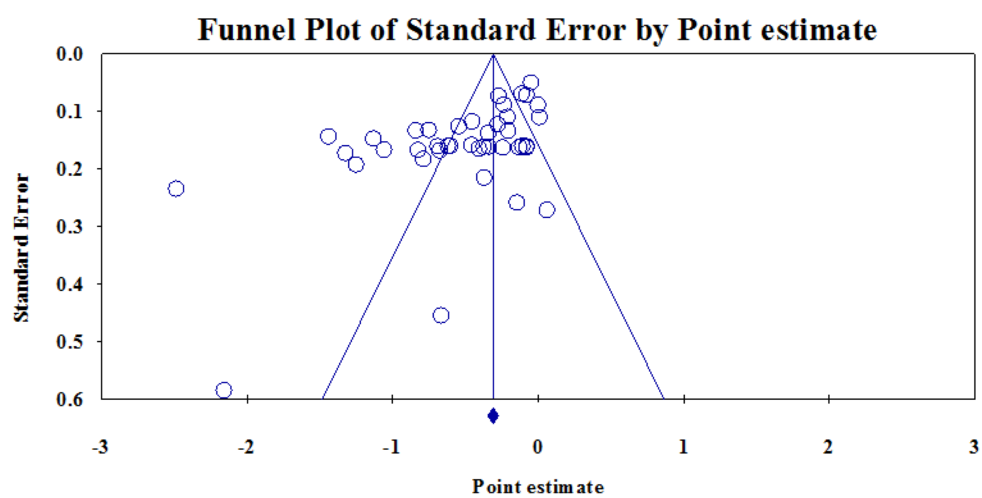
Effect of Food Fortification with Multiple Micronutrients (anemia)



Study name	Subgroup within study	Point estimate	Standard error	Lower limit	Upper limit	Z-Value	p-Value
Aaron, 2011	T4A MMN For Dri NUT Biom Anem Hemoglob B&G Sch	0.000	0.089	-0.174	0.174	0.000	1.000
Aaron, 2011	T4B MMN For Dri NUT Biom Anem Serum fe B&G Sch	0.000	0.089	-0.174	0.174	0.000	1.000
Aaron, 2011	T5A MMN For Dri NUT Biom Anem Serum Zi B&G Sch	-0.205	0.133	-0.466	0.056	-1.537	0.124
Aaron, 2011	T5B MMN For Dri NUT Biom Anem Hemoglob B&G Sch	-0.144	0.259	-0.651	0.363	-0.557	0.578
Abrams, 2003	T4E MMN For Dri NUT Biom Anem Hemoglob B&G Sch	-0.544	0.126	-0.791	-0.297	-4.321	0.000
Abrams, 2003	T4G MMN For Dri NUT Biom Anem Serum fe B&G Sch	-0.276	0.122	-0.516	-0.036	-2.255	0.024
Abrams, 2003	T4H MMN For Dri NUT Biom Anem Folate B&G Sch	-1.130	0.147	-1.419	-0.841	-7.671	0.000
Abrams, 2003	T4J MMN For Dri NUT Biom Anem Vit B12 B&G Sch	-0.342	0.138	-0.612	-0.072	-2.482	0.013
Abrams, 2003	T5A MMN For Dri NUT Biom Anem Hemoglob B&G Sch	-0.405	0.165	-0.728	-0.082	-2.461	0.014
Abrams, 2003	T5B MMN For Dri NUT Biom Anem Ferritin B&G Sch	-0.664	0.455	-1.555	0.227	-1.461	0.144
Abrams, 2003	T5D MMN For Dri NUT Biom Anem Zinc PP B&G Sch	-2.157	0.585	-3.303	-1.011	-3.688	0.000
Ash, 2003	T3A MMN For Dri NUT Biom Anem Hemoglob B&G Sch	-0.269	0.073	-0.413	-0.125	-3.665	0.000
Ash, 2003	T3B MMN For Dri NUT Biom Anem Ferritin B&G Sch	-0.452	0.118	-0.682	-0.222	-3.847	0.000
Dalton, 2009	T3D MMN For Spr NUT Biom Anem Redcells B&G Sch	-1.057	0.167	-1.384	-0.730	-6.341	0.000
Dalton, 2009	T3E MMN For Spr NUT Biom Anem Redcells B&G Sch	-1.322	0.172	-1.660	-0.984	-7.668	0.000
Dalton, 2009	T3F MMN For Spr NUT Biom Anem Redcells B&G Sch	-0.617	0.160	-0.930	-0.304	-3.859	0.000
Dalton, 2009	T3G MMN For Spr NUT Biom Anem Redcells B&G Sch	-0.689	0.161	-1.004	-0.374	-4.285	0.000
Dalton, 2009	T3H MMN For Spr NUT Biom Anem Redcells B&G Sch	-0.457	0.158	-0.767	-0.147	-2.889	0.004
Dalton, 2009	T3J MMN For Spr NUT Biom Anem Redcells B&G Sch	-0.602	0.160	-0.915	-0.289	-3.770	0.000
Kumar, 2009	T2A MMN For Sal NUT Biom Anem Hemoglob B&G Sch	-1.250	0.193	-1.627	-0.873	-6.490	0.000
Kumar, 2009	T2B MMN For Sal NUT Biom Anem Hematocr B&G Sch	-0.788	0.183	-1.146	-0.430	-4.311	0.000
Kumar, 2009	T2C MMN For Sal NUT Biom Anem Red cell B&G Sch	-2.485	0.235	-2.945	-2.025	-10.597	0.000
Solon, 2003	T3A MMN For Dri NUT Biom Anem Hemoglob B&G Sch	-0.047	0.050	-0.144	0.050	-0.946	0.344
Solon, 2003	T3B MMN For Dri NUT Biom Anem Hemoglob B&G Sch	-0.369	0.215	-0.790	0.052	-1.716	0.086
Solon, 2003	T3C MMN For Dri NUT Biom Anem Hemoglob B&G Sch	-0.209	0.110	-0.424	0.006	-1.905	0.057
Solon, 2003	T3D MMN For Dri NUT Biom Anem Hemoglob B&G Sch	-0.110	0.069	-0.245	0.025	-1.592	0.111
Solon, 2003	T3E MMN For Dri NUT Biom Anem Hemoglob B&G Sch	-0.079	0.072	-0.219	0.061	-1.103	0.270
Thankachan, 2012	T3A MMN For Ric NUT Biom Anem Hemoglob B&G Sch	-0.128	0.162	-0.446	0.190	-0.788	0.431
Thankachan, 2012	T3B MMN For Ric NUT Biom Anem Hemoglob B&G Sch	-0.372	0.162	-0.689	-0.055	-2.302	0.021
Thankachan, 2012	T3C MMN For Ric NUT Biom Anem Ferritin B&G Sch	-0.079	0.163	-0.398	0.240	-0.485	0.627
Thankachan, 2012	T3D MMN For Ric NUT Biom Anem Ferritin B&G Sch	-0.079	0.161	-0.394	0.236	-0.492	0.623
Thankachan, 2012	T3E MMN For Ric NUT Biom Anem Transfer B&G Sch	-0.242	0.163	-0.561	0.077	-1.486	0.137
Thankachan, 2012	T3F MMN For Ric NUT Biom Anem Plasma H B&G Sch	-0.337	0.161	-0.653	-0.021	-2.089	0.037
Thankachan, 2012	T3F MMN For Ric NUT Biom Anem Transfer B&G Sch	-0.106	0.160	-0.420	0.208	-0.661	0.508
Thankachan, 2012	T3P MMN For Ric NUT Biom Anem Plasma V B&G Sch	-0.674	0.168	-1.003	-0.345	-4.014	0.000
Thankachan, 2012	T3Q MMN For Ric NUT Biom Anem Plasma V B&G Sch	-0.824	0.167	-1.152	-0.496	-4.922	0.000
Vinodkumar, 2007	T6A MMN For Sal NUT Biom Anem Anemia B&G Sch	-0.839	0.133	-1.100	-0.578	-6.294	0.000
Vinodkumar, 2007	T6B MMN For Sal NUT Biom Anem Hematocr B&G Sch	-0.749	0.132	-1.008	-0.490	-5.666	0.000
Vinodkumar, 2007	T6C MMN For Sal NUT Biom Anem Red cell B&G Sch	-1.439	0.143	-1.720	-1.158	-10.035	0.000
Winichagoon, 2006	T2D MMN For Pow NUT Biom Anem B&G Sch	0.011	0.110	-0.205	0.227	0.100	0.920
Winichagoon, 2006	T2E MMN For Pow NUT Biom Anem Serum fe B&G Sch	0.062	0.271	-0.470	0.594	0.229	0.819
Winichagoon, 2006	T4A MMN For Pow NUT Biom Anem Hemoglob B&G Sch	-0.234	0.088	-0.407	-0.061	-2.653	0.008
Winichagoon, 2006	T4B MMN For Pow NUT Biom Anem Anemia B&G Sch	0.011	0.110	-0.205	0.227	0.100	0.920
Winichagoon, 2006	T4G MMN For Pow NUT Biom Anem Serum fe B&G Sch	0.062	0.271	-0.470	0.594	0.229	0.819
		-0.476	0.062	-0.598	-0.354	-7.637	0.000

Effect size and significance				
Model	Number Studies	Point estimate	Significance	Standard error
Random effects	44.000	(0.476)	***	0.062

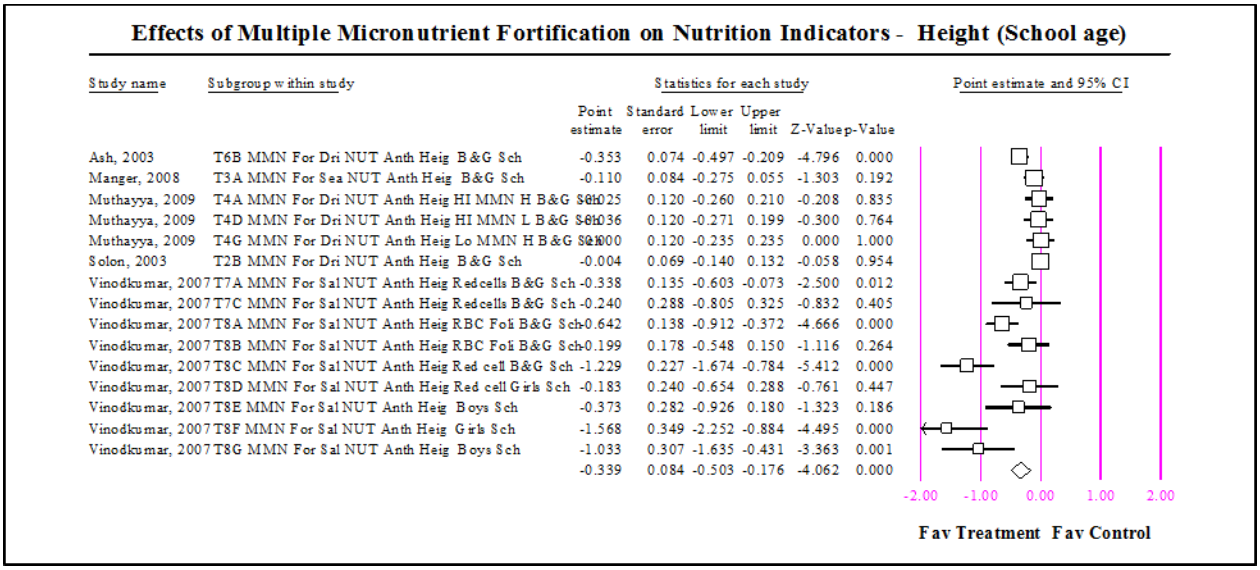
Heterogeneity				Tau-squared			
Q-value	df (Q)	P-value	I-squared	Tau Squared	Standard Error	Variance	Tau
436.767	43.000	-	90.155	0.143	0.046	0.002	0.378



Egger's regression intercept

Intercept	-4.22840
Standard error	0.96803
95% lower limit (2-tailed)	-6.18195
95% upper limit (2-tailed)	-2.27484
t-value	4.36806
df	42.00000
P-value (1-tailed)	0.00004
P-value (2-tailed)	0.00008

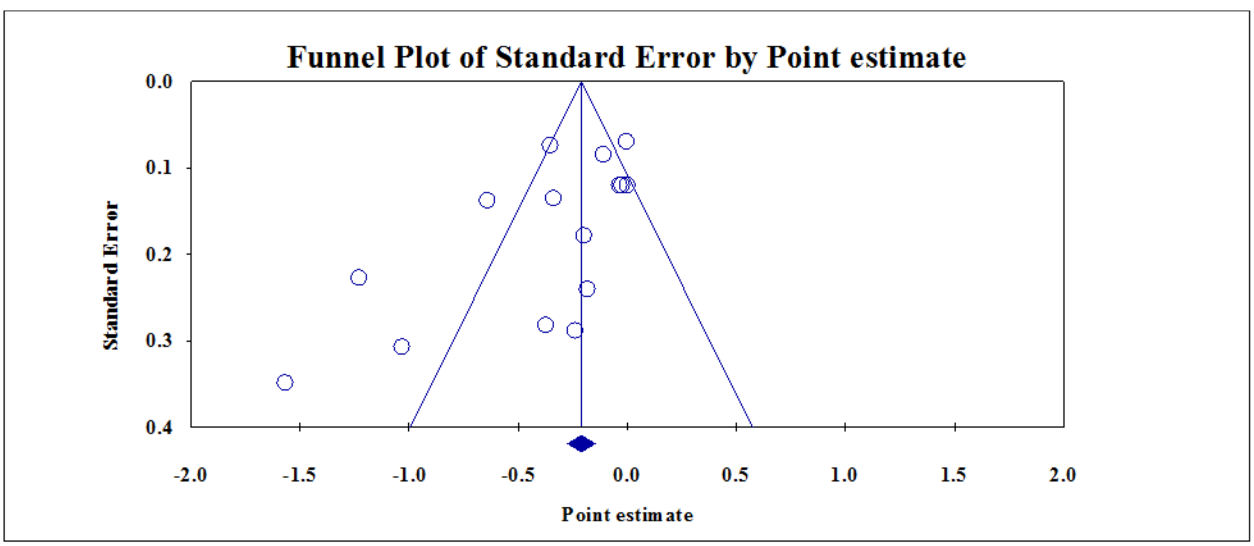
Effect of Food Fortification with Multiple Micronutrients (height)



Study name	Subgroup within study	Point estimate	Standard error	Lower limit	Upper limit	Z-Value	p-Value
Ash, 2003	T6B MMN For Dri NUT Anth Heig B&G Sch	-0.353	0.074	-0.497	-0.209	-4.796	0.000
Manger, 2008	T3A MMN For Sea NUT Anth Heig B&G Sch	-0.110	0.084	-0.275	0.055	-1.303	0.192
Muthayya, 2009	T4A MMN For Dri NUT Anth Heig HI MMN H B&G Sch	-0.025	0.120	-0.260	0.210	-0.208	0.835
Muthayya, 2009	T4D MMN For Dri NUT Anth Heig HI MMN L B&G Sch	-0.036	0.120	-0.271	0.199	-0.300	0.764
Muthayya, 2009	T4G MMN For Dri NUT Anth Heig Lo MMN H B&G Sch	0.000	0.120	-0.235	0.235	0.000	1.000
Solon, 2003	T2B MMN For Dri NUT Anth Heig B&G Sch	-0.004	0.069	-0.140	0.132	-0.058	0.954
Vinodkumar, 2007	T7A MMN For Sal NUT Anth Heig Redcells B&G Sch	-0.338	0.135	-0.603	-0.073	-2.500	0.012
Vinodkumar, 2007	T7C MMN For Sal NUT Anth Heig Redcells B&G Sch	-0.240	0.288	-0.805	0.325	-0.832	0.405
Vinodkumar, 2007	T8A MMN For Sal NUT Anth Heig RBC Foli B&G Sch	-0.642	0.138	-0.912	-0.372	-4.666	0.000
Vinodkumar, 2007	T8B MMN For Sal NUT Anth Heig RBC Foli B&G Sch	-0.199	0.178	-0.548	0.150	-1.116	0.264
Vinodkumar, 2007	T8C MMN For Sal NUT Anth Heig Red cell B&G Sch	-1.229	0.227	-1.674	-0.784	-5.412	0.000
Vinodkumar, 2007	T8D MMN For Sal NUT Anth Heig Red cell Girls Sch	-0.183	0.240	-0.654	0.288	-0.761	0.447
Vinodkumar, 2007	T8E MMN For Sal NUT Anth Heig Boys Sch	-0.373	0.282	-0.926	0.180	-1.323	0.186
Vinodkumar, 2007	T8F MMN For Sal NUT Anth Heig Girls Sch	-1.568	0.349	-2.252	-0.884	-4.495	0.000
Vinodkumar, 2007	T8G MMN For Sal NUT Anth Heig Boys Sch	-1.033	0.307	-1.635	-0.431	-3.363	0.001
		-0.339	0.084	-0.503	-0.176	-4.062	0.000

Effect size and significance				
Model	Number Studies	Point estimate	Significance	Standard error
Random effects	15.000	(0.339)	***	0.084

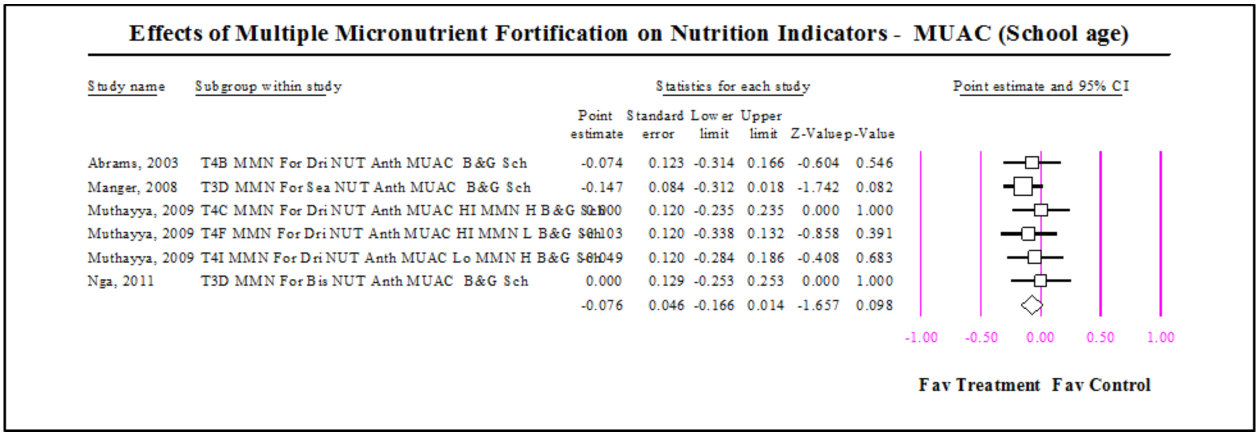
Heterogeneity				Tau-squared			
Q-value	df (Q)	P-value	I-squared	Tau Squared	Standard Error	Variance	Tau
75.113	14.000	0.000	81.361	0.073	0.043	0.002	0.270



Egger's regression intercept

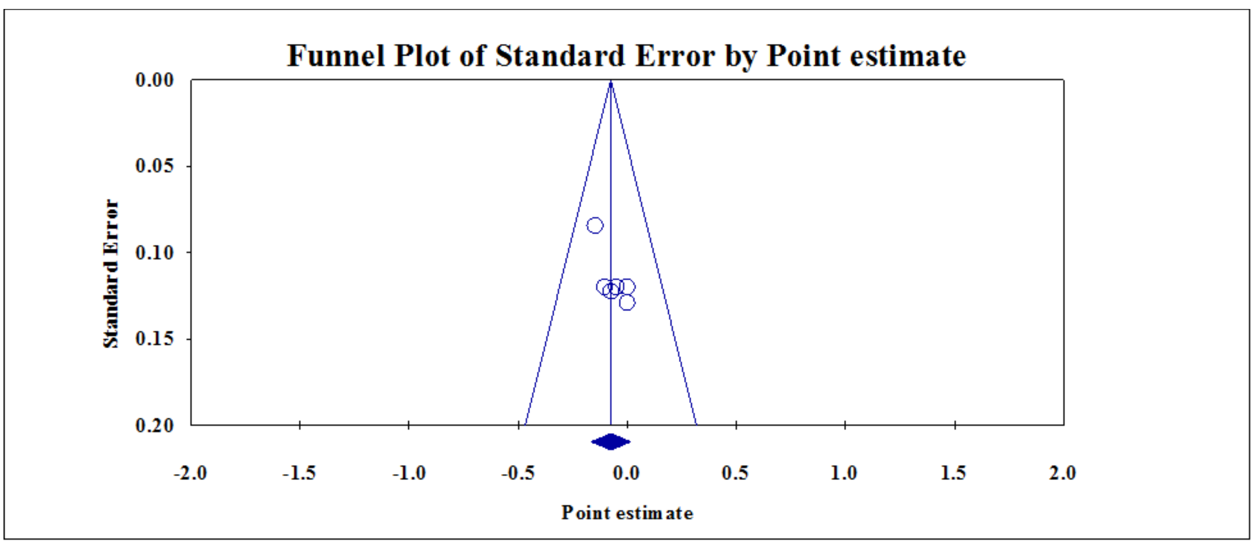
Intercept	-2.75303
Standard error	1.12775
95% lower limit (2-tailed)	-5.18938
95% upper limit (2-tailed)	-0.31667
t-value	2.44117
df	13.00000
P-value (1-tailed)	0.01485
P-value (2-tailed)	0.02970

Effect of Food Fortification with Multiple Micronutrients (MUAC)



Effect size and significance				
Model	**Number Studies**	**Point estimate**	**Significance**	**Standard error**
Random effects	6.000	(0.076)	*	0.046

Heterogeneity				Tau-squared			
Q-value	**df (Q)**	**P-value**	**I-squared**	**Tau Squared**	**Standard Error**	**Variance**	**Tau**
1.557	5.000	0.906	-	-	0.008	0.000	-



Egger's regression intercept

Intercept	2.74200
Standard error	0.90036
95% lower limit (2-tailed)	0.24220
95% upper limit (2-tailed)	5.24180
t-value	3.04545
df	4.00000
P-value (1-tailed)	0.01910
P-value (2-tailed)	0.03820

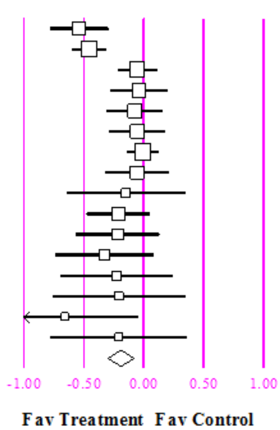
Effect of Food Fortification with Multiple Micronutrients (weight)

Effects of Multiple Micronutrient Fortification on Nutrition Indicators - Weight (School age)

Statistics for each study

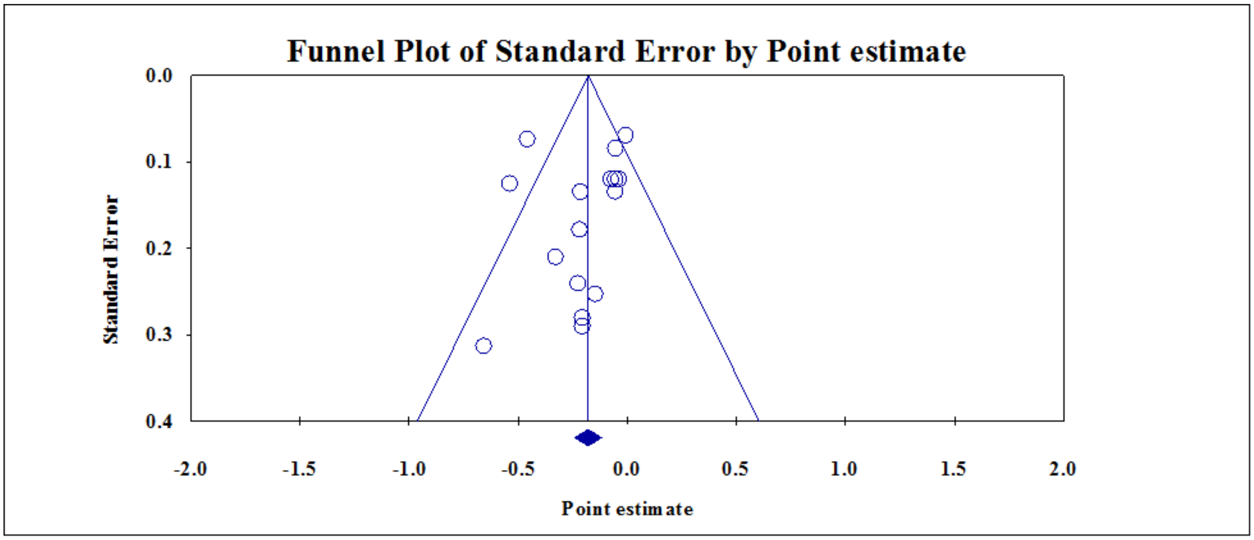
Study name	Subgroup within study	Point estimate	Standard error	Lower limit	Upper limit	Z-Value	p-Value
Abrams, 2003	T4D MMN For Dri NUT Anth Weig B&G Sch	-0.539	0.125	-0.784	-0.294	-4.309	0.000
Ash, 2003	T6A MMN For Dri NUT Anth Weig B&G Sch	-0.458	0.074	-0.602	-0.314	-6.223	0.000
Manger, 2008	T3B MMN For Sea NUT Anth Weig B&G Sch	-0.054	0.084	-0.219	0.111	-0.641	0.522
Muthayya, 2009	T4B MMN For Dri NUT Anth Weig HI MMN H B&G Sch	-0.038	0.120	-0.273	0.197	-0.317	0.751
Muthayya, 2009	T4E MMN For Dri NUT Anth Weig HI MMN L B&G Sch	-0.075	0.120	-0.310	0.160	-0.625	0.532
Muthayya, 2009	T4H MMN For Dri NUT Anth Weig Lo MMN H B&G Sch	-0.055	0.120	-0.290	0.180	-0.458	0.647
Solon, 2003	T2A MMN For Dri NUT Anth Weig B&G Sch	-0.007	0.069	-0.143	0.129	-0.101	0.920
Vinodkumar, 2007	T7B MMN For Sal NUT Anth Weig Redcells B&G Sch	-0.055	0.134	-0.318	0.208	-0.410	0.682
Vinodkumar, 2007	T7D MMN For Sal NUT Anth Weig Redcells B&G Sch	-0.147	0.253	-0.643	0.349	-0.581	0.561
Vinodkumar, 2007	T8H MMN For Sal NUT Anth Weig B&G Sch	-0.214	0.135	-0.478	0.050	-1.590	0.112
Vinodkumar, 2007	T8J MMN For Sal NUT Anth Weig B&G Sch	-0.218	0.178	-0.568	0.132	-1.222	0.222
Vinodkumar, 2007	T8K MMN For Sal NUT Anth Weig B&G Sch	-0.329	0.210	-0.741	0.083	-1.567	0.117
Vinodkumar, 2007	T8L MMN For Sal NUT Anth Weig Girls Sch	-0.226	0.241	-0.698	0.246	-0.939	0.348
Vinodkumar, 2007	T8M MMN For Sal NUT Anth Weig Boys Sch	-0.206	0.280	-0.756	0.344	-0.735	0.463
Vinodkumar, 2007	T8N MMN For Sal NUT Anth Weig Girls Sch	-0.658	0.313	-1.272	-0.044	-2.101	0.036
Vinodkumar, 2007	T8O MMN For Sal NUT Anth Weig Boys Sch	-0.206	0.290	-0.775	0.363	-0.710	0.478
		-0.192	0.055	-0.301	-0.084	-3.475	0.001

Point estimate and 95% CI



Effect size and significance				
Model	Number Studies	Point estimate	Significance	Standard error
Random effects	16.000	(0.192)	***	0.055

Heterogeneity				Tau-squared			
Q-value	df (Q)	P-value	I-squared	Tau Squared	Standard Error	Variance	Tau
38.080	15.000	0.001	60.609	0.025	0.017	0.000	0.159



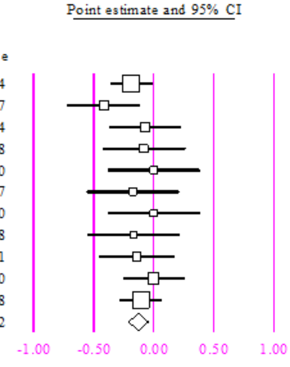
Egger's regression intercept

Intercept	-0.53169
Standard error	0.95126
95% lower limit (2-tailed)	-2.57195
95% upper limit (2-tailed)	1.50857
t-value	0.55893
df	14.00000
P-value (1-tailed)	0.29252
P-value (2-tailed)	0.58504

Effect of Food Fortification with Multiple Micronutrients (vitamin A status)

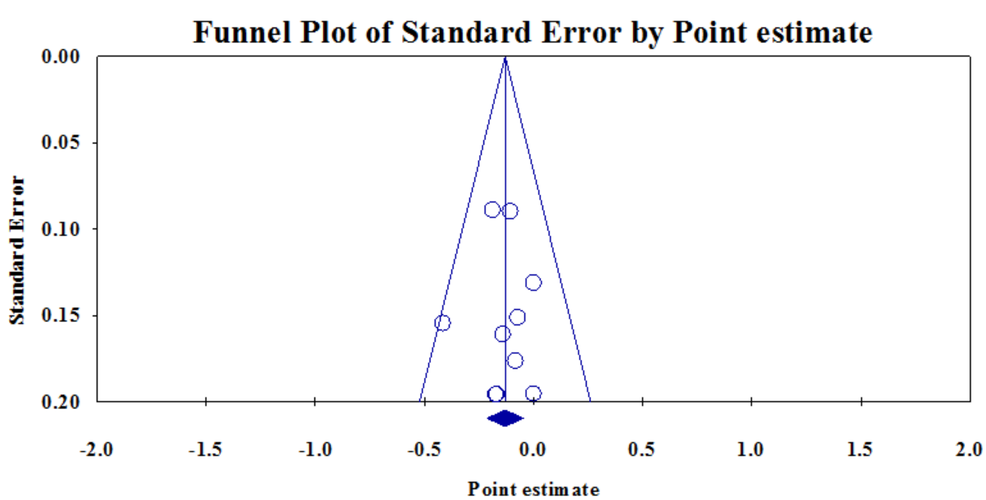
Effects of Multiple Micronutrient Fortification on Nutrition Indicators - Vitamin A (School age)

Study name	Subgroup within study	Point estimate	Standard error	Lower limit	Upper limit	Z-Value	p-Value
Aaron, 2011	T4C MMN For Dri NUT Biom Vit Serum re B&G Sch	-0.188	0.089	-0.362	-0.014	-2.115	0.034
Aaron, 2011	T5C MMN For Dri NUT Biom Vit Serum re B&G Sch	-0.416	0.155	-0.719	-0.113	-2.693	0.007
Abrams, 2003	T4K MMN For Dri NUT Biom Vit Retinol B&G Sch	-0.072	0.151	-0.368	0.224	-0.476	0.634
Kumar, 2009	T2D MMN For Sal NUT Biom Vit Serum V B&G Sch	-0.083	0.176	-0.428	0.262	-0.471	0.638
Thankachan, 2012	T3B MMN For Ric NUT Biom Vit Serum re B&G Sch	0.000	0.195	-0.383	0.383	0.000	1.000
Thankachan, 2012	T3G MMN For Ric NUT Biom Vit Serum re B&G Sch	-0.173	0.196	-0.557	0.211	-0.884	0.377
Thankachan, 2012	T3J MMN For Ric NUT Biom Vit Retinol B&G Sch	0.000	0.195	-0.383	0.383	0.000	1.000
Thankachan, 2012	T3K MMN For Ric NUT Biom Vit Retinol B&G Sch	-0.169	0.196	-0.553	0.215	-0.864	0.388
Vinodkumar, 2007	T6D MMN For Sal NUT Biom Vit Serum V B&G Sch	-0.141	0.161	-0.457	0.175	-0.876	0.381
Winichagoon, 2006	T2C MMN For Pow NUT Biom Vit Serum re B&G Sch	0.000	0.131	-0.257	0.257	0.000	1.000
Winichagoon, 2006	T4F MMN For Pow NUT Biom Vit Urine Io B&G Sch	-0.106	0.090	-0.282	0.070	-1.180	0.238
		-0.131	0.042	-0.213	-0.049	-3.123	0.002



Effect size and significance				
Model	Number Studies	Point estimate	Significance	Standard error
Random effects	11.000	(0.131)	***	0.042

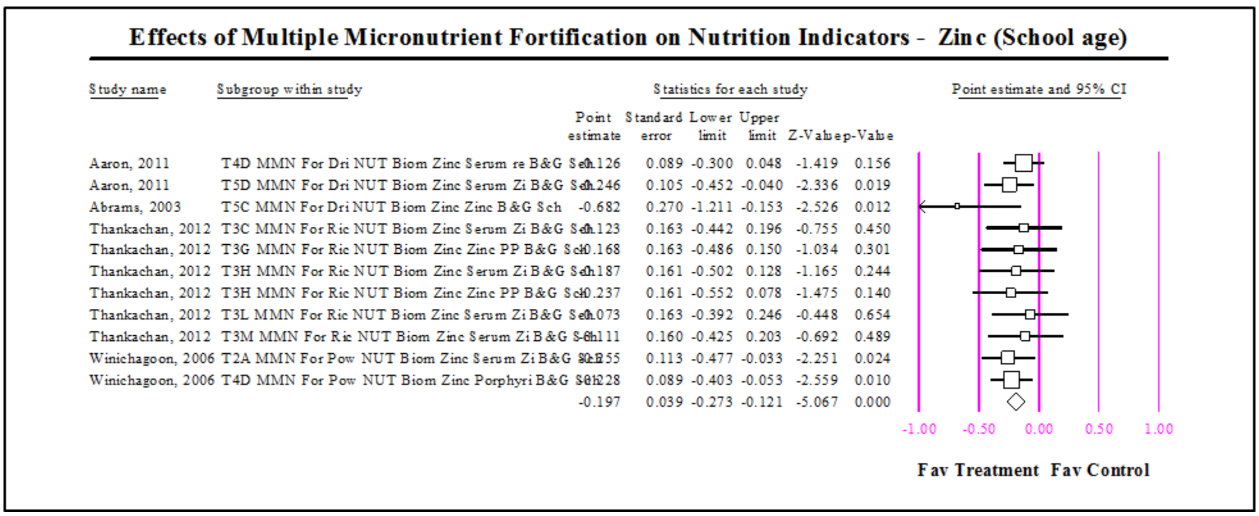
Heterogeneity				Tau-squared			
Q-value	df (Q)	P-value	I-squared	Tau Squared	Standard Error	Variance	Tau
6.103	10.000	0.807	-	-	0.009	0.000	-



Egger's regression intercept

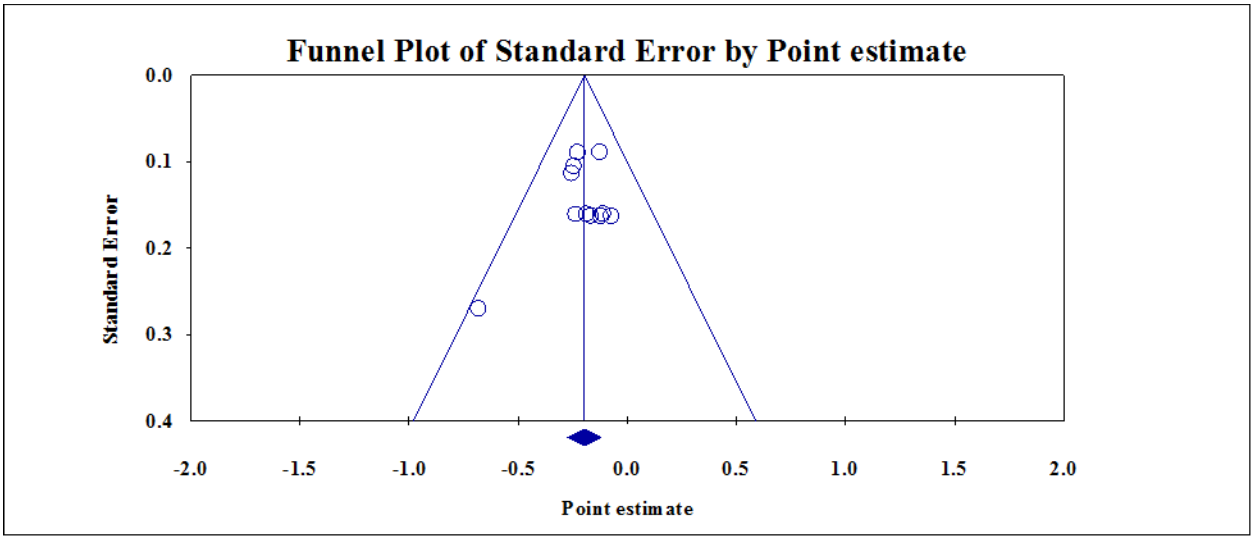
Intercept	0.30967
Standard error	0.81235
95% lower limit (2-tailed)	-1.52800
95% upper limit (2-tailed)	2.14734
t-value	0.38120
df	9.00000
P-value (1-tailed)	0.35595
P-value (2-tailed)	0.71190

Effect of Food Fortification with Multiple Micronutrients (zinc status))



Effect size and significance				
Model	Number Studies	Point estimate	Significance	Standard error
Random effects	11.000	(0.197)	***	0.039

Heterogeneity				Tau-squared			
Q-value	df (Q)	P-value	I-squared	Tau Squared	Standard Error	Variance	Tau
5.638	10.000	0.845	-	-	0.008	0.000	-



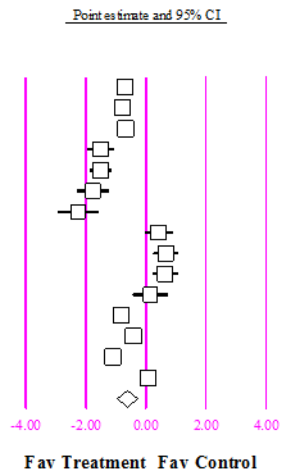
Egger's regression intercept

Intercept	-0.62996
Standard error	0.77666
95% lower limit (2-tailed)	-2.38690
95% upper limit (2-tailed)	1.12697
t-value	0.81112
df	9.00000
P-value (1-tailed)	0.21911
P-value (2-tailed)	0.43822

Effect of Intermittent Iron Supplementation (anemia, girls only)

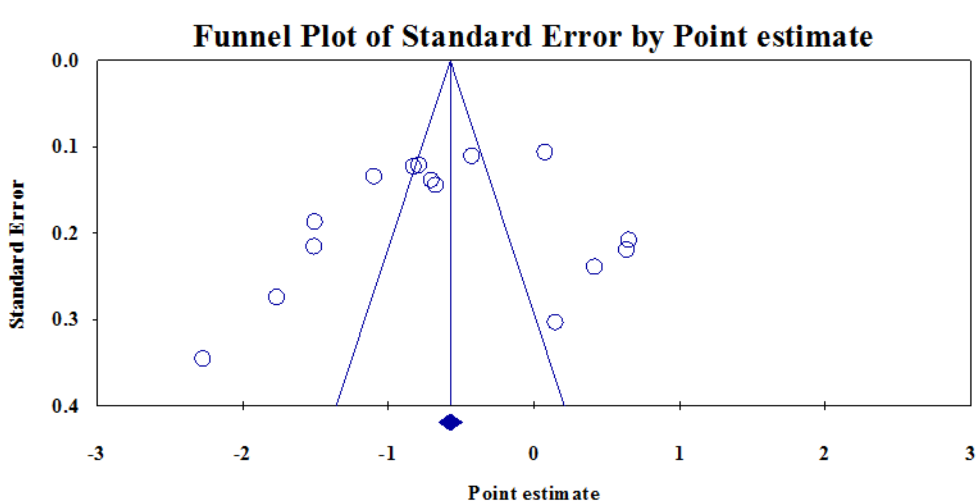
Effects of Iron Supplementation on Nutrition Indicators - Anemia (School age Girls)

Study name	Subgroup within study	Point estimate	Standard error	Lower limit	Upper limit	Z-Value	p-Value
Aditi, 2012	T1A Iron Sup Int NUT Biom Anem Hb 1/wk Girls Sch	-0.705	0.139	-0.977	-0.433	-5.087	0.000
Aditi, 2012	T1B Iron Sup Int NUT Biom Anem Hb 2/wk Girls Sch	-0.789	0.121	-1.027	-0.551	-6.499	0.000
Aditi, 2012	T1C Iron Sup Int NUT Biom Anem Hb Daily Girls Sch	-0.674	0.144	-0.957	-0.391	-4.674	0.000
Aditi, 2012	T2A Iron Sup Int NUT Biom Anem Hb 1/wk Girls Sch	-1.508	0.216	-1.930	-1.086	-6.998	0.000
Aditi, 2012	T2B Iron Sup Int NUT Biom Anem Hb 2/wk Girls Sch	-1.505	0.187	-1.872	-1.138	-8.048	0.000
Aditi, 2012	T2C Iron Sup Int NUT Biom Anem Hb Daily Girls Sch	-1.766	0.274	-2.304	-1.228	-6.436	0.000
Aditi, 2012	T2D Iron Sup Int NUT Biom Anem Hb Contr Girls Sch	-2.273	0.346	-2.950	-1.596	-6.577	0.000
Aditi, 2012	T2E Iron Sup Int NUT Biom Anem Hb 1/wk Girls Sch	0.418	0.239	-0.051	0.887	1.747	0.081
Aditi, 2012	T2F Iron Sup Int NUT Biom Anem Hb 2/wk Girls Sch	0.652	0.208	0.244	1.060	3.133	0.002
Aditi, 2012	T2G Iron Sup Int NUT Biom Anem Hb Daily Girls Sch	0.638	0.219	0.208	1.068	2.908	0.004
Aditi, 2012	T2H Iron Sup Int NUT Biom Anem Hb Contr Girls Sch	0.148	0.303	-0.446	0.742	0.488	0.625
Ahmed, 2005	T3A Iron Sup Int NUT Biom Anem Hemoglob Girls Sch	-0.827	0.123	-1.068	-0.586	-6.735	0.000
Ahmed, 2005	T3B Iron Sup Int NUT Biom Anem Hemoglob Girls Sch	-0.426	0.111	-0.643	-0.209	-3.848	0.000
Ahmed, 2005	T3C Iron Sup Int NUT Biom Anem RBC Foli Girls Sch	-1.098	0.134	-1.361	-0.835	-8.182	0.000
Ahmed, 2005	T3D Iron Sup Int NUT Biom Anem Serum V Girls Sch	0.077	0.106	-0.131	0.285	0.725	0.468
		-0.630	0.173	-0.969	-0.290	-3.638	0.000



Effect size and significance				
Model	**Number Studies**	**Point estimate**	**Significance**	**Standard error**
Random effects	15.000	(0.630)	***	0.173

Heterogeneity				Tau-squared			
Q-value	**df (Q)**	**P-value**	**I-squared**	**Tau Squared**	**Standard Error**	**Variance**	**Tau**
238.069	14.000	-	94.119	0.410	0.192	0.037	0.640



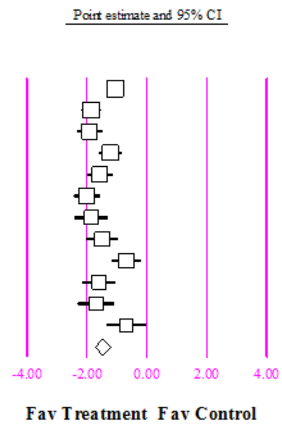
Egger's regression intercept

Intercept	-1.49955
Standard error	3.30380
95% lower limit (2-tailed)	-8.63699
95% upper limit (2-tailed)	5.63788
t-value	0.45389
df	13.00000
P-value (1-tailed)	0.32870
P-value (2-tailed)	0.65739

Effect of Intermittent Iron Supplementation (BMI, girls only)

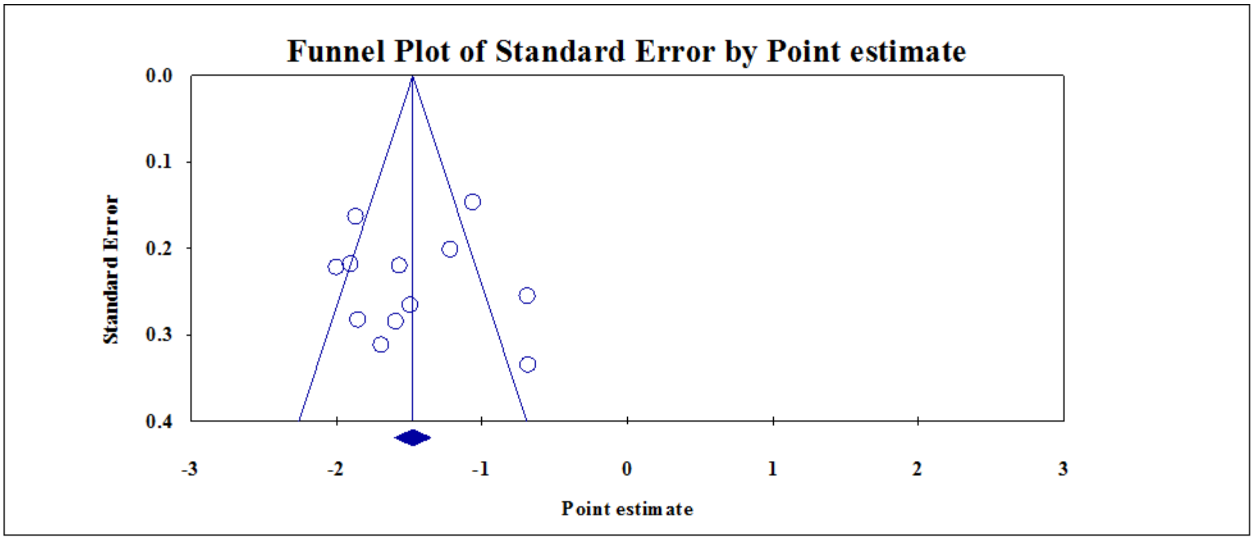
Effects of Iron Supplementation on Nutrition Indicators - BMI (School age Girls)

Study name	Subgroup within study	Point estimate	Standard error	Lower limit	Upper limit	Z-Value	p-Value
		Statistics for each study					
Aditi, 2012	T3A Iron Sup Int NUT Anth BMI 1/wk Girls Sch	-1.063	0.146	-1.350	-0.776	-7.261	0.000
Aditi, 2012	T3B Iron Sup Int NUT Anth BMI 2/wk Girls Sch	-1.867	0.163	-2.187	-1.547	-11.440	0.000
Aditi, 2012	T3C Iron Sup Int NUT Anth BMI Daily Girls Sch	-1.903	0.218	-2.331	-1.475	-8.721	0.000
Aditi, 2012	T3D Iron Sup Int NUT Anth BMI Control Girls Sch	-1.218	0.201	-1.613	-0.823	-6.051	0.000
Aditi, 2012	T4A Iron Sup Int NUT Anth BMI 1/wk Girls Sch	-1.567	0.220	-1.998	-1.136	-7.123	0.000
Aditi, 2012	T4B Iron Sup Int NUT Anth BMI 2/wk Girls Sch	-2.000	0.222	-2.435	-1.565	-9.017	0.000
Aditi, 2012	T4C Iron Sup Int NUT Anth BMI Daily Girls Sch	-1.852	0.283	-2.406	-1.298	-6.553	0.000
Aditi, 2012	T4D Iron Sup Int NUT Anth BMI Control Girls Sch	-1.494	0.266	-2.015	-0.973	-5.625	0.000
Aditi, 2012	T4E Iron Sup Int NUT Anth BMI 1/wk Girls Sch	-0.687	0.255	-1.187	-0.187	-2.693	0.007
Aditi, 2012	T4F Iron Sup Int NUT Anth BMI 2/wk Girls Sch	-1.593	0.285	-2.151	-1.035	-5.597	0.000
Aditi, 2012	T4G Iron Sup Int NUT Anth BMI Daily Girls Sch	-1.692	0.312	-2.303	-1.081	-5.425	0.000
Aditi, 2012	T4H Iron Sup Int NUT Anth BMI Control Girls Sch	-0.682	0.335	-1.338	-0.026	-2.037	0.042
		-1.478	0.130	-1.733	-1.223	-11.369	0.000



Effect size and significance				
Model	Number Studies	Point estimate	Significance	Standard error
Random effects	12.000	(1.478)	***	0.130

Heterogeneity				Tau-squared			
Q-value	df (Q)	P-value	I-squared	Tau Squared	Standard Error	Variance	Tau
42.537	11.000	0.000	74.140	0.144	0.089	0.008	0.380



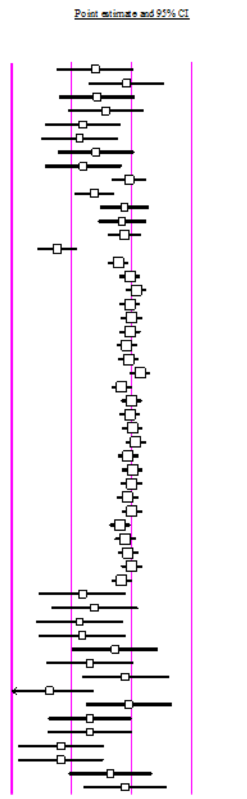
Egger's regression intercept

Intercept	-0.09773
Standard error	2.41506
95% lower limit (2-tailed)	-5.47882
95% upper limit (2-tailed)	5.28336
t-value	0.04047
df	10.00000
P-value (1-tailed)	0.48426
P-value (2-tailed)	0.96852

Effect of Multiple Micronutrient Supplementation on All Educational Outcomes

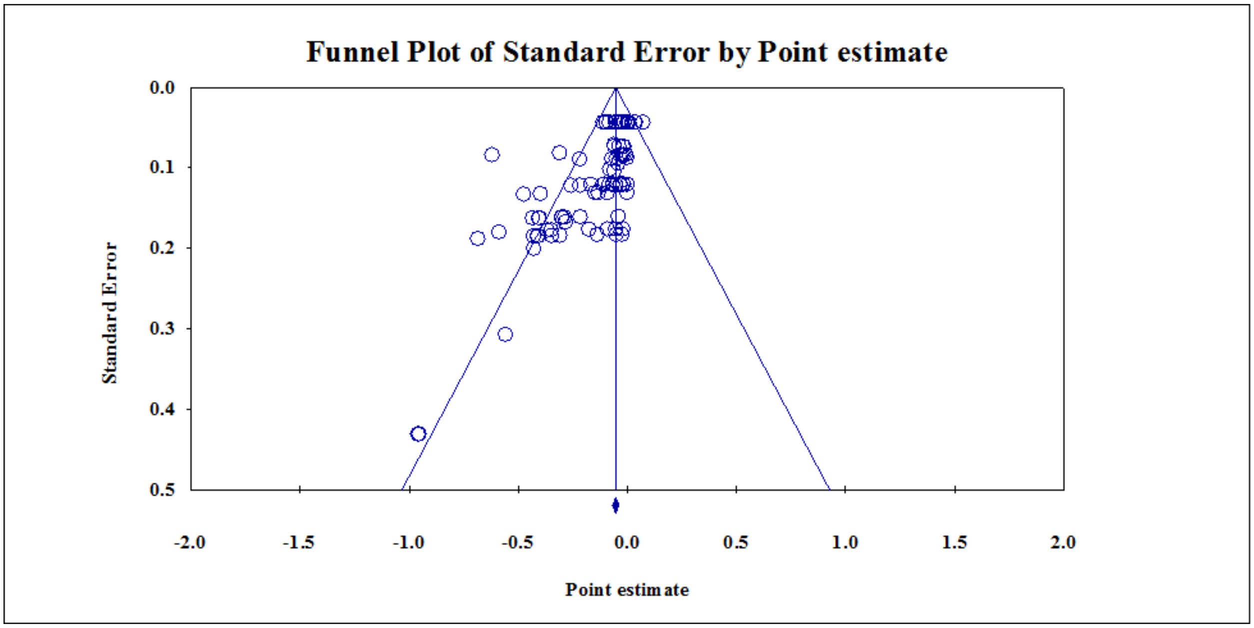
Effect of Multiple Micronutrient Supplementation on Education Indicators

Study name	Subgroup within study	Point estimate	Standard error	Lower limit	Upper limit	Z-Value	p-Value
		Statistics for each study					
Dalton, 2009	T4A MMN For Spr ED Cogn Verb HVLT Rec B&G Sch	-0.302	0.162	-0.619	0.015	-1.869	0.062
Dalton, 2009	T4B MMN For Spr ED Cogn Verb HVLT Rec B&G Sch	-0.041	0.161	-0.356	0.274	-0.255	0.799
Dalton, 2009	T4C MMN For Spr ED Cogn Verb HVLT Rec B&G Sch	-0.287	0.162	-0.604	0.030	-1.777	0.076
Dalton, 2009	T4D MMN For Spr ED Cogn Verb HVLT tot B&G Sch	-0.216	0.161	-0.532	0.100	-1.341	0.180
Dalton, 2009	T4E MMN For Spr ED Cogn Verb HVLT Rec B&G Sch	-0.406	0.162	-0.724	-0.088	-2.502	0.012
Dalton, 2009	T4F MMN For Spr ED Cogn Verb HVLT Dis B&G Sch	-0.434	0.163	-0.752	-0.116	-2.671	0.008
Dalton, 2009	T4G MMN For Spr ED Cogn Verb Reading B&G Sch	-0.298	0.162	-0.615	0.019	-1.845	0.065
Dalton, 2009	T4H MMN For Spr ED Cogn Verb Spelling B&G Sch	-0.403	0.162	-0.721	-0.085	-2.483	0.013
Eilander et al.	F3A MMN For MMN ED Cogn Inte Solon 20 B&G Sch	-0.020	0.074	-0.165	0.125	-0.271	0.787
Eilander et al.	F3B MMN For MMN ED Cogn Inte Vazir 20 B&G Sch	-0.310	0.082	-0.470	-0.150	-3.804	0.000
Eilander et al.	F5A MMN For MMN ED Cogn Inte Jinathai B&G Sch	-0.060	0.104	-0.264	0.144	-0.575	0.565
Eilander et al.	F5B MMN For MMN ED Cogn Inte Osendarp B&G Sch	-0.080	0.102	-0.279	0.119	-0.787	0.432
Eilander et al.	F5C MMN For MMN ED Cogn Inte Solon 20 B&G Sch	-0.060	0.071	-0.200	0.080	-0.842	0.400
Eilander et al.	F5D MMN For MMN ED Cogn Inte Vazir 20 B&G Sch	-0.620	0.084	-0.785	-0.455	-7.372	0.000
Gewan, 2009	T3A MMN For Sna ED Cogn Reas Fe avail B&G Sch	-0.111	0.044	-0.196	-0.026	-2.546	0.011
Gewan, 2009	T3B MMN For Sna ED Cogn Reas Zn avail B&G Sch	-0.015	0.044	-0.100	0.070	-0.345	0.730
Gewan, 2009	T3C MMN For Sna ED Cogn Reas B12 Vita B&G Sch	0.038	0.044	-0.047	0.123	0.874	0.382
Gewan, 2009	T3D MMN For Sna ED Cogn Reas B6 Vitam B&G Sch	-0.014	0.044	-0.099	0.071	-0.322	0.748
Gewan, 2009	T3E MMN For Sna ED Cogn Reas Folate B&G Sch	0.000	0.044	-0.085	0.085	0.000	1.000
Gewan, 2009	T3F MMN For Sna ED Cogn Reas Riboflav B&G Sch	-0.013	0.044	-0.098	0.072	-0.299	0.765
Gewan, 2009	T3G MMN For Sna ED Cogn Verb Fe avail B&G Sch	-0.041	0.044	-0.126	0.044	-0.943	0.346
Gewan, 2009	T3H MMN For Sna ED Cogn Verb Zn avail B&G Sch	-0.024	0.044	-0.109	0.061	-0.552	0.581
Gewan, 2009	T3I MMN For Sna ED Cogn Verb B12 Vita B&G Sch	0.072	0.044	-0.013	0.157	1.655	0.098
Gewan, 2009	T3J MMN For Sna ED Cogn Verb B6 Vitam B&G Sch	-0.082	0.044	-0.167	0.003	-1.881	0.060
Gewan, 2009	T3K MMN For Sna ED Cogn Verb Folate B&G Sch	0.000	0.044	-0.085	0.085	0.000	1.000
Gewan, 2009	T3L MMN For Sna ED Cogn Verb Riboflav B&G Sch	-0.015	0.044	-0.100	0.070	-0.345	0.730
Gewan, 2009	T3M MMN For Sna ED Lear M&S Math B&G Sch	0.007	0.044	-0.078	0.092	0.161	0.872
Gewan, 2009	T3N MMN For Sna ED Lear M&S Math B&G Sch	0.034	0.044	-0.051	0.119	0.782	0.434
Gewan, 2009	T3O MMN For Sna ED Lear M&S Math B&G Sch	-0.028	0.044	-0.113	0.057	-0.644	0.520
Gewan, 2009	T3P MMN For Sna ED Lear M&S Math B&G Sch	0.006	0.044	-0.079	0.091	0.138	0.890
Gewan, 2009	T3Q MMN For Sna ED Lear M&S Math B&G Sch	0.000	0.044	-0.085	0.085	0.000	1.000
Gewan, 2009	T3R MMn For Sna ED Lear M&S Math B&G Sch	-0.034	0.044	-0.119	0.051	-0.782	0.434
Gewan, 2009	T3S MMN For Sna ED Cogn Memo Fe avail B&G Sch	0.003	0.044	-0.082	0.088	0.069	0.945
Gewan, 2009	T3T MMN For Sna ED Cogn Memo Zn avail B&G Sch	-0.097	0.044	-0.182	-0.012	-2.225	0.026
Gewan, 2009	T3U MMN For Sna ED Cogn Memo B12 Vita B&G Sch	-0.054	0.044	-0.139	0.031	-1.241	0.214
Gewan, 2009	T3V MMN For Sna ED Cogn Memo B6 Vitam B&G Sch	-0.031	0.044	-0.116	0.054	-0.713	0.476
Gewan, 2009	T3W MMN For Sna ED Cogn Memo Folate B&G Sch	0.000	0.044	-0.085	0.085	0.000	1.000
Gewan, 2009	T3X MMN For Sna ED Cogn Memo Riboflav B&G Sch	-0.083	0.044	-0.168	0.002	-1.904	0.057
Kumar, 2008	T4A MMN Sup Cap ED Cogn Memo Red cell B&G Sch	-0.409	0.185	-0.771	-0.047	-2.212	0.027
Kumar, 2008	T4B MMN Sup Cap ED Cogn Memo Cattell B&G Sch	-0.309	0.184	-0.670	0.052	-1.678	0.093
Kumar, 2008	T4C MMN Sup Cap ED Cogn Memo MannSui B&G Sch	-0.430	0.185	-0.793	-0.067	-2.323	0.020
Kumar, 2008	T4D MMN Sup Cap ED Cogn Memo Delayed B&G Sch	-0.413	0.185	-0.775	-0.051	-2.234	0.026
Kumar, 2008	T4E MMN Sup Cap ED Cogn Memo Persona B&G Sch	-0.138	0.183	-0.497	0.221	-0.753	0.451
Kumar, 2008	T4F MMN Sup Cap ED Cogn Memo Digit sp B&G Sch	-0.347	0.184	-0.708	0.014	-1.882	0.060
Kumar, 2008	T4G MMN Sup Cap ED Cogn Memo Digit sp B&G Sch	-0.051	0.183	-0.410	0.308	-0.279	0.781
Kumar, 2008	T4H MMN Sup Cap ED Cogn Reas Letter c B&G Sch	-0.685	0.188	-1.054	-0.316	-3.640	0.000
Kumar, 2008	T4I MMN Sup Cap ED Cogn Inte Raven's B&G Sch	-0.024	0.183	-0.383	0.335	-0.131	0.896
Kumar, 2009	T3A MMN For Sal ED Cogn Memo Benton B&G Sch	-0.348	0.178	-0.696	-0.000	-1.961	0.050
Kumar, 2009	T3B MMN For Sal ED Cogn Memo Cattell B&G Sch	-0.348	0.178	-0.696	-0.000	-1.961	0.050
Kumar, 2009	T3C MMN For Sal ED Cogn Memo MannSui B&G Sch	-0.588	0.180	-0.941	-0.235	-3.268	0.001
Kumar, 2009	T3D MMN For Sal ED Cogn Memo Delayed B&G Sch	-0.588	0.180	-0.941	-0.235	-3.268	0.001
Kumar, 2009	T3E MMN For Sal ED Cogn Memo Persona B&G Sch	-0.176	0.177	-0.522	0.170	-0.997	0.319
Kumar, 2009	T3F MMN For Sal ED Cogn Memo Digit sp B&G Sch	-0.053	0.176	-0.398	0.292	-0.301	0.764



Effect size and significance				
Model	Number Studies	Point estimate	Significance	Standard error
Random effects	97.000	(0.092)	***	0.013

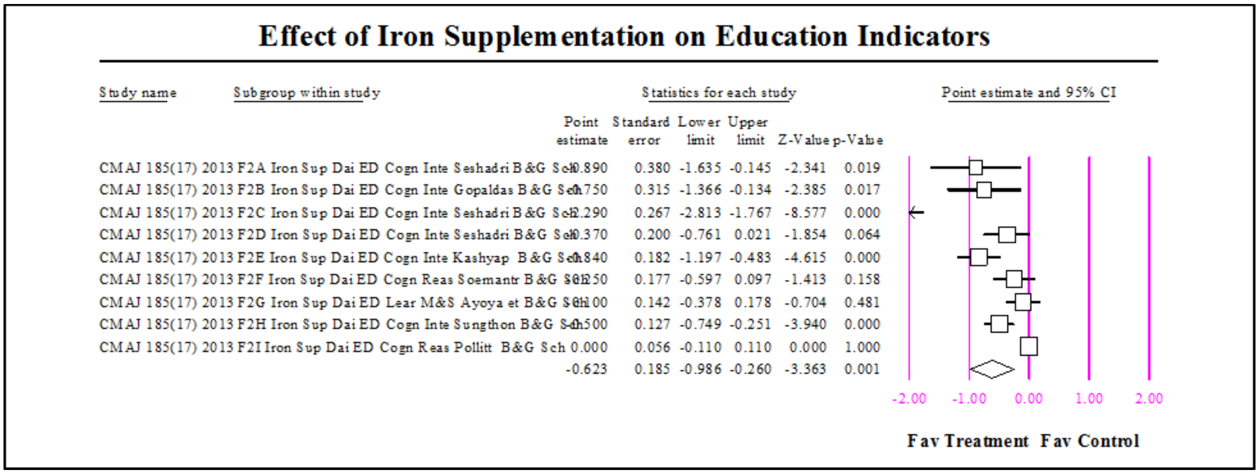
Heterogeneity				Tau-squared			
Q-value	df (Q)	P-value	I-squared	Tau Squared	Standard Error	Variance	Tau
219.802	96.000	-	56.324	0.007	0.002	0.000	0.084



Egger's regression intercept

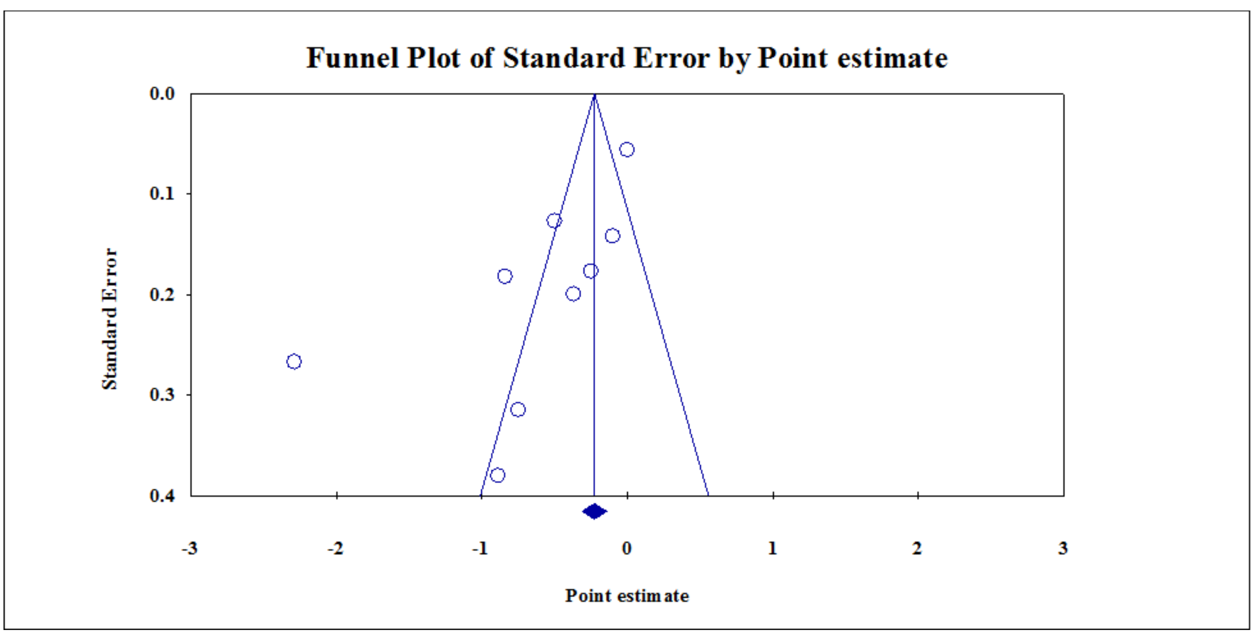
Intercept	-1.88222
Standard error	0.23102
95% lower limit (2-tailed)	-2.34085
95% upper limit (2-tailed)	-1.42358
t-value	8.14742
df	95.00000
P-value (1-tailed)	0.00000
P-value (2-tailed)	0.00000

Effect of Iron Supplementations on All Educational Outcomes



Effect size and significance				
Model	**Number Studies**	**Point estimate**	**Significance**	**Standard error**
Random effects	9.000	(0.623)	***	0.185

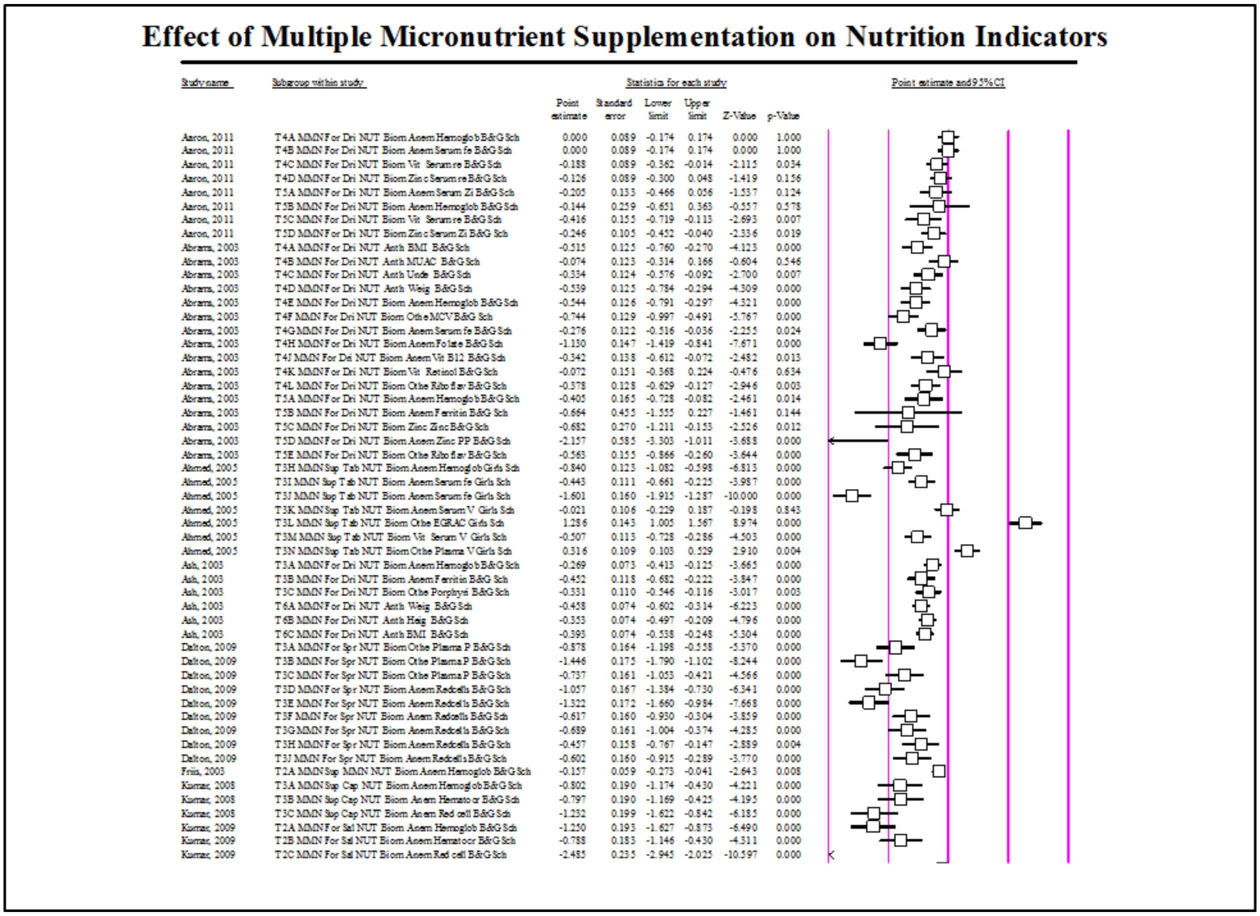
Heterogeneity				Tau-squared			
Q-value	**df (Q)**	**P-value**	**I-squared**	**Tau Squared**	**Standard Error**	**Variance**	**Tau**
99.183	8.000	-	91.934	0.263	0.200	0.040	0.513



Egger's regression intercept

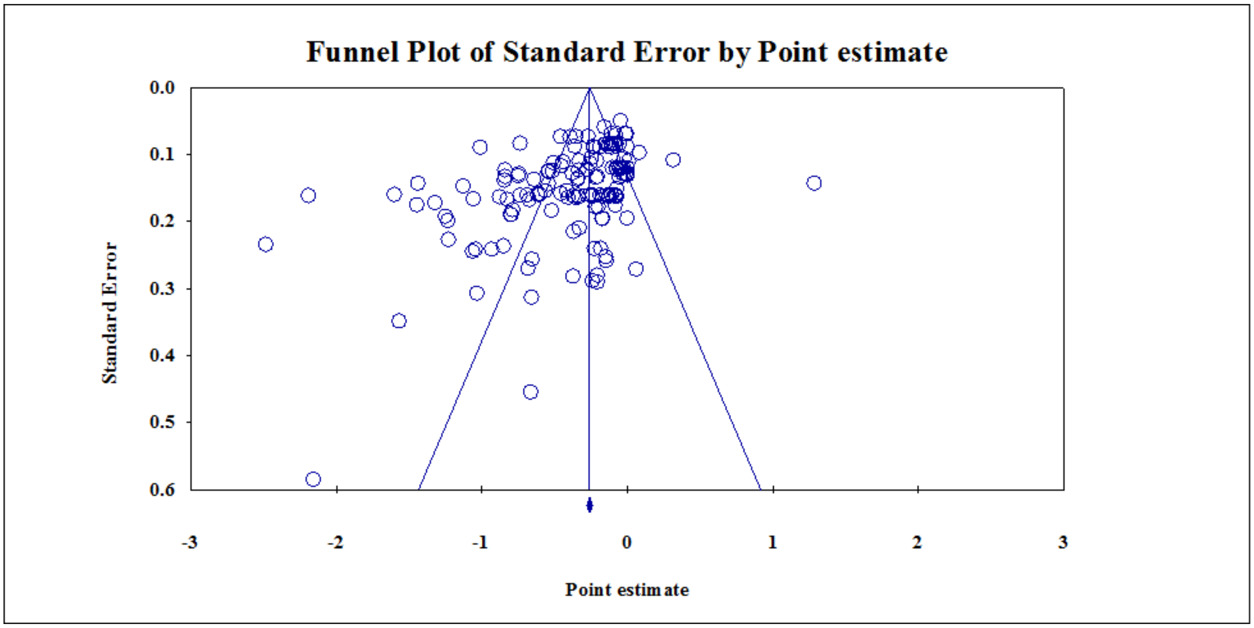
Intercept	-4.54313
Standard error	1.47801
95% lower limit (2-tailed)	-8.03807
95% upper limit (2-tailed)	-1.04819
t-value	3.07381
df	7.00000
P-value (1-tailed)	0.00899
P-value (2-tailed)	0.01797

Effect of Multiple Micronutrient Supplementations on All Nutrition Outcomes



Effect size and significance				
Model	Number Studies	Point estimate	Significance	Standard error
Random effects	152.000	(0.366)	***	0.031

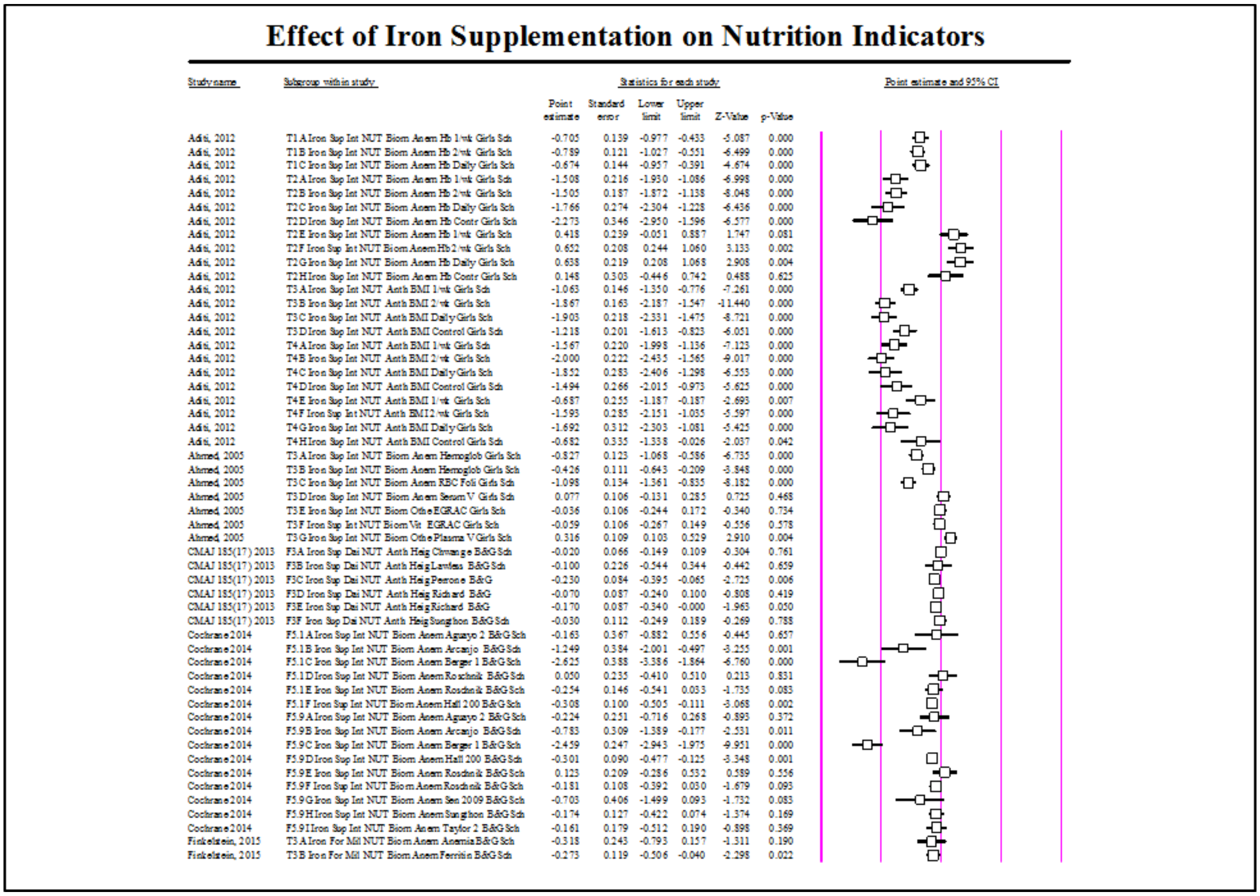
Heterogeneity				Tau-squared			
Q-value	df (Q)	P-value	I-squared	Tau Squared	Standard Error	Variance	Tau
1,385.458	151.000	-	89.101	0.119	0.019	0.000	0.345



Egger's regression intercept

Intercept	-3.13561
Standard error	0.58818
95% lower limit (2-tailed)	-4.29781
95% upper limit (2-tailed)	-1.97342
t-value	5.33101
df	150.00000
P-value (1-tailed)	0.00000
P-value (2-tailed)	0.00000

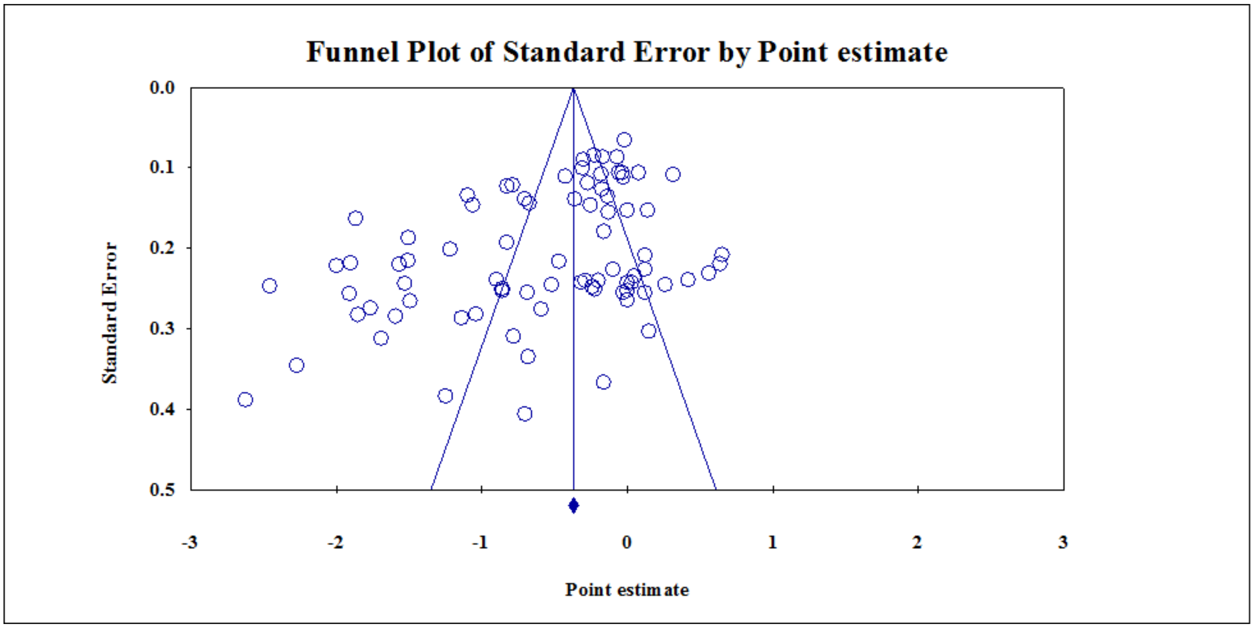
Effect of Iron Supplementations on All Nutrition Outcomes



Study name	Subgroup within study	Point estimate	Standard error	Lower limit	Upper limit	Z-Value	p-Value
Aditi, 2012	T1 A Iron Sup Int NUT Biom Anem Hb 1/wk Girls Sch	-0.705	0.139	-0.977	-0.433	-5.087	0.000
Aditi, 2012	T1 B Iron Sup Int NUT Biom Anem Hb 2/wk Girls Sch	-0.789	0.121	-1.027	-0.551	-6.499	0.000
Aditi, 2012	T1 C Iron Sup Int NUT Biom Anem Hb Daily Girls Sch	-0.674	0.144	-0.957	-0.391	-4.674	0.000
Aditi, 2012	T2 A Iron Sup Int NUT Biom Anem Hb 1/wk Girls Sch	-1.508	0.216	-1.930	-1.086	-6.998	0.000
Aditi, 2012	T2 B Iron Sup Int NUT Biom Anem Hb 2/wk Girls Sch	-1.505	0.187	-1.872	-1.138	-8.048	0.000
Aditi, 2012	T2 C Iron Sup Int NUT Biom Anem Hb Daily Girls Sch	-1.766	0.274	-2.304	-1.228	-6.436	0.000
Aditi, 2012	T2 D Iron Sup Int NUT Biom Anem Hb Contr Girls Sch	-2.273	0.346	-2.950	-1.596	-6.577	0.000
Aditi, 2012	T2 E Iron Sup Int NUT Biom Anem Hb 1/wk Girls Sch	0.418	0.239	-0.051	0.887	1.747	0.081
Aditi, 2012	T2 F Iron Sup Int NUT Biom Anem Hb 2/wk Girls Sch	0.652	0.208	0.244	1.060	3.133	0.002
Aditi, 2012	T2 G Iron Sup Int NUT Biom Anem Hb Daily Girls Sch	0.638	0.219	0.208	1.068	2.908	0.004
Aditi, 2012	T2 H Iron Sup Int NUT Biom Anem Hb Contr Girls Sch	0.148	0.303	-0.446	0.742	0.488	0.625
Aditi, 2012	T3 A Iron Sup Int NUT Anth BMI 1/wk Girls Sch	-1.063	0.146	-1.350	-0.776	-7.261	0.000
Aditi, 2012	T3 B Iron Sup Int NUT Anth BMI 2/wk Girls Sch	-1.867	0.163	-2.187	-1.547	-11.440	0.000
Aditi, 2012	T3 C Iron Sup Int NUT Anth BMI Daily Girls Sch	-1.903	0.218	-2.331	-1.475	-8.721	0.000
Aditi, 2012	T3 D Iron Sup Int NUT Anth BMI Control Girls Sch	-1.218	0.201	-1.613	-0.823	-6.051	0.000
Aditi, 2012	T4 A Iron Sup Int NUT Anth BMI 1/wk Girls Sch	-1.567	0.220	-1.998	-1.136	-7.123	0.000
Aditi, 2012	T4 B Iron Sup Int NUT Anth BMI 2/wk Girls Sch	-2.000	0.222	-2.435	-1.565	-9.017	0.000
Aditi, 2012	T4 C Iron Sup Int NUT Anth BMI Daily Girls Sch	-1.852	0.283	-2.406	-1.298	-6.553	0.000
Aditi, 2012	T4 D Iron Sup Int NUT Anth BMI Control Girls Sch	-1.494	0.266	-2.015	-0.973	-5.625	0.000
Aditi, 2012	T4 E Iron Sup Int NUT Anth BMI 1/wk Girls Sch	-0.687	0.255	-1.187	-0.187	-2.693	0.007
Aditi, 2012	T4 F Iron Sup Int NUT Anth BMI 2/wk Girls Sch	-1.593	0.285	-2.151	-1.035	-5.597	0.000
Aditi, 2012	T4 G Iron Sup Int NUT Anth BMI Daily Girls Sch	-1.692	0.312	-2.303	-1.081	-5.425	0.000
Aditi, 2012	T4 H Iron Sup Int NUT Anth BMI Control Girls Sch	-0.682	0.335	-1.338	-0.026	-2.037	0.042
Ahmed, 2005	T3 A Iron Sup Int NUT Biom Anem Hemoglob Girls Sch	-0.827	0.123	-1.068	-0.586	-6.735	0.000
Ahmed, 2005	T3 B Iron Sup Int NUT Biom Anem Hemoglob Girls Sch	-0.426	0.111	-0.643	-0.209	-3.848	0.000
Ahmed, 2005	T3 C Iron Sup Int NUT Biom Anem RBC Foli Girls Sch	-1.098	0.134	-1.361	-0.835	-8.182	0.000
Ahmed, 2005	T3 D Iron Sup Int NUT Biom Anem Serum V Girls Sch	0.077	0.106	-0.131	0.285	0.725	0.468
Ahmed, 2005	T3 E Iron Sup Int NUT Biom Othe EGRAC Girls Sch	-0.036	0.106	-0.244	0.172	-0.340	0.734
Ahmed, 2005	T3 F Iron Sup Int NUT Biom Vit EGRAC Girls Sch	-0.059	0.106	-0.267	0.149	-0.556	0.578
Ahmed, 2005	T3 G Iron Sup Int NUT Biom Othe Plasma V Girls Sch	0.316	0.109	0.103	0.529	2.910	0.004
CMAJ 185(17) 2013	F3A Iron Sup Dai NUT Anth Heig Chwange B&G Sch	-0.020	0.066	-0.149	0.109	-0.304	0.761
CMAJ 185(17) 2013	F3B Iron Sup Dai NUT Anth Heig Lawless B&G Sch	-0.100	0.226	-0.544	0.344	-0.442	0.659
CMAJ 185(17) 2013	F3C Iron Sup Dai NUT Anth Heig Perrone B&G	-0.230	0.084	-0.395	-0.065	-2.725	0.006
CMAJ 185(17) 2013	F3D Iron Sup Dai NUT Anth Heig Richard B&G	-0.070	0.087	-0.240	0.100	-0.808	0.419
CMAJ 185(17) 2013	F3E Iron Sup Dai NUT Anth Heig Richard B&G	-0.170	0.087	-0.340	-0.000	-1.963	0.050
CMAJ 185(17) 2013	F3F Iron Sup Dai NUT Anth Heig Sungthon B&G Sch	-0.030	0.112	-0.249	0.189	-0.269	0.788
Cochrane 2014	F5.1 A Iron Sup Int NUT Biom Anem Aguayo 2 B&G Sch	-0.163	0.367	-0.882	0.556	-0.445	0.657
Cochrane 2014	F5.1 B Iron Sup Int NUT Biom Anem Arcanjo B&G Sch	-1.249	0.384	-2.001	-0.497	-3.255	0.001
Cochrane 2014	F5.1 C Iron Sup Int NUT Biom Anem Berger 1 B&G Sch	-2.625	0.388	-3.386	-1.864	-6.760	0.000
Cochrane 2014	F5.1 D Iron Sup Int NUT Biom Anem Roschnik B&G Sch	0.050	0.235	-0.410	0.510	0.213	0.831
Cochrane 2014	F5.1 E Iron Sup Int NUT Biom Anem Roschnik B&G Sch	-0.254	0.146	-0.541	0.033	-1.735	0.083
Cochrane 2014	F5.1 F Iron Sup Int NUT Biom Anem Hall 200 B&G Sch	-0.308	0.100	-0.505	-0.111	-3.068	0.002
Cochrane 2014	F5.9 A Iron Sup Int NUT Biom Anem Aguayo 2 B&G Sch	-0.224	0.251	-0.716	0.268	-0.893	0.372
Cochrane 2014	F5.9 B Iron Sup Int NUT Biom Anem Arcanjo B&G Sch	-0.783	0.309	-1.389	-0.177	-2.531	0.011
Cochrane 2014	F5.9 C Iron Sup Int NUT Biom Anem Berger 1 B&G Sch	-2.459	0.247	-2.943	-1.975	-9.951	0.000
Cochrane 2014	F5.9 D Iron Sup Int NUT Biom Anem Hall 200 B&G Sch	-0.301	0.090	-0.477	-0.125	-3.348	0.001
Cochrane 2014	F5.9 E Iron Sup Int NUT Biom Anem Roschnik B&G Sch	0.123	0.209	-0.286	0.532	0.589	0.556
Cochrane 2014	F5.9 F Iron Sup Int NUT Biom Anem Roschnik B&G Sch	-0.181	0.108	-0.392	0.030	-1.679	0.093
Cochrane 2014	F5.9 G Iron Sup Int NUT Biom Anem Sen 2009 B&G Sch	-0.703	0.406	-1.499	0.093	-1.732	0.083
Cochrane 2014	F5.9 H Iron Sup Int NUT Biom Anem Sungthon B&G Sch	-0.174	0.127	-0.422	0.074	-1.374	0.169
Cochrane 2014	F5.9 I Iron Sup Int NUT Biom Anem Taylor 2 B&G Sch	-0.161	0.179	-0.512	0.190	-0.898	0.369
Finkelstein, 2015	T3 A Iron For Mil NUT Biom Anem Anemia B&G Sch	-0.318	0.243	-0.793	0.157	-1.311	0.190
Finkelstein, 2015	T3 B Iron For Mil NUT Biom Anem Ferritin B&G Sch	-0.273	0.119	-0.506	-0.040	-2.298	0.022

Effect size and significance				
Model	Number Studies	Point estimate	Significance	Standard error
Random effects	82.000	(0.566)	***	0.065

Heterogeneity				Tau-squared			
Q-value	df (Q)	P-value	I-squared	Tau Squared	Standard Error	Variance	Tau
1,016.174	81.000	-	92.029	0.304	0.070	0.005	0.551



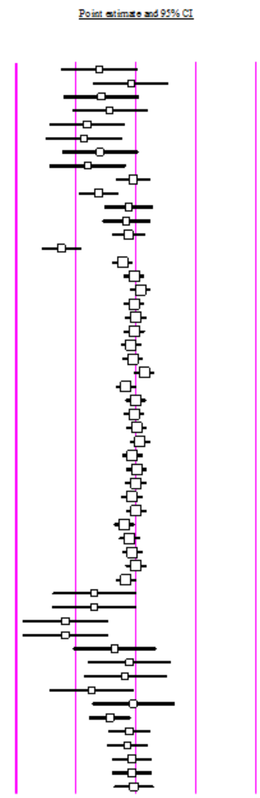
Egger's regression intercept

Intercept	-3.48304
Standard error	0.85564
95% lower limit (2-tailed)	-5.18582
95% upper limit (2-tailed)	-1.78025
t-value	4.07066
df	80.00000
P-value (1-tailed)	0.00005
P-value (2-tailed)	0.00011

Effect of Fortification with Multiple Micronutrients on All Educational Outcomes

Effect of Multiple Micronutrient Fortification on Education Outcomes

Study name	Subgroup within study	Point estimate	Standard error	Lower limit	Upper limit	Z-Value	p-Value
Dalton, 2009	T4A MMN For Spr ED Cogn Verb HVLT Rec B&G Sch	-0.302	0.162	-0.619	0.015	-1.869	0.062
Dalton, 2009	T4B MMN For Spr ED Cogn Verb HVLT Rec B&G Sch	-0.041	0.161	-0.356	0.274	-0.255	0.799
Dalton, 2009	T4C MMN For Spr ED Cogn Verb HVLT Rec B&G Sch	-0.287	0.162	-0.604	0.030	-1.777	0.076
Dalton, 2009	T4D MMN For Spr ED Cogn Verb HVLT tot B&G Sch	-0.216	0.161	-0.532	0.100	-1.341	0.180
Dalton, 2009	T4E MMN For Spr ED Cogn Verb HVLT Rec B&G Sch	-0.406	0.162	-0.724	-0.088	-2.502	0.012
Dalton, 2009	T4F MMN For Spr ED Cogn Verb HVLT Dis B&G Sch	-0.434	0.163	-0.752	-0.116	-2.671	0.008
Dalton, 2009	T4G MMN For Spr ED Cogn Verb Reading B&G Sch	-0.298	0.162	-0.615	0.019	-1.845	0.065
Dalton, 2009	T4H MMN For Spr ED Cogn Verb Spelling B&G Sch	-0.403	0.162	-0.721	-0.085	-2.483	0.013
Eilander et al.	F3A MMN For MMN ED Cogn Inte Solon 20 B&G Sch	-0.020	0.074	-0.165	0.125	-0.271	0.787
Eilander et al.	F3B MMN For MMN ED Cogn Inte Vazir 20 B&G Sch	-0.310	0.082	-0.470	-0.150	-3.804	0.000
Eilander et al.	F5A MMN For MMN ED Cogn Inte Jinabhai B&G Sch	-0.060	0.104	-0.264	0.144	-0.575	0.565
Eilander et al.	F5B MMN For MMN ED Cogn Inte Osendarp B&G Sch	-0.080	0.102	-0.279	0.119	-0.787	0.432
Eilander et al.	F5C MMN For MMN ED Cogn Inte Solon 20 B&G Sch	-0.060	0.071	-0.200	0.080	-0.842	0.400
Eilander et al.	F5D MMN For MMN ED Cogn Inte Vazir 20 B&G Sch	-0.620	0.084	-0.785	-0.455	-7.372	0.000
Gewan, 2009	T3A MMN For Sna ED Cogn Reas Fe avail B&G Sch	-0.111	0.044	-0.196	-0.026	-2.546	0.011
Gewan, 2009	T3B MMN For Sna ED Cogn Reas Zn avail B&G Sch	-0.015	0.044	-0.100	0.070	-0.345	0.730
Gewan, 2009	T3C MMN For Sna ED Cogn Reas B12 Vita B&G Sch	0.038	0.044	-0.047	0.123	0.874	0.382
Gewan, 2009	T3D MMN For Sna ED Cogn Reas B6 Vitam B&G Sch	-0.014	0.044	-0.099	0.071	-0.322	0.748
Gewan, 2009	T3E MMN For Sna ED Cogn Reas Folate B&G Sch	0.000	0.044	-0.085	0.085	0.000	1.000
Gewan, 2009	T3F MMN For Sna ED Cogn Reas Riboflav B&G Sch	-0.013	0.044	-0.098	0.072	-0.299	0.765
Gewan, 2009	T3G MMN For Sna ED Cogn Verb Fe avail B&G Sch	-0.041	0.044	-0.126	0.044	-0.943	0.346
Gewan, 2009	T3H MMN For Sna ED Cogn Verb Zn avail B&G Sch	-0.024	0.044	-0.109	0.061	-0.552	0.581
Gewan, 2009	T3I MMN For Sna ED Cogn Verb B12 Vita B&G Sch	0.072	0.044	-0.013	0.157	1.655	0.098
Gewan, 2009	T3J MMN For Sna ED Cogn Verb B6 Vitam B&G Sch	-0.082	0.044	-0.167	0.003	-1.881	0.060
Gewan, 2009	T3K MMN For Sna ED Cogn Verb Folate B&G Sch	0.000	0.044	-0.085	0.085	0.000	1.000
Gewan, 2009	T3L MMN For Sna ED Cogn Verb Riboflav B&G Sch	-0.015	0.044	-0.100	0.070	-0.345	0.730
Gewan, 2009	T3M MMN For Sna ED Lear M&S Math B&G Sch	0.007	0.044	-0.078	0.092	0.161	0.872
Gewan, 2009	T3N MMN For Sna ED Lear M&S Math B&G Sch	0.034	0.044	-0.051	0.119	0.782	0.434
Gewan, 2009	T3O MMN For Sna ED Lear M&S Math B&G Sch	-0.028	0.044	-0.113	0.057	-0.644	0.520
Gewan, 2009	T3P MMN For Sna ED Lear M&S Math B&G Sch	0.006	0.044	-0.079	0.091	0.138	0.890
Gewan, 2009	T3Q MMN For Sna ED Lear M&S Math B&G Sch	0.000	0.044	-0.085	0.085	0.000	1.000
Gewan, 2009	T3R MMn For Sna ED Lear M&S Math B&G Sch	-0.034	0.044	-0.119	0.051	-0.782	0.434
Gewan, 2009	T3S MMN For Sna ED Cogn Memo Fe avail B&G Sch	0.003	0.044	-0.082	0.088	0.069	0.945
Gewan, 2009	T3T MMN For Sna ED Cogn Memo Zn avail B&G Sch	-0.097	0.044	-0.182	-0.012	-2.225	0.026
Gewan, 2009	T3U MMN For Sna ED Cogn Memo B12 Vita B&G Sch	-0.054	0.044	-0.139	0.031	-1.241	0.214
Gewan, 2009	T3V MMN For Sna ED Cogn Memo B6 Vitam B&G Sch	-0.031	0.044	-0.116	0.054	-0.713	0.476
Gewan, 2009	T3W MMN For Sna ED Cogn Memo Folate B&G Sch	0.000	0.044	-0.085	0.085	0.000	1.000
Gewan, 2009	T3X MMN For Sna ED Cogn Memo Riboflav B&G Sch	-0.083	0.044	-0.168	0.002	-1.904	0.057
Kumar, 2009	T3A MMN For Sal ED Cogn Memo Benton B&G Sch	-0.348	0.178	-0.696	-0.000	-1.961	0.050
Kumar, 2009	T3B MMN For Sal ED Cogn Memo Cattell B&G Sch	-0.348	0.178	-0.696	-0.000	-1.961	0.050
Kumar, 2009	T3C MMN For Sal ED Cogn Memo MannSui B&G Sch	-0.588	0.180	-0.941	-0.235	-3.268	0.001
Kumar, 2009	T3D MMN For Sal ED Cogn Memo Delayed B&G Sch	-0.588	0.180	-0.941	-0.235	-3.268	0.001
Kumar, 2009	T3E MMN For Sal ED Cogn Memo Persona B&G Sch	-0.176	0.177	-0.522	0.170	-0.997	0.319
Kumar, 2009	T3F MMN For Sal ED Cogn Memo Digit sp B&G Sch	-0.053	0.176	-0.398	0.292	-0.301	0.764
Kumar, 2009	T3G MMN For Sal ED Cogn Memo Digit sp B&G Sch	-0.091	0.176	-0.436	0.254	-0.516	0.606
Kumar, 2009	T3H MMN For Sal ED Cogn Reas Letter c B&G Sch	-0.367	0.178	-0.715	-0.019	-2.066	0.039
Kumar, 2009	T3I MMN For Sal ED Cogn Inte Raven's B&G Sch	-0.020	0.176	-0.365	0.325	-0.114	0.910
Manger, 2008	T6A MMN For Sea ED Cogn Memo Visual r B&G Sch	-0.218	0.089	-0.393	-0.043	-2.447	0.014
Manger, 2008	T6B MMN For Sea ED Cogn Reas Digits f B&G Sch	-0.050	0.089	-0.224	0.124	-0.563	0.573
Manger, 2008	T6C MMN For Sea ED Cogn Reas Digits b B&G Sch	-0.070	0.089	-0.244	0.104	-0.787	0.431
Manger, 2008	T6D MMN For Sea ED Lear Lang Thai B&G Sch	-0.034	0.084	-0.199	0.131	-0.404	0.686
Manger, 2008	T6E MMN For Sea ED Lear Lang Thai B&G Sch	-0.033	0.084	-0.198	0.132	-0.392	0.695
Manger, 2008	T6F MMN For Sea ED Lear M&S Math B&G Sch	-0.017	0.084	-0.182	0.148	-0.202	0.840



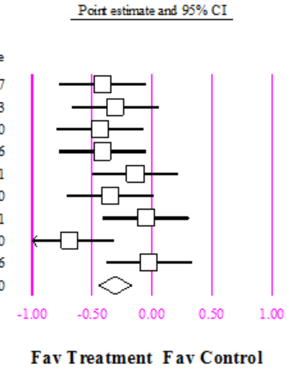
Effect size and significance				
Model	Number Studies	Point estimate	Significance	Standard error
Random effects	88.000	(0.080)	***	0.013

Heterogeneity				Tau-squared			
Q-value	df (Q)	P-value	I-squared	Tau Squared	Standard Error	Variance	Tau
191.984	87.000	-	54.684	0.006	0.002	0.000	0.078

Effect of Supplementation with Multiple Micronutrients on All Educational Outcomes

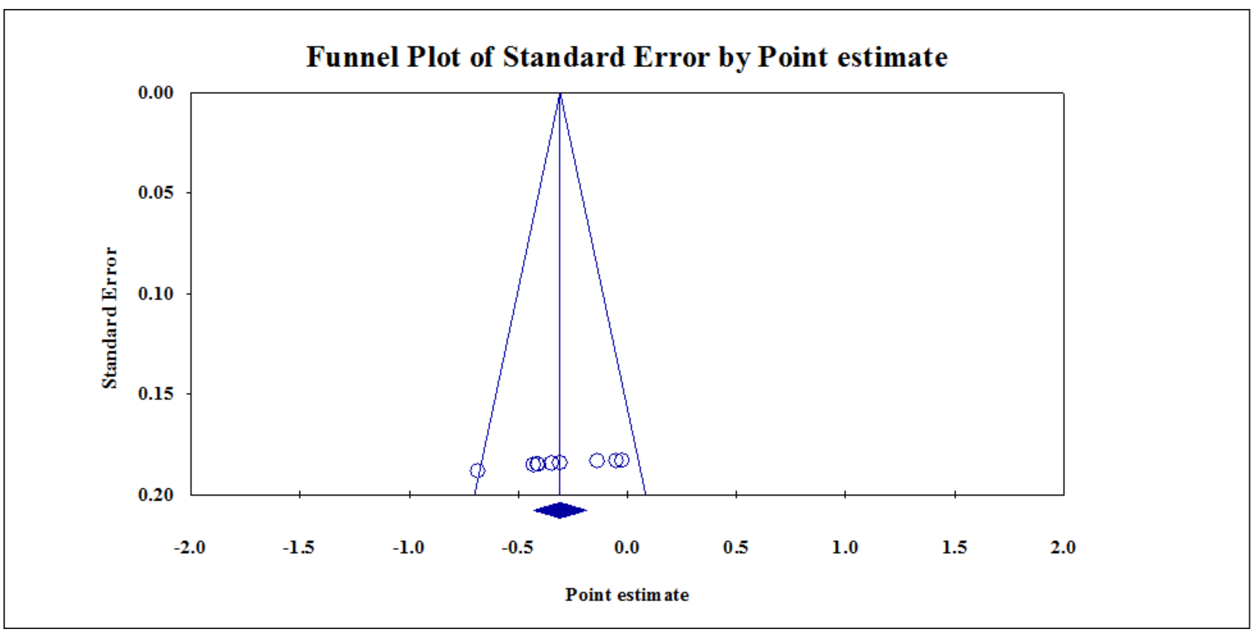
Effect of Multiple Micronutrient Supplementation on Educational Outcomes

Study name	Subgroup within study	Point estimate	Standard error	Lower limit	Upper limit	Z-Value	p-Value
Kumar, 2008	T4A MMN Sup Cap ED Cogn Memo Red cell B&G Sch	-0.409	0.185	-0.771	-0.047	-2.212	0.027
Kumar, 2008	T4B MMN Sup Cap ED Cogn Memo Cattell B&G Sch	-0.309	0.184	-0.670	0.052	-1.678	0.093
Kumar, 2008	T4C MMN Sup Cap ED Cogn Memo MannSui B&G Sch	-0.430	0.185	-0.793	-0.067	-2.323	0.020
Kumar, 2008	T4D MMN Sup Cap ED Cogn Memo Delayed B&G Sch	-0.413	0.185	-0.775	-0.051	-2.234	0.026
Kumar, 2008	T4E MMN Sup Cap ED Cogn Memo Persona B&G Sch	-0.138	0.183	-0.497	0.221	-0.753	0.451
Kumar, 2008	T4F MMN Sup Cap ED Cogn Memo Digit sp B&G Sch	-0.347	0.184	-0.708	0.014	-1.882	0.060
Kumar, 2008	T4G MMN Sup Cap ED Cogn Memo Digit sp B&G Sch	-0.051	0.183	-0.410	0.308	-0.279	0.781
Kumar, 2008	T4H MMN Sup Cap ED Cogn Reas Letter c B&G Sch	-0.685	0.188	-1.054	-0.316	-3.640	0.000
Kumar, 2008	T4I MMN Sup Cap ED Cogn Inte Raven's B&G Sch	-0.024	0.183	-0.383	0.335	-0.131	0.896
		-0.309	0.070	-0.447	-0.172	-4.422	0.000



Effect size and significance				
Model	Number Studies	Point estimate	Significance	Standard error
Random effects	9.000	(0.309)	***	0.070

Heterogeneity				Tau-squared			
Q-value	df (Q)	P-value	I-squared	Tau Squared	Standard Error	Variance	Tau
10.352	8.000	0.241	22.722	0.010	0.022	0.000	0.100



Egger's regression intercept

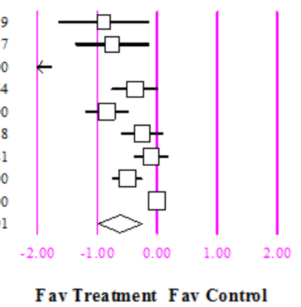
Intercept	-125.72362
Standard error	16.12793
95% lower limit (2-tailed)	-163.86012
95% upper limit (2-tailed)	-87.58712
t-value	7.79540
df	7.00000
P-value (1-tailed)	0.00005
P-value (2-tailed)	0.00011

Effect of Iron Interventions on All Educational Outcomes

Effect of Iron Fortification and Supplementation on Educational Outcomes

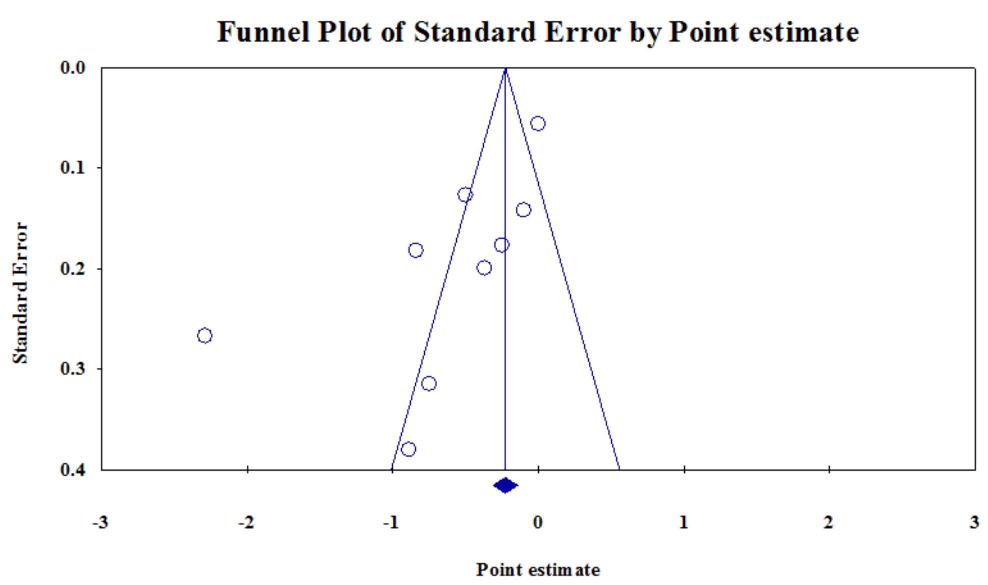
Study name	Subgroup within study	Point estimate	Standard error	Lower limit	Upper limit	Z-Value	p-Value
CMAJ 185(17) 2013 F2A Iron Sup Dai ED Cogn Inte Seshadri	B&G Sch	-0.890	0.380	-1.635	-0.145	-2.341	0.019
CMAJ 185(17) 2013 F2B Iron Sup Dai ED Cogn Inte Gopaldas	B&G Sch	-0.750	0.315	-1.366	-0.134	-2.385	0.017
CMAJ 185(17) 2013 F2C Iron Sup Dai ED Cogn Inte Seshadri	B&G Sch	-2.290	0.267	-2.813	-1.767	-8.577	0.000
CMAJ 185(17) 2013 F2D Iron Sup Dai ED Cogn Inte Seshadri	B&G Sch	-0.370	0.200	-0.761	0.021	-1.854	0.064
CMAJ 185(17) 2013 F2E Iron Sup Dai ED Cogn Inte Kashyap	B&G Sch	-0.840	0.182	-1.197	-0.483	-4.615	0.000
CMAJ 185(17) 2013 F2F Iron Sup Dai ED Cogn Reas Soemantr	B&G Sch	-0.250	0.177	-0.597	0.097	-1.413	0.158
CMAJ 185(17) 2013 F2G Iron Sup Dai ED Lear M&S Ayoya et	B&G Sch	-0.100	0.142	-0.378	0.178	-0.704	0.481
CMAJ 185(17) 2013 F2H Iron Sup Dai ED Cogn Inte Sungthon	B&G Sch	-0.500	0.127	-0.749	-0.251	-3.940	0.000
CMAJ 185(17) 2013 F2I Iron Sup Dai ED Cogn Reas Pollitt	B&G Sch	0.000	0.056	-0.110	0.110	0.000	1.000
		-0.623	0.185	-0.986	-0.260	-3.363	0.001

Point estimate and 95% CI



Effect size and significance				
Model	Number Studies	Point estimate	Significance	Standard error
Random effects	9.000	(0.623)	***	0.185

Heterogeneity				Tau-squared			
Q-value	df (Q)	P-value	I-squared	Tau Squared	Standard Error	Variance	Tau
99.183	8.000	-	91.934	0.263	0.200	0.040	0.513



Egger's regression intercept

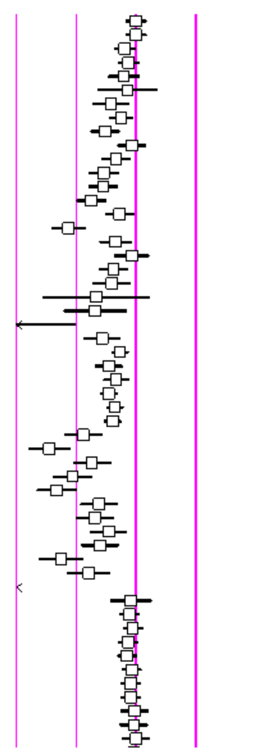
Intercept	-4.54313
Standard error	1.47801
95% lower limit (2-tailed)	-8.03807
95% upper limit (2-tailed)	-1.04819
t-value	3.07381
df	7.00000
P-value (1-tailed)	0.00899
P-value (2-tailed)	0.01797

Effect of Fortification with Multiple Micronutrients on All Nutrition Outcomes

Effect of Multiple Micronutrient Fortification on Nutritional Indicators

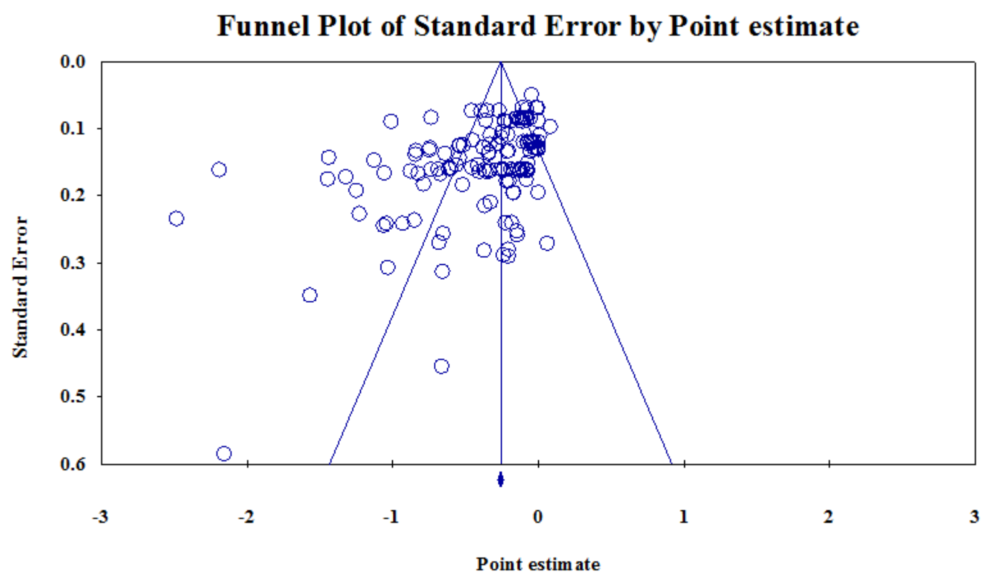
Study name	Subgroup within study	Statistics for each study					
		Point estimate	Standard error	Lower limit	Upper limit	Z-Value	p-Value
Aaron, 2011	T4A MMN For Dri NUT Biom Anem Hemoglob B&G Sch	0.000	0.089	-0.174	0.174	0.000	1.000
Aaron, 2011	T4B MMN For Dri NUT Biom Anem Serum fe B&G Sch	0.000	0.089	-0.174	0.174	0.000	1.000
Aaron, 2011	T4C MMN For Dri NUT Biom Vit Serum re B&G Sch	-0.188	0.089	-0.362	-0.014	-2.115	0.034
Aaron, 2011	T4D MMN For Dri NUT Biom Zinc Serum re B&G Sch	-0.126	0.089	-0.300	0.048	-1.419	0.156
Aaron, 2011	T5A MMN For Dri NUT Biom Anem Serum Zi B&G Sch	-0.205	0.133	-0.466	0.056	-1.537	0.124
Aaron, 2011	T5B MMN For Dri NUT Biom Anem Hemoglob B&G Sch	-0.144	0.259	-0.651	0.363	-0.557	0.578
Aaron, 2011	T5C MMN For Dri NUT Biom Vit Serum re B&G Sch	-0.416	0.155	-0.719	-0.113	-2.693	0.007
Aaron, 2011	T5D MMN For Dri NUT Biom Zinc Serum Zi B&G Sch	-0.246	0.105	-0.452	-0.040	-2.336	0.019
Abrams, 2003	T4A MMN For Dri NUT Anth BMI B&G Sch	-0.515	0.125	-0.760	-0.270	-4.123	0.000
Abrams, 2003	T4B MMN For Dri NUT Anth MUAC B&G Sch	-0.074	0.123	-0.314	0.166	-0.604	0.546
Abrams, 2003	T4C MMN For Dri NUT Anth Unde B&G Sch	-0.334	0.124	-0.576	-0.092	-2.700	0.007
Abrams, 2003	T4D MMN For Dri NUT Anth Weig B&G Sch	-0.539	0.125	-0.784	-0.294	-4.309	0.000
Abrams, 2003	T4E MMN For Dri NUT Biom Anem Hemoglob B&G Sch	-0.544	0.126	-0.791	-0.297	-4.321	0.000
Abrams, 2003	T4F MMN For Dri NUT Biom Othe MCV B&G Sch	-0.744	0.129	-0.997	-0.491	-5.767	0.000
Abrams, 2003	T4G MMN For Dri NUT Biom Anem Serum fe B&G Sch	-0.276	0.122	-0.516	-0.036	-2.255	0.024
Abrams, 2003	T4H MMN For Dri NUT Biom Anem Folate B&G Sch	-1.130	0.147	-1.419	-0.841	-7.671	0.000
Abrams, 2003	T4J MMN For Dri NUT Biom Anem Vit B12 B&G Sch	-0.342	0.138	-0.612	-0.072	-2.482	0.013
Abrams, 2003	T4K MMN For Dri NUT Biom Vit Retinol B&G Sch	-0.072	0.151	-0.368	0.224	-0.476	0.634
Abrams, 2003	T4L MMN For Dri NUT Biom Othe Riboflav B&G Sch	-0.378	0.128	-0.629	-0.127	-2.946	0.003
Abrams, 2003	T5A MMN For Dri NUT Biom Anem Hemoglob B&G Sch	-0.405	0.165	-0.728	-0.082	-2.461	0.014
Abrams, 2003	T5B MMN For Dri NUT Biom Anem Ferritin B&G Sch	-0.664	0.455	-1.555	0.227	-1.461	0.144
Abrams, 2003	T5C MMN For Dri NUT Biom Zinc Zinc B&G Sch	-0.682	0.270	-1.211	-0.153	-2.526	0.012
Abrams, 2003	T5D MMN For Dri NUT Biom Anem Zinc PP B&G Sch	-2.157	0.585	-3.303	-1.011	-3.688	0.000
Abrams, 2003	T5E MMN For Dri NUT Biom Othe Riboflav B&G Sch	-0.563	0.155	-0.866	-0.260	-3.644	0.000
Ash, 2003	T3A MMN For Dri NUT Biom Anem Hemoglob B&G Sch	-0.269	0.073	-0.413	-0.125	-3.665	0.000
Ash, 2003	T3B MMN For Dri NUT Biom Anem Ferritin B&G Sch	-0.452	0.118	-0.682	-0.222	-3.847	0.000
Ash, 2003	T3C MMN For Dri NUT Biom Othe Porphyri B&G Sch	-0.331	0.110	-0.546	-0.116	-3.017	0.003
Ash, 2003	T6A MMN For Dri NUT Anth Weig B&G Sch	-0.458	0.074	-0.602	-0.314	-6.223	0.000
Ash, 2003	T6B MMN For Dri NUT Anth Heig B&G Sch	-0.353	0.074	-0.497	-0.209	-4.796	0.000
Ash, 2003	T6C MMN For Dri NUT Anth BMI B&G Sch	-0.393	0.074	-0.538	-0.248	-5.304	0.000
Dalton, 2009	T3A MMN For Spr NUT Biom Othe Plasma P B&G Sch	-0.878	0.164	-1.198	-0.558	-5.370	0.000
Dalton, 2009	T3B MMN For Spr NUT Biom Othe Plasma P B&G Sch	-1.446	0.175	-1.790	-1.102	-8.244	0.000
Dalton, 2009	T3C MMN For Spr NUT Biom Othe Plasma P B&G Sch	-0.737	0.161	-1.053	-0.421	-4.566	0.000
Dalton, 2009	T3D MMN For Spr NUT Biom Anem Redcells B&G Sch	-1.057	0.167	-1.384	-0.730	-6.341	0.000
Dalton, 2009	T3E MMN For Spr NUT Biom Anem Redcells B&G Sch	-1.322	0.172	-1.660	-0.984	-7.668	0.000
Dalton, 2009	T3F MMN For Spr NUT Biom Anem Redcells B&G Sch	-0.617	0.160	-0.930	-0.304	-3.859	0.000
Dalton, 2009	T3G MMN For Spr NUT Biom Anem Redcells B&G Sch	-0.689	0.161	-1.004	-0.374	-4.285	0.000
Dalton, 2009	T3H MMN For Spr NUT Biom Anem Redcells B&G Sch	-0.457	0.158	-0.767	-0.147	-2.889	0.004
Dalton, 2009	T3J MMN For Spr NUT Biom Anem Redcells B&G Sch	-0.602	0.160	-0.915	-0.289	-3.770	0.000
Kumar, 2009	T2A MMN For Sal NUT Biom Anem Hemoglob B&G Sch	-1.250	0.193	-1.627	-0.873	-6.490	0.000
Kumar, 2009	T2B MMN For Sal NUT Biom Anem Hematocr B&G Sch	-0.788	0.183	-1.146	-0.430	-4.311	0.000
Kumar, 2009	T2C MMN For Sal NUT Biom Anem Red cell B&G Sch	-2.485	0.235	-2.945	-2.025	-10.597	0.000
Kumar, 2009	T2D MMN For Sal NUT Biom Vit Serum V B&G Sch	-0.083	0.176	-0.428	0.262	-0.471	0.638
Manger, 2008	T3A MMN For Sea NUT Anth Heig B&G Sch	-0.110	0.084	-0.275	0.055	-1.303	0.192
Manger, 2008	T3B MMN For Sea NUT Anth Weig B&G Sch	-0.054	0.084	-0.219	0.111	-0.641	0.522
Manger, 2008	T3C MMN For Sea NUT Anth BMI B&G Sch	-0.129	0.084	-0.294	0.036	-1.528	0.126
Manger, 2008	T3D MMN For Sea NUT Anth MUAC B&G Sch	-0.147	0.084	-0.312	0.018	-1.742	0.082
Manger, 2008	T3E MMN For Sea NUT Anth Othe Subscapu B&G Sch	-0.074	0.084	-0.239	0.091	-0.878	0.380
Manger, 2008	T3F MMN For Sea NUT Anth Othe Triceps B&G Sch	-0.089	0.084	-0.254	0.076	-1.056	0.291
Manger, 2008	T3G MMN For Sea NUT Anth Othe Sum B&G Sch	-0.088	0.084	-0.253	0.077	-1.044	0.297
Muthayya, 2009	T4A MMN For Dri NUT Anth Heig HI MMN H B&G Sch	-0.025	0.120	-0.260	0.210	-0.208	0.835
Muthayya, 2009	T4B MMN For Dri NUT Anth Weig HI MMN H B&G Sch	-0.038	0.120	-0.273	0.197	-0.317	0.751
Muthayya, 2009	T4C MMN For Dri NUT Anth MUAC HI MMN H B&G Sch	0.000	0.120	-0.235	0.235	0.000	1.000

Point estimate and 95%CI



Effect size and significance				
Model	Number Studies	Point estimate	Significance	Standard error
Random effects	141.000	(0.360)	***	0.030

Heterogeneity				Tau-squared			
Q-value	df (Q)	P-value	I-squared	Tau Squared	Standard Error	Variance	Tau
1,093.095	140.000	-	87.192	0.100	0.017	0.000	0.316



Egger's regression intercept

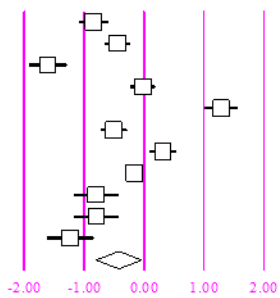
Intercept	-3.02491
Standard error	0.55573
95% lower limit (2-tailed)	-4.12369
95% upper limit (2-tailed)	-1.92613
t-value	5.44312
df	139.00000
P-value (1-tailed)	0.00000
P-value (2-tailed)	0.00000

Effect of Supplementation with Multiple Micronutrients on All Nutrition Outcomes

Effect of Multiple Micronutrient Supplementation on Nutritional Indicators

Study name	Subgroup within study	Point estimate	Standard error	Lower limit	Upper limit	Z-Value	p-Value
Ahmed, 2005	T3H MMN Sup Tab NUT Biom Anem Hemoglob Girls Sch	-0.840	0.123	-1.082	-0.598	-6.813	0.000
Ahmed, 2005	T3I MMN Sup Tab NUT Biom Anem Serum fe Girls Sch	-0.443	0.111	-0.661	-0.225	-3.987	0.000
Ahmed, 2005	T3J MMN Sup Tab NUT Biom Anem Serum fe Girls Sch	-1.601	0.160	-1.915	-1.287	-10.000	0.000
Ahmed, 2005	T3K MMN Sup Tab NUT Biom Anem Serum V Girls Sch	-0.021	0.106	-0.229	0.187	-0.198	0.843
Ahmed, 2005	T3L MMN Sup Tab NUT Biom Othe EGRAC Girls Sch	1.286	0.143	1.005	1.567	8.974	0.000
Ahmed, 2005	T3M MMN Sup Tab NUT Biom Vit Serum V Girls Sch	-0.507	0.113	-0.728	-0.286	-4.503	0.000
Ahmed, 2005	T3N MMN Sup Tab NUT Biom Othe Plasma V Girls Sch	0.316	0.109	0.103	0.529	2.910	0.004
Friis, 2003	T2A MMN Sup MMN NUT Biom Anem Hemoglob B&G Sch	-0.157	0.059	-0.273	-0.041	-2.643	0.008
Kumar, 2008	T3A MMN Sup Cap NUT Biom Anem Hemoglob B&G Sch	-0.802	0.190	-1.174	-0.430	-4.221	0.000
Kumar, 2008	T3B MMN Sup Cap NUT Biom Anem Hematocr B&G Sch	-0.797	0.190	-1.169	-0.425	-4.195	0.000
Kumar, 2008	T3C MMN Sup Cap NUT Biom Anem Red cell B&G Sch	-1.232	0.199	-1.622	-0.842	-6.185	0.000
		-0.427	0.195	-0.808	-0.045	-2.192	0.028

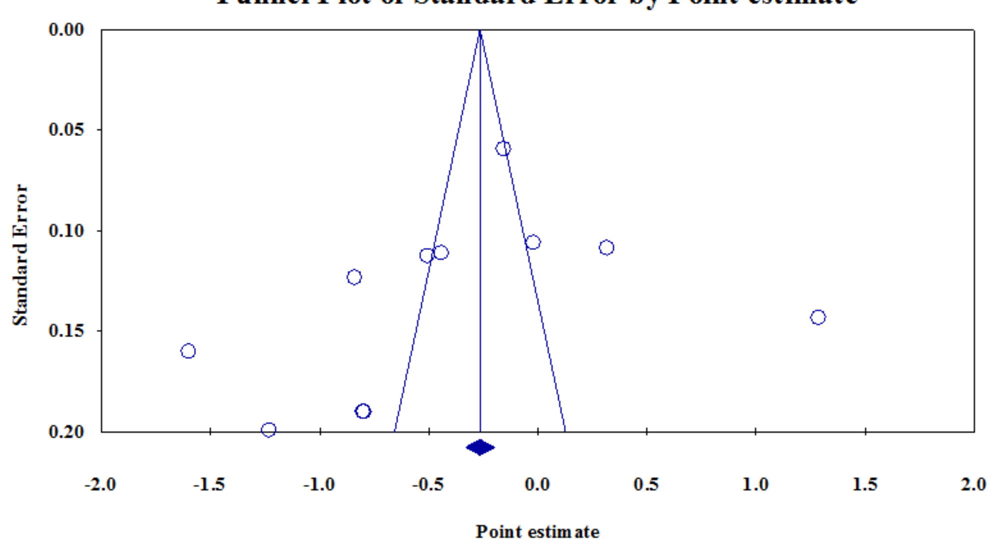
Point estimate and 95% CI



Effect size and significance				
Model	Number Studies	Point estimate	Significance	Standard error
Random effects	11.000	(0.427)	**	0.195

Heterogeneity				Tau-squared			
Q-value	df (Q)	P-value	I-squared	Tau Squared	Standard Error	Variance	Tau
292.335	10.000	-	96.579	0.397	0.225	0.051	0.630

Funnel Plot of Standard Error by Point estimate



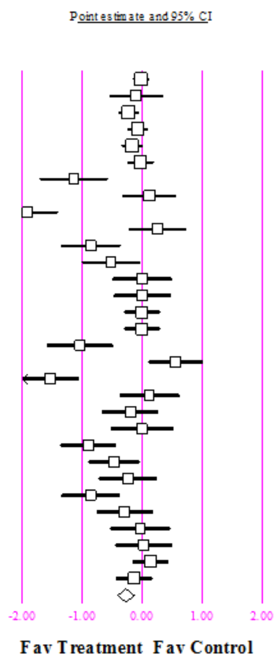
Egger's regression intercept

Intercept	-4.82433
Standard error	4.48114
95% lower limit (2-tailed)	-14.96138
95% upper limit (2-tailed)	5.31271
t-value	1.07659
df	9.00000
P-value (1-tailed)	0.15484
P-value (2-tailed)	0.30968

Effect of Daily Iron Supplementation on All Nutrition Outcomes

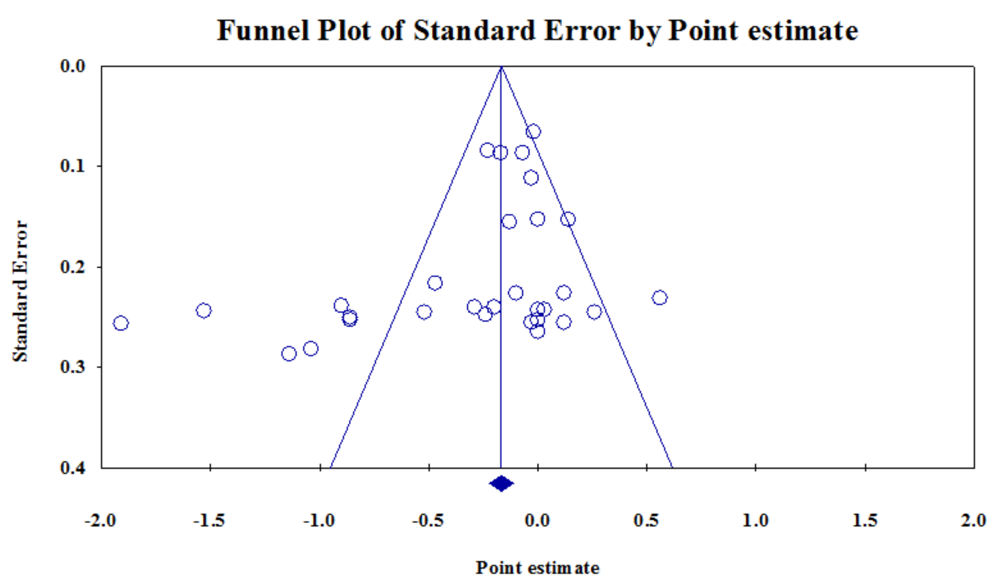
Effect of Daily Iron Supplementation on Nutritional Indicators

Study name	Subgroup within study	Point estimate	Standard error	Lower limit	Upper limit	Z-Value	p-Value
CMAJ 185(17) 2013	F3A Iron Sup Dai NUT Anth Heig Chwang e B&G Sch	0.020	0.066	-0.149	0.109	-0.304	0.761
CMAJ 185(17) 2013	F3B Iron Sup Dai NUT Anth Heig Lawless B&G Sch	0.100	0.226	-0.544	0.344	-0.442	0.659
CMAJ 185(17) 2013	F3C Iron Sup Dai NUT Anth Heig Perrone B&G	-0.230	0.084	-0.395	-0.065	-2.725	0.006
CMAJ 185(17) 2013	F3D Iron Sup Dai NUT Anth Heig Richard B&G	-0.070	0.087	-0.240	0.100	-0.808	0.419
CMAJ 185(17) 2013	F3E Iron Sup Dai NUT Anth Heig Richard B&G	-0.170	0.087	-0.340	-0.000	-1.963	0.050
CMAJ 185(17) 2013	F3F Iron Sup Dai NUT Anth Heig Sungthon B&G Sch	0.030	0.112	-0.249	0.189	-0.269	0.788
Sachdev	F3A Iron Sup dai NUT Anth Unde Latham e B&G Sch	1.140	0.287	-1.702	-0.578	-3.975	0.000
Sachdev	F3B Iron Sup dai NUT Anth Unde Angeles B&G Pre	0.120	0.226	-0.323	0.563	0.531	0.596
Sachdev	F3C Iron Sup dai NUT Anth Unde Lawless B&G Sch	1.910	0.257	-2.413	-1.407	-7.446	0.000
Sachdev	F3D Iron Sup dai NUT Anth Unde Aguayo, B&G Sch	0.260	0.245	-0.221	0.741	1.060	0.289
Sachdev	F3E Iron Sup dai NUT Anth Unde Mwanri e B&G Sch	0.860	0.253	-1.355	-0.365	-3.402	0.001
Sachdev	F3F Iron Sup dai NUT Anth Unde Mwanri e B&G Sch	0.520	0.245	-1.001	-0.039	-2.121	0.034
Sachdev	F3G Iron Sup dai NUT Anth Unde Dossa et B&G Pre	0.000	0.253	-0.495	0.495	0.000	1.000
Sachdev	F3H Iron Sup dai NUT Anth Unde Dossa et B&G Pre	0.000	0.243	-0.476	0.476	0.000	1.000
Sachdev	F3I Iron Sup dai NUT Anth Unde Sungthon B&G Sch	0.000	0.153	-0.299	0.299	0.000	1.000
Sachdev	F3J Iron Sup dai NUT Anth Unde Sungthon B&G Sch	0.000	0.153	-0.299	0.299	0.000	1.000
Sachdev	F4A Iron Sup dai NUT Anth Wast Latham e B&G Sch	1.040	0.282	-1.592	-0.488	-3.691	0.000
Sachdev	F4B Iron Sup dai NUT Anth Wast Angeles B&G Pre	0.560	0.231	0.107	1.013	2.423	0.015
Sachdev	F4C Iron Sup dai NUT Anth Wast Lawless B&G Sch	1.530	0.244	-2.008	-1.052	-6.273	0.000
Sachdev	F4D Iron Sup dai NUT Anth Wast Dossa et B&G Pre	0.120	0.255	-0.380	0.620	0.470	0.638
Sachdev	F4E Iron Sup dai NUT Anth Wast Dossa et B&G Pre	0.200	0.240	-0.671	0.271	-0.833	0.405
Sachdev	F5A Iron Sup dai NUT Anth Stun Latham e B&G Sch	0.000	0.264	-0.518	0.518	0.000	1.000
Sachdev	F5B Iron Sup dai NUT Anth Stun Angeles B&G Pre	-0.900	0.239	-1.368	-0.432	-3.772	0.000
Sachdev	F5C Iron Sup dai NUT Anth Stun Lawless B&G Sch	-0.470	0.216	-0.894	-0.046	-2.173	0.030
Sachdev	F5D Iron Sup dai NUT Anth Stun Aguayo, B&G Sch	-0.240	0.248	-0.725	0.245	-0.969	0.333
Sachdev	F5E Iron Sup dai NUT Anth Stun Mwanri e B&G Sch	-0.860	0.250	-1.351	-0.369	-3.436	0.001
Sachdev	F5F Iron Sup dai NUT Anth Stun Mwanri e B&G Sch	-0.290	0.240	-0.761	0.181	-1.207	0.227
Sachdev	F5G Iron Sup dai NUT Anth Stun Dossa et B&G Pre	-0.030	0.255	-0.530	0.470	-0.118	0.906
Sachdev	F5H Iron Sup dai NUT Anth Stun Dossa et B&G Pre	0.030	0.243	-0.446	0.506	0.124	0.902
Sachdev	F5I Iron Sup dai NUT Anth Stun Sungthon B&G Sch	0.140	0.153	-0.159	0.439	0.917	0.359
Sachdev	F5J Iron Sup dai NUT Anth Stun Sungthon B&G Sch	-0.130	0.155	-0.434	0.174	-0.838	0.402
		-0.277	0.071	-0.417	-0.137	-3.886	0.000



Effect size and significance				
Model	**Number Studies**	**Point estimate**	**Significance**	**Standard error**
Random effects	31.000	(0.277)	***	0.071

Heterogeneity				Tau-squared			
Q-value	**df (Q)**	**P-value**	**I-squared**	**Tau Squared**	**Standard Error**	**Variance**	**Tau**
160.496	30.000	-	81.308	0.113	0.050	0.003	0.337



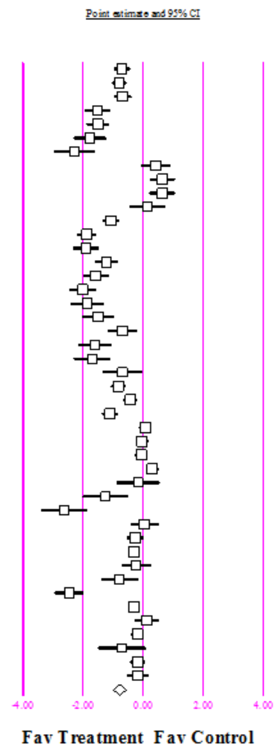
Egger's regression intercept

Intercept	-1.80282
Standard error	0.84522
95% lower limit (2-tailed)	-3.53150
95% upper limit (2-tailed)	-0.07414
t-value	2.13294
df	29.00000
P-value (1-tailed)	0.02076
P-value (2-tailed)	0.04152

Effect of Intermittent Iron Supplementation on All Nutrition Outcomes

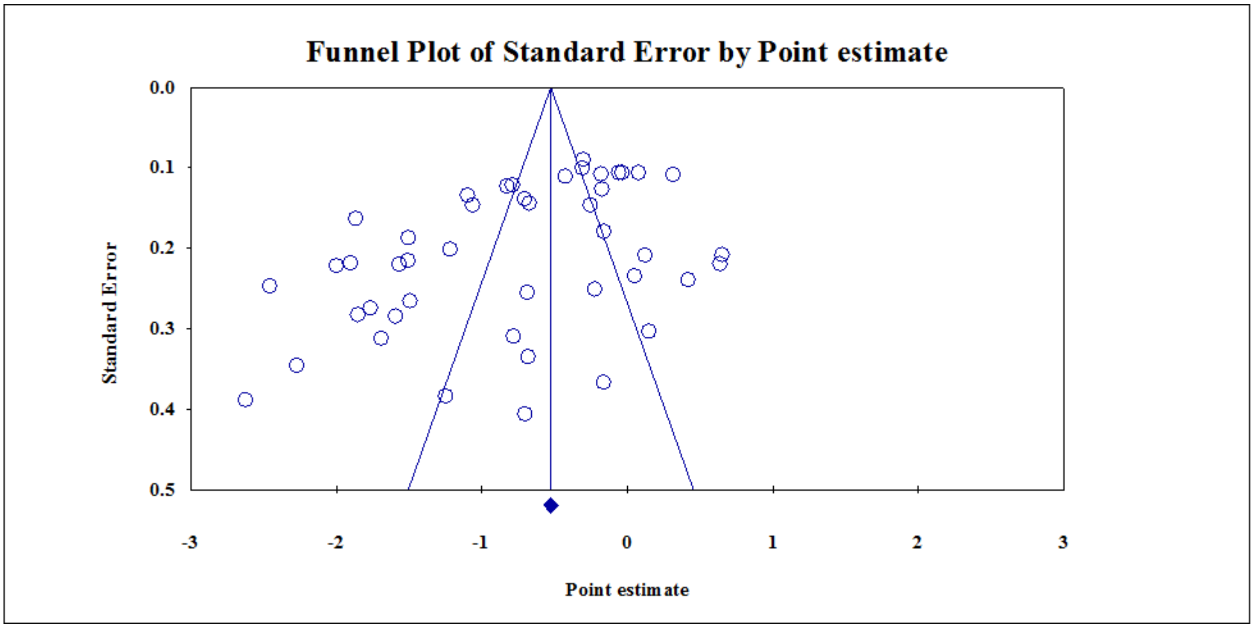
Effect of Intermittent Iron Supplementation on Nutritional Indicators

Study name	Subgroup within study	Point estimate	Standard error	Lower limit	Upper limit	Z-Value	p-Value
Aditi, 2012	T1A Iron Sup Int NUT Biom Anem Hb 1/wk Girls Sch	-0.705	0.139	-0.977	-0.433	-5.087	0.000
Aditi, 2012	T1B Iron Sup Int NUT Biom Anem Hb 2/wk Girls Sch	-0.789	0.121	-1.027	-0.551	-6.499	0.000
Aditi, 2012	T1C Iron Sup Int NUT Biom Anem Hb Daily Girls Sch	-0.674	0.144	-0.957	-0.391	-4.674	0.000
Aditi, 2012	T2A Iron Sup Int NUT Biom Anem Hb 1/wk Girls Sch	-1.508	0.216	-1.930	-1.086	-6.998	0.000
Aditi, 2012	T2B Iron Sup Int NUT Biom Anem Hb 2/wk Girls Sch	-1.505	0.187	-1.872	-1.138	-8.048	0.000
Aditi, 2012	T2C Iron Sup Int NUT Biom Anem Hb Daily Girls Sch	-1.766	0.274	-2.304	-1.228	-6.436	0.000
Aditi, 2012	T2D Iron Sup Int NUT Biom Anem Hb Contr Girls Sch	-2.273	0.346	-2.950	-1.596	-6.577	0.000
Aditi, 2012	T2E Iron Sup Int NUT Biom Anem Hb 1/wk Girls Sch	0.418	0.239	-0.051	0.887	1.747	0.081
Aditi, 2012	T2F Iron Sup Int NUT Biom Anem Hb 2/wk Girls Sch	0.652	0.208	0.244	1.060	3.133	0.002
Aditi, 2012	T2G Iron Sup Int NUT Biom Anem Hb Daily Girls Sch	0.638	0.219	0.208	1.068	2.908	0.004
Aditi, 2012	T2H Iron Sup Int NUT Biom Anem Hb Contr Girls Sch	0.148	0.303	-0.446	0.742	0.488	0.625
Aditi, 2012	T3A Iron Sup Int NUT Anth BMI 1/wk Girls Sch	-1.063	0.146	-1.350	-0.776	-7.261	0.000
Aditi, 2012	T3B Iron Sup Int NUT Anth BMI 2/wk Girls Sch	-1.867	0.163	-2.187	-1.547	-11.440	0.000
Aditi, 2012	T3C Iron Sup Int NUT Anth BMI Daily Girls Sch	-1.903	0.218	-2.331	-1.475	-8.721	0.000
Aditi, 2012	T3D Iron Sup Int NUT Anth BMI Control Girls Sch	-1.218	0.201	-1.613	-0.823	-6.051	0.000
Aditi, 2012	T4A Iron Sup Int NUT Anth BMI 1/wk Girls Sch	-1.567	0.220	-1.998	-1.136	-7.123	0.000
Aditi, 2012	T4B Iron Sup Int NUT Anth BMI 2/wk Girls Sch	-2.000	0.222	-2.435	-1.565	-9.017	0.000
Aditi, 2012	T4C Iron Sup Int NUT Anth BMI Daily Girls Sch	-1.852	0.283	-2.406	-1.298	-6.553	0.000
Aditi, 2012	T4D Iron Sup Int NUT Anth BMI Control Girls Sch	-1.494	0.266	-2.015	-0.973	-5.625	0.000
Aditi, 2012	T4E Iron Sup Int NUT Anth BMI 1/wk Girls Sch	-0.687	0.255	-1.187	-0.187	-2.693	0.007
Aditi, 2012	T4F Iron Sup Int NUT Anth BMI 2/wk Girls Sch	-1.593	0.285	-2.151	-1.035	-5.597	0.000
Aditi, 2012	T4G Iron Sup Int NUT Anth BMI Daily Girls Sch	-1.692	0.312	-2.303	-1.081	-5.425	0.000
Aditi, 2012	T4H Iron Sup Int NUT Anth BMI Control Girls Sch	-0.682	0.335	-1.338	-0.026	-2.037	0.042
Ahmed, 2005	T3A Iron Sup Int NUT Biom Anem Hemoglob Girls Sch	-0.827	0.123	-1.068	-0.586	-6.735	0.000
Ahmed, 2005	T3B Iron Sup Int NUT Biom Anem Hemoglob Girls Sch	-0.426	0.111	-0.643	-0.209	-3.848	0.000
Ahmed, 2005	T3C Iron Sup Int NUT Biom Anem RBC Foli Girls Sch	-1.098	0.134	-1.361	-0.835	-8.182	0.000
Ahmed, 2005	T3D Iron Sup Int NUT Biom Anem Serum V Girls Sch	0.077	0.106	-0.131	0.285	0.725	0.468
Ahmed, 2005	T3E Iron Sup Int NUT Biom Othe EGRAC Girls Sch	-0.036	0.106	-0.244	0.172	-0.340	0.734
Ahmed, 2005	T3F Iron Sup Int NUT Biom Vit EGRAC Girls Sch	-0.059	0.106	-0.267	0.149	-0.556	0.578
Ahmed, 2005	T3G Iron Sup Int NUT Biom Othe Plasma V Girls Sch	0.316	0.109	0.103	0.529	2.910	0.004
Cochrane 2014	F5.1A Iron Sup Int NUT Biom Anem Aguayo 2 B&G Sch	-0.163	0.367	-0.882	0.556	-0.445	0.657
Cochrane 2014	F5.1B Iron Sup Int NUT Biom Anem Arcanjo B&G Sch	-1.249	0.384	-2.001	-0.497	-3.255	0.001
Cochrane 2014	F5.1C Iron Sup Int NUT Biom Anem Berger 1 B&G Sch	-2.625	0.388	-3.386	-1.864	-6.760	0.000
Cochrane 2014	F5.1D Iron Sup Int NUT Biom Anem Roschnik B&G Sch	0.050	0.235	-0.410	0.510	0.213	0.831
Cochrane 2014	F5.1E Iron Sup Int NUT Biom Anem Roschnik B&G Sch	-0.254	0.146	-0.541	0.033	-1.735	0.083
Cochrane 2014	F5.1F Iron Sup Int NUT Biom Anem Hall 200 B&G Sch	-0.308	0.100	-0.505	-0.111	-3.068	0.002
Cochrane 2014	F5.9A Iron Sup Int NUT Biom Anem Aguayo 2 B&G Sch	-0.224	0.251	-0.716	0.268	-0.893	0.372
Cochrane 2014	F5.9B Iron Sup Int NUT Biom Anem Arcanjo B&G Sch	-0.783	0.309	-1.389	-0.177	-2.531	0.011
Cochrane 2014	F5.9C Iron Sup Int NUT Biom Anem Berger 1 B&G Sch	-2.459	0.247	-2.943	-1.975	-9.951	0.000
Cochrane 2014	F5.9D Iron Sup Int NUT Biom Anem Hall 200 B&G Sch	-0.301	0.090	-0.477	-0.125	-3.348	0.001
Cochrane 2014	F5.9E Iron Sup Int NUT Biom Anem Roschnik B&G Sch	0.123	0.209	-0.286	0.532	0.589	0.556
Cochrane 2014	F5.9F Iron Sup Int NUT Biom Anem Roschnik B&G Sch	-0.181	0.108	-0.392	0.030	-1.679	0.093
Cochrane 2014	F5.9G Iron Sup Int NUT Biom Anem Sen 2009 B&G Sch	-0.703	0.406	-1.499	0.093	-1.732	0.083
Cochrane 2014	F5.9H Iron Sup Int NUT Biom Anem Sungthon B&G Sch	-0.174	0.127	-0.422	0.074	-1.374	0.169
Cochrane 2014	F5.9I Iron Sup Int NUT Biom Anem Taylor 2 B&G Sch	-0.161	0.179	-0.512	0.190	-0.898	0.369
		-0.785	0.104	-0.990	-0.580	-7.515	0.000



Effect size and significance				
Model	Number Studies	Point estimate	Significance	Standard error
Random effects	45.000	(0.785)	***	0.104

Heterogeneity				Tau-squared			
Q-value	df (Q)	P-value	I-squared	Tau Squared	Standard Error	Variance	Tau
752.999	44.000	-	94.157	0.441	0.127	0.016	0.664



Egger's regression intercept

Intercept	-4.78098
Standard error	1.39296
95% lower limit (2-tailed)	-7.59014
95% upper limit (2-tailed)	-1.97182
t-value	3.43225
df	43.00000
P-value (1-tailed)	0.00067
P-value (2-tailed)	0.00133