

**UNICEF**

**Latin America and the Caribbean Regional Office**

**REVIEW OF EFFECTIVE INTERVENTIONS IN THE LIFE  
COURSE OF MATERNAL-CHILD AND ADOLESCENCE  
TO PREVENT NON-COMMUNICABLE DISEASES (NCDs)  
AND ITS RISK FACTORS**

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## Table of Contents

1. Introduction.....	4
2. Methodology.....	5
2.1. Selection criteria .....	5
2.2. Search methods .....	6
2.3. Search results .....	6
2.4. Review quality assessment and analysis.....	8
2.5. Data analysis .....	8
3. Results.....	8
3.1. Overweight and obesity .....	9
3.1.1. School-based intervention.....	9
3.1.2. Not only school, but also family and general population setting interventions.....	10
3.1.3. Diet, physical activity, or both interventions to prevent overweight and obesity.....	10
3.1.4. Programs promoting healthy weight in a wide range of strategies .....	11
3.1.5. Breastfeeding and obesity prevention.....	12
3.1.6. Policies to influence overweight, obesity or nutritional impacts .....	13
3.1.7. Innovation and Technologies of Information and Communication (TICs) .....	13
3.2. Healthy eating and risk factors .....	14
3.2.1. Behavioural change and interventions to promote fruit and vegetable consumption. ....	14
3.2.2. School-based interventions .....	15
3.2.3. School policies .....	16
3.2.4. Community programs, media literacy and advocacy approach .....	16
3.2.5. Computer and web-based interventions.....	17
3.3. Physical activity .....	17
3.3.1. Interventions to promote physical activity.....	17
3.3.2. School-based interventions .....	17
3.3.3. School, family, community and general population setting interventions.....	18
3.3.4. Technology-based intervention.....	19
3.4. Alcohol, tobacco, and substance use.....	19
3.4.1. Alcohol.....	19
3.4.2. Tobacco.....	20
3.4.3. Multiple substance-using and risk behaviours in adolescents .....	20
3.4.4. Alcohol, tobacco and poor nutrition in women of childbearing age and pregnant women.....	20

3.4.5. Policies on banning alcohol and tobacco .....	21
3.5. Diabetes and gestational diabetes .....	21
3.6. Cervical cancer.....	22
3.7. Ischemic heart disease.....	22
3.8. Related health outcomes .....	22
3.9. Mental health and postpartum depression.....	23
3.10. Injuries .....	23
3.11. Violence .....	24
Table 1. Summary of the effective interventions by context, lifecycle, and strength of the evidence .....	26
Table 2. Summary of the interventions without evidence of effectiveness, according to context, lifecycle, and strength .....	29
4. Discussion and conclusions .....	32
4.1. Overweight and obesity .....	33
4.2. Healthy eating and risk factors .....	34
4.3 Physical activity .....	34
4.4. Alcohol, tobacco, and substance use.....	35
4.5. Diabetes and gestational diabetes .....	35
4.6. Cervical cancer.....	35
4.7. Related health outcomes .....	35
5. References.....	36

Annex 1. Algorithm for the search strategy into the databases in the Ovid platform

Annex 2. Summary table of the systematic reviews

## 1. Introduction

Non-communicable diseases (NCDs), also known as chronic diseases, are the leading causes of death globally, killing more people each year than all other causes combined, and they strike hardest at the world's low- and middle-income populations, where nearly 80% of NCD deaths occur. Of the 57 million global deaths in 2008, 36 million, or 63%, were due to NCDs, principally cardiovascular diseases, diabetes, cancers and chronic respiratory diseases. The combined burden of these diseases is rising fastest among lower-income countries, populations and communities, where they impose large, avoidable costs in human, social and economic terms (WHO, 2011). Despite their rapid growth and inequitable distribution, much of the human and social impact caused each year by NCD-related deaths could be averted through well-understood, cost-effective and feasible interventions.

According with the WHO, the leading NCDs are: cardiovascular diseases (17 million deaths, or 48% of NCD deaths), cancers (7.6 million, or 21% of NCD deaths), chronic respiratory diseases (4.2 million deaths), and diabetes (additional 1.3 million deaths). These 4 groups of diseases account for 82% of all NCD deaths. NCDs are caused, to a large extent, by four behavioral risk factors that are pervasive aspects of economic transition, rapid urbanization and 21st-century lifestyles: physical inactivity, unhealthy diet, exposure to tobacco smoke, harmful use of alcohol drinking. In turn, these behaviors lead to four key metabolic/physiological risk factors also called intermediate risk factors: raised blood pressure, increased blood glucose, elevated blood lipids, overweight and obesity (WHO, 2011, 2015).

While popular belief presumes that NCDs afflict mostly high-income populations, the evidence tells a very different story. Nearly 80% of NCD deaths occur in low-and middle-income countries and NCDs are the most frequent causes of death in most countries, except in Africa. Even in African nations, NCDs are rising rapidly and are projected to exceed communicable, maternal, perinatal, and nutritional diseases as the most common causes of death by 2030. The greatest effects of NCDs risk factors fall increasingly on low- and middle-income countries, and on poorer people within all countries, mirroring the underlying socioeconomic determinants (WHO, 2011).

On the other hand, it has been recognized an important increasing of NCDs risk factors in childhood worldwide. For example, it was estimated that 170 million children worldwide were overweight or obese in 2008, with the majority of them living in low-to-middle income countries undergoing accelerated economic development and nutritional transitions (Lobelo et al., 2013). The calculated global prevalence of overweight (including obesity) in children aged 5–19 years is 10%, but varying from 5.7% in Pakistan to over 40% in Mexico. Prevalence rates of obesity are high (>15%) in many developing countries including Brazil, India, Argentina, and Mexico (Gupta, Goel, Shah, & Misra, 2012).

Childhood obesity has been associated with diseases in childhood such as asthma, early-onset diabetes mellitus, and childhood hypertension. It has also been shown that childhood obesity is a predictor of obesity during adulthood. High BMI in adulthood is strongly linked to chronic diseases, such as hypertension, diabetes mellitus, coronary arterial disease, occlusive cerebrovascular disease, and degenerative joint disease. Being overweight between ages 14 and 19 years is associated with increased mortality after age 30 years from systemic diseases (Gonzalez-Suarez, Worley, Grimmer-Somers, & Dones, 2009).

A review of the literature was performed in order to analyze the evidence on the effective prevention interventions in NCDs and its risk factors in maternal, child and adolescence. The aim of this review was to search for proven, effective interventions in the life course of maternal-child and adolescence to prevent Non-Communicable Diseases (NCDs) and its risk factors, which could assist UNICEF in its formulation of priorities in this area of work.

This review is focused on NCDs and its risk factors, and the search strategy corresponded with this aim. However, other subjects, like mental health, injuries, and violence were indirectly pulled, but the search strategy was not exhaustive and not systematic for these themes; they are here included just with introductory purposes.

## 2. Methodology

### 2.1. Selection criteria

Seven relevance criteria were included:

1. The article is a systematic review (independently if they were from randomized controlled trials –RCTs-, controlled but not randomized or uncontrolled trials, cohort or case-control studies).
2. The population of the review correspond to maternal, child or adolescence (0 to 18 years).
3. Interventions or policies to intent to reduce chronic or non-communicable diseases (NCDs) and/or its risk factors.
4. Covering a single or multiple NCDs or its risk factors.
5. Including any length duration for the intervention or policy.
6. Studies in English, French, Italian, Portuguese or Spanish.
7. Regardless of the data was available or not.

Articles were considered relevant if they met all the criteria.

We included not only RCTs, but also controlled but not randomized trials, uncontrolled trials, cohort and case-control studies, recognizing the importance in public health of a wide approach due to the complexity of the interventions. According to Rychetnik, Frommer, Hawe, and Shiell (2002), in the field of public health «*Evidence comprises the interpretation of empirical data derived from formal research or systematic investigations, using any type of science or social science methods*» (p.119) (Rychetnik, Frommer, Hawe, & Shiell, 2002). As Victora, Habicht, and Bryce (2004) say, randomized controlled trials (RCTs) are essential for evaluating the efficacy of clinical interventions, but they have limitations when used as the only source of data on the performance of public health interventions which are complex and context-dependent. It is therefore necessary to use complementary and alternative approaches that will yield valid and generalizable evidence (Victora, Habicht, & Bryce, 2004).

Both published journal articles and non-published reports were included, but conference abstracts were excluded on the basis of inadequate information to assess the study quality and its outcomes, studies presented only as abstracts with no subsequent full report of study results were also excluded. Reasons for exclusion included non-true systematic reviews (overviews or literature reviews), clinical interventions, and exploration of an association that was not an intervention or program or policy, non-pertinent subject for the research question, lack of abstract or full text.

Our PICO (population, intervention, comparison and outcome) strategy started with the following question: What are the effective NCDs and its risk factors prevention interventions in maternal-child and adolescence? Population: maternal-child and adolescence; intervention: prevent NDCs and its risk factors; comparison: not-applied; outcome: effective prevention.

## 2.2. Search methods

The review was undertaken between April and June 2015. Initial search was done into the Cochrane Database of Systematic Reviews.

The combination of the keywords used to search into the Cochrane Database of Systematic Reviews was the following: child\$ or adolescent\* or teen\* or maternal or mother\* in Title, Abstract, Keywords AND "chronic disease\*" or neoplasm\* or cancer\* or "cardiovascular disease\*" or diabetes or "respiratory disease\*" or "pulmonary disease\*" or "lung disease\*" or "risk factor\*" in Title, Abstract, Keywords AND intervention\* or program\$ or policy or policies or prevent in Title, Abstract, Keywords.

We also searched by a hybrid manner (subject and key words) and using the Ovid platform, the following six electronic databases: MEDLINE(R), EMBASE, PsycINFO, Global Health, Social Policy and Practice, and Health Management Information Consortium (HMIC). The algorithm for the hybrid search strategy is presented in the annex 1.

In addition, we searched the Canadian Best Practices Portal Website, for systematic reviews, and the WHO and PAHO Websites. Besides, reference lists, of included reviews, were scanned for additional relevant studies.

Two review authors independently selected the studies that met all the selection criteria. Disagreements over inclusion were resolved through consensus and, where necessary, through discussion with a third member of the team.

## 2.3. Search results

From the Cochrane Database of Systematic Reviews we found 255 results from 8948 records.

We found the following results from the six electronic databases:

Ovid MEDLINE(R) 1946 to April Week 2 2015 = 730

Embase Classic+Embase1947 to 2015 April 17 = 965

PsycINFO1806 to April Week 2 2015 = 28

Global Health1910 to 2015 Week 15 = 99

Social Policy and Practice201503 = 2

HMIC Health Management Information Consortium1979 to March 2015 = 6

Total = 1830 (as April 20, 2015)

And after deleting 406 duplicates:

Ovid MEDLINE(R) 1946 to April Week 2 2015 = 695

Embase Classic+Embase1947 to 2015 April 17 = 662

PsycINFO1806 to April Week 2 2015 = 15

Global Health1910 to 2015 Week 15 = 51

Social Policy and Practice 201503 = 1  
 HMIC Health Management Information Consortium 1979 to March 2015 = 0  
 Total = 1424 (as April 20, 2015)

To summarize the selection process, we present our PRISMA-Statement (Moher, Liberati, Tetzlaff, Altman, & Group, 2009) flow chart in the figure 1.

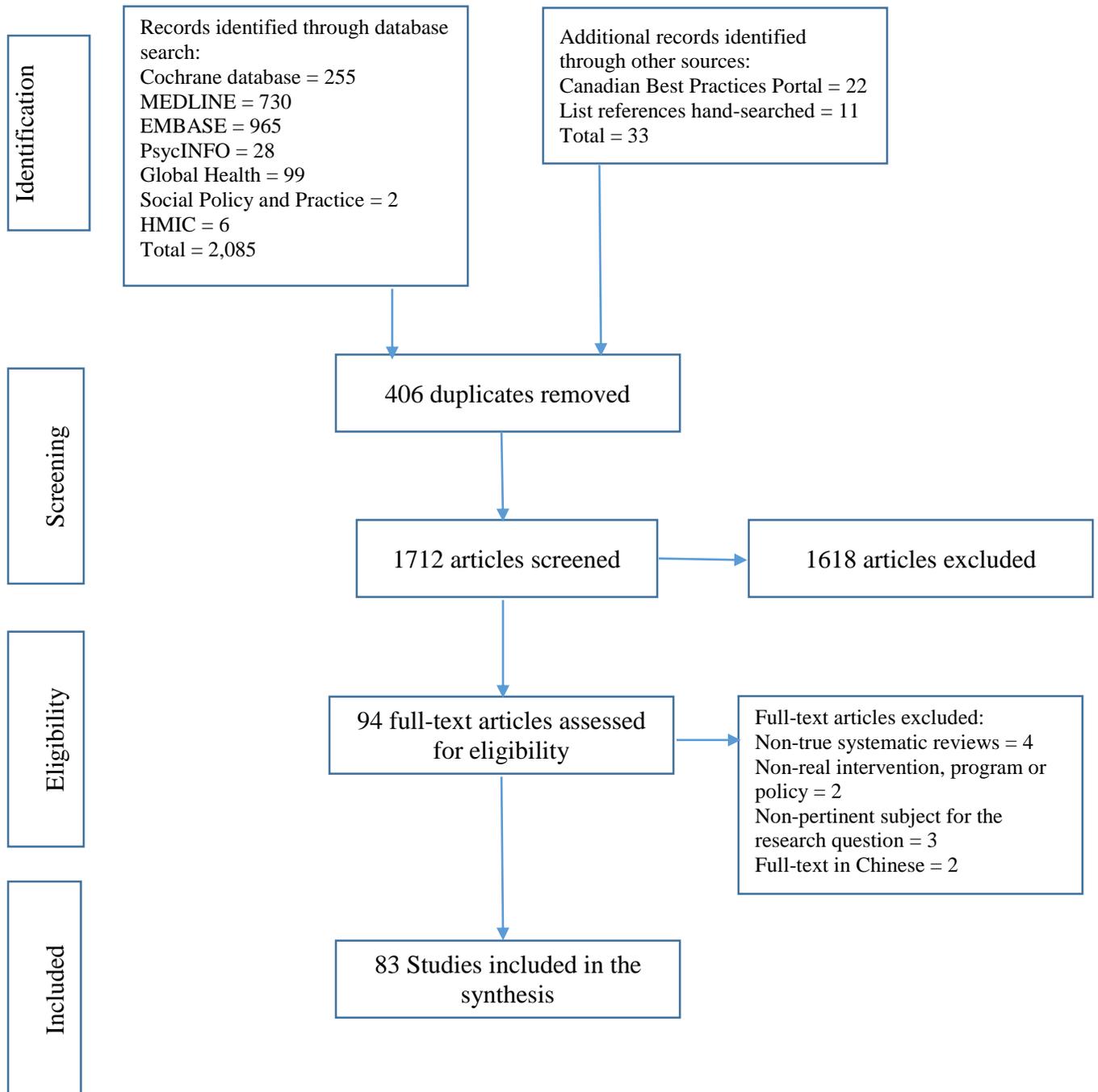


Figure 1. PRISMA flow chart.

Of the 1712 unduplicated papers identified for review, 94 reported on interventions designed to prevent NCDs and its risk factors. A further 11 papers were excluded as they did not meet our eligibility criteria. Of the remaining 83 reviews, 3 were rated as weak on the review quality assessment and excluded from the review.

#### 2.4. Review quality assessment and analysis

Two authors conducted independently a quality assessment of the systematic reviews applying the Quality Assessment Tool of the Effective Public Health Practice Project (EPHPP) from McMaster Health Evidence. This tool has been recommended by the Cochrane Collaboration for Health Promotion and Public Health Interventions (Armstrong et al., 2007), and includes the following 10 criteria: a focused question, appropriate inclusion criteria used to select the primary studies, a comprehensive search strategy, a search strategy that covers an adequate number of years, a clear description of the level of evidence in the primary studies, assessment of the methodological quality of the included studies, a transparent review quality, appropriate assessment of similarity across the studies, weighting of the overall measure of effect or a discussion about quality of the included studies (for qualitative reviews), and authors' interpretation of the results supported by the data. Besides, we reviewed the critical appraisal conducted by the authors across the selected reviews.

#### 2.5. Data analysis

The results were summarized narratively to synthesize the findings, due to a wide variations in the populations, interventions evaluated, and outcomes measured. A meta-analysis was not possible due to the heterogeneity of the interventions, study designs, and outcome measurements (Aveyard, 2010); so given the studies features, a narrative synthesis of the results was considered more relevant to synthesize evidence (Slavin, 1995).

For the presentation of the results, a combination of the matrix method (Garrard, 2011) and the simplified method (Aveyard, 2010) was used to analyze and summarize the studies. The matrix method includes the development of an examination matrix or table, which is used to synthesize information from the literature (Garrard, 2011). The simplified method involves examining themes or elements that stem from the identified literature, and the relations between them, to address the research question (Aveyard, 2010). The table in the Annex 2 was inspired by that of Garrard (2011), and some elements were added to synthesize: the objectives, theme/subject/outcome, intervention examined, lifecycle approach, study features, type of evidence, significant results, the critical appraisal across the studies/reviews, and the review quality assessment. The different types of interventions/policies were grouped and analyzed according to the risk factors/NCDs targeted (Annex 2).

### 3. Results

The search strategy yielded 83 systematic reviews that met the review inclusion criteria, of which 3 were rated as weak on the quality assessment criteria and excluded from this review, 2 were conference presentations without full text, and 3 more that it was not possible to get the full text article, were also excluded. Of the remaining 75 reviews, 4 were systematic review of reviews. Some of these reviews covered several themes/outcomes (Risk factors/NCDs). Of the 75 reviews,

24 related to overweight, obesity and nutritional impacts, 13 related to diet, healthy eating and other risk factors, 10 to physical activity, 9 to tobacco, alcohol, and substance use, 8 to diabetes or gestational diabetes, 2 to breast and cervical cancer, 1 to prevention of ischaemic heart disease, and 1 to placental and maternal factors associated with NCDs. Other subjects included 5 reviews related to injuries, 5 to mental health and postpartum depression, 4 to breastfeeding, 4 to violence, and 2 to health outcomes (presence or absence of disease, risk factors, health behaviours and indicators of well-being).

The main findings of the 83 systematic reviews are summarized in the annex 2. Full consideration of such a large number of reviews would prove too lengthy, therefore, and for the synthesis purpose of this report, we have chosen to highlight the main findings rather than provide details of individual interventions discussed within each of them.

### 3.1. Overweight and obesity

#### 3.1.1. School-based intervention

We found five systematic reviews, including two meta-analysis, on these type of interventions aiming to prevent overweight and obesity, all of them assessed as strong quality reviews.

Lobelo et al. (2013) conducted a systematic review of ten studies (of high, moderate, and low quality) to examine the effectiveness of school-based interventions in Latin America, and comparing youth exposed versus not exposed. They found sufficient evidence to recommend school-based interventions (for children and adolescents ranged from 6 to 14,5 years old) to prevent obesity among youth in Latin America. Authors concluded that evidence-based interventions in the school setting should be promoted as an important component for integrated programs, policies, and monitoring frameworks designed to reverse the childhood obesity in the region (Lobelo et al., 2013).

Verstraeten et al. (2012) also conducted a systematic review of twenty two studies (of low and moderate quality) to examine the evidence on the effectiveness of school-based interventions targeting dietary behavior and/or physical activity for the primary prevention of obesity in children and adolescents aged 6 to 18 years in low and middle income countries, most of them in Latin America and Asia, but also in Hungary, Iran, India, Russia, South Africa. They concluded that school-based interventions have the potential to improve dietary and physical activity behavior and to prevent unhealthy body weights in low- and middle-income countries. To reach their full potential, interventions should conduct process evaluations to document program implementation. Effective interventions targeted diet and physical activity, involved multiple stakeholders, and integrated educational activities into the school curriculum (Verstraeten et al., 2012).

Other three systematic reviews (two meta-analyses), of studies done most in high income countries, including few in low-middle income countries, to evaluate school-based programs to prevent obesity in children and adolescents, found sufficient evidence of their effectiveness. Interventions in schools to reduce overweight and obesity, as well as to increase fruits and vegetable consumption, demonstrated effectiveness in twenty four primary randomized controlled trials (RCTs) studies, most of them of high and moderate quality (J. A. C. Silveira et al., 2011). School-based nutrition education interventions were effective in reducing the body mass index

(BMI) of children and adolescents in a meta-analysis of eight randomized controlled community trials, most of high quality (J. A. Silveira, Taddei, Guerra, & Nobre, 2013). There is strong evidence from meta-analysis including RCTs and clinical controlled trials with high methodologic critical appraisal scores proving that school-based interventions are effective in reducing the prevalence of childhood obesity, and longer-running programs were more effective than shorter programs (Gonzalez-Suarez et al., 2009).

### 3.1.2. Not only school, but also family and general population setting interventions

Three systematic reviews and meta-analysis examined the effect of interventions not only in school, but also in family and general population settings. All of them were assessed as strong quality systematic reviews and meta-analysis.

There is strong evidence, from fifty five controlled trials (rated as low or unclear risk of bias) to support beneficial effects of child obesity prevention programmes on body mass index (BMI), particularly for programmes targeted to children aged 6 to 12 years. The promising policies and strategies, at school and family context, are: school curriculum that includes healthy eating, physical activity and body image, increased sessions for physical activity, improvements in nutritional quality of the food supply in schools, environments and cultural practices, support for teachers to implement health promotion strategies, parent support and home activities (Waters et al., 2011).

A systematic review and meta-analysis, of 131 RCTs, quasi-experimental studies, and natural experiments with high heterogeneity, was conducted to assess the effectiveness of childhood obesity prevention programs by reviewing all interventional studies that aimed to improve diet, physical activity, or both, in schools, homes, primary care clinics, childcare settings, the community, or combinations of these settings in high-income countries. Authors found that physical activity interventions in a school-based setting with a family component or diet and physical activity interventions in a school-based setting with home and community components have the most evidence for effectiveness (Wang et al., 2013).

A systematic review and meta-analysis of 30 RCTs and 4 controlled trials, assessed as of variable quality, to provide an overview of the evidence regarding the effects of interventions, implemented in the school and general population setting, aiming to prevent excessive sedentary behaviour in children and adolescents, found that interventions in the school and general population setting aiming to reduce only sedentary behaviour and interventions targeting multiple health behaviours can result in significant decreases in sedentary behaviour. The results also showed significant decreases for the amount of sedentary behaviour and BMI, although most studies were conducted in the United States and Europe, only one in Mexico (van Grieken, Ezendam, Paulis, van der Wouden, & Raat, 2012).

### 3.1.3. Diet, physical activity, or both interventions to prevent overweight and obesity

A strong quality systematic review and meta-analysis, of twenty-five mainly high to moderate quality RCTs (only four rated as weak quality), conducted in high income countries, to assess the overall effect size of sedentary behavior interventions on body mass index (BMI) reduction, and to compare whether interventions that have multiple components (sedentary behavior, physical activity, and diet) have a higher mean effect size than interventions with single (sedentary

behavior) component, found that sedentary behavior interventions had a significant effect on BMI reduction in children under 18 years old. The pooled effect sizes of multi-components interventions did not differ from the single component interventions, and neither of them had a significant effect size on its own. Future obesity interventions may consider focusing on developing strategies to decrease multiple screen-related sedentary behaviours (Liao, Liao, Durand, & Dunton, 2014).

High-quality evidence (strong quality systematic review and meta-analysis with primary RCTs studies mostly of high and moderate quality), from developed countries, indicates that diet or exercise, or both, during pregnancy can reduce the risk of excessive gestational weight gain. Other benefits may include a lower risk of caesarean delivery, macrosomia, and neonatal respiratory morbidity, particularly for high-risk women receiving combined diet and exercise interventions. Maternal hypertension may also be reduced. Exercise appears to be an important part of controlling weight gain in pregnancy (Muktabhant, Lawrie, Lumbiganon, & Laopaiboon, 2015).

Other systematic review and meta-analysis, of strong quality, to evaluate the effect of diet, exercise or both for weight reduction in women after childbirth, and to assess the impact of these interventions on maternal body composition, cardiorespiratory fitness, breastfeeding performance and other child and maternal outcomes, found that both diet and exercise together and diet alone help women to lose weight after childbirth. Nevertheless, it may be preferable to lose weight through a combination of diet and exercise as this improves maternal cardiorespiratory fitness and preserves fat-free mass, while diet alone reduces fat-free mass. Data were mostly gathered in affluent countries (Amorim Adegboye & Linne, 2013).

#### 3.1.4. Programs promoting healthy weight in a wide range of strategies

Flynn et al. (2006) conducted a systematic review, rated as strong quality with primary studies mainly of moderate quality, to explore interventions and strategies, in children and youth that have been implemented to promote healthy weight in children and prevent chronic diseases associated with obesity. Authors concluded that while no single programme emerged as a model of best practice, synthesis of included programmes provided rich information on elements that represent innovative rather than best practice under particular circumstances that are dynamic (changing according to population subgroups, age, ethnicity, setting, leadership, etc.). Schools were found to be a critical setting for programming where health status indicators, such as body composition, chronic disease risk factors and fitness, can all be positively impacted. Engagement in physical activity emerged as a critical intervention in obesity prevention and reduction programmes. Involving stakeholders in programme design, implementation and evaluation could be crucial to the success of interventions (Flynn et al., 2006).

In order to assess the efficacy of lifestyle, drug and surgical interventions for treating obesity in childhood, a systematic review and meta-analysis (assessed as strong quality with primary studies of a varied methodological quality, mostly from high income countries), was conducted, and authors concluded that combined behavioural lifestyle interventions compared to standard care or self-help can produce a significant and clinically meaningful reduction in overweight in children and adolescents (Oude Luttikhuis et al., 2009). The effectiveness of educational interventions including behavioral modification, nutrition and physical activity to prevent or treat childhood obesity was also assessed through a strong quality systematic review and meta-analysis of

randomized trials of variable quality. However, authors concluded that educational interventions are effective in treatment, but not prevention, of childhood obesity and its consequences. In treatment studies, educational interventions were associated with a significant reduction in waist circumference, body mass index (BMI) and diastolic blood pressure (Sbruzzi et al., 2013).

The effectiveness of interventions to prevent macrosomic and large-for-gestational (LGA) age babies was also evaluated in a systematic review and meta-analysis (of strong quality with four small RCTs of moderate to high risk of bias), assessing the effects of different types of management strategies for pregnant women with hyperglycaemia not meeting diagnostic criteria for gestational diabetes mellitus (GDM) and type 2 diabetes mellitus (T2DM). Authors found that interventions including providing dietary advice and blood glucose level monitoring for women with pregnancy hyperglycaemia not meeting GDM and T2DM diagnostic criteria helped reduce the number of macrosomic and large-for-gestational (LGA) age babies without increasing caesarean section and operative vaginal birth rates (Han, Crowther, & Middleton, 2012).

On the other side, Furber et al. (2013) intended to evaluate the effectiveness of interventions that reduce weight in obese pregnant women; however, they did not find trials designed to reduce weight in obese pregnant women. Until the safety of weight loss in obese pregnant women can be established, there can be no practice recommendations for these women to intentionally lose weight during the pregnancy period (Furber et al., 2013).

#### 3.1.5. Breastfeeding and obesity prevention

A systematic review and meta-analysis (assessed as moderate quality systematic review and meta-analysis of observational studies without confounding bias) examined the evidence regarding breastfeeding protection against the later development of obesity and related metabolic diseases. Authors concluded that taken together, current findings show clearly that breastfeeding is effective in lowering the risk of developing key features of the metabolic syndrome in later life, and should therefore be promoted. Breast feeding, in general, is shown to be associated later in a child's life with decreased risk of overweight, decreased blood cholesterol and blood pressure, and a reduced risk of developing type 2 diabetes (Plagemann & Harder, 2005).

Interventions which aim is to encourage women to breastfeed have showed effectiveness in terms of changes in the number of women who start to breastfeed, according with the systematic review and meta-analysis conducted by Dyson, McCormick, & Renfrew (2005), and assessed as strong quality with primary studies of uncertain risk of bias. This review showed that health education and peer support interventions can result in some improvements in the number of women beginning to breastfeed. Findings from these studies suggest that larger increases are likely to result from needs-based, informal repeat education sessions than more generic, formal antenatal sessions. However, these findings are based only on studies conducted in the USA, among women on low incomes with varied ethnicity and feeding intention, and this raises some questions regarding generalizability to other settings.

In the systematic review and meta-analysis conducted by Crepinsek, Crowe, Michener, & Smart (2012), assessed as of strong quality with primary studies of variable quality, to assess the effects of preventive strategies for mastitis and the subsequent effect on breastfeeding duration, there was insufficient evidence to show effectiveness of any of the interventions, including breastfeeding

education, pharmacological treatments and alternative therapies, regarding the occurrence of mastitis or breastfeeding exclusivity and duration.

### 3.1.6. Policies to influence overweight, obesity or nutritional impacts

Dangour et al. (2013) reviewed the available evidence on agricultural policies that directly affect the price of food and their influence on the prevalence rates of under-nutrition or nutrition-related chronic disease in children and adults. They concluded that the limited evidence provided some support for the notion that agricultural policies that change the prices of foods at a national level can have an effect on population-level nutrition and health outcomes, and that there is a paucity of robust direct evidence on the impact of agricultural price policies on nutrition and health. This review was assessed as moderate quality. Authors stated that all four reports met the predefined quality criteria, but they did not include the complete quality criteria requirements. The included studies were conducted in India, Egypt, the Netherlands, and USA; and therefore should be careful generalizing the results to other contexts (Dangour et al., 2013).

An assessed as strong quality review on the food subsidy programs among disadvantaged families from high income countries (United States, United Kingdom, and New Zealand), evidenced that food subsidy program participants, women and children, mostly pregnant or postnatal women, were shown to have 10-20% increased intake of targeted foods or nutrients. However, limited high quality evidence of the impacts of food subsidy programs on the health and nutrition of adults and children was identified. The improved intake of targeted nutrients and foods, such as fruit and vegetables, could potentially reduce the rate of non-communicable diseases in adults, if the changes in diet are sustained. Associated improvements in perinatal outcomes were limited and most evident in women who smoked during pregnancy (Black et al., 2012).

Relative to school food and nutrition policies, the evidence suggests that nutrition guidelines and price interventions focused on healthier foods are effective to improve the school food environment and students' dietary intake of children and adolescents, but there is little evaluation of their impact on body mass index (BMI). However, this review was assessed as moderate quality, there was marked heterogeneity in the included studies, and all of them were from the USA and Europe (Jaime & Lock, 2009).

### 3.1.7. Innovation and Technologies of Information and Communication (TICs)

Three systematic reviews, including two meta-analysis (all of them assessed as of strong quality with primary studies of different range of quality), evaluated the effectiveness of the TICs to prevent overweight and obesity in children and adolescents.

In a strong quality systematic review and meta-analysis (with most of the primary studies of low to moderate quality), electronic health records (HER) use was associated with increased body mass index (BMI) screening rates in 5 of 8 studies. Telemedicine counseling was associated with changes in BMI percentile similar to that of in-person counseling and improved treatment access in 2 studies. Text message or telephone support was associated with weight loss maintenance in 1 of 3 studies. In conclusion, to date, health information technology (IT) interventions – electronic health records, telemedicine, text message or telephone support – have improved access to obesity treatment and rates of screening. However, the impact on weight loss and other health outcomes

remains understudied and inconsistent. These studies were conducted in USA, Australia and Canada (Smith, Skow, Bodurtha, & Kinra, 2013).

There is no clear evidence that technology-based interventions (web-based, e-learning, and active video games) decrease obesity in adolescents. According with Chen & Wilkosz (2014), in their systematic review assessed as of strong quality with most of the primary studies of high to moderate quality, slightly less than half of the studies reviewed supported the use of technology in reducing unhealthy weight in adolescents. All effective interventions included improving physical activity and healthy eating habit as key components. The literature currently available (most studies conducted in the United States and Canada, only one in Taiwan) is also insufficient to examine the impact of technology-based obesity prevention interventions on weight-health related outcomes such as physical activity, sedentary activity, dietary behaviors, or psychosocial outcomes (Chen & Wilkosz, 2014).

The systematic review and meta-analysis conducted by Siopis et al. (2015), to investigate the efficacy of weight management programmes incorporating text messaging, found that the weighted mean change in body weight in intervention participants was -2.56 kg (95% confidence interval=-3.46 to -1.65) and in controls -0.37 kg (95% confidence interval=-1.22 to 0.48). The small body of evidence indicates that text messaging interventions can promote weight loss. However, lack of long-term results indicate that further efficacy studies are required. The studies in children and adolescents that could not be combined in meta-analysis did not show additional advantage of incorporation of text messaging into weight management programmes, although this may be because they were using lower frequency of texting, whereas the adult studies employed daily to weekly texting. Most of the primary studies had positive and neutral quality rating, and all of them were conducted in high income countries (Siopis, Chey, & Allman-Farinelli, 2015).

## 3.2. Healthy eating and risk factors

### 3.2.1. Behavioural change and interventions to promote fruit and vegetable consumption

We found five systematic reviews evaluating behavioural change interventions to promote fruit and vegetable consumption, including two reviews of reviews and two meta-analysis. All of them were assessed as systematic reviews of strong quality; however, the primary studies showed a variable range of quality.

Related to interventions that are effective in achieving behaviour change, Ammerman et al. (2002) conducted a systematic review and meta-analysis, to evaluate the overall effectiveness of behavioural dietary interventions in promoting dietary change related to chronic disease risk reduction, and to explore the relative effectiveness of specific intervention features among different population subgroups of children and adolescents. The majority of the interventions reviewed resulted in meaningful improvements in dietary factors behaviours associated with the prevention of chronic disease, particularly among individuals at elevated disease risk. The lack of similarity across studies in outcome measures, study design, analysis strategy, and intervention technique hampered the ability to draw broad conclusions about the most effective behavioural dietary interventions. Two intervention components seemed to be particularly promising in modifying dietary behaviour: goal setting and small groups. However, it is necessary to take into

account that these studies were conducted in North America, Europe, and Australia (Ammerman, Lindquist, Lohr, & Hersey, 2002).

A systematic review of reviews conducted by Baird et al. (2009) to look for evidence related to the features of interventions that are effective in achieving behaviour change to improve the nutrition of young women of child-bearing age from disadvantaged backgrounds, of developed country settings, found four aspects of intervention design that were effective at changing one or more of the health behaviours: 1) the use of an educational component; 2) provision of continued support after the initial intervention; 3) family involvement; and 4) social support from peers or lay health workers (Baird et al., 2009).

Another systematic review of reviews conducted by Jepson et al. (2010) to evaluate and synthesise review-level findings on the effectiveness of interventions to change unhealthy behaviours or promote healthy behaviours, including fruit and vegetable consumption, found that interventions that were most effective across a range of health behaviours included physician advice or individual counselling, and workplace- and school-based activities. Mass media campaigns and legislative interventions also showed small to moderate effects in changing health behaviours. Generally, the evidence related to short-term effects rather than sustained/longer-term impact and there was a relative lack of evidence on how best to address inequalities (Jepson, Harris, Platt, & Tannahill, 2010).

In relation to interventions to promote fruit and vegetable consumption, Knai et al. (2006) conducted a systematic review to synthesize evidence on interventions that promote an increased consumption of currently suboptimal levels of fruit and vegetables by children. Articles rated as weak on the quality criteria were excluded from the review. According with the authors, the evidence is strongest in favour of multi-component interventions to increase fruit and vegetable consumption in children. Ten studies had a significant effect, ranging from +0.3 to +0.99 servings/day. None of the studies reviewed had a detrimental effect on fruit and vegetable consumption, but they were conducted in developed country settings (Knai, Pomerleau, Lock, & McKee, 2006).

A systematic review and meta-analysis to assess the effectiveness of interventions designed to increase the consumption of fruit and/or vegetables amongst children aged five years and under concluded that repeated food exposure versus a no intervention comparison was no significantly different in target vegetable consumption in the short term; coupling repeated food exposure with a tangible non-food or social reward, was effective in increasing targeted vegetable consumption in the short term based on one trial; home visiting programs provided to disadvantaged groups did not significantly increase overall fruit intake in the short term; a multicomponent preschool-based intervention failed to significantly increase child consumption of vegetables, but did report a small significant increase in mean child consumption of fruit. The review provides little specific direction, and among those trials which significantly increased consumption, the effect sizes were small and intervention effects typically assessed only in the short term (Wolfenden et al., 2012).

### 3.2.2. School-based interventions

A systematic review (of strong quality with primary studies of moderate quality) assessed the effectiveness of school-based interventions for prevention of NCDs risk factors, including diet,

physical inactivity, and tobacco consumption. Most of the 37 studies were conducted in high income countries (USA, Europe, and Australia), although 2 in China, and 1 in India. The proportion of studies showing a positive result was 83% (10/12) among those that involved family, 87% (7/8) that involved both community and family, and 76% (13/17) that involved school only. Overall, 80% of the studies reported at least some evidence of a positive intervention effect. This review supports the effectiveness of school-based interventions for prevention of risk factors associated with NCDs (Saraf et al., 2012).

A systematic review and meta-analysis (of moderate quality with primary studies of poor quality) conducted to quantify the impact of school-based interventions on fruit and vegetable intake in children aged 5 to 12 years in high-income countries found a moderately improvement of fruit intake, but minimal impact on vegetable intake. However, there was some evidence of publication bias and authors concluded that additional studies are needed to address the barriers for success in changing dietary behaviour, particularly in relation to vegetables (Evans, Christian, Cleghorn, Greenwood, & Cade, 2012).

### 3.2.3. School policies

A systematic review assessed as of strong quality, but primary studies at high risk of bias, examined the effects of interventions delivered in home, school and other nutritional environments to increase fruits and vegetables availability for children and adolescents from 5 to 18 years old. Authors concluded that there are promising strategies to improve the fruit and vegetable environment, particularly through school food service policies, even though the majority of studies were done in high-income countries (Ganann et al., 2014).

As it was said in the previous section on overweight and obesity, relative to school food and nutrition policies, the evidence suggests that nutrition guidelines and price interventions focused on healthier foods are effective to improve the school food environment and students' dietary intake of children and adolescents, but there is little evaluation of their impact on body mass index (BMI). However, this systematic review was assessed as of moderate quality, and the primary studies had marked heterogeneity. All included studies were from the USA and Europe (Jaime & Lock, 2009).

### 3.2.4. Community programs, media literacy and advocacy approach

A systematic review and meta-analysis, assessed as of strong quality with risk of bias that varied across the primary studies, was conducted to determine if eating disorder prevention programs for children and adolescents are effective. Combined data from two eating disorder prevention programs based on a media literacy and advocacy approach indicate a reduction in the internalisation or acceptance of societal ideals relating to appearance at a 3- to 6-month follow-up. There is insufficient evidence to support the effect of five programs designed to address eating attitudes and behaviours and other adolescent issues in the general community or those classified as being at high risk for eating disorder and insufficient evidence to support the effect of two programs designed to improve self-esteem. The one significant pooled effect in this review does not allow for any firm conclusions to be made about the impact of prevention programs for eating disorders in children and adolescents, although none of the pooled comparisons indicated evidence of harm (Pratt & Woolfenden, 2002).

### 3.2.5. Computer and web-based interventions

Related to TICs, a systematic review assessed as of strong quality with primary studies of high quality too, was conducted to determine the effect of computer and web-based interventions on improving eating behaviour (e.g. increasing fruit and vegetable consumption; decreasing fat consumption) and/or diet-related physical outcomes (e.g. body mass index) among children and adolescents 6 to 18 years old. Authors found that computer and web-based interventions can improve eating behaviour and diet-related physical outcomes among children and adolescents, particularly when conducted in schools and individually tailored feedback. These interventions can complement and support nursing efforts to give preventive care; however, maintenance efforts are recommended. It is necessary to note that all of these studies were conducted in USA and Western Europe (Hamel & Robbins, 2013).

## 3.3 Physical activity

### 3.3.1. Interventions to promote physical activity

A systematic review, rated as moderate quality with primary studies of variable quality, was conducted to examine the effectiveness of interventions to increase physical activity or physical fitness among African-Americans children and adults. Findings suggest modest short-term and long-term success of various intervention approaches for increasing physical activity levels among African-American. Based on this, practitioners and researchers who are designing interventions should consider implementing interventions that include a structured exercise program or that provide opportunities to practice physical activity during the intervention sessions as one of the components, and evaluating the effectiveness of the intervention using an objective measure of physical activity (Whitt-Glover & Kumanyika, 2009).

As it was saw in the previous section about diet and healthy eating, Jepson et al. (2010) conducted a systematic review of reviews, rated as strong quality with primary reviews of variable quality, to evaluate the effectiveness of interventions to change unhealthy behaviours or promote healthy behaviours, including physical activity. They found that interventions that were most effective across a range of health behaviours included physician advice or individual counselling, and workplace- and school-based activities. Mass media campaigns and legislative interventions also showed small to moderate effects in changing health behaviours. Generally, the evidence related to short-term effects rather than sustained/longer-term impact and there was a relative lack of evidence on how best to address inequalities. Despite limitations of the review of reviews approach, it is encouraging that there are interventions that are effective in achieving behavioural change (Jepson et al., 2010).

### 3.3.2. School-based interventions

Dobbins et al. (2014) conducted a systematic review, assessed as of strong quality with primary RCTs at low and moderate risk of bias, to summarize the evidence of the effectiveness of school-based interventions in promoting physical activity and fitness in children and adolescents, 6 to 18 years old. The evidence recommends the ongoing implementation of school-based physical

activity interventions, given the effectiveness on behaviour and physical health status measure (Dobbins, DeCorby, Robeson, Husson, & Tirilis, 2009).

In youngest children at the childcare, aged 2 to 6 years old, Mehtala et al. (2014) conducted a systematic review, rated as strong quality with primary studies of high, moderate, and low quality, to examine the evidence on physical activity interventions by applying a socio-ecological approach. Authors found no evidence of effect of multi-component and theory-based interventions. Although it is difficult to draw general conclusions based on the mixed results of the studies included in the review, the most effective intervention strategy seems to lie in the personal characteristics, and more specifically physical activity in-service training of teachers. 14 studies found increases in physical activity levels or reductions in sedentary time, although the changes were modest. The studies yielded very few high quality interventions and were conducted in high income countries (Mehtala, Saakslanti, Inkinen, & Poskiparta, 2014).

As it was said in the section about diet and healthy eating, Saraf et al. (2012) conducted a systematic review, assessed as of strong quality with primary studies of variable quality, to assess the effectiveness of school-based interventions for prevention of NCD risk factors (physical inactivity, diet, and tobacco consumption). The proportion of studies showing a positive result was 83% (10/12) among those that involved family, 87% (7/8) that involved both community and family, and 76% (13/17) that involved school only. Overall, 80% of the studies reported at least some evidence of a positive intervention effect. This review supports the effectiveness of school-based interventions for prevention of risk factors associated with NCDs. Most of the studies were conducted in high income countries (Saraf et al., 2012).

### 3.3.3. School, family, community and general population setting interventions

A systematic review of reviews, assessed as of strong quality with primary reviews of strong and moderate quality, was conducted to assess the effectiveness of community-based interventions to promote physical activity and healthy eating. Among children and adolescents, authors found moderate evidence for effects on weight change in primary school-aged children for interventions containing a school component. The evidence for interventions aimed at general adult populations was inconclusive. Self-monitoring, group-based components, and motivational signs to encourage stair use were identified as promising strategies to increase physical activity. However, the studies were conducted in Europe and North America (Brand et al., 2014).

A systematic review, assessed as of moderate quality with primary studies also of moderate quality, was conducted to summarize the literature on the association between parental support and physical activity behaviours of children and adolescents. Despite methodological differences between the studies, significant positive correlations between parental support and the physical activity level of children and adolescents were found. This association changes with age, gender, socio economical status, the involvement social and physical and body composition of children. Although several studies have shown that when pairs support increases, parental support decreases throughout childhood. The results point out that the factors of physical and social involvement of families should be taken into account in the physical activity promotion programs. It is necessary to take into account that these studies were done in USA, Europe, Australia, and only one in China (Pereira & Palmeira, 2013).

As it was said previously in the section on overweight and obesity, van Grieken et al. (2012) conducted a systematic review and meta-analysis, rated as strong quality with primary studies of 30 RCTs and 4 controlled trials of variable quality, to summarize the effects of interventions, implemented in the school and general population setting, aiming to prevent excessive sedentary behaviour in children and adolescents on the amount of sedentary behaviour and body mass index (BMI). They found that interventions in the school and general population setting aiming to reduce only sedentary behaviour and interventions targeting multiple health behaviours can result in significant decreases in sedentary behaviour. The results showed significant decreases for the amount of sedentary behaviour and BMI, although most studies were conducted in the United States and Europe, only one in Mexico (van Grieken et al., 2012).

#### 3.3.4. Technology-based intervention

As it was saw in the section on overweight, obesity and nutritional impacts, Chen & Wilkosz (2014) conducted a systematic review, assessed as of strong quality with primary studies of high to moderate quality, to evaluate the existing literature reported on the effectiveness of technology-based intervention (web-based, e-learning, and active video games) in preventing obesity in adolescents. All effective interventions included improving physical activity and healthy eating habit as key components, but authors concluded that the literature currently available is also insufficient to examine the impact of technology-based obesity prevention interventions on weight-health related outcomes such as physical activity, sedentary activity, dietary behaviors, or psychosocial outcomes (Chen & Wilkosz, 2014).

### 3.4. Alcohol, tobacco, and substance use

#### 3.4.1. Alcohol

Foxcroft & Tsertsvadze (2011) conducted two Cochrane systematic reviews, both assessed as strong quality review, but with poor quality of the primary trials. One to evaluate the effectiveness of universal family-based prevention programs (Foxcroft & Tsertsvadze, 2011a); and the other one to evaluate the effectiveness of universal school-based prevention programs (Foxcroft & Tsertsvadze, 2011b), in preventing alcohol misuse, in school-aged children up to 18 years of age. Both of them found evidence of effectiveness.

The effects of family-based prevention interventions are small but generally consistent and also persistent into the medium to longer-term. In the case of the school-based prevention programs, most commonly observed positive effects across programs were for drunkenness and binge drinking. Current evidence suggests that certain generic psychosocial and developmental prevention programs can be effective and could be considered as policy and practice options. These include the “Life Skills Training Program”, the “Unplugged program”, and the “Good Behaviour Game”.

Other systematic review and meta-analysis, assessed as strong quality with primary studies of low to moderate quality, was conducted to summarise the evidence about the effects of motivational interviewing intended to address alcohol and alcohol-related problems in young adults. Authors found that there are no proven substantive, meaningful benefits of motivational interviewing interventions for the prevention of alcohol misuse in young people up to the age of 25 years.

Although some significant effects were found, the effect sizes were interpreted as being too small, given the measurement scales used in the studies included in the review, to be of relevance to policy or practice (Foxcroft, Coombes, Wood, Allen, & Almeida Santimano, 2014).

#### 3.4.2. Tobacco

A systematic review and meta-analysis, assessed as strong quality with primary studies of moderate quality, found that there is some evidence available to suggest that multi-component community interventions are effective in influencing smoking behaviour and preventing the uptake of smoking in young people under the age of 25. These include education of tobacco retailers about age restrictions, programmes for prevention of smoking-related diseases, mass media, school and family-based programmes. Changes in intentions to smoke, knowledge, attitudes and perceptions about smoking did not generally appear to affect the long-term effectiveness of the programmes. However, the evidence is not strong and contains a number of methodological flaws (Carson et al., 2011).

#### 3.4.3. Multiple substance-using and risk behaviours in adolescents

A systematic review of reviews, rated as strong quality with primary reviews of strong quality and primary studies of variable quality, was conducted by Thomas et al. (2005) to determine the effectiveness of adolescent risk behaviour prevention programs (including tobacco, alcohol and other drug use, sexual risk-taking behaviour and behavioural disorders), in which a school-based program was one component, found that some universal drug use prevention programs are effective. Interactive programs with trained facilitators and focused on comprehensive life skills are effective. Successful programs were more effective with an additional community-based component. Although not as strong, the evidence for programs to reduce sexual risk-taking shows that successful programs have similar characteristics. Didactic programs were not found to be effective in reducing any of the risk behaviours; equally, universal suicide prevention programs were not proven effective (Thomas, Micucci, Ciliska, & Mirza, 2005).

Carney et al. (2014) conducted a systematic review, assessed as of strong quality with primary studies of moderate quality, to evaluate the effectiveness of brief school-based interventions on reducing substance use and other behavioural outcomes among adolescents compared to another intervention or assessment-only conditions. There was limited quality evidence that brief school-based interventions were more effective in reducing substance use than the assessment-only condition, but were similar to information provision. There is some evidence for the effectiveness of brief interventions in reducing adolescent substance use, particularly cannabis, when compared to assessment only. However, it is premature to make definitive statements about the effectiveness of brief school-based interventions for reducing adolescent substance use in USA and UK (Carney, Myers, Louw, & Okwundu, 2014).

#### 3.4.4. Alcohol, tobacco and poor nutrition in women of childbearing age and pregnant women

A systematic review and meta-analysis, assessed as strong quality with primary studies at some risk of bias, was conducted to assess the effectiveness of routine pre-pregnancy health promotion for improving pregnancy outcomes when compared with no pre-pregnancy care or usual care (Whitworth & Dowswell, 2009). The health promotion intervention was encouraging behavioural change, or allowing early identification of risk factors such as smoking, drinking excess alcohol, and poor nutrition. The authors concluded that there is little evidence on the effects of pre-

pregnancy health promotion and much more research is needed in this area. There is currently insufficient evidence to recommend the widespread implementation of routine pre-pregnancy health promotion for women of childbearing age, either in the general population or between pregnancies.

#### 3.4.5. Policies on banning alcohol and tobacco

Siegfried et al. (2014) conducted a systematic review, assessed as of strong quality with primary studies at high risk of bias, regarding the policies on restricting or banning the advertising of alcohol, via any format, compared with no restrictions or counter-advertising, on alcohol consumption in adolescents and adults. Authors concluded that there is a lack of robust evidence for or against recommending the implementation of alcohol advertising restrictions. Advertising restrictions should be implemented within a high-quality, well-monitored research programme to ensure the evaluation over time of all relevant outcomes in order to build the evidence base.

A systematic review, conducted in China by Coppo et al. (2014), assessed as of strong quality, evaluated the effectiveness of policies aiming to prevent smoking initiation among students by regulating smoking in schools. Only 1 study was eligible for inclusion and it was judged to be at high risk of bias. Despite a comprehensive literature search, and rigorous evaluation of studies, authors found no evidence to support school tobacco policies. It is needed well-designed randomised controlled trials or quasi-experimental studies to evaluate the effectiveness of school tobacco policies.

### 3.5. Diabetes and gestational diabetes

This section includes 7 systematic reviews, 6 of them with meta-analysis, of interventions related to prevent gestational diabetes in pregnant women (Bain et al., 2015; Barrett, Dekker Nitert, Conwell, & Callaway, 2014; Han, Middleton, & Crowther, 2012; Middleton, Crowther, & Simmonds, 2012; Tieu, Crowther, & Middleton, 2008; Tieu, McPhee, Crowther, & Middleton, 2014), and 2 systematic reviews to prevent diabetes and health outcomes for mother and baby during preconception period in women with history of diabetes (Tieu, Bain, Middleton, & Crowther, 2013; Tieu, Middleton, & Crowther, 2010). All of these reviews were assessed as of strong quality with primary studies of variable quality.

For both of the last two reviews, no eligible trials were identified or did not report on the pre-specified outcomes of the reviews, indicating that little evidence is available to recommend for or against preconception care for women with pre-existing diabetes.

Regarding the seven reviews of interventions related to prevent gestational diabetes in pregnant women, just the Cochrane review of Barret et al. (2014) found evidence in one trial about reduction in the rate of gestational diabetes mellitus (GDM) when women are randomised to probiotics early in pregnancy, but more uncertain evidence of any effect on miscarriage/IUFD/stillbirth/neonatal death, and there are no data on macrosomia. However, the lack of evidence for other interventions included in these reviews, is related to the limited availability of studies or conclusive evidence to guide practice.

### 3.6. Cervical cancer

Shepherd, Frampton, & Harris (2011) conducted a systematic review assessed as of strong quality with many trials judged to be at uncertain risk of bias due to incomplete or ambiguous reporting. They evaluated the effectiveness of behavioural interventions for young women to encourage safer sexual behaviours to prevent cervical cancer, and found that behavioural interventions for young women which aim to promote sexual behaviours protective of sexually transmitted infections, primarily at encouraging condom use, can be effective. There were no statistically significant effects of abstaining from or reducing sexual activity. However, it is necessary to note that most studies were conducted in the USA and in health-care clinics, and so the intervention should be evaluated in the context of developing countries.

### 3.7. Ischemic heart disease

We found one systematic review, assessed as of strong quality with 19 primary observational studies rated at moderate risk of bias, about the promotion of infant growth of children, from 3 months to 2 years old, to prevent ischemic heart disease and other NCDs in adults (Fisher et al., 2006). However, authors concluded that there is insufficient evidence to recommend prevention of adult disease through strategies to alter infant growth. Although larger size in infancy was associated with increased risk of insulin-dependent diabetes, there were considerable gaps in the evidence, and few studies or no studies for other NCDs.

### 3.8. Related health outcomes

We found two systematic reviews that examine the evidence of centre-based (developed in a preschool centre or institution) preschool interventions for preschoolers. One of them examines the evidence for the adult health impacts of centre-based preschool interventions (D'Onise, McDermott, & Lynch, 2010); and the other one examines the evidence for child health effects of centre-based preschool intervention programs for healthy 4 year olds, beyond the preschool years (D'Onise, Lynch, Sawyer, & McDermott, 2010). Both reviews were conducted mainly in disadvantaged populations of USA.

D'Onise, McDermott, et al. (2010) developed a systematic review assessed as of strong quality with primary studies of variable quality. They found some support for the role of early childhood interventions to improve health behaviours, such as tobacco and marijuana smoking, exercise and safety behaviours, and for a reduced risk of poor mental health outcomes, all of which are strongly associated with adult social disadvantage. The evidence for health service use was inconsistent, and while there was some evidence for increased risk of hypertension, chronic disease outcomes were difficult to assess due to small event numbers. Given the long-term nature of the follow-up, attrition was remarkably low for most studies. A number of methodological limitations weaken the conclusions that can be made from the review of these studies.

In the second systematic review, rated as strong quality, D'Onise, Lynch, et al. (2010) found some evidence for obesity reduction, greater social competence, improved mental health and crime prevention. While there are other well established positive social impacts of such interventions, there is a shortage of robust studies examining health effects more directly. Only eight of the 37

studies had a strong methodological rating, 15 were evaluated as at moderate potential risk of bias and 14 as at high potential risk of bias.

### 3.9. Mental health and postpartum depression

In this section, one systematic reviews and meta-analysis was related to evaluate the effectiveness of interventions to prevent depressive disorder in children and adolescents (Stice, Shaw, Bohon, Marti, & Rohde, 2009); two systematic reviews (including one meta-analysis) were related to assess interventions to prevent post-partum depression (Dale, Caramlau, Lindenmeyer, & Williams, 2008; Dennis & Dowswell, 2013); and one systematic review and meta-analysis to evaluate the impact of antenatal psychosocial assessment on perinatal mental health morbidity (Austin, Priest, & Sullivan, 2008).

Regarding the interventions to prevent depressive disorder in children and adolescents, the systematic review and meta-analysis of Stice et al. (2009), assessed as of strong quality with primary studies of significant heterogeneity, suggest that depression prevention efforts would produce a higher yield if they incorporate factors associated with larger intervention effects (e.g., programs that include homework produce larger intervention effects than programs without homework).

There is also evidence of the effectiveness of psychosocial and psychological interventions to reduce the risk of developing postpartum depression. The systematic review and meta-analysis of (Dennis & Dowswell, 2013), assessed as of strong quality with primary studies of low risk of bias, found that psychosocial and psychological interventions significantly reduce the number of women who develop postpartum depression. Promising interventions include the provision of intensive, professionally-based postpartum home visits, telephone based peer support, and interpersonal psychotherapy. On the other hand, the systematic review of Dale et al. (2008), assessed as of strong quality with primary studies of moderate quality, found that in mothers with postnatal depression the peer support telephone calls intervention significantly decreased depressive symptomatology at the 4-week assessment and 8-week assessment, and at the same time peer support telephone calls were associated with greater continuation of breastfeeding in mothers at 3 months postpartum.

On the other hand, the review of Austin et al. (2008), assessed as of strong quality with primary studies of significant heterogeneity, found that while the use of an antenatal psychosocial assessment may increase the clinician's awareness of psychosocial risk, neither of the two small RCT studies, compressing their review, provided sufficient evidence that routine antenatal psychosocial assessment by itself leads to improved perinatal mental health outcomes.

### 3.10. Injuries

Five systematic reviews were related to injuries prevention. There is evidence of the effectiveness of interventions to prevent injuries in children in different settings.

For example, the systematic review and meta-analysis of Kendrick et al. (2012), assessed as of strong quality with primary studies of variable quality, found that home safety interventions for

children, most commonly provided as one-to-one, face-to-face education, especially with the provision of safety equipment, are effective in increasing a range of safety practices. There is some evidence that such interventions may reduce injury rates, particularly where interventions are provided at home; and this review included studies conducted in disadvantaged populations.

Kendrick et al. (2013) conducted a systematic review and meta-analysis, assessed as of strong quality with primary studies rated as moderate quality, which found that parenting interventions, most commonly provided within the home using multi-faceted interventions, are effective in reducing child injury. Fairly consistent evidence suggests that they also improve home safety. This evidence relates mainly to interventions provided to families from disadvantaged populations, who are at risk of adverse child health outcomes, or whose families may benefit from extra support.

Community-based and school-based prevention programmes addressed to children aged 8 to 12 years old also showed effectiveness, according with the systematic review conducted by Nauta, van Mechelen, Otten, & Verhagen (2014), assessed as of strong quality with primary studies rated as moderate quality. The short term effects for school and community-based interventions using safety devices, such as a cycle helmet and visibility aids, are promising. More high quality research is, however warranted, preferably shifting focus from safety behaviour change to actual physical activity injury reduction. Nevertheless, most of the studies were conducted in high income countries.

A systematic review and meta-analysis, assessed as of strong quality with primary studies of variable quality, conducted by Owen, Kendrick, Mulvaney, Coleman, & Royal (2011), to assess the effectiveness of non-legislative interventions in increasing helmet use among children, found that non-legislative interventions appear to be effective in increasing observed helmet use, particularly community-based interventions and those providing free helmets. Those set in schools appear to be effective but possibly less so than community-based interventions. Interventions providing education only are less effective than those providing free helmets. There is insufficient evidence to recommend providing subsidised helmets at present. Interventions may be more effective if provided to younger rather than older children. There is evidence that interventions offered in healthcare settings can increase self-reported helmet wearing. However, the studies were undertaken in higher-income countries, and the additional effect of helmet promotion above existing legislation was not explored; so, the effect of interventions in countries with existing cycle helmet legislation and in low and middle income countries also requires investigation.

In relation to information, advice or educational programs to prevent unintentional injuries to children under 15 years during outdoor play and leisure, there is evidence that suggests that more extensive educational programs (such as health fairs and media campaigns) increase use of protective equipment. However, in this systematic review, assessed as of strong quality, the methodological weaknesses of relevant primary studies substantially limit the basis for policy making. To better inform policy and practice, future research should use robust study designs and not rely on short term proxy outcome measures (Pearson et al., 2012).

### 3.11. Violence

Four reviews were related to evaluated interventions to prevent violence. Two of them on violence prevention in children (Fagan & Catalano, 2012; Mytton, DiGuseppi, Gough, Taylor, & Logan,

2006), one on prevention of domestic violence in pregnant women (Jahanfar, Howard, & Medley, 2014), and one to identify and evaluate the characteristics of successful school-based violence prevention programs (Park-Higgerson, Perumean-Chaney, Bartolucci, Grimley, & Singh, 2008).

Both reviews evaluating violence prevention programs in children and adolescents found evidence of effectiveness. The systematic review conducted by Fagan & Catalano (2012), rated as moderate quality with primary studies of apparently of high quality, found that there are effective interventions, which implemented rigorously, can substantially reduce youth violence. These effective strategies targeted a variety of risk and protective/promotive factors using diverse mechanisms and included individual, school, family and community focused strategies. The systematic review and meta-analysis of Mytton et al. (2006), rated as strong quality with primary studies of uncertain quality, found that school-based secondary prevention programmes to reduce aggressive behaviour appear to produce improvements in behaviour greater than would have been expected by chance. Benefits can be achieved in both primary and secondary school age groups and in both mixed sex groups and boys-only groups.

The systematic review and meta-analysis conducted by Park-Higgerson et al. (2008), assessed as of moderate quality with primary studies of low quality, did not find the characteristics of successful school-based violence prevention programs, instead exemplifying the complexity of identifying effective program strategies. On the other hand, the systematic review of Jahanfar et al. (2014), rated as strong quality with primary studies of mixed risk of bias, concluded that there is insufficient evidence to assess the effectiveness of interventions for domestic violence against pregnant women.

In the next pages, table 1 summarizes the effective interventions by context, lifecycle approach, and strength of the evidence. Table 2 summarizes the interventions without evidence of effectiveness, according to context, lifecycle, and strength.

In table 1, the criteria used to rate the strength of evidence were: the result of the review quality assessment, the primary studies quality, as well as the strength of the evidence itself in terms of the results of the corresponding reviews, the amount of evidence, and the diversity of the contexts involved. Three check marks indicate stronger evidence, two indicate an intermediate level, and one indicates evidence of less strength.

Please note that this review is focused only in NCDs and its risk factors; subjects on mental health, injuries, and violence were indirectly pulled by the search strategy, but they were not exhaustive and not systematically searched. However, they are here included just with introductory purposes.

Table 1. Summary of the effective interventions by context, lifecycle, and strength of the evidence

Theme / Outcome	Intervention	Context	Lifecycle approach	Review quality	Primary studies quality	Evidence
Overweight and obesity	School-based interventions	Developed and developing	Children and adolescents	Strong quality systematic reviews and meta-analysis	High, moderate and low quality	✓✓✓
	Not only school, but also family, and general population setting interventions	Mainly in developed countries	Children and adolescents	Strong quality systematic reviews and meta-analysis	High, unclear, and variable quality	✓✓
	Diet, physical activity, or both interventions	Mainly in developed countries	Children and adolescents, pregnant women and women during postpartum	Strong quality systematic reviews and meta-analysis	High, moderate, and low quality	✓✓✓
	Programs promoting healthy weight in a wide range of strategies	Mainly in developed countries	Children, adolescents, and pregnant women	Strong quality systematic reviews and meta-analysis	High, moderate, low, and variable quality	✓✓
	Breastfeeding and obesity prevention	Developed countries	Children under 2 years old	Moderate and strong quality systematic reviews and meta-analysis	Incomplete quality criteria, high, moderate and low risk of bias, and heterogeneity	✓
	Policies to influence overweight, obesity or nutritional impacts	Developed countries, Egypt and India	Children, adolescents, women, and adults	Moderate and strong quality systematic reviews	Wide range of study designs rated at high, moderate and low quality	✓
	Health information technology improving access to obesity treatment and rates of screening	Developed countries	Children and adolescents	Strong quality systematic review and meta-analysis	Low to moderate quality	✓

Healthy eating and risk factors	Behavioural change and interventions to promote fruit and vegetable consumption	Developed countries	Children, adolescents, and women of child-bearing age	Strong quality systematic reviews and meta-analysis	Variable quality	✓✓
	School-based interventions	Mainly in developed countries	Children and adolescents	Strong and moderate quality systematic reviews and meta-analysis	Moderate and poor quality	✓
	School policies	Mainly in developed countries	Children and adolescents	Strong and moderate quality systematic reviews	High risk of bias, marked heterogeneity	✓
	Computer and web-based interventions	Developed countries	Children and adolescents	Strong quality systematic review	High quality	✓✓✓
Physical activity	Interventions to promote physical activity	Developed countries	Children, adolescents, and adults	Moderate and strong quality systematic reviews	Variable quality	✓✓
	School-based interventions	Mainly in developed	Children and adolescents	Strong quality systematic reviews	Low, moderate, and variable quality	✓✓
	School, family, community and general population setting interventions	Mainly in developed countries	Children and adolescents	Strong and moderate quality systematic reviews and meta-analysis	Moderate, strong, and variable quality	✓✓
Alcohol, tobacco, and substance use	Universal family-based and school-based alcohol prevention programs	Mainly in developed countries	Children and adolescents	Strong quality systematic reviews	Poor quality	✓
	Multi-component community interventions on tobacco	Mainly in developed countries	Adolescents and young people	Strong quality systematic review and meta-analysis	Moderate quality	✓✓
	Multiple substance-using and risk behaviours in adolescents	Developed countries	Adolescents	Strong quality systematic review of reviews	Primary reviews of strong quality and primary studies of variable quality	✓✓

Cancer	Behavioural interventions to prevent cervical cancer	Developed countries	Young women up to the age of 25 years	Strong quality systematic review	Uncertain risk of bias	✓✓
Related health outcomes	Centre-based early childhood interventions	Mainly in developed countries	Preschool children	Strong quality systematic reviews	Variable, and high, moderate and low quality	✓
Mental health*	Depression prevention programs	Developed countries	Children and adolescents	Strong quality systematic review and meta-analysis	Significant heterogeneity	✓✓
	Postpartum depression	Mainly in developed countries	Pregnant women and postpartum	Strong quality systematic reviews and meta-analysis	Moderate and high quality	✓✓
Injuries*	Home safety education	Mainly in developed countries	Children and adolescents	Strong quality systematic review and meta-analysis	Variable quality	✓✓
	Parenting interventions	Developed countries	Children and adolescents	Strong quality systematic review and meta-analysis	Moderate quality	✓✓
	Community-based and school-based prevention programmes	Developed countries	Children and adolescents	Strong quality systematic review	Moderate quality	✓✓
	Non-legislative, interventions in increasing helmet use	Developed countries	Children and adolescents	Strong quality systematic review and meta-analysis	Variable quality	✓✓
Violence*	Individual, school, family and community focused strategies	Developed countries	Children and adolescents	Moderate quality systematic review	High quality?	✓✓
	School-based secondary prevention programmes	Mainly in developed countries	Children and adolescents	Strong quality systematic review and meta-analysis	Uncertain quality	✓✓

\*This review is not exhaustive and non-systematic for these themes/outcomes, which are included here just with introductory purposes.

Table 2. Summary of the interventions without evidence of effectiveness, according to context, lifecycle, and strength

Theme / Outcome	Intervention	Context	Lifecycle approach	Review quality	Primary studies quality	Evidence
Overweight and obesity	Reducing weight in obese pregnant women	N/A	Pregnant women	Strong quality systematic review	N/A	Did not find studies
	Preventive strategies for mastitis and subsequent effect on breastfeeding duration	Developed and developing countries	Breastfeeding women or who intend to breastfeed	Strong quality systematic review and meta-analysis	Poor study quality and design.	Insufficient evidence to show effectiveness
	Technology-based interventions (web-based, e-learning, and active video games)	Mainly in developed countries	Adolescents	Strong quality systematic review	Most studies rated as high or moderate quality	Not clear and insufficient evidence
	Text messaging into weight management programmes	Developed countries	Children and adolescents	Strong quality systematic review and meta-analysis	Most had positive and neutral quality rating	Did not show additional advantage
Healthy eating and risk factors	To increase the consumption of fruit and/or vegetables in pre-schoolers	Developed countries	Children aged 5 years and under	Strong quality systematic review and meta-analysis	Low to high risk of bias	Insufficient and not specific direction
	Eating disorder prevention programs in the community, media literacy and advocacy approach	Mainly in developed countries	Children and adolescents	Strong quality systematic review and meta-analysis	Variable risk of bias	Insufficient evidence
Physical activity	Applying a socio-ecological approach	Developed countries	Children at the childcare	Strong quality systematic review	High, moderate, and low quality	No evidence and mixed results
	Technology-based interventions (web-based, e-learning, and active video games)	Mainly in developed countries	Adolescents	Strong quality systematic review	Most studies rated as high or moderate quality	Not clear and insufficient evidence

Alcohol, tobacco, and substance use	Motivational interviewing intended to address alcohol and alcohol-related problems	Mainly in developed countries	Young people up to the age of 25 years	Strong quality systematic review and meta-analysis	Low to moderate quality	Not proven substantive, meaningful benefits
	Brief school-based interventions on reducing substance use	Developed countries	Adolescents	Strong quality systematic review	Moderate quality	Limited quality evidence
	Routine pre-pregnancy health promotion encouraging behavioural change on smoking, drinking, and poor nutrition	Developed countries	Women of childbearing age and pregnant women	Strong quality systematic review and meta-analysis	Some risk of bias	There is insufficient evidence
	Policies on restricting or banning the advertising of alcohol	Developed countries	Adolescents	Strong quality systematic review	High risk of bias	Lack of robust evidence
	Policies aiming to prevent smoking initiation among students by regulating smoking in schools	China	Children and adolescents	Strong quality systematic review	Only one study at high risk of bias	There is no evidence
Diabetes and gestational diabetes	Prevent gestational diabetes in pregnant women	Mainly in developed countries	Pregnant women	Strong quality systematic review and meta-analysis	Variable risk of bias	There is no evidence, or insufficient evidence
	Prevent diabetes and health outcomes for mother and baby during preconception period in women with history of diabetes	Developed countries	Women with pre-existing diabetes, or women with history of gestational diabetes in a previous pregnancy	Strong quality systematic review	Not applicable	No eligible trials identified

Ischemic heart disease	Promotion of infant growth during the first 2 years	Mainly in developed countries	Children under 2 years old	Strong quality systematic review	Moderate risk of bias	There is insufficient evidence
Mental health*	Antenatal psychosocial assessment on perinatal mental health morbidity	Not informed	Pregnant women	Strong quality systematic review and meta-analysis	Significant heterogeneity	There is insufficient evidence
Injuries*	Information, advice or educational programs to prevent unintentional injuries	Developed countries	Children under 15 years	Strong quality systematic review	Poor quality	Considerable methodological weaknesses
Violence*	Identify and evaluate the characteristics of successful school-based violence prevention programs	Developed countries	Children and adolescents	Moderate quality systematic review and meta-analysis	Low quality	Did not find the characteristics of successful programs
	Domestic violence against pregnant women	Mainly in developed countries	Pregnant women	Strong quality systematic review	Mixed risk of bias	There is insufficient evidence

\*This review is not exhaustive and non-systematic for these themes/outcomes, which are included here just with introductory purposes.

## 4. Discussion and conclusions

Given the heterogeneity of interventions included within each review and the large number of papers across the eleven themes/outcomes areas, it has not been possible to report any particular area in great depth. One of the strengths of this systematic review is its capacity to offer a broad overview of the evidence.

We have gathered a wide body of evidence which illustrates that there are a considerable number of effective interventions in the life course of maternal-child and adolescence to prevent non-communicable diseases risk factors.

The interventions that appear to be most successful include those addressed to prevent overweight and obesity, specifically school-based interventions, as well as prevention or treatment of overweight and obesity by diet, physical activity, or both. This is important to point out that school-based interventions have a considerable amount of evidence, in both developed and developing countries. Furthermore, not only school, but also family and general population setting interventions also have important evidence, same for programs promoting healthy weight in a wide range of strategies, such as stakeholders' participation and behavioural lifestyle interventions. Nevertheless, there is some evidence regarding the effectiveness of breastfeeding, policies to influence this outcome and health information technology improving access to obesity treatment and screening.

Interventions to improve healthy eating also has showed evidence, specially computer and web-based interventions, but also there is some evidence regarding behavioural change interventions to promote fruit and vegetable consumption, school-based interventions, and school policies. Promoting physical activity interventions also have important amount of evidence, also school-based, family and general population setting interventions. Regarding alcohol, tobacco and substance use, the most promissory are multi-component, community, and risk behaviour interventions. It is noteworthy that centre-based early childhood interventions are promising innovative strategies for both, the child health effects as well as adult health impacts.

Importantly, we didn't find mixed effects of the evidence, this means for or against to the same intervention, but different interventions with evidence for or against.

While there is a good body of evidence of effectiveness of interventions to prevent non-communicable diseases risk factors, a focused and complete systematic review is required in order to determine the scope of the evidence regarding the interventions about injuries, violence and mental health, since, as we noted previously, this review was focused only in NCDs and its risk factors; subjects on mental health, injuries, and violence were indirectly pulled by the search strategy, but they were not exhaustive and not systematically searched.

In conclusion, as a result of this systematic review, here are the main findings on the evidence of the effective interventions in the life course of maternal-child and adolescence to prevent non-communicable diseases risk factors.

## 4.1. Overweight and obesity

There is sufficient evidence about the effectiveness of the interventions and policies to prevent overweight, obesity, and nutritional impacts in children and adolescents.

- The evidence from different context, low-middle income countries as well as high income countries, have proved that school-based interventions are effective to prevent overweight and obesity in children and adolescents.
- Interventions including not only school, but also family and community support, as well as general population setting interventions, have also demonstrated effectiveness in high-income countries.
- Diet, physical activity, or both, are also effective to reduce BMI in children under 18 years old, excessive gestational weight gain during pregnancy, as well as help women to lose weight after childbirth, particularly combined diet and exercise interventions, as proved in developed countries.
- Involving stakeholders in programme design, implementation and evaluation could be crucial to the success of interventions.
- Combined behavioural lifestyle interventions, including behavioural modification, nutrition and physical activity, and educational interventions are effective to prevent and treatment of overweight and obesity in children and adolescents of developed countries.
- Providing dietary advice and blood glucose level monitoring for women with pregnancy hyperglycaemia, not meeting gestational diabetes and type 2 diabetes criteria, help to reduce the number of macrosomic and large-for-gestational (LGA) age babies.
- Breastfeeding is effective in lowering the risk of developing key features of the metabolic syndrome in later life, and is shown to be associated with decreased risk of overweight, decreased blood cholesterol, blood pressure, and risk of type 2 diabetes.
- Interventions which aim is to encourage women to breastfeed have showed effectiveness in terms of changes in the number of women who start to breastfeed. Health education and peer support interventions can result in some improvements in the number of women beginning to breastfeed. Larger increases are likely to result from needs-based, informal repeat education sessions than more generic, formal antenatal sessions. These findings are based only on studies conducted in the USA among women of low income with varied ethnicity and feeding intention.
- Agricultural policies that change the prices of foods at a national level can have an effect on population-level nutrition and health outcomes, as showed in India, Egypt, the Netherlands, and USA.
- In United States, United Kingdom, and New Zealand, food subsidy program participants, women, children of disadvantaged families, mostly pregnant or postnatal women, were shown to have 10-20% increased intake of targeted foods or nutrients.
- Health information technology interventions (electronic health records, telemedicine, text message or telephone support) can improve access to obesity treatment and rates of screening in developed countries, however the impact on weight loss remains understudied and inconsistent.

## 4.2. Healthy eating and risk factors

- Behavioural change interventions are effective, in developed countries, to improve dietary behaviours associated with the prevention of chronic diseases; two intervention components are particularly promising: goal setting and small groups.
- Four aspects of behavioural interventions design that are effective for women of child-bearing age from disadvantaged backgrounds in developed country settings: 1) the use of an educational component; 2) provision of continued support after the initial intervention; 3) family involvement; and 4) social support from peers or lay health workers.
- Effective behavioural interventions to promote fruit and vegetable consumption are: physician advice or individual counselling, school-based activities, mass media campaigns and legislative interventions.
- The evidence is strong in favour of multi-component interventions to increase fruit and vegetable consumption in children of developed country settings.
- School-based interventions for prevention of NCDs risk factors, including diet, physical inactivity, and tobacco consumption, that involved both community and family, have showed a higher positive result, mainly in high income countries.
- School food and nutrition policies, nutrition guidelines and price interventions focused on healthier foods, are effective to improve the school food environment and students' dietary intake of children and adolescents in developed countries.
- In developed countries, computer and web-based interventions can improve eating behaviour and diet-related physical outcomes among children and adolescents, particularly when conducted in schools and individually tailored feedback.

## 4.3 Physical activity

- Effective behavioural interventions, including physical activity, are: physician advice or individual counselling, school-based activities, mass media campaigns and legislative interventions.
- An intervention component for increasing physical activity levels among African-American is a structured exercise program that provide opportunities to practice physical activity during the intervention sessions.
- School-based interventions for prevention of NCDs risk factors, including diet, physical inactivity, and tobacco consumption, that involve both community and family, have showed a higher positive result, mainly in high income countries.
- The evidence shows that interventions including not only school, but also general population settings, and interventions targeting multiple health behaviours, are effective to promote physical activity in children and adolescents, mainly in developed countries.
- Self-monitoring, group-based components, and motivational signs to encourage stair use were identified as promising strategies to increase physical activity in developed countries.
- Social involvement of families should be taken into account in the physical activity promotion programs given the association between parental support and the physical activity level of children and adolescents, mostly in developed countries.

#### 4.4. Alcohol, tobacco, and substance use

- Family-based and school-based prevention programs have demonstrated effectiveness to prevent alcohol misuse in school-aged children up to 18 years of age. The most commonly observed positive effects across school-based programs were for drunkenness and binge drinking. Psychosocial and developmental prevention programs can be effective and could be considered as policy and practice options.
- Multi-component community interventions are effective in influencing smoking behaviour and preventing the uptake of smoking in adolescents and young people under 25 years. These include education of tobacco retailers about age restrictions, programmes for prevention of smoking-related diseases, mass media, school and family-based programmes. However, the evidence is not strong.
- Some universal drug use prevention programs and behaviour prevention programs (including tobacco, alcohol and other drug use, sexual risk-taking behaviour and behavioural disorders) for adolescents, in which a school-based program was one component, have demonstrated effectiveness. Interactive programs with trained facilitators and focused on comprehensive life skills are effective, and successful programs were more effective with an additional community-based component.

#### 4.5. Diabetes and gestational diabetes

- It was found evidence in one trial about reduction in the rate of gestational diabetes mellitus (GDM) when women are randomised to probiotics early in pregnancy, but more uncertain evidence of any effect on miscarriage/IUFD/stillbirth/neonatal death, and there are no data on macrosomia. However, this means that there is little evidence available on this theme.

#### 4.6. Cervical cancer

- Behavioural interventions for young women, which aim is to promote sexual behaviours protective of sexually transmitted infections, primarily at encouraging condom use, can be effective to prevent cervical cancer. Most studies were conducted in the USA and in health-care clinics.

#### 4.7. Related health outcomes

- There are some evidence on the role of early childhood interventions, centre-based, to improve adults health behaviours, such as tobacco and marijuana smoking, exercise and safety behaviours, and for a reduced risk of poor mental health outcomes among disadvantaged populations in US.
- Centre-based preschool intervention programs, for healthy 4 year olds, also have child health effects beyond the preschool years. There are some positive evidence, for disadvantaged populations in US, such as obesity reduction, greater social competence, improved mental health and crime prevention.

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