

Impact of Health and Nutrition Interventions in the Prevention and Recovery of Child Malnutrition in Sub-Saharan Africa from 2010 to 2020: Review Article

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Abstract

Malnutrition is still a widespread public health problem worldwide. The objective of this review is to identify the most effective nutrition programs used in the prevention and management of child malnutrition in children under five years. Also, it is to suggest courses of action to improve interventions in the fight against malnutrition. The promotion of exclusive breastfeeding and food diversification improves the mothers' knowledge and contributes to prevention of malnutrition. Food supplementation increases the weight/height ratio of malnourished children. The two programs combined bring better results on mothers' feeding practices and children's anthropometric data. This review has highlighted the importance of food supplementation and nutritional education in the management and prevention of child malnutrition. In addition, the combination of several approaches to good dietary practices brings better results. Finally, primary prevention can protect children from the harmful consequences of malnutrition.

Keywords

Malnutrition, Nutritional Education, Breastfeeding, Supplementation

1. Introduction

Malnutrition is still a widespread public health problem worldwide, serious enough to challenge the Sustainable Development Goals (SDGs), mainly in developing countries [1]. Children with severe acute malnutrition (SAM) have a nine-fold higher risk of death than healthy children [2]. Three million children under 5 die of malnutrition each year [3]. Nutrition should be seen as a strategic investment to achieve the SDGs by 2030 [4]. Investing in child nutrition is crucial for the development of human capital. Nutrition is a cornerstone of children's growth, cognitive development, successful academic performance, and future productivity [4]. Nutrition has the power to break vicious intergenerational cycles that want malnutrition to perpetuate poverty which in turn perpetuates malnutrition. Malnutrition is caused in large part by extreme poverty and ignorance of good nutritional practices [5].

It occurs mainly in sub-Saharan Africa. Yet, in that region, the climatic conditions offer the possibility for the inhabitants to cultivate and thus satisfy their food needs; with annual rainfall exceeding 900 mm. In addition, arable land represents 35% to 54% of the territory [6]. Despite this, many children from that region suffer from malnutrition. This synthesis explores the different programs offered to mothers of malnourished children to improve their knowledge of food and nutrition practices as well as the treatment of child malnutrition in sub-Saharan Africa [2]. The frameworks for the care of children suffering from moderate or severe malnutrition are similar in all countries. Indeed, this management involves an initial phase of treatment, with intensive feeding of the child and nutritional education for mothers [7]. The term malnutrition is defined, in this work, as a "nutritional deficit" [8]. The term "mother" refers to both the child's mother and another caregiver. First, the problem of malnutrition will be described, in order to lead to a research question. Then, the different concepts related to this theme will be defined in order to improve understanding of the research question and to discuss the results. Subsequently, scientific articles dealing with this issue will be analyzed, with the aim of highlighting the results. These results will then be presented and discussed. Finally, improvements for the programs used resulting from the results found will be proposed as a conclusion.

In order for mothers to be able to take charge of appropriate nutrition for their children and to effectively combat malnutrition, they must receive relevant nutritional education, adapted to their needs. To this end, there are numerous programs aimed at promoting exclusive breastfeeding, dietary diversification and the care of children already suffering from severe or moderate acute malnutrition. Therefore, the research question could be formulated as follows: What programs are used, in hospital and out-of-hospital settings, in the prevention and treatment of malnutrition? And what are their effects on mothers' knowledge and practices regarding the nutrition and health of children aged six months to five years, suffering from moderate or severe malnutrition, in devel-

oping countries? Thus, the population concerned by this research question is made up of children under five suffering from moderate or severe malnutrition and their mothers. The context encompasses both hospital and non-hospital settings. Finally, the outcome concerns the effects of the change in feeding practices and child nutrition care. The aim of this review is to take stock of the various programs offered to mothers of children suffering from malnutrition and to identify their impacts on the child's state of health and his environment. Also, this review will offer healthcare professionals the various programs that have shown good results and in order to improve professional practice.

2. Methodology of the Research

The research to be selected is that conducted between 2010 and 2020, so it illustrates the current issue and indicates that the topic is still relevant. In addition, this research proposes interventions that have been recently evaluated, which increases their relevance. The various publications made it possible to better target the research problem as well as the collection of valuable information on this subject. Thus, to complete this bibliographic search, specialists and actors working on health/nutrition issues were consulted in order to identify other unlisted studies. The target population included children under the age of five suffering from severe or moderate acute malnutrition, pregnant and lactating women in developing countries. The variables identified in this research are the anthropometric data of the children, the mothers' knowledge of the initiation, duration and practices of exclusive breastfeeding as well as dietary diversity practices (dietary diversity score). The data collection methods used is derived from standardized procedures for measuring anthropometric data. The mothers' knowledge and the change in feeding practices were assessed during tests or questionnaires [9] [10] [11] [12] [13], focus groups [13], semi-structured interviews [14] [15] and observations [16]. The interviews were recorded and transcribed to guarantee their authenticity. In the bill of quantities, the scientific value criteria are precision and validity. Reliability corresponds to "the consistency or consistency with which an instrument measures the attribute it is supposed to measure" [17]. The fidelity was attested in the collection of anthropometric data. Indeed, in some studies, the children were naked during each weighing [16] [18]. In addition, these studies use standardized procedures to collect anthropometric data [10] [14] [16] [18] [19] [20] [21]. These procedures have been tested several times to ensure consistency of measurement. The study conducted by le Roux *et al.* does not name the procedure for weighing children [22]. The various anthropometric data measurement instruments certify accuracy in the data collection. Indeed, the scales are sophisticated and frequently checked [10] [16] [21]. Other anthropometric data such as height and arm circumference were also measured with valid instruments. The margin of error for anthropometric data is fifty to one hundred grams for weight [10] [16] [18] and 1 to 5 millimeters for height [10] [14] [16].

The selected research fully or partially takes into account ethical aspects such as consent, anonymity and respect for participants. Indeed, most of the research has been approved by ethics committees [11] [14] [16] [18] [19] [20] [21] [22]. The studies conducted by other researchers do not appoint an ethics committee but have been approved by research institutes [9] [10] [12] [21]. Anonymity was respected in all research. Most of the authors requested oral or written consent from the participants. The studies used software to analyze their data such as SAS [16] [18] [19] [22], Anthro [14], SPSS [11] [14] [16] [20]. Researchers performed statistical analyzes in all searches. The value of the relationship between variables was assessed with the Pearson correlation coefficient [10] [14] [16]. The Pearson correlation coefficient is the most frequently used correlation index [17]. Statistical tests were performed in the majority of research to verify the hypotheses. All research has calculated the probability (p) that the results are due to chance. The significance level is 0.05 [17]. The t test, calculated in six studies [11] [14] [16] [18] [19] [22] is a bivariate statistical test making it possible to compare the scores obtained in the two groups, for the dependent variable, and thus to check the statistical significance between the two groups [17]. Analysis of variance (ANOVA) has been used in several studies [11] [14] [16] [20]. This bivariate statistical test makes it possible to “verify the differences between three or more groups, by comparing the variability between the groups to the variability within the groups” [17]. The chi-square test is used to determine the possible existence of a relationship between two variables [17]. This method is used in six studies [11] [14] [16] [18] [19] [20] [23]. Finally, two studies used multiple regression analyzes in order to “understand the simultaneous effects of two or more independent variables on a dependent variable” [17].

Two studies conducted respectively by Mwangome *et al.* [24] in the Gambia and Imdad *et al.* [25] were excluded. Mwangome *et al.* [24] qualitative study explores the determinants of dietary practices but does not propose a concrete method to achieve a satisfactory result, like that of Imdad *et al.* [25]. Sixteen studies were therefore retained in the context of this literature review. Thirteen studies have a quantitative design, of which seven are randomized controlled studies. Three studies have a mixed design (Figure 1). All the studies were carried out in developing countries in Africa (South Africa, Ghana, Nigeria).

2.1. Results

The results were classified according to the different methods used during the malnutrition treatment phase (Figure 2) as well as their impacts on the nutritional status of children and feeding practices. They were then presented in such a way as to highlight the knowledge on this subject.

2.2. Intervention with Mothers to Promote Exclusive Breastfeeding

Exclusive breastfeeding is the cornerstone of any malnutrition prevention strategy because of its ability to prevent disease and child mortality [26]. Nutrition

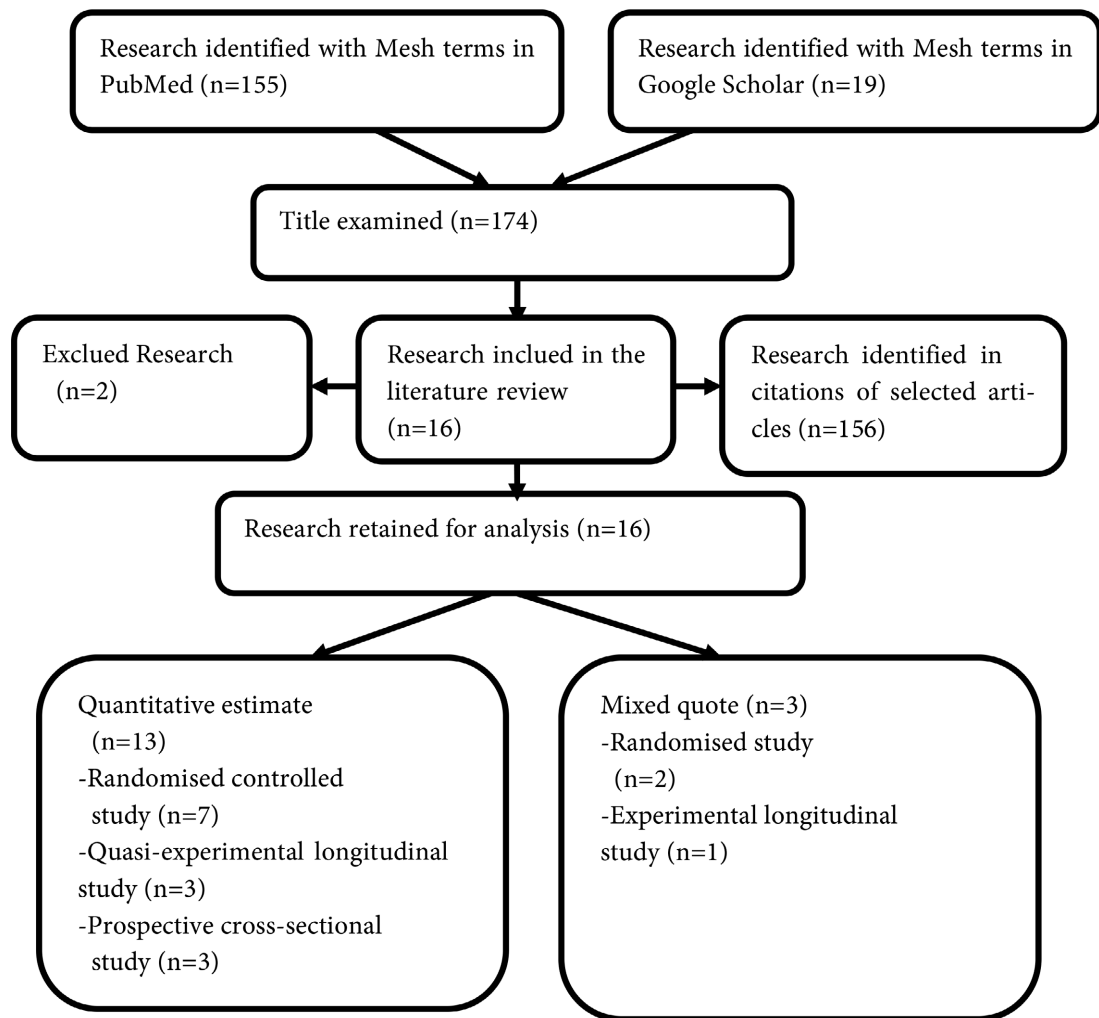


Figure 1. Research presentation diagram.

interventions are most effective in the first 1000 days of life, between the first day of pregnancy and the child's second birthday. Any undernutrition during this period could cause significant and largely irreversible damage to the child's physical and cognitive development [27]. Thus, several authors believe that it is important to provide nutritional education to pregnant and breastfeeding women in order to improve their knowledge of food practices and infant nutrition. Indeed, studies already carried out by several authors reveal a correlation between the improvement in the nutritional status of the majority of children who have been exclusively breastfed and mothers' knowledge of nutrition [11] [12] [28] [29]. On the basis of growth indicators (weight, height and age), the study carried out by others studies shows a statistically significant difference between the type of children's diet and the Height for Age Z-score (HAZ) ($p < 0.001$), as well as the Weight for Age Z-score (WAZ) at recruitment. ($p < 0.005$) [30]. Indeed, the HAZ and WAZ were normal in the majority of exclusively breastfed children. In addition, the analysis by age group of children revealed a significant association between exclusive breastfeeding and Weight for Height

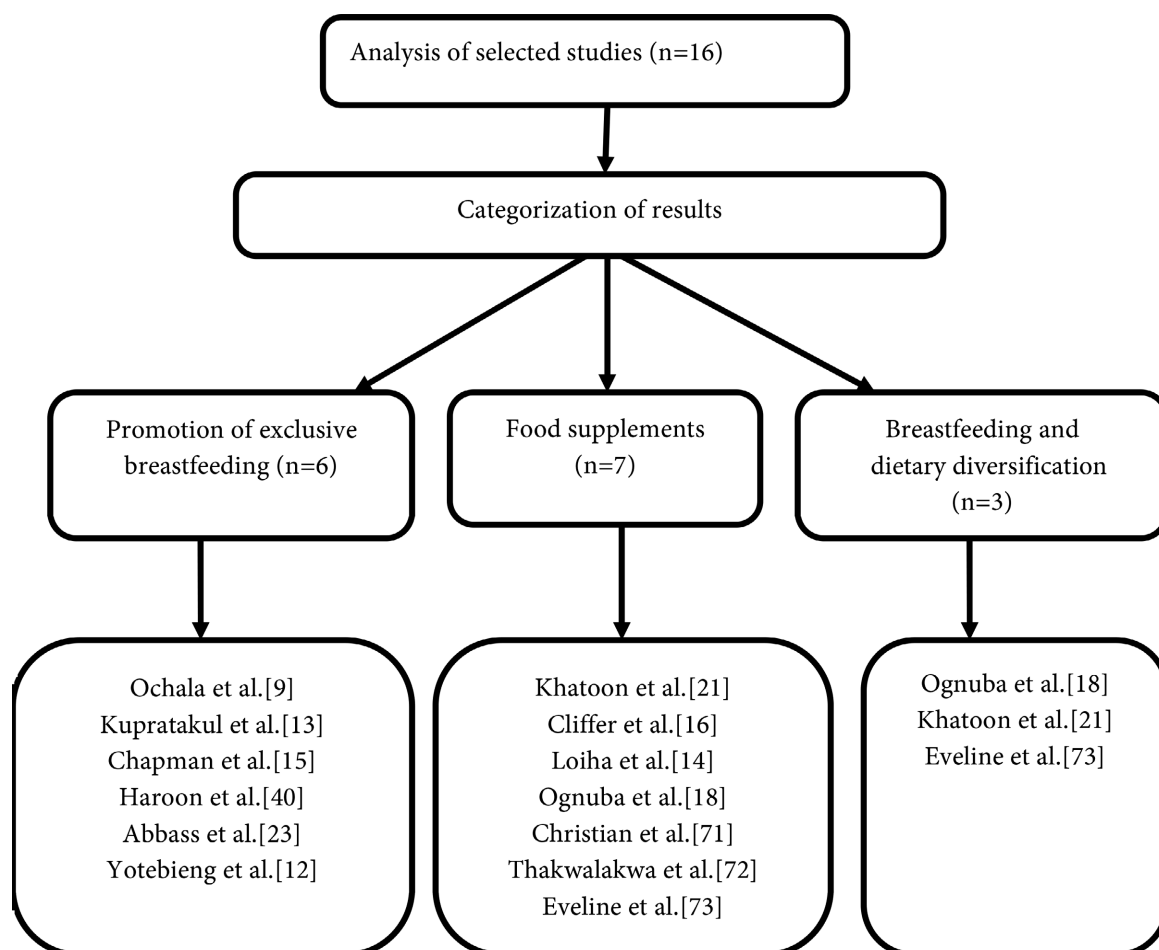


Figure 2. Analysis of selected studies.

Z-score (WHZ) in children aged 6 to 8 months ($p = 0.005$) and between breastfeeding and the Weight/Age index in children aged 9 to 11 months ($p = 0.018$). The early introduction of foods to breastfed children is likely to reduce the consumption of breast milk, which may affect nutritional and immune status [31]. Indeed, when intakes of additional food and fluids exceed the nutritional requirements of the child, it can lead to overweight.

Kamran *et al.* [11] showed that in the fourth month of birth, the rates of exclusive breastfeeding (77.3%) in the experimental group of primiparous mothers, during their prenatal period, who received the education strategy and behavioural skills reinforcement interventions, were significantly higher than those in the control group (47.7%). This result corroborates with other studies also demonstrated that after an intervention, there was no difference between the two groups with regard to the mean weight of the children [11] [32]. During the first month, but by the fourth month, the mean weight in the experimental group was significantly higher than in the control group. This is similar to other studies that children who were exclusively breastfed had significantly greater weight gains and that prolonged and exclusive breastfeeding could in fact accelerate weight and height gain in the breast, during the first months [33] [34]. It has

therefore been proven that exclusive breastfeeding reduces exposure to fluids and often contaminated foods [35], which makes it possible to protect oneself diseases and promote normal growth of the child. The importance of exclusive breastfeeding for the prevention of morbidity and mortality is confirmed by Lamberti *et al.* [36].

Furthermore, an increase in the duration of breastfeeding was associated with a reduction in overweight and obesity in children [37] [38]. It added that the promotion of infant nutrition and exclusive breastfeeding is an important way to fight obesity and improve the overall health of these populations. Despite WHO recommendations for exclusive breastfeeding for the first six months of a baby's life, some mothers give up early. The main reason for stopping breastfeeding that emerges frequently in the literature is the lack of qualified advice and support. On the other hand, lack of motivation and living conditions lead mothers to stop breastfeeding [39]. Currently, strategies to prolong breastfeeding are implemented either by trained health workers or through educational or facility-based programs [40]. Healthcare professionals have tried various interventions to encourage mothers to continue exclusive breastfeeding. One of the strategies described in the literature is the use of multiple forms of interactive counselling by peers or health workers. These counselling sessions are conducted primarily using individual strategies through home visits or phone calls [15]. All types of counselling are categorized as separate interventions with different effects on the main outcome: promotion of breastfeeding. In a large randomized controlled trial conducted by some authors, women in the intervention group who received support from providers and completed a two-day crash course at the baby-friendly hospital initiative had significantly higher rates of exclusive breastfeeding at 6 months [12]. Another recent randomized controlled trial showed that mothers in the intervention group, who participated in counselling groups led by peer counsellors, had rates of exclusive breastfeeding four times higher than those in the control group found higher rates of exclusive breastfeeding among women who received breastfeeding training and knowledge sharing with a registered nurse [9] [13]. In fact, exclusive breastfeeding rates were higher in the study group compared to those in the control group at 14 days (82.5% vs. 52.6%, $p = 0.005$), 1 month (77.5% vs. 52.6%, $p = 0.021$), 2 months (62.5% vs. 36.8%, $p = 0.023$), 4 months (35.0% vs. 7.9%, $p = 0.008$), 5 months (25.0% vs. 2.6%, $p = 0.012$), and 6 months after childbirth (20.0% vs. 0%, $p = 0.005$).

Some studies have been limited to examining the effect of interventions on stopping exclusive breastfeeding any time after birth [41]. Additionally, Haroon *et al.* [40] reviewed 34 trials and found a significant increase in exclusive breastfeeding rates following breastfeeding promotion interventions (43% at day 1, 30% at <1 month and 90% at 1 - 5 months). Other single-method interventions showed the least significant results. This finding is consistent with previous evaluations which recommend a multi-component intervention as the optimal strategy [42]. Most hospital-based interventions, especially in low-income coun-

tries, can be associated with inequalities, as they benefit wealthy mother more than disadvantaged mothers.

In addition, the baby-friendly hospital initiative requires staff training, which the hospital administration also sees as obstacles to staff engagement. An intervention study found a link between the degree of staff engagement and exclusive breastfeeding rates confirming the importance of staff engagement in the initiative: baby friendly hospitals [43]. Combined interventions provided by hospital and community had greater effects than interventions in hospital or at home. Interventions that started during the prenatal period and lasted after birth had greater effects than prenatal or postnatal interventions only. This corroborates with an earlier systematic review of breastfeeding interventions which also identified greater effects of longer interventions during the pre and postnatal periods than intensive interventions provided during the prenatal or postnatal period [44]. Prenatal education that combines information on the beneficial effects of exclusive breastfeeding and breastfeeding techniques improves the ability of mothers to breastfeed exclusively because it increases confidence in exclusive breastfeeding [45]. Mothers show high confidence during the prenatal period, which decreases considerably during the postnatal period [46]. Prenatal intervention alone is not sufficient to maintain exclusive breastfeeding for up to 6 months, although these interventions during this period motivate mothers to opt for initiation into exclusive breastfeeding. In addition, compared to prenatal interventions, larger effects were observed in an analysis of pooled outcomes of postnatal interventions implementing professional counselling and peer support. Although a mother's intention to breastfeed is a key factor in initiating exclusive breastfeeding, previous research has highlighted the importance of postnatal support to long term to increase exclusive breastfeeding rates for six months [23] [47]. The majority of interventions that started after birth used an individualized intervention through a home visit or by telephone. Providing interventions in this way ensured responsive interventions, and established relationships with providers thereby producing better results [43]. In addition, the importance of early postpartum intervention is frequently underscored by the fact that mothers, who experienced breastfeeding problems during the first week, were more likely to stop exclusive breastfeeding before 6 months [46]. The results showed that interventions led by professionals had greater effects than interventions led by peers. In addition, studies with detailed descriptions of staff training and intervention protocol have found exclusive breastfeeding rates greater than 6 months. This is consistent with a review which recommended the use of a systematized protocol and the support of well-trained professionals [44]. One possible explanation for this finding is the lack of knowledge between professionals and lay people. The role of professionals can be crucial as the knowledge and information provided by health professionals has been found to be more credible and important. However, the lack of professional health care providers may hamper the promotion of breastfeeding in resource-limited countries. Peer

support is a low-cost intervention that enables mothers to communicate and exchange knowledge. It is therefore a potentially sustainable alternative [48]. In addition, interventions that combine both professional support and peer support are also plausible. For interventions to be cost-effective and proliferative, the use of peer support should be recommended, especially for people in low-income countries. Overall, there is a critical need for long-term, multi-component interventions covering the pre and postnatal periods. Others authors observed in their study that the self-efficacy of exclusively breastfeeding mothers during pregnancy and after two months of childbirth in the experimental group were significantly higher [28]. The experimental group had a higher level of knowledge and attitude than the subjects in the control group. Additionally, exclusively breastfeeding mothers had higher levels of postnatal self-efficacy in the experimental and control groups compared to breastfeeding women (52.00 vs. 39.45 in the control and 57.69 vs. 36.00 in experimental subjects; $p < 0.001$).

Thus, the encouragement and promotion of exclusive breastfeeding should be a priority for health care providers in improving mother-child health as long as the basis for sustainable good health begins with giving women. The support they need to be able to breastfeed their infants. Appropriate duration of breastfeeding, based on expert recommendations, is strongly recommended, as it represents the most affordable public health intervention that maximizes the health benefits of the mother and child by improving nutrition knowledge, community involvement in the management and promotion of breastfeeding.

2.3. Intervention with Mothers to Promote Dietary Diversification

This research analyzed the effectiveness of the diversification score in evaluating children's feeding practices and their interdependence with the nutritional status of children aged 6 to 24 months, in accordance with the vision of Ruel and Me-non, concerning the food diversification in developing countries [49]. From the age of 6 months, children need adequate dietary diversification in order to provide the nutrients necessary for good full-weight growth. Inadequate diet during the first years of life could lead to malnutrition correlated with reduced growth and increased child morbidity [50]. It is therefore necessary to have a practical food diversification score in order to assess feeding practices as well as the quality of infant and young child feeding. The dietary diversification score is essential for the prevention of stunting in infancy and early childhood as well as the disruption of the intergenerational cycle of undernourishment [51]. It is an effective public health tool with several components to ensure the prevention of infant morbidity and mortality [52]. The link between poor nutritional status and poor infant and young child feeding practices is well established by several studies. These studies suggest that early life interventions play an important role in modifying eating habits and promoting healthy food choices throughout life [53] [54] [55]. The dietary diversification score, as developed by Ruel and Me-non, measures infant and young child feeding in a single score. The dietary di-

versification score has been validated and its association with nutritional status has been assessed by numerous studies at the international level [14] [21] [56]-[61]. Several studies have revealed hypotheses about the Ruel and Menon dietary diversification score and height-for-age growth rate in children aged 6 to 42 months, internationally. Indeed, some reviews agree on the fact that the score of diversifications is associated with the nutritional status of children aged 6 to 23 months [21] [49] [56] [58] [59]. However, other authors have found that the dietary diversification score is not associated with length for age [30] [62] observed a significant and positive relationship between Size index for Age and the total dietary diversification score ($p < 0.001$), at all ages in children. In addition, an interrelation was made between the Weight/Length and the dietary diversification score only for children aged 6 to 8 months ($p < 0.001$), alongside Weight/Age and the dietary diversification score for 9 to 11 months, with the age group of 12 to 24 months.

Ruel and Menon also observed that feeding practices were strongly and significantly associated with the Length for Age in children, especially after 12 months ($p < 0.001$) [49]. Study demonstrated a significant association between the diversification score and under-nutrition [63]. The same observation was made by Mukhopadhyay *et al.* [64]. In addition, Khatoon *et al.* [21] found a significant relationship between the dietary diversification score and the Height for Age, especially in older children from 12 to 23 months [21]. Indeed, the Length for Age Z-score (LAZ) of children from 12 to 23 months with a high dietary diversity score was significantly improved ($P < 0.05$) compared to children with a low diversity score (-2.01 and -3.20 respectively). A significant correlation was found between the dietary diversity score and the LAZ ($r = 0.24$, $p = 0.01$ and $r = 0.29$, $P = 0.01$) in children aged 6 - 8 months and 12 - 23 months. Multivariate analyzes after adjustment also showed a significant association between the dietary diversity score and the LAZ ($\beta = 0.13$, $P = 0.03$).

In Burkina Faso, the dietary diversification score was significantly and positively associated with the average Length/Age of children aged 6 - 11 months and 12 - 23 months and with the average Weight/Length (W/L) in children aged 12 - 23 month [56]. In Madagascar, Moursi *et al.* [57] also showed a statistically significant link between the Length/Age and the dietary diversification score in children aged 6 to 8 months [57]. In Senegal, the dietary diversification score was strongly and positively related to the Length/Age among children aged 6 - 12 months and less strongly associated with the category of children aged 18 - 24 months [59].

2.4. Impact of Food Diversification on the Nutritional Status of Children

The correlation between the components of the dietary diversification score and the nutritional status of children was studied separately for all children in the age ranges (6 - 8, 9 - 11 and 12 - 24 months). Numerous studies have shown that certain components, such as dietary diversity or the frequency of food groups,

have the intrinsic ability to be good indicators of sufficient micronutrient intake and are further associated with the nutritional status of the human body [65] [66] [67]. We point out that it has been confirmed that the growth of infants is mainly accelerated and sensitive to food intake [68]. In addition, researchers have shown that dietary diversity and the frequency score of food groups are likely to induce the relationship of the diversification score with the Length/Age [58] [59]. They also argued that the frequency of meals or snacks and the absence of bottle-feeding are important components that are significantly associated with anthropometric indices [18]. An adequate minimum meal frequency is associated with better impacts on nutritional status, indicating the need for optimal complementary feeding [14] [69] [70]. A significant association was shown between Length/Age and all components of the Infant and Child Feeding Index ($p < 0.001$), at all ages. Contrary to previous studies, a research attested that dietary diversity and the frequencies of consumption of foods of animal origin were not associated with the height growth of children [62].

2.5. Impact of Food Supplements on the Nutritional Status of Children

In these studies, the authors note the importance of supplementing children with food to meet their needs for energy and protein. These interventions significantly improved the nutritional status of children ($WAZ < -1.5$) [16] [20] [71]. Food supplements therefore provide malnourished children with the nutrients they need to heal. The children aged 6 - 15 months received an average daily ration of 71 g Corn-Soy Blend (CSB) or 43 g Lipid-based Nutrient Supplement (LNS), providing 1188 kJ and 920 kJ respectively for 12 weeks or no supplements according to a study [72]. This intervention improved the mean weight gain of more than 90 g ($p = 0.185$) in children who received LNS and a Weight for Length Z-score (WLZ) of more than 0.22 ($p = 0.049$) compared to children who received no supplementation. Likewise in the study carried out by Cliffer *et al.* [16] in Burkina Faso where moderately acutely malnourished children (MAM) enrolled in a complementary feeding program at the age of 6 months and measured monthly up to 18 months received monthly dietary supplements (SC+, CSB+, CSWB and RUSF). With a sample of 6112 children (CSB+, $n = 1519$; CSWB, $n = 1503$; SC+, $n = 1564$; RUSF, $n = 1526$) distributed in four communes assigned to one of the four intervention arms: Maize mix-Soy Plus (CSB+) programmed with fortified vegetable oils (the reference food), blend of corn and soybeans (CSWB; a new formulation) with oil, Super Cereal Plus (SC+), and ready to use supplementary foods (RUSF). The effects of each intervention arm were compared on growth (length-for-age z-score (LAZ), weight-for-length z-score (WLZ), stunting ($LAZ < -2$) and the monthly total wasting measures ($WLZ < -2$). The rations were 500 kcal distributed monthly. The average costs per child affected related to efficacy were compared between the dietary supplements. The authors found a significant mean improvement in LAZ and WLZ in children fed CSB + with oil after leaving the program. They also concluded that

CSB + with oil was the cheapest and most cost-effective ration for the prevention of wasting and stunting in children. Christian *et al.* [71] in their randomized control trial conducted in rural areas of Bangladesh, reported tested the effect of two local ready-to-use foods (made from chickpeas and rice lentils) and an enriched mixed feed (wheat-soy mixture++, WSB++) compared to Plumpy'doz, all with nutritional advice compared to nutritional advice alone (control) on the results of the prevalence of malnutrition in children from 6 to 18 months. Children (n = 5536) were enrolled at 6 months of age and, in food groups, received one of the daily allotted supplements for one year. This intervention improved the nutritional status of the children. In fact, the prevalence of stunting, which was 50% at the start, fell from 44% at 18 months in the control group, but was 5 to 6% lower ($p \leq 0.01$) in the children receiving Plumpy'doz and chickpeas. The mean length and LAZ at 18 months were 0.27 - 0.30 cm and 0.07 - 0.10 (all $p < 0.05$) higher in the four food groups, respectively, compared to the control group. The study conducted by Eveline *et al.* [73] proposes a systematic treatment associated with food supplements in children with moderate acute malnutrition. In this study, children aged 6 to 23 months with MAM received a monthly ration of 3 kg of Super Cereal and MAM children aged 24 to 59 months received a monthly ration of 6 kg of Super Cereal Plus. The children also received routine medical treatment provided by health workers. The results of the study show that, out of a total of 35,522 MAM children enrolled in the program in early December 2018, 25,253 had recovered by the end of December 2018 (*i.e.* $WHZ \geq -1, 5$) with a recovery rate of 71% after 12 months of care.

Nahar *et al.* [20] studied the food supplements named "Pushti Packet" and contain 20 g of rice powder, 10 g of powdered lentils, 5 g of molasses and 3 g of soybean oil, which corresponds to 150 Kcal and of which 11% of energy from protein. The brothers and sisters of the malnourished child also benefited from the food supplements to decrease the risk of food sharing among siblings. Dietary supplements did not significantly improve anthropometric data and child development after six months of intervention. The psychosocial stimulation and food supplements group showed a significant improvement in mental development ($p = 0.022$ compared to the control group at the clinic and $p = 0.092$ compared to the control group in the hospital), in psychomotor development ($p = 0.031$ by compared to the control group at the clinic, $p = 0.047$ compared to the control group in the hospital and $P = 0.003$ compared to the food supplements group). The psychosocial stimulation associated with dietary supplements improved WAZ ($p = 0.011$) and HAZ ($p = 0.048$) significantly.

In Haiti, Ruel *et al.* [49] used a cluster-randomized trial to evaluate an age-based model for the prevention of undernutrition, offering a package of food aid, maternal health and child and nutritional interventions. They found that this strategy was more effective in reducing child undernutrition, including wasting, stunting and underweight, than the traditional recovery based on targeting underweight children. A combination of interventions might be more effective than separate interventions, especially when they target the same population and can

use the same facilities, supply routes, transport links and contacts with clients according to a study [74]. Their work focuses on the integration of early childhood development and nutrition interventions.

3. Discussion

Several studies showed an improvement in the nutritional status of the majority of children who have been exclusively breastfed and in mothers' knowledge of nutrition following nutritional sensitization [11] [12] [28] [29] [30] [75]. In addition, the analysis by age group of children has revealed a significant link between exclusive breastfeeding and anthropometric data of children aged 6 to 8 months and those aged 9 to 11 months. However, one study conducted highlighted deterioration in the nutritional status of infants in mothers who have practiced suboptimal breastfeeding [30]. Indeed, the suboptimal breastfeeding practice could reduce the consumption of breast milk, which may affect the nutritional status and immune system [31]. Consumption of additional foods and fluids exceeding the infant's nutritional needs can lead to overweight. Also, the study conducted by Kamran *et al.* [11] showed that the exclusive breastfeeding rates of the experimental group of women who benefited from an educational program during their prenatal period were significantly higher than those of the control group. Furthermore, highly self-efficacy mothers were significantly more likely to breastfeed their babies exclusively after childbirth than poorly self-efficacy mothers following awareness [28]. Kamran *et al.* [11] also demonstrated that the mean weight in the experimental group was significantly higher than in the control group. The importance of exclusive breastfeeding for the prevention of morbidity and mortality is confirmed [36]. Furthermore, an increase in the duration of breastfeeding was associated with a reduction in overweight and obesity in children [37]. Steinman *et al.* [38] confirm that the promotion of infant nutrition and exclusive breastfeeding is an important means of combating obesity and improving the overall health of these populations. Research has found that interventions that started during the prenatal period and lasted after birth had greater effects than either prenatal or postnatal isolation interventions. These interventions result in better rates of exclusive breastfeeding and improve the nutritional status of children. In addition, they showed that interventions led by health professionals had greater effects than interventions led by mentor mothers.

3.1. Food Diversification

Many studies have established link between poor nutritional status and poor child and young child feeding practices. These studies showed that early life interventions play an important role in modifying eating habits and promoting healthy food choices throughout life [53] [54] [55]. Other studies have highlighted hypotheses relating to the dietary diversification score and satisfactory nutritional status in children aged 6 to 42 months, in several countries [21] [30]

[58] [59]. On the other hand, other studies have found a significant association between the diversification score and undernutrition [18] [63] [64]. Many authors have observed that dietary diversity and food group frequency score were likely to induce the relationship of the diversification score with child growth [58] [59]. Also, they observed that the frequency of meals or snacks and the absence of bottle-feeding are important components that are significantly associated with the nutritional status of children [18]. Adequate minimum feeding frequency was associated with better impacts on nutritional status, indicating the need for optimal complementary feeding [14] [49]. Contrary to previous studies, the dietary diversity and the frequencies of consumption of foods of animal origin were not associated with the height growth of children [62]. Ruel *et al.* [49] show that the association between feeding practices and the growth in height of the child was conditioned by other social determinants of health such as the socio-economic status of households. They demonstrate that socio-economic factors have emerged as more decisive factors for stunting than biological factors. Studies carried out in several countries show that continuing education for health professionals is effective and relevant in positively modifying maternal attitudes and practices in terms of breastfeeding and complementary nutrition [76] [77] [78].

Various reviews have shown that the effect of maternal education on child health outcomes is explained by socioeconomic status. As a result, they underscored the need for broad and sustained investments to address social determinants in developing countries such as education, girls' empowerment, and dedicated decent work opportunities for women [79] [80].

A low-cost and sustainable intervention in a primary care setting can be effective in promoting better feeding practices, especially the diversification score and delaying the introduction of unhealthy foods in the first year of life in children. A systematic review of the effectiveness and cost-effectiveness of complementary feeding interventions highlighted that the most effective interventions included well-delivered nutrition education and counselling, optimal use of locally available foods, provision of food fortified, and finally the use of complementary micronutrient inputs [81].

3.2. Food Supplements

Studies agree that dietary supplements improve anthropometric data in children [16] [20] [59] [71]. Indeed, "with a high energy diet, most severely malnourished children reach the target weight for discharge after 2 to 4 weeks [7]. Food supplements therefore provide malnourished children with the nutrients they need to heal. Food supplements are essential for children under two years old. Indeed, this period is critical in the growth of the child [82]. Dietary deficiencies in early childhood cause morbidities and developmental delay that is difficult to reverse. Thus, dietary supplements can meet the nutritional needs of children and thus avoid long-term consequences [16]. Dietary supplements encourage regular par-

ticipation in the program, which is an important part of the child's treatment. In fact, in view of the socio-economic precariousness, the food offered to mothers is an important support for families. Food supplements help meet the nutritional needs of malnourished children and therefore promote their healing observes a much stronger impact on nutritional status when relationship intervention is combined with dietary supplements [83] [84].

The complementarity of these interventions thus offers holistic care for the child. It is important not to consider only the sick child but also the siblings. Food supplements are therefore sometimes given to other family members, in order to minimize the risk of sharing [16] [20]. Also, food supplements have an effect on the child's condition only for the duration of the program. Once the dietary supplements are stopped, the child is at risk of relapse if eating habits are not changed. Thus, dietary supplements should be combined with nutritional education, in order to encourage lasting change in nutritional practices. Moreover, it reported that dietary supplements had better effects when combined with another community program, which agrees with other study [20] [85]. Daily fortified complementary foods in addition to nutritional advice significantly increase growth and reduce stunting in children [71]. This encompasses, in addition to the balanced energy-protein supplement, the multiple micronutrient supplements.

3.3. Strengths and Weaknesses of the Study

The selected research took place in different developing countries. The cultural differences encountered in these countries can be a limitation to this research. Indeed, the programmes proposed in the various research studies must be adapted to the local culture before being offered to the population.

Although methodological rigour was applied in the analysis of the research and the writing of the review, this work may contain some errors. In addition, some of the research presented complex statistical analyses and, despite different research on this topic, the presentation of these results may not be entirely accurate.

The strengths of this work are the methodological quality of the selected articles. The different parts were clearly detailed, which allowed an easy analysis. Moreover, as these were quantitative articles, meeting the criteria of fidelity and validity, the generalisation of the results to other contexts is possible, provided that the cultural aspect is respected.

4. Conclusions

This review made it possible to highlight the various interventions implemented in the prevention and treatment of child malnutrition in hospital or community settings. Sixteen selected studies were categorized according to the sub-themes of mothers' knowledge of exclusive breastfeeding practices, dietary diversification and dietary supplementation. The selected research took place in different de-

veloping countries. If health/nutrition interventions implemented in communities and health facilities are to generate high levels of impact, their implementation will need to involve not only epidemiologists and experts in implantation science, but social science researchers and health economists, so as to take into account all potential influencing factors including context. In addition, health workers should offer actions to promote healthy eating and growth monitoring with healthy children. It is important to involve the community in the implementation of these practices.

These actions should aim at increasing the knowledge of mothers, building on the importance of exclusive breastfeeding for up to six months, the timing of the introduction of complementary foods and food hygiene.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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