Impact of home food production on nutritional blindness, stunting, wasting, underweight and mortality in children: a systematic review and meta-analysis of controlled trials

Chizoba Bassey[a*], Harriet Crooks[b], Katherine Paterson[c], Rachel Ball[c], Kristoffer Howell[c], Iona Humphries-Cuff[c], Kirsty Gaffigan[c], Nitya Rao[d], Jennifer A. Whitty[a, e], Lee Hooper[a]

[a]Norwich Medical School, University of East Anglia, Norwich, United Kingdom; [b]Student Services, University of East Anglia, Norwich, United Kingdom; [c]Department of Nutrition and Dietetics, Norfolk and Norwich University Hospitals NHS Foundation Trust, Norwich, United Kingdom; [d]School of Developmental Studies, University of East Anglia, Norwich, United Kingdom; [e] National Institute for Health Research (NIHR) Applied Research Collaboration (ARC) East of England, United Kingdom

*Corresponding author: Chizoba Bassey, c.nwabichie@uea.ac.uk, Norwich Medical School, University of East Anglia, Norwich NR4 7TJ, United Kingdom.

Funding acknowledgements

This work was carried out as part of a self-funded PhD (CB). Internal funding was provided by the University of East Anglia for NR, JAW, and LH. J.A. Whitty is supported by the National Institute for Health Research (NIHR) Applied Research Collaboration (ARC) East of England. The views expressed are those of the authors and not necessarily those of the NHS, the NIHR or the Department of Health and Social Care.

Impact of home food production on nutritional blindness, stunting, wasting, underweight and mortality in children: a systematic review and meta-analysis of controlled trials

Vitamin A deficiency is highly prevalent and remains the major cause of nutritional blindness in children in low-and middle-income countries, despite supplementation programmes. Xeropthalmia (severe drying and thickening of the conjunctiva) is caused by vitamin A deficiency and leads to irreversible blindness. Vitamin A supplementation programmes effectively reduce vitamin A deficiency but many rural children are not reached. Home food production may help prevent rural children's vitamin A deficiency. We aimed to systematically review trials assessing effects of home food production (also called homestead food production and agricultural interventions) on xeropthalmia, nightblindness, stunting, wasting, underweight and mortality (primary outcomes).. We searched Medline, Embase, Scopus, Cochrane CENTRAL and trials registers to February 2019. Inclusion of studies, data extraction and risk of bias were assessed independently in duplicate. Random-effects meta-analysis, sensitivity analyses, subgrouping and GRADE were used. We included 16 trials randomizing 2498 children, none reported xerophthalmia, night-blindness or mortality. Home food production may slightly reduce stunting (mean difference (MD) 0.13 (z-score), 95% CI 0.01 to 0.24), wasting (MD 0.05 (z-score), 95% CI -0.04 to 0.14) and underweight (MD 0.07 (z-score), 95% CI -0.01 to 0.15) in young children (all GRADE low-consistency evidence), and increase dietary diversity (standardized mean difference (SMD) 0.24, 95% CI 0.15 to 0.34). Home food production may usefully complement vitamin A supplementation for rural children. Large, long-duration trials with good randomization, allocation concealment and correct adjustment for clustering are needed to assess effectiveness of home food production on nutritional blindness in young children.

Prospero registration: CRD42019126455

(https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42019126455)

Keywords: Retinol; xerophthalmia; night blindness; gardening; infant nutrition disorders; child nutrition disorders; anthropometry; meta-analysis

Word count: 4968

Introduction

Approximately 250 million preschool children are vitamin A deficient (WHO, 2018). Vitamin A deficiency is the main global cause of preventable childhood blindness with about 2.8 million preschool-age children at risk of blindness (WHO, 2009). Vitamin A deficiency also increases the risk of mortality from other childhood diseases such as diarrhea and measles and plays a significant role in normal immune function (UNICEF, 2018). Vitamin A deficiency remains one of the most prevalent micronutrient deficiencies globally, being most predominant in low and middle income countries (Bahreynian et al., 2017).

Nutritional blindness in children is caused by vitamin A deficiency and manifests as xerophthalmia which is an array of ocular signs and symptoms. Xerophthalmia presents as night blindness, Bitot's spots, conjunctival xerosis, corneal xerosis, corneal ulcer, corneal scarring and keratomalacia. It mainly affects children under 5 years of age, with the greatest concentration in preschool children. Once the cornea becomes ulcerated and melts away, blindness becomes irreversible (Gilbert, 2013). Xerophthalmia is predominantly caused by an insufficient intake of vitamin A (Akhtar et al., 2013).

One of the major causes of vitamin A deficiency is insufficient dietary intake of foods rich in vitamin A (including retinol, retinal, retinoic acid, and pro-vitamin A carotenoids such as beta-carotene) (Wirth et al., 2017). Vitamin A deficiency is more prevalent in children living in rural areas (Sherwin et al., 2012; Schemann et al., 2007; Dole et al., 2009; Hanson et al., 2016). A cross sectional study carried out in the Democratic Republic of Congo by Samba et al. (2006) revealed that larger quantities of vitamin A-rich foods were consumed in urban than rural areas. Bitot's spots were significantly more prevalent in children of lower socioeconomic status ($P < 0.001$) in a cross-sectional survey from rural India by Arlappa et al. (2011) and there was a gross deficiency of vitamin A-rich food in rural areas.

Programmes of high dose vitamin A supplementation occur in 82 countries, and involve supplementing children aged 6 to 59 months with retinol twice yearly (UNICEF, 2018). According to a systematic review and meta-analysis of randomized controlled trials carried out by Imdad et al in 2017, vitamin A supplementation caused a 12% reduction in all-cause mortality (Risk Ratio (RR) 0.88, 95% CI 0.83 – 0.93). It also reduced the risk of diarrhea (RR 0.85, 95%Cl 0.82 – 0.87), measles (RR 0.50, 95%Cl 0.37 – 0.67), night blindness (RR 0.32, 95% Cl 0.21 – 0.50) and Bitot's spots (RR 0.42 95%Cl 0.33 – 0.53) in children below 5 years of age. Although supplementation programmes are clearly beneficial, programme coverage can be low (Semba et al., 2008). In 2016, vitamin A supplementation programmes reached only 64% of targeted children (UNICEF, 2018). Of the 82 priority countries for vitamin A supplementation, only 57 achieved two-dose coverage (UNICEF, 2018). Coverage is not equitable. Thapa (2008) analyzed data from the 2006 Nepal Demographic and Health Survey, reporting that vitamin A supplementation bypassed the poorest of the poor, illiterate mothers and rural inhabitants. Nguyen et al. (2012) examined associations between vitamin A supplementation program coverage and socio-demographic factors in Nepal. Ironically, they found that children living in rural areas, who are more susceptible to vitamin A deficiency, were less likely to receive vitamin A supplements than children living in urban areas.

Food based approaches may have the potential for achieving sustainability in controlling vitamin A deficiency and can complement vitamin A supplementation programmes (Chakravarty, 2000). Food based approaches include point-of-use fortification with micro-nutrient powders, home food production of vitamin A-rich crops and fortification of staple foods such as oil, wheat flour, sugar with vitamin A (Chakravarty, 2000). Although point-of-use fortification appears easy and efficacious in reducing vitamin A deficiency, achieving high coverage, adherence and appropriate doses (as excessive doses can lead to toxicity) are key challenges that hamper its utility (Dhillon et al. 2017). Food fortification tends to be less useful in resource-poor settings as poorer people make food choices based on price rather than quality (Dary and Mora 2002).

A systematic review assessing the effects of home food production on key outcomes of vitamin A deficiency, including nutritional blindness, in children would help to understand the utility of this approach. Existing systematic reviews (Girard et al., 2012; Masset et al., 2012) that assess effects on vitamin A status and nutritional outcomes in children are outdated and do not assess the impact of home food production on nutritional blindness. This review aims to systematically assess the effectiveness of home food production on nutritional blindness and anthropometric measures in children.

Materials and methods

Our systematic review methodology was based on the Cochrane Handbook (Higgins et al., 2019) and reported using PRISMA guidelines (Moher et al., 2015).

Search strategy

A protocol was developed, registered with PROSPERO (CRD42019126455) and used to ensure methodological rigor. Medline Ovid, Embase Ovid, Scopus, Cochrane Central Register of Controlled Trials and The World Health Organization International Clinical Trial Registry Platform were searched from inception to the 1st of February 2019. A complex search strategy using text words, index terms, truncation and Boolean operators was developed using the following framework: ((children or women) AND (home gardening) AND (RCT OR CCT)) (Lefebvre et al., 2019). See Appendices 1 – 5 in the Supplementary Materials for full search strategies.

Inclusion/exclusion criteria

We included controlled clinical trials (CCTs) (studies with a concurrent intervention and control arm) and randomized controlled trials (RCTs) of at least one year duration. Participants were women of childbearing age. Interventions included were provision of seedlings and/or training in the planting of vitamin A- rich foods and other crops on a piece of land attached to the home or near home primarily for household consumption, training in and/or distribution of chicks for home rearing and consumption with or without behavioral change interventions. The comparator needed to be a non-intervention group or an alternative approach to home gardening. Studies without a comparator and before/after studies were excluded, as were studies that assessed commercial or school farming. Primary outcomes were night blindness, xerophthalmia, all-cause mortality, stunting, wasting, underweight (all assessed in children). Secondary outcomes included family income, children's serum retinol levels, children's dietary diversity, and the cost of intervention.

Data extraction and synthesis

Search results were uploaded to Covidence software (Covidence, 2019). Two independent reviewers screened titles and abstracts, and then full texts using the inclusion/exclusion criteria. Where inclusion of a title/abstract was unclear, or appeared likely, the full text was obtained for full assessment. Conflicts were settled through discussion. A data extraction form bespoke to this review was developed, tested and used in data extraction. Data were extracted and risk of bias assessed by two independent reviewers and conflicts resolved by a third reviewer. The Cochrane risk of bias tool (Higgins et al., 2011) was used in assessing risk of bias in this systematic review, studies were assessed for selection bias, performance bias, detection bias, attrition bias and reporting bias (Higgins et al., 2011). A study outcome was judged to be at low risk of bias if that outcome was at low risk of bias for all domains, otherwise it was judged at high risk of bias (Higgins et al. 2011).

Data were tabulated, meta-analysis and narrative synthesis were used. Random effects meta-analysis (in Review Manager version 5.3 (Review Manager, 2014)) was the default analysis as we assumed included studies had related intervention effects and were similar enough to pool but displayed slightly different effect estimates (Deeks et al., 2019). Statistical heterogeneity was examined using $\mathbf{I^2}$ (Deeks et al., 2019), assuming that $\mathbf{I^2}$ >75% represented important heterogeneity (Deeks et al., 2019). We sub-grouped by methodology – some studies (appropriately) adjusted data for clustering, some adjusted for clustering and other factors such as age, sex, education (important and appropriate where there are few clusters), and some were unadjusted (which is statistically inappropriate). We subgrouped by adjustments to prevent overestimation of effects. Our main analysis included data adjusted for clustering and other factors, to reduce effects of confounding factors resulting from randomization in large clusters.

We ran sensitivity analyses using the fixed effects model of meta-analysis (Deeks et al., 2019). The following subgroups were analyzed for primary outcomes:

- Studies that focused on planting of fruits, vegetables and rearing of chickens versus only planting of fruits and vegetables.
- Studies with a duration of 12 ≤ 24 months versus > 24 months
- Studies conducted in Africa versus studies conducted in Asia.

Small study bias was assessed by comparing random- and fixed-effects meta-analysis results. The quality and consistency of the findings in this review were assessed and reported using

GRADE assessment in GRADEpro GDT (Schunemann et al., 2019, GRADE pro G.D.T, 2015).

Results

In total, 7021 titles and abstracts were retrieved and uploaded to Covidence, 1623 were eliminated as duplicates, and 5398 titles and abstracts were screened using the inclusion and exclusion criteria. One hundred and fifteen full text papers were collected of which 92 were excluded. Twenty-three papers were included and merged into 16 individual included studies (Figure 1). Seven further studies were found eligible but are on-going, with no published outcomes (Supplementary Table 1).

Included studies were conducted in Africa (nine studies) and Asia (seven studies). Eleven studies had a duration of 12 to ≤ 24 months and five studies had a duration of > 24 months. Studies were cluster randomized trials (ten studies), individually randomized trials (one study), and controlled clinical trials (five studies). Gelli et al., 2018 reported their data grouping children into 6 – 24 months and 36 – 72 months of age, so results were reported separately for these two groups. See Table 1 for characteristics of all included studies. Types of intervention in the included studies ranged from training in setting up home gardens, rearing of chicks and other domestic animals, cooking sessions, offer of loans to set up home gardens, training in selling of surplus produce, nutrition education, distribution of seedlings, chicks, orange sweet potato, and other planting materials. Most of the comparator groups had no intervention (Table 1).

Six of the sixteen trials were at low risk of bias from randomization, none from allocation concealment, 3 from blinding of participants and personnel, and 3 from blinding of outcome assessment. All included studies were judged at high risk of bias (See Figure 2 for risk of bias details trial by trial and Appendix 8 in supplementary materials for details of risk of bias assessment). Omitting participant blinding from this assessment (as it is unrealistic to expect this for such and intervention) all included studies would still be at high risk of bias.

Of the 16 included studies, twelve provided data that could be included in meta-analysis. The remaining four studies (Raneri et al., 2017; Lakzadeh et al., 2016; Low et al., 2007; Schreinemachers et al., 2016) reported income, cost of intervention and dietary diversity. Results are shown study by study in Supplementary Tables 2 and 3

Primary Outcomes

Effects of home food production on xerophthalmia, night blindness and mortality in children less than 5 years old

This review found no evidence of effects of home food production on these outcomes as no trials assessed or reported them.

Effect of home food production on stunting (height-for-age) in children less than 5 years of age

Evidence of low-certainty showed that home food production may improve height-for-age in children.

Eight studies (Gelli et al., 2018; Osei et al., 2015; Olney et al., 2015; Khamhoung et al., 2000, Reinbott et al., 2016; Kuchenbecker et al., 2017; Olney et al., 2009; Marquis et al., 2017) reported on stunting and were all included in meta-analysis. Home food production increased height-for-age in children compared to control arm children in the highest quality data - adjusted for clustering and other factors (mean difference MD 0.13 (z score), 95% CI 0.01 to 0.24, six studies, 5469 participants, I^2 = 84%, Figure 3). This finding was supported by data adjusted for clustering only (MD 0.24 (z score), 95% CI 0.00 to 0.48, I^2 = 41%), though the lowest quality data, unadjusted for clustering, did not (MD 0.03 (z score), 95% CI -0.05 to 0.12, I^2 = 0%). However, sensitivity analysis using fixed-effects analysis produced differing results (data adjusted for clustering and other factors - MD 0.00 (z score), 95% CI -0.01 to 0.01).

Heterogeneity was partly explained by subgrouping by type of intervention. A positive effect was suggested in studies that combined home gardening and poultry keeping (MD 0.17 (z score), 95% CI -0.03 to 0.32, I^2 = 86%), but less effect (MD 0.06 (z score), 95% CI -0.20 to 0.80, I^2 = NA) was suggested in studies that practiced only home gardening (difference in p value between subgroups P =0.02). Effect sizes did not differ by duration (P = 0.63) or continent (P = 0.77).

Some studies reported prevalence of stunting as well as using z-scores. Meta-analysis of prevalence data suggested that home food production reduced the prevalence of stunting in children (data adjusted for clustering, risk ratio (RR) 0.86, 95% CI 0.66 to 1.12, 206 participants, one study; unadjusted data RR 0.95, 95% CI 0.88 to 1.03, 3885 participants, four studies, I^2 = 52%). Supplementary Table 4 shows all analyses for stunting.

GRADE assessment suggested low-certainty evidence that home gardening may reduce stunting in young children (downgraded once each for risk of bias and inconsistency, see Table 2).

Effect of home food production on wasting (weight-for-height) in children less than 5 years of age

Evidence of low-certainty showed that home food production may slightly improve weight-for-height in children.

Eight studies (Gelli et al., 2018; Osei et al., 2015; Olney et al., 2015; Khamhoung et al., 2000, Reinbott et al., 2016; Kuchenbecker et al., 2017; Olney et al., 2009; Marquis et al., 2017) reported wasting and were included in meta-analysis (Figure 4). Meta-analysis suggested a small benefit of home gardening on wasting (data adjusted for clustering and other factors - MD 0.05 (z score), 95% CI -0.04 to 0.14, $I^2 = 61\%$, five studies, 4510 participants), echoed in data adjusted only for clustering, but not unadjusted data. Heterogeneity was partially explained by subgrouping by continent, with greater effects in Asia (MD 0.59 z score, 95% CI 0.15 to 1.04, $I^2 = 48\%$) than Africa (MD 0.04 z score, 95% CI -0.03 to 0.11), (P for differences between subgroups = 0.021). We found no important differences between subgroups when subgrouping by duration (P = 0.22) or intervention type (P = 0.49).

Sensitivity analysis (using fixed effects) supported this small beneficial effect of home gardening (MD 0.09 z score, 95% CI 0.08 to 0.10), as did the single study on prevalence of wasting in children with home gardening interventions (data adjusted for clustering, RR 0.91, 95% CI 0.44 to 1.87, 206 participants). Supplementary Table 5 shows all the analyses for wasting.

GRADE assessment suggested low-certainty evidence that home gardening may slightly reduce wasting in young children (downgraded once each for risk of bias and imprecision, see Table 2).

Effect of home food production on underweight (weight-for-age) in children less than 5 years of age

Evidence of low certainty showed that home food production may slightly reduce underweight in children.

Seven studies (Kuchenbecker et al. 2017, Olney et al., 2015, Olney et al., 2009, Osei et al., 2015, Marquis et al., 2017, Gelli et al., 2018, Reinbott et al., 2016) were included in meta-analysis. Data adjusted for clustering and other factors suggested a small improvement in z-score for underweight (MD 0.07 z score, 95% CI -0.01 to 0.15, five studies, 4510 participants, I^2 =53%), supported by data adjusted only for clustering (MD 0.16 z score, 95% CI -0.02 to 0.34, two studies, 707 participants, I^2 = 0%, unadjusted data (MD 0.03 z score, 95% CI -0.05 to 0.11, three studies, 2751 participants, I^2 = 0%, Figure 5), and fixed effects sensitivity analysis (MD 0.05 z score, 95% CI 0.04 to 0.06). There was no important heterogeneity, and no important differences between subgroups by duration (P = 0.77), type of intervention (P = 0.18) or continent (P = 0.43).

Data on prevalence of underweight also showed a small benefit of home gardening though not statistically significant (data adjusted for clustering RR 0.82, 95% CI 0.57 to 1.19, one study, 206 participants; unadjusted data RR 0.95, 95% CI 0.86 to 1.05, four studies, 3888 participants, I^2 = 25%). Supplementary Table 6 shows all the analyses for underweight.

GRADE assessment suggested evidence of low certainty that home food production slightly reduced underweight in children (downgraded for risk of bias and imprecision, Table 2).

Secondary Outcomes

Effects of home food production on serum retinol in children aged less than 5 years old

The effect of home food production on serum retinol was unclear. Three studies, all at high risk of bias (Faber et al., 2002; Kidala et al., 2000; Hotz et al., 2012 Uganda) reported serum retinol in children and were included in meta-analysis, but only one of these studies reported data adjusted for clustering. Home food production did not affect serum retinol (Figure 6, data adjusted for clustering and other factors MD -0.01umol/l, 95 % CI -0.06 to 0.05, one study, 413 participants; unadjusted data MD -0.07umol/l, CI -0.37 to 0.24, two studies, 367 participants, I^2 = 92%). This was confirmed in fixed effects analysis (MD -0.01umol/l, 95% CI -0.06 to 0.05). With a single adjusted trial subgrouping was not possible, and prevalence data were not reported. Supplementary Table 7 shows all serum retinol analyses.

Effect of home food production on dietary diversity in children less than 5 years of age

Six studies (Gelli et al., 2018, Raneri et al., 2017., 2017; Reinbott et al., 2016; Marquis et al., 2017; Kuchenbecker et al., 2017and Olney et al. 2009) reported dietary diversity. Three studies (Gelli et al., 2018; Kuchenbecker et al., 2017 and Olney et al., 2009) could be included in meta-analysis (reported in a format that could be pooled statistically, Figure 7). For all studies, the higher the score, the higher dietary diversity in a population. Random effects meta-analysis showed that home food production increased dietary diversity in children compared to the control arm (standardized mean difference (SMD) 0.24, 95% CI 0.15 to 0.34, three studies, 2643 participants, I^2 = 0%), supported by the exact same result from fixed effects analysis . Supplementary Table 8 shows all dietary diversity analyses.

Increased dietary diversity in children of intervention arms were supported by all three studies not included in meta-analysis (Raneri et al., 2017, Reinbott et al., 2016 and Marquis et al., 2017). Raneri et al., 2017showed 18% increase in minimum dietary diversity score in children in the intervention arm compared to the control arm (in the intervention arm, minimum dietary diversity increased by 0.4, P <0.01). Reinbott et al., 2016 reported mean child dietary diversity score 3.9 (SD 1.5) for the intervention arm and 3.7 (SD 1.5) for the control arm (921 children). Marquis et al., 2017 reported minimum dietary diversity of 80.2% in the intervention arm and 69.5% in the control arm (500 children, P = 0.02).

Although consumption of vitamin A-rich foods was not a pre-specified outcome of this review, post hoc we felt collecting and reporting these data may be useful. Eight studies (Kuchenbecker et al., 2017; Low et al., 2007; Hotz et al., 2012 for Mozambique; Lakzadeh et al., 2016; Hotz et al., 2012 for Uganda; Raneri et al., 2017., 2017; Reinbott et al., 2016; Marquis et al., 2016) showed that home food production increased the consumption of vitamin A-rich foods. However, 3 studies (Lakzadeh et al., 2016; Kuchenbecker et al., 2017 and Hotz et al., 2012 for Mozambique) were not statistically significant (Supplementary Table 3).

Meta-analysis and other trials suggested that home food production improved dietary diversity and vitamin-A rich food consumption in children, but the quality of this evidence is very low. Secondary outcomes were not formally assessed using GRADE.

Effect of home food production on family income

Four studies (Olney et al., 2009; Schreinemachers et al., 2016; Lakzadeh et al., 2016; Low et al., 2007) reported on income generated by home food production through sale of surplus produce but could not be pooled statistically as they lacked useable variance data. These studies all showed that home food production can generate additional income for the household. Low et al., 2007 reported a mean revenue from home food production US$ 3.17 ± 2.91 from orange sweet potato sales in Mozambique. Olney et al., 2009 showed that household income increased in home food production by 14.2% ($P <0.05$) compared to the control arm in Cambodia. Lakzadeh et al., 2016 reported a mean income of 1. 58 ($P < 0.001$) from home garden and fishpond in Cambodia. Schreinemachers et al., 2016 reported a mean income of -1.4 ($P = 0.798$) in Bangladesh (See Supplementary Table 3).

Cost of intervention

The cost of setting up a home garden was reported by two studies (Schreinemachers et al., 2016; Lakzadeh et al., 2016). Schreinemachers et al., 2016 reported that the cost of setting up a home garden in Bangladesh (project costs, women's opportunity cost and seedlings) was $23.2 USD per annum per garden while Lakzadeh et al. (2010) reported a cost of $220 USD for 22 months per garden and $239 for a garden, fish pond and training per household in Cambodia (Supplementary Table 3).

Discussion

This systematic review aimed to assess effects of home food production on nutritional blindness, mortality, anthropometric measures, vitamin A status and dietary diversity in young children. No studies assessed xerophthalmia, night blindness or mortality, but evidence was found amongst the 16 included trials (2498 children) for the remaining outcomes. Evidence of low-certainty showed that introduction of home food production may slightly improve height-for-age (stunting), weight-for-height (wasting) and weight-for-age (underweight) in young children. Clinically, for a 24-month old boy, to move from a height-for-age z-score of -2 to -1, 3.1cm in height is achieved, or 3.2cm for a girl (WHO, 2006). A boy of 24 months needs a weight gain of 1.1kg to move from a weight-for-age z-score of -2 to -1 and a girl 1.2kg. At a height of 109.5cm, 1.3kg and 1.4kg weight gain will move a boy or girl from a weight-to-height z score of -2 to -1 respectively (WHO, 2006). Limited evidence suggested no effect on children's serum retinol levels, but an increase in children's dietary diversity and household income.

This review included only studies that had an intervention and control arm. Despite this, all the studies were assessed as being of poor methodological quality. GRADE assessments were mainly downgraded due to high risk of bias of the included studies and the wide confidence intervals of the results (high levels of imprecision). Most studies were unclear on whether allocation concealment was adequate, which throws the studies open to selection bias. Most studies were unclear on whether or how participants, personnel and outcome assessors were blinded. Many of the included studies did not adjust for their clustered methodology. Overall, the evidence in this review is of low quality.

We identified seven on-going trials that will add to existing evidence and may change the findings of this review (Supplementary Table 1). This systematic review attempted to limit bias in our own methodology by adhering strictly to Cochrane methods of conducting systematic reviews. From the screening of titles to data extraction, two independent reviewers were involved, and conflicts were all resolved through discussion. Protocols were not found for most of the included studies, so it was not possible to assess outcome reporting bias. It is possible we missed some studies published in languages other than English, or published in the grey literature, such as government and charity websites.

Comparison with results of other research

A systematic review by Masset et al. (2012) included 23 clinical controlled trials and assessed the effectiveness of agricultural interventions on the nutritional status of children in low-and middle-income countries. The review found little evidence that home gardening interventions had positive effects on children's serum retinol (MD 2.4 µg/dL, 95% CI 1.67 to 3.16). Nineteen included studies reported that home gardening improved dietary diversity, however they could not summarize across studies as the included studies measured dietary diversity in different ways. Also, the review found limited evidence that home gardening interventions increased household incomes but did not provide details on the extent of increase.

A similar systematic review by Girard et al. (2012) assessed the effectiveness of agricultural interventions on nutritional outcomes in children and women. It included 36 studies of which 32 reported on nutritional outcomes for children, finding inconsistent results for vitamin A status. All were quasi-experimental apart from one RCT. School gardening has been recently systematically reviewed by Ohly et al. (2016) using both quantitative and qualitative evidence. Ohly and colleagues included 40 studies. The quantitative evidence was of poor quality and reported that there was limited improvement in the intake of fruits and vegetables. Qualitative evidence was of a higher quality and demonstrated healthier food consumption in children with school gardening programmes.

Our systematic review was limited to higher quality trials and included more recent research. Our results are similar to those of Masset et al. (2012) and Girard et al. (2012). However, our review differed from the previous reviews regarding children's serum retinol. While they found small positive or inconsistent effects on serum retinol, our review reports that home food production did not affect serum retinol in children. Neither Girard et al. (2012) or

Masset et al. (2012) reported blindness-related outcomes. To the best of our knowledge, our systematic review is the first to investigate the impact of home food production on nutritional blindness in children, attempting to assess blindness-related outcomes. We did not find studies that reported blindness-related outcomes.

Our review suggested that home gardening including poultry production may be more effective at reducing stunting than home gardening alone. Prado et al. (2020) conducted an RCT that supplied one egg per day for six months to children aged 6 to 15 months in Malawi. They found no effect of the egg in an eye-tracking task.

Implications for Practice

This systematic review found that home food production may slightly reduce stunting, wasting and underweight in children. No study reported effects of home food production on xerophthalmia, night blindness or mortality in children, and no effects on serum retinol were found. Hence, while home food production can support anthropometric improvements, it is not clear whether it can reduce nutritional blindness in children. Better-evidenced interventions such as vitamin A supplementation programs should be adopted and expanded to children at greatest risk to prevent nutritional blindness until there is enough evidence on effects of home food production. However, introduction of home food production to improve nutritional stunting, wasting and underweight may be appropriate in areas where these are prevalent and more intensive nutritional support is not available. Home food production may be needed in low and middle income countries as 35 low and middle income countries showed a high prevalence of stunting (38.8%, 95% CI 38.6%-38.9%), wasting (12.9%, 95% CI, 12.8%-13.0%) and underweight (27.5% 95% CI 27.3% -27.6%) in 299, 353 children (Li et al., 2020).

Implications for Research

Effects of home gardening on serum retinol were inconclusive as few studies of poor quality reported on it. Large-scale high-quality trials that actively minimize selection bias, performance bias and detection bias are needed to assess effects of home food production on serum retinol as well as ophthalmic outcomes (such as night blindness, conjunctival dryness, bitot's spots), mortality, stunting, wasting and underweight in children. For example, using a common center for collection of data (rather than doing data collection at the houses of participants) and separating intervention and control geographically may help to avoid performance and detection bias. Large sample sizes, including larger numbers of small clusters, should be used to improve sample size issues, and correct adjustment for clustering effects should be routine. Adjusting for clustering prevents overestimation of statistical significance of research impact thereby avoiding biased results. One major advantage of clustering is that contamination is appropriately managed, and it is an effective way of measuring the overall effects of an intervention across a population.

Researchers should record and analyze other factors that might affect the impact of home food production on nutritional status such as deworming, environmental sanitization and potable water availability, alongside the formal results of the trial, ensuring that they are randomly distributed amongst the clusters. Even better, a factorial design could be used to assess effects of improving these factors in conjunction with home food production on nutritional blindness in children.

Choosing the right crops for the intervention (ensuring that many are rich in Vitamin A, and that they can be consumed for a large part of the year) and collection of data at the right time of the year is important when planning trials. Interventions should be culturally specific in addressing barriers and facilitators to home gardening, rallying community support, ensuring water supplies, training on foods high in vitamin A, cooking lessons for these foods and ensuring these are locally enjoyed and accepted. Future large trials should also assess and report cost-effectiveness of home food production, and barriers and facilitators in its implementation.

Conclusion

Our review has shown that home food production may be useful in enhancing anthropometric measures in children. Home food production may, if shown to be cost-effective, be important as an integral part of other evidence-based interventions such as vitamin A supplementation in tackling stunting, wasting and underweight in children. It is likely to have a role particularly in rural areas where children are not well covered by vitamin A supplementation programs. This review may be helpful towards the global action plan launched in 2020 by the United Nations partners to urgently act towards eliminating wasting in children (WHO, 2020). Few studies, all of poor quality reported the effect of home food production on serum retinol in children. We consider the results on serum retinol inconclusive until high quality trials are carried out

Conflicts of interest

The authors state that they have no conflict of interests

References

Akhtar, S., Ahmed, A., Randhawa, M.A., Atukorala, S., Arlappa, N., Ismail, T. and Ali, Z. 2013. Prevalence of vitamin A deficiency in South Asia: causes, outcomes, and possible remedies. *Journal of health, population, and nutrition*. *31*(4) : 413.

Arlappa, N., Balakrishna, N., Laxmaiah, A., Raghu, P., Vikas Rao, V., Madhavan Nair, K. and Brahmam, G.N.V. 2011. Prevalence of vitamin A deficiency and its determinants among the rural pre-school children of Madhya Pradesh, India. *Annals of human biology*. *38*(2) : 131-136.

Atuobi-Yeboah, A., Marquis, G.S., Colecraft, E., Kanlisi, R., Aryeetey, R. and Klevor, M., 2016. An integrated nutrition-sensitive health and agriculture intervention to increase egg consumption among infants and young children in Upper Manya Krobo, Ghana. *The FASEB Journal*. *30*(1) : 274-5.

Bahreynian, M., Qorbani, M., Naderimagham, S., Nejatinamini, S., Ataie-Jafari, A., Sharifi, F., Saqib, F., Khajavi, A., Mansourian, M., Ahmadishokouh, A.A. and Asayesh, H. 2017. Burden of disease attributable to vitamin A deficiency in Iranian population aged less than five years: findings from the global burden of disease study 2010. *Journal of Diabetes & Metabolic Disorders. 16*(1) : 32.

Chakravarty, I. 2000. Food-based strategies to control vitamin A deficiency. *Food and nutrition Bulletin*. *21*(2) : 135-143.

Covidence. 2019. Community.Cochrane.org. [online] Available at: https://community.cochrane.org/help/tools-and-software/covidence [Accessed 30 Nov. 2018].

Dary, O. and Mora, J.O. 2002. Food fortification to reduce vitamin A deficiency: International Vitamin A Consultative Group recommendations. *The Journal of nutrition*, *132*(9) : 2927S-2933S.

Deeks, J.J., Higgins, J.P., Altman, D.G. and Cochrane Statistical Methods Group. 2019. Analysing data and undertaking meta-analyses. *Cochrane handbook for systematic reviews of interventions*. 241-284.

Dole, K., Gilbert, C., Deshpande, M. and Khandekar, R. 2009. Prevalence and determinants of xerophthalmia in preschool children in urban slums, Pune, India—a preliminary assessment. *Ophthalmic epidemiology*. *16*(1) : 8-14.

Faber, M., Phungula, M.A., Venter, S.L., Dhansay, M.A. and Benadé, A.S. 2002. Home gardens focusing on the production of yellow and dark-green leafy vegetables increase the serum retinol concentrations of 2–5-y-old children in South Africa. *The American journal of clinical nutrition*, *76*(5) : 1048-1054.

Gelli, A., Margolies, A., Santacroce, M., Roschnik, N., Twalibu, A., Katundu, M., Moestue, H., Alderman, H. and Ruel, M. 2018. Using a community-based early childhood development center as a platform to promote production and consumption diversity increases children's dietary intake and reduces stunting in Malawi: a cluster-randomized trial. *The Journal of nutrition*. *148*(10) : 1587-1597.

Gilbert, C. and Foster, A. 2001. Childhood blindness in the context of VISION 2020: the right to sight. *Bulletin of the World Health Organization*. *79*:227-232.

Girard, A.W., Self, J.L., McAuliffe, C. and Olude, O. 2012. The effects of household food production strategies on the health and nutrition outcomes of women and young children: a systematic review. *Paediatric and Perinatal Epidemiology*. (*26*) : 205-222.

GRADEpro, G.D.T. 2015. Computer program. *McMaster University (developed by Evidence Prime). GRADEpro GDT. Hamilton (ON): McMaster University (developed by Evidence Prime)*

Hanson, C., Lyden, E., Abresch, C. and Anderson-Berry, A. 2016. Serum retinol concentrations, race, and socioeconomic status in of women of childbearing age in the United States. *Nutrients*. *8*(8) : 508.

Higgins, J.P., Altman, D.G., Gøtzsche, P.C., Jüni, P., Moher, D., Oxman, A.D., Savović, J., Schulz, K.F., Weeks, L. and Sterne, J.A. 2011. The Cochrane Collaboration’s tool for assessing risk of bias in randomised trials. *BMJ*. *343 :* 5928.

Hotz, C., Loechl, C., de Brauw, A., Eozenou, P., Gilligan, D., Moursi, M., Munhaua, B., van Jaarsveld, P., Carriquiry, A. and Meenakshi, J.V. 2012. A large-scale intervention to introduce orange sweet potato in rural Mozambique increases vitamin A intakes among children and women. *British journal of nutrition*. *108*(1) : 163-176.

Hotz, C., Loechl, C., Lubowa, A., Tumwine, J.K., Ndeezi, G., Nandutu Masawi, A., Baingana, R., Carriquiry, A., de Brauw, A., Meenakshi, J.V. and Gilligan, D.O. 2012. Introduction of β-carotene–rich orange sweet potato in rural Uganda resulted in increased vitamin A intakes among children and women and improved vitamin A status among children. *The Journal of nutrition*. *142*(10) : 1871-1880.

Imdad, A., Mayo-Wilson, E., Herzer, K., & Bhutta, Z. A. 2017. Vitamin A supplementation for preventing morbidity and mortality in children from six months to five years of age. *Cochrane Database of Systematic Reviews*. *2017*(3).

Khamhoung, K., Bodhisane, N., Pathammavong, C., Ouenvilay, S., Senthavisouk, B., Pongpaew, P., Tungtrongchitr, R., Phonrat, B., Saowakontha, S., Merkle, A. and Schelp, F.P., 2000. Nutritional status of pre-school children and women in selected villages in the Suvannakhet Province, Lao PDR--an intervention trial. *The Southeast Asian journal of tropical medicine and public health*. 31 : 63-74.

Kidala, D., Greiner, T. and Gebre-Medhin, M. 2000. Five-year follow-up of a food-based vitamin A intervention in Tanzania. *Public Health Nutrition*. *3*(4) : 425-431.

Kuchenbecker, J., Reinbott, A., Mtimuni, B., Krawinkel, M.B. and Jordan, I. 2017. Nutrition education improves dietary diversity of children 6-23 months at community-level: Results from a cluster randomized controlled trial in Malawi. *PloS one*. *12*(4).

Lakzadeh, P. 2016. Economic evaluation of a novel homestead food production program in rural Cambodia. PhD Diss., University of British Columbia.

Lefebvre, C., Glanville, J., Briscoe, S., Littlewood, A., Marshall, C., Metzendorf, M.I., Noel-Storr, A., Rader, T., Shokraneh, F., Thomas, J. and Wieland, L.S. 2019. Searching for and selecting studies. *Cochrane Handbook for Systematic Reviews of Interventions*. 67-107.

Li Z, Kim R, Vollmer S, Subramanian SV. Factors Associated With Child Stunting, Wasting, and Underweight in 35 Low-and Middle-Income Countries. *JAMA Netw Open.* 2020;3(4):203386. doi:10.1001/jamanetworkopen.2020.3386

Low, J.W., Arimond, M., Osman, N., Cunguara, B., Zano, F. and Tschirley, D. 2007. Ensuring the supply of and creating demand for a biofortified crop with a visible trait: lessons learned from the introduction of orange-fleshed sweet potato in drought-prone areas of Mozambique. *Food and Nutrition Bulletin*. *28*(2) : S258-S270.

Marquis, G.S., Colecraft, E.K., Kanlisi, R., Aidam, B.A., Atuobi-Yeboah, A., Pinto, C. and Aryeetey, R. 2018. An agriculture–nutrition intervention improved children's diet and growth in a randomized trial in Ghana. *Maternal & child nutrition*. *14* : 12677.

Masset, E., Haddad, L., Cornelius, A. and Isaza-Castro, J. 2012. Effectiveness of agricultural interventions that aim to improve nutritional status of children: systematic review. *BMJ*. *344* : 8222.

Moher, D., Shamseer, L., Clarke, M., Ghersi, D., Liberati, A., Petticrew, M., Shekelle, P. and Stewart, L.A. 2015. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Systematic reviews*. *4*(1) : 1.

Nguyen, A.M., Grover, D.S., Sun, K., Raju, V.K., Semba, R.D. and Schaumerg, D.A. 2012. Coverage of the vitamin A supplementation programme for child survival in Nepal: success and challenges. *Paediatrics and international child health*. *32*(4) : 233-238.

Nyhus Dhillon, C., Sarkar, D., Klemm, R.D., Neufeld, L.M., Rawat, R., Tumilowicz, A. and

Namaste, S.M. 2017. Executive summary for the micronutrient powders consultation: Lessons learned for operational guidance. *Maternal & Child Nutrition*. *13* : 12493.
Ohly, H., Gentry, S., Wigglesworth, R., Bethel, A., Lovell, R. and Garside, R. 2016. A systematic review of the health and well-being impacts of school gardening: synthesis of quantitative and qualitative evidence. *BMC Public Health*. *16*(1) : 286.
Olney, D., Pedehombga, A., Ruel, M. and Dillon, A. 2013. Participation in an integrated homestead food production and nutrition and health-related education program increased children's hemoglobin levels in burkina faso. *Annals of Nutrition and Metabolism*. *63*.
Olney, D.K., Pedehombga, A., Ruel, M.T. and Dillon, A. 2015. A 2-year integrated agriculture and nutrition and health behavior change communication program targeted to women in Burkina Faso reduces anemia, wasting, and diarrhea in children 3–12.9 months of age at baseline: a cluster-randomized controlled trial. *The Journal of nutrition*. *145*(6) : 1317-1324.
Olney, D.K., Talukder, A., Iannotti, L.L., Ruel, M.T. and Quinn, V. 2009. Assessing impact and impact pathways of a homestead food production program on household and child nutrition in Cambodia. *Food and Nutrition Bulletin*. *30*(4) : 355-369.
Osei, A., Pandey, P., Nielsen, J., Pries, A., Spiro, D., Davis, D., Quinn, V. and Haselow, N. 2017. Combining home garden, poultry, and nutrition education program targeted to families with young children improved anemia among children and anemia and underweight among nonpregnant women in Nepal. *Food and Nutrition Bulletin*. *38*(1) : 49-64.
Osei, A.K., Pandey, P., Spiro, D., Adhikari, D., Haselow, N., De Morais, C. and Davis, D. 2015. Adding multiple micronutrient powders to a homestead food production programme yields marginally significant benefit on anaemia reduction among young children in Nepal. *Maternal & child nutrition*. *11* : 188-202.
Prado, E.L., Maleta, K., Caswell, B.L., George, M., Oakes, L.M., DeBolt, M.C., Bragg, M.G., Arnold, C.D., Iannotti, L.L., Lutter, C.K. and Stewart, C.P. 2020. Early Child Development Outcomes of a Randomized Trial Providing 1 Egg Per Day to Children Age 6 to 15 Months in Malawi. *The Journal of Nutrition*. DOI: https://doi.org/10.1093/jn/nxaa088
Pries, A., Osei, A., Pandey, P., Adhikari, D., Sharma, N., Davis, D., Nielsen, J., Quinn, V. and Haselow, N. 2013. Impact of homestead food production on the nutritional status of children 12-48 months and their mothers in baitadi district, nepal. *Annals of Nutrition and Metabolism*. *63*.
Raneri, J. E., Hoang, K., Berti, P., Kennedy, G., and Lachat, C. 2017. Promotion of local agrobiodiversity improves diets of women and children in north west vietnam: a cluster rct. in *Annals of nutrition and metabolism*. 71 : 408-409.
Reinbott A.; Schelling A.; Jordan I.; Krawinkel M.B. 2018. Effectiveness of a nutrition education linked to agricultural interventions to improve infant and young child feeding practices, perceptions, and nutritional status in Cambodia, *Maternal and Child Nutrition. 14(2)*
Reinbott, A., Schelling, A., Kuchenbecker, J., Jeremias, T., Russell, I., Kevanna, O., Krawinkel, M.B. and Jordan, I. 2016. Nutrition education linked to agricultural interventions improved child dietary diversity in rural Cambodia. *British Journal of Nutrition*. *116*(8) : 1457-1468.
Review Manager (RevMan). 2014. Version 5.3. Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration.
Samba, C., Tchibindat, F., Houze, P., Gourmel, B. and Malvy, D. 2006. Prevalence of infant vitamin A deficiency and undernutrition in the Republic of Congo. *Acta tropica*. *97*(3) : 270-283.
Semba, R., de Pee, S., Sun, K., Bloem, M. and Raju, V. 2007. Coverage of the National Vitamin A Supplementation Program in Ethiopia. *Journal of Tropical Pediatrics*. 54(2) : 141-144.
Schemann, J.F., Malvy, D., Zefack, G., Traoré, L., Sacko, D., Sanoussi, B., Banou, A.A., Boré, O., Coulibaly, S. and Moutchaidine, M.E. 2007. Mapping xerophthalmia in Mali: results of a national survey on regional distribution and related risk factors. *Journal of the American College of Nutrition*. *26*(6) : 630-638.

Schreinemachers, P., Patalagsa, M.A. and Uddin, N. 2016. Impact and cost-effectiveness of women's training in home gardening and nutrition in Bangladesh. *Journal of Development Effectiveness*. *8*(4) : 473-488.

Schunemann, H.J., Higgins, J.P., Vist, G.E., Glasziou, P., Akl, E.A., Skoetz, N., Guyatt, G.H. and Cochrane GRADEing Methods Group (formerly Applicability and Recommendations Methods Group) and the Cochrane Statistical Methods Group. 2019. Completing 'Summary of findings' tables and grading the certainty of the evidence. *Cochrane Handbook for Systematic Reviews of Interventions*. 375-402.

Sherwin, J.C., Reacher, M.H., Dean, W.H. and Ngondi, J. 2012. Epidemiology of vitamin A deficiency and xerophthalmia in at-risk populations. *Transactions of the Royal Society of Tropical Medicine and Hygiene*. *106*(4) : 205-214.

Talukder A.; Mundy G.; Hou K.; Stormer A.; Michaux K.; McLean J.; Whitfield K.C.; Lynd L.; Green T.J.; Wesley A. 2017. The role of small scale aquaculture and enhanced homestead food production in improving household food security and nutrition *Annals of Nutrition and Metabolism. 71(2):214-215*

Thapa S. 2010. Nepal's vitamin A supplementation programme, 15 years on: Sustained growth in coverage and equity and children still missed. *Global Public Health*. 5(4) : 325-334, DOI: 10.1080/17441690802676352

United Nations International Children's Emergency Fund. 2018. *Coverage at a Crossroads: New directions for Vitamin A supplementation programmes - UNICEF DATA*. AccessedSep 11, 2018. https://data.unicef.org/resources/vitamin-a-coverage/

Verbowski, V., Talukder, Z., Hou, K., Sok Hoing, L., Michaux, K., Anderson, V., Gibson, R., Li, K.H., Lynd, L.D., McLean, J. and Green, T.J. 2018. Effect of enhanced homestead food production and aquaculture on dietary intakes of women and children in rural Cambodia: A cluster randomized controlled trial. *Maternal & child nutrition*. *14*(3) : 12581.

Wirth, J.P., Petry, N., Tanumihardjo, S.A., Rogers, L.M., McLean, E., Greig, A., Garrett, G.S., Klemm, R.D. and Rohner, F. 2017. Vitamin A supplementation programs and country-level evidence of vitamin A deficiency. *Nutrients*. *9*(3) : 190.

World Health Organization. 2006. WHO child growth standards: length/height-for-age, weight-for-age, weight-for-length, weight-for-height and body mass index-for-age: methods and development. World Health Organization.

World Health Organization. 2009. Global prevalence of vitamin A deficiency in populations at risk 1995-2005: WHO global database on vitamin A deficiency.

World Health Organization International. 2018. *WHO | Global prevalence of Vitamin A Deficiency*. / Accessed Sep 10, 2018. http://www.who.int/nutrition/publications/micronutrients/vitamin_a_deficiency/WHO_NUT_95.3/en.

World Health Organization. 2020. Global Action Plan on Child Wasting: A framework for action to accelerate progress in preventing and managing child wasting and the achievement of the Sustainable Development Goals. *WHO Department of Nutrition and Food Safety*. Accessed March 10, 2020. https://www.who.int/who-documents-detail/global-action-plan-on-child-wasting-a-framework-for-action.

Table 1. Characteristics of included studies

Study (reference)	Country	Duration of study	Setting	Study design	No. of clusters	Age of children	Age of women	Type of intervention
Faber 2002 (Faber et al., 2002)	South Africa	2 years	Rural	CCT	NR	2 – 5 years	NR	Training in home gardens and nutrition education. Control arm received no intervention.
Gelli 2018 (Gelli et al., 2018)	Malawi	1 year	Rural	Cluster RCT	10	6 – 72 months	>14	Training in agricultural practices and distribution of chicks and seedlings. Loans granted to households, cooking sessions, nutrition education. Control group was exposed to child nutrition education
Hotz 2012 Mozambique (Hotz et al., 2012)	Mozam-bique	3 years	Rural	Cluster RCT	72 clusters	6 – 35 months	Mean age 28.9	Distribution of orange sweet potato vines and nutrition education, demand creation. Control was exposed to no intervention
Hotz 2012 Uganda (Hotz et al., 2012)	Uganda	2 years	Rural	Cluster RCT	NR	6 – 35 months. 3 – 5 years	Mean age of 34.0	Distribution of orange sweet potato vines and nutrition education, demand creation. Control group had no intervention

Khamhoung 2000 (Khamhoung et al., 2000)	LAO	2 years	Rural	CCT		Preschool children	15 – 45 years	Training on setting up home gardens and animal rearing. Control group received no intervention
Kidala 2000 (Kidala et al., 2000)	Tanzania	2 years	Rural	CCT	NR	6 – 71 months	NR	Training and distribution of seedlings, nutrition education, cooking sessions. Control arm received no intervention
Kuchenbecker 2017 (Kuchenbecker et al., 2017)	Malawi	3 years	Rural	Cluster RCT	24 clusters	6 – 23 months	Mean age 27.2	Distribution of farming items, livestock and training in farming. Nutrition education and cooking sessions. Control arm received only agricultural practices with no nutrition education
Lakzadeh 2016 (Lakzadeh et al., 2016; Talukder et al., 2017, Verbowski et al., 2018	Cambodia	22 months	Rural	Cluster RCT	60 clusters	<5 years	NR	Training and distribution of seedlings for home gardening. Creation of fishponds. 3 arms – home food production (HFP) plus fishpond, HFP only and control with no intervention
Low 2007 (Low et al., 2007)	Mozambique	2 years	Rural	CCT	NR	< 39 months	NR	Training and distribution of orange sweet potato vines, demand creation, nutrition education. Control group was not exposed to the interventions

Marquis 2017 (Marquis et al., 2017; Atuobi-Yeboah et al., 2016)	Ghana	1 year	rural	Cluster RCT	16 clusters	0 – 32 months	NR	Training, distribution of seedlings, chicks and orange sweet potato vines, cooking sessions, nutrition education. Control group received no intervention
Olney 2009 (Olney et al., 2009)	Cambodia	19 months	Rural	RCT	NR	>5 years	NR	Training and distribution of seedlings and chicks, nutrition education. Control arm received no intervention
Olney 2015 (Olney et al., 2013; Olney et al., 2015)	Burkina Faso	2 years	Rural	Cluster RCT	NR	3 – 12.9 months	NR	Training in home garden, distributions of seedlings and chicks, nutrition education. Control arm received no intervention. Nutrition education was carried out by two groups of women – health committee and older women group.
Osei 2015 (Osei et al., 2015; Osei et al., 2017; Pries et al., 2013)	Nepal	4 years	rural	Cluster RCT	63	0 – 23 months	NR	Training in home gardening, and poultry. Nutrition education. Three arms were used- HFP, HFP plus micronutrient powder and control group that received no intervention.
Raneri 2017 (Raneri et al., 2017.)	Vietnam	1 year	Rural	Cluster RCT	NR	12 – 24 months	NR	Training in home garden, nutrition education and cooking demonstrations. Control group had no intervention.

Reinbott 2016 (Reinbott et al., 2016; Reinbott et al., 2018)	Cambodia	2 years	Rural	Cluster RCT	NR	0 – 23 months	NR	Training in home gardening, nutrition education and giving out of vouchers. Control arm received agricultural practices with no nutrition education
Schreinemacher 2016 (Schreinemacher et al., 2016)	Banglades h	3 years	Rural	CCT	NR	Entire household	NR	Training in home gardening, distribution of seedlings and orange sweet potato vines. Control arm received no intervention

CCT – Controlled clinical trial (not randomized)

HFP – Home Food Production

RCT – Randomized Controlled Trial

NR – Not Reported

Table 2. Quality of evidence using GRADEpro GDT

Question: Home food production compared to control for home food production

Certainty assessment							№ of patients		Effect		Certainty	Importance
№ of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	home food production	control	Relative (95% CI)	Absolute (95% CI)		
Xerophthalmia												
0	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	Critical
Night blindness												
0	NR	NR	NR	NR	NR	NR	NR	NR	-NR	NR	NR	Critical
Mortality												
0	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	Critical
Stunting, z-score, GIV - adjusted for clustering and other factors												
7	RCT	serious [c]	serious [d]	not serious	not serious	none	2991	2478	-	MD 0.13 higher (0.01 higher to 0.24 higher)	⊕⊕◯◯ LOW	IMPORTANT
Wasting GIV - Adjusted for clustering and other factors												
6	RCT	serious [c]	not serious	not serious	serious [e]	none	2498	2012	-	MD 0.05 higher (0.04 lower to 0.14 higher)	⊕⊕◯◯ LOW	IMPORTANT
Underweight GIV - Adjusted for clustering and other factors												
6	RCT	serious [c]	not serious	not serious	Serious [e]	none	2498	2012	-	MD 0.07 higher (0.01 lower to 0.15 higher)	⊕⊕◯◯ LOW	IMPORTANT

CI: Confidence interval; **MD:** Mean difference; **SMD:** Standardized mean difference; **RR:** Risk ratio

Explanations

a. All the 3 studies were at high risk of bias for almost all the domains

b. Heterogeneity was high at 90%

c. All the studies had a high risk of bias for at least one domain

d. High heterogeneity at 85%e. Result was not statistically significant

Figure 1. PRISMA Flow Diagram

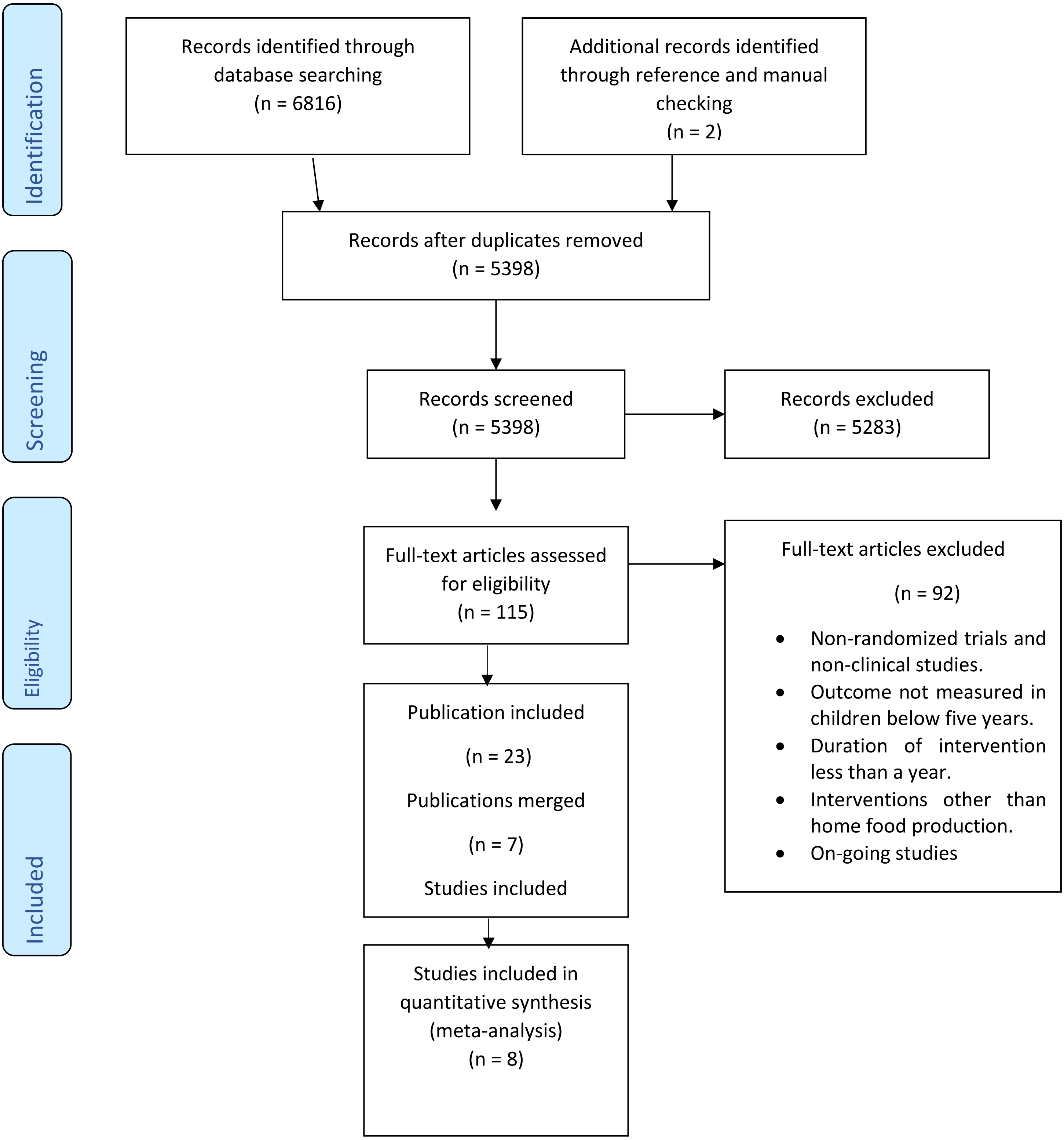


Figure 2. Risk of bias summary

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel (performance bias)	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Other bias
Faber 2002	-	?	?	?	?	?	-
Gelli 2018	+	-	?	?	+	+	+
Hotz 2012 Mozambique	-	?	?	?	+	?	+
Hotz 2012 Uganda	?	?	?	+	-	?	-
Khamhoung 2000	?	-	-	-	+	?	-
Kidala 2000	-	-	-	-	-	?	-
Kuchenbecker 2017	+	?	?	?	+	?	+
Lakzadeh 2010	+	?	?	?	+	+	+
Low 2007	?	?	?	?	+	?	+
Marquis 2017	+	?	+	+	+	+	+
Olney 2009	-	?	?	?	?	?	-
Olney 2015	?	?	?	-	+	?	+
Osei 2015	+	?	+	?	+	?	+
Raneri 2017	?	?	?	?	?	?	?
Reinbott 2018	+	?	+	+	+	?	+
Schreinemachers 2016	?	?	?	?	+	?	+

- represents high risk of bias, ? represents unclear risk of bias, + represents low risk of bias

Figure 3. Effects of home food production on stunting in children (z-score): Meta-analysis assessing mean difference using the random effects model

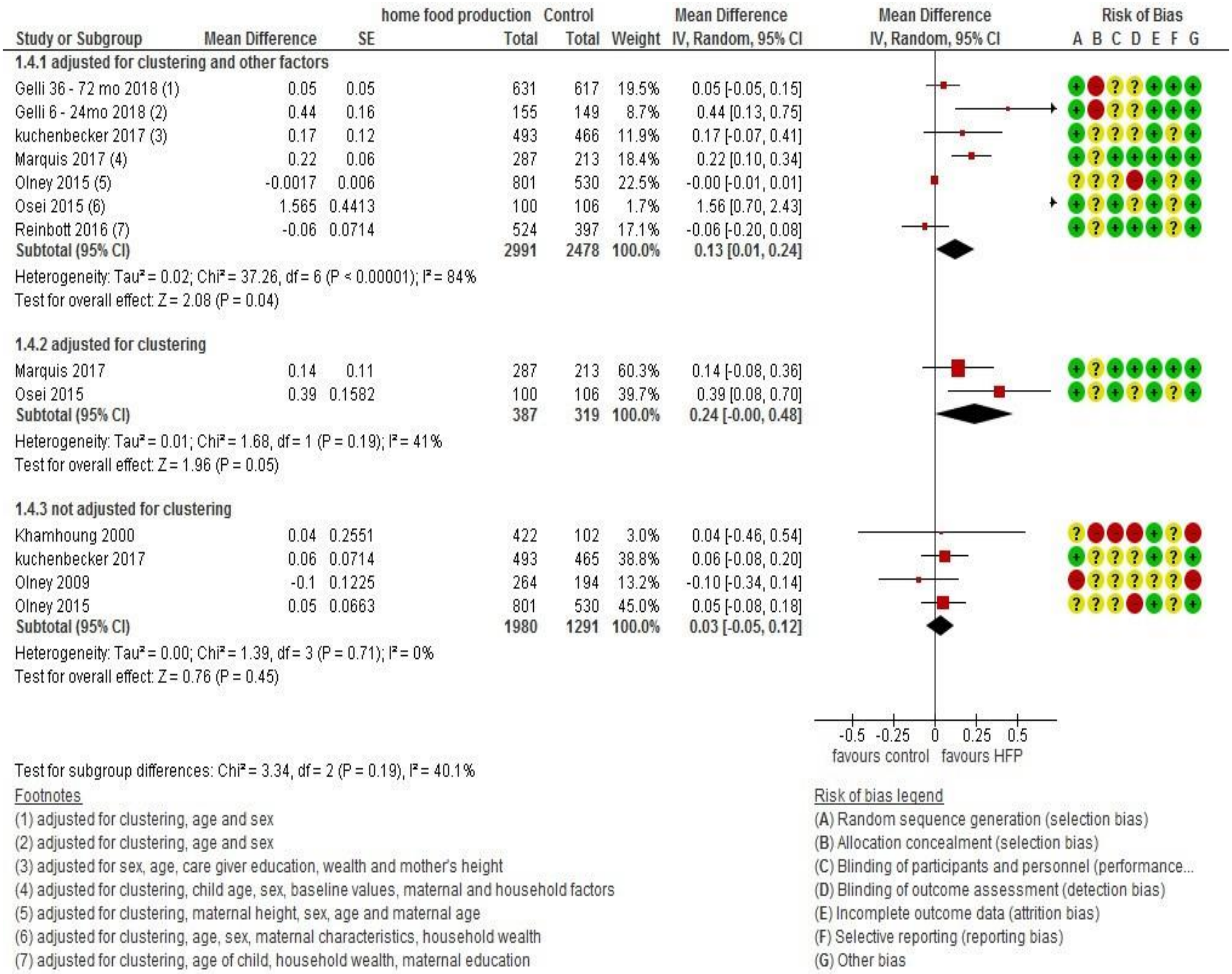
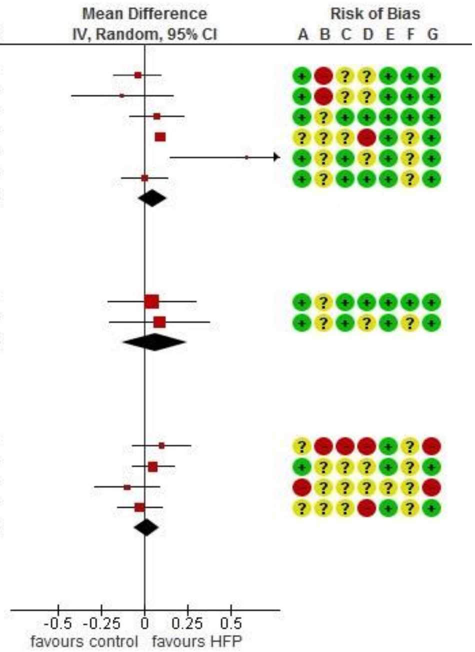


Figure 4. Effects of home food production on wasting in children (z-score): Meta-analysis assessing mean difference using the random effects model

Study or Subgroup	Mean Difference	SE	home food production Total	Control Total	Weight	Mean Difference IV, Random, 95% CI
1.5.1 Adjusted for clustering and other factors						
Gelli 36 - 72 mo 2018 (1)	-0.04	0.07	631	617	18.9%	-0.04 [-0.18, 0.10]
Gelli 6 - 24mo 2018 (2)	-0.13	0.15	155	149	7.2%	-0.13 [-0.42, 0.16]
Marquis 2017 (3)	0.07	0.08	287	213	16.6%	0.07 [-0.09, 0.23]
Olney 2015 (4)	0.0932	0.0066	801	530	34.0%	0.09 [0.08, 0.11]
Osei 2015	0.595	0.227	100	106	3.6%	0.59 [0.15, 1.04]
Reinbott 2016 (5)	0	0.0663	524	397	19.8%	0.00 [-0.13, 0.13]
Subtotal (95% CI)			**2498**	**2012**	**100.0%**	**0.05 [-0.04, 0.14]**
Heterogeneity: Tau² = 0.01; Chi² = 12.67, df = 5 (P = 0.03); I² = 61%						
Test for overall effect: Z = 1.05 (P = 0.29)						
1.5.2 adjusted for clustering						
Marquis 2017	0.04	0.13	287	213	56.4%	0.04 [-0.21, 0.29]
Osei 2015	0.09	0.148	100	106	43.6%	0.09 [-0.20, 0.38]
Subtotal (95% CI)			**387**	**319**	**100.0%**	**0.06 [-0.13, 0.25]**
Heterogeneity: Tau² = 0.00; Chi² = 0.06, df = 1 (P = 0.80); I² = 0%						
Test for overall effect: Z = 0.63 (P = 0.53)						
1.5.3 Unadjusted for clustering						
Khamhoung 2000	0.1	0.0867	422	102	18.5%	0.10 [-0.07, 0.27]
kuchenbecker 2017	0.05	0.0612	493	465	35.8%	0.05 [-0.07, 0.17]
Olney 2009	-0.1	0.0969	264	193	14.9%	-0.10 [-0.29, 0.09]
Olney 2015	-0.03	0.0663	801	530	30.8%	-0.03 [-0.16, 0.10]
Subtotal (95% CI)			**1980**	**1290**	**100.0%**	**0.01 [-0.06, 0.09]**
Heterogeneity: Tau² = 0.00; Chi² = 3.15, df = 3 (P = 0.37); I² = 5%						
Test for overall effect: Z = 0.32 (P = 0.75)						



Test for subgroup differences: Chi² = 0.48, df = 2 (P = 0.79), I² = 0%

Footnotes
(1) adjusted for clustering, age, sex and clustering
(2) adjusted for clustering, age, sex and clustering
(3) adjusted for clustering, child age, sex, baseline values, maternal and household factors
(4) adjusted for clustering, maternal height, sex, age and maternal age
(5) adjusted for clustering, age, household wealth and maternal education

Risk of bias legend
(A) Random sequence generation (selection bias)
(B) Allocation concealment (selection bias)
(C) Blinding of participants and personnel (performance...
(D) Blinding of outcome assessment (detection bias)
(E) Incomplete outcome data (attrition bias)
(F) Selective reporting (reporting bias)
(G) Other bias

Figure 5. Effects of home food production on underweight in children (z-score): Meta-analysis assessing mean difference using the random effects model

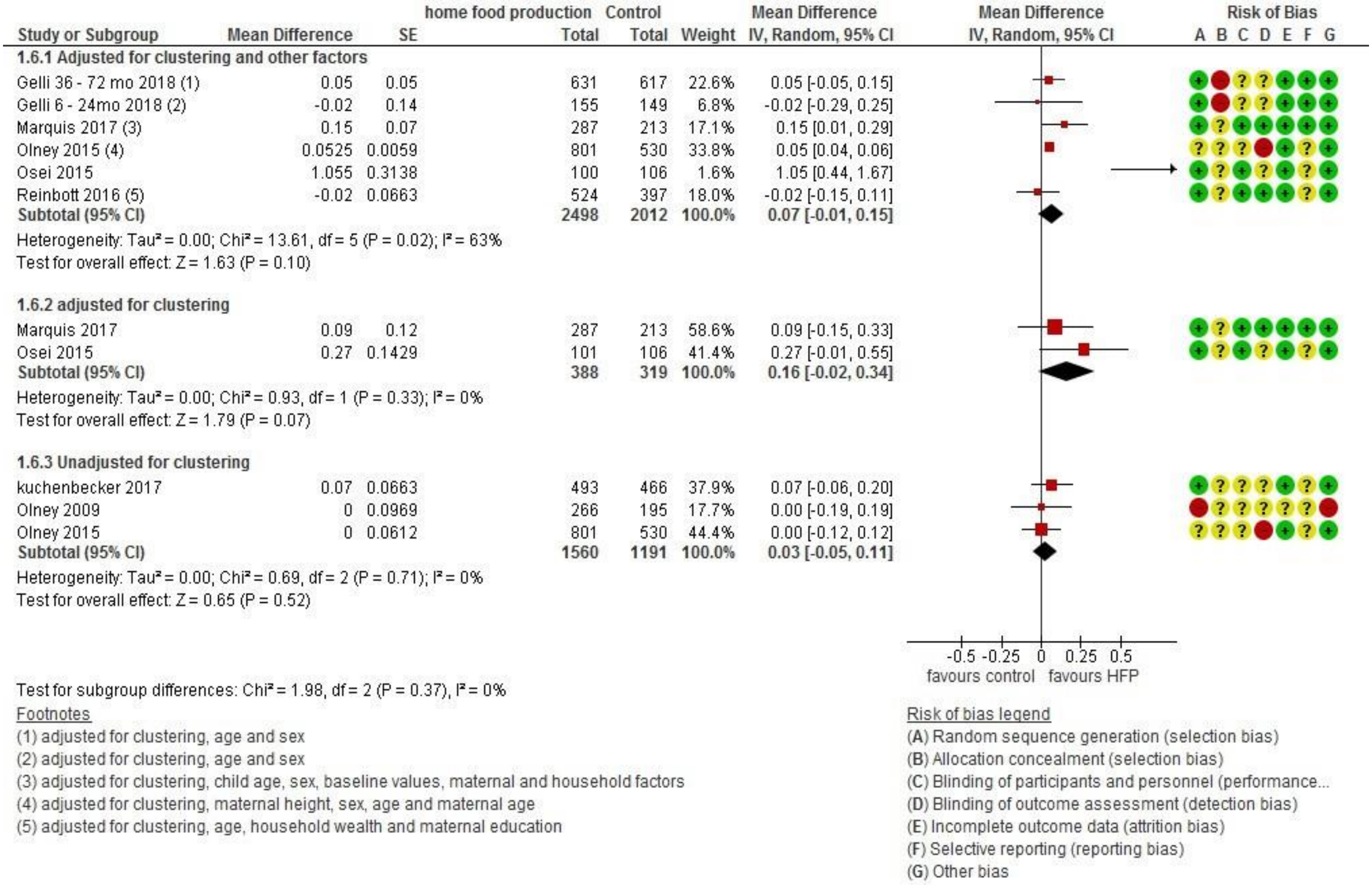


Figure 6. Forest plot showing serum retinol (µmol/l) in children using random effects meta-analysis

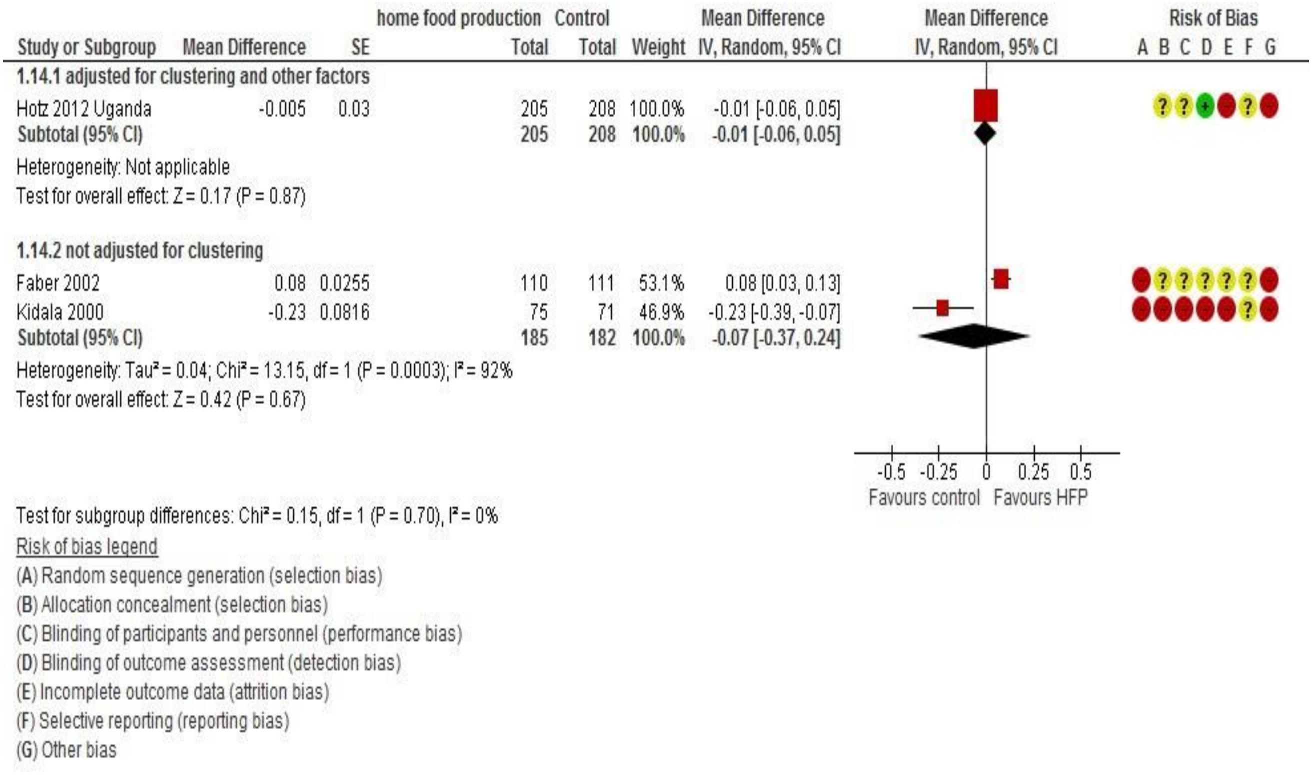


Figure 7. Effects of home food production on dietary diversity in children (z-score): Meta-analysis assessing mean difference using the random effects model