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Review

Physical Activity and Nutritional Pattern Related to Maturation and Development

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Abstract: In order to better understand the implications of physical activity and nutrition in child development, we conducted the present narrative with the aim to analyze the physical activity and nutritional patterns related to maturation and development. To reach our study objective, a consensus and critical review were conducted by analyzing primary sources such as academic research and secondary sources such as databases, web pages, and bibliographic indexes following procedures of previous critical narrative reviews. We employed the MedLine (Pubmed), Cochrane (Wiley), PsychINFO, Embase, and CinAhl databases to search the MeSH-compliant keywords of exercise, physical activity, nutrition, maturation, development, child, neonatal, infantry, and cognitive development. We used manuscripts published from 1 January 2012 to 1 September 2022, although previous studies were included to explain some information in several points of the review. We found that physical activity and nutrition are basic pillars for the correct development and maturation of the child. Factors associated with development as a species such as breastfeeding, the correct intake of micro and macronutrients, and the performance of both passive and active physical activity will modulate the correct motor and cognitive development in preschool age, childhood, and adolescence.

Keywords: pregnancy; neonatal; maturation; childhood; physical activity; nutrition; cognitive development

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1. Background

The initial periods of life of the human being are fundamental for a correct development and an adult stage free of diseases at both organic and cognitive levels [1]. The context of development is fundamental and various contextual epigenetic factors will have a drastic effect on the development of the child. Thus, from the prenatal period and during the development of the child, the social context, the nutrition, and the physical activity that they carry out will mark their status at an adult level [2,3].

The prenatal period is basic in the correct psychophysiological development of the subject, and the influence of the methylations produced at that time have great effects on the programming of the development of the fetus [4]. For example, subjects who were fetuses in the Dutch famine period (November 1944 to spring 1945) had a 10% higher mortality [5], and the bases of how these deoxyribonucleic acid (DNA) methylations in prenatal stages are mediators and risk factors for suffering metabolic diseases in adulthood have already been described [6]. It was also possible to verify how these subjects who were fetuses at that

time presented low weights, a characteristic that accompanied them for the rest of their lives, even though they already had free access to food. However, if the mother's malnutrition only occurred during early pregnancy, the children had higher rates of obesity [7]. Serious effects have also been found at other levels, since this population group appears to be more sensitive to stress and has a rate twice the average of suffering from coronary heart disease, as well as type 2 diabetes [8]. Interestingly, they also have greater reproductive success, having children earlier and with a greater chance of having twins, and, amazingly, some of these negative health effects continue to show up in the grandchildren of people who had lived through the Dutch famine in the first trimester of pregnancy [9].

Findings from studies of the Dutch famine have shown that maternal malnutrition during pregnancy has long-lasting negative consequences for the health of the offspring. Many chronic diseases that plague our society today can originate in the womb. The effects appear to be large and dependent on when the malnutrition occurred during gestation. Furthermore, the effects are independent of the child size at birth. In particular, those exposed to famine early in pregnancy did not have lower birth weights than those exposed to famine prenatally, but had poorer general health as adults. This implies that adaptations that allow the fetus to continue to grow may have adverse health consequences in adulthood [10]. Chronic degenerative diseases can be seen as a high price paid for adaptations made in an adverse intrauterine environment. Maternal nutrition during pregnancy plays an important role in subsequent susceptibility to the disease, hence the importance of taking care of maternal nutrition in this very sensitive period [11].

Contextual stressors and nutrition in these early stages of life are critical to child development. Another factor intrinsically related to the correct child development is the level of physical activity. As a species, we are animals made by and for movement; we need movement so that the powerful endocrine organ that is our skeletal muscle works and can produce the basic cytokines for the regulation of other organic processes in the rest of the body's systems [12]. This will help the child develop physically and cognitively, and has a direct implication with the future academic performance of the child [13]. In order to better understand the implications of physical activity and nutrition in child development, we conducted the present narrative with the aim of to analyze the physical activity and nutritional patterns related to maturation and development.

2. Materials and Methods

Search Methods and Strategies for Research Identification

To reach our study objective, a consensus and critical review was conducted analyzing primary sources such as academic research and secondary sources such as databases, web pages, and bibliographic indexes following procedures of previous critical narrative reviews [1,14–16]. We employed the MedLine (Pubmed), Cochrane (Wiley), PsychINFO, Embase, and CinAhl databases to search the MeSH-compliant keywords of exercise, physical activity, nutrition, maturation, development, child, neonatal, infantry, and cognitive development. We used manuscripts published from 1 January 2012 to 1 September 2022, although previous studies were included to explain some information in several points of the review. We used the following exclusion criteria per previous reviews [15–18]: i. research out of the time period analysis; ii. presented topics out of the review scope; iii. unpublished studies, books, conference proceedings, abstracts, and PhD dissertations. We used all of the studies that met the scientific methodological standards and had implications with any of the subsections of the present review. The information treatment was performed by the seven authors of the review. Finally, articles were discussed by the authors to write the present review. A total of 2151 papers were retrieved from the above bibliographic searches, and 514 papers were removed after the publishing period inclusion criteria. Then, 192 papers were removed as duplicates, and 248 were rejected after reviewing paper titles and abstracts. The final 193 papers were read to be considered relevant to the search criteria and appropriate for assessing our research objective.

3. Physical Activity and Nutritional Status in Pregnancy

There are different factors related to poor obstetrical outcomes—such as hypertensive disorders, glycemic dysregulation, and aberrant fetal growth—including obesity and excessive weight gain during pregnancy. Therefore, adopting healthy habits and behaviors during pregnancy is a key factor in reducing risk factors, improving obstetrical outcomes, and promoting optimal fetal growth trajectories.

Traditionally, at the time of conception, a woman should have a Body Mass Index (BMI) of between 18.5–24.9, which is what the authors have determined as "prevention before conception [19]". However, in the majority of cases, many women have low fitness levels with a tendency to be overweight, which makes the "prevention before conception" process difficult and slow. However, achieving a healthy pre-pregnancy BMI must be a basic goal. From a holistic perspective, heath professionals among doctors, care providers, nutritionists, and specialists in physical exercise should jointly focus on reducing weight and reaching an optimal BMI before pregnancy [20]. The risk for the mother of suffering risk of cardiac and pulmonary disease, gestational hypertension, and diabetes as well as obstructive sleep apnea is high. Recent studies have focused on physical activity as a key tool to mitigate comorbidities associated with an increased body weight pre- and post-pregnancy, and optimize their health and longevity as well as that of their baby [21].

However, the scientific literature is scarce and lacks randomized control trials that allow for precise guidelines for physical exercise pre- and post-pregnancy. Nevertheless, we summarize our findings and suggest guidelines and benefits.

In a study of 1014 pregnant women, those who performed aerobic physical exercise saw benefits during the pregnancy period. The authors state that the women who performed between 2–3 sessions per week had similar pregnancy duration, risk of cesarean delivery, and infant birth weight [22]. Following the recommendations of the American College of Sports Medicine (ACSM) of 150 min of moderate intensity aerobic activity per week translates into weight maintenance and physical condition, which already offers significant benefits for the mother's health, but can be insufficient in some cases [23]. Maintenance of the levels of physical activity prior to pregnancy translates into a reduction in cesarean birth, increasing postpartum recovery time [24]. These levels of physical activity translate into an essential factor in the prevention of depressive disorders in the postpartum period [25], greater self-reported overall physical fitness [26] and cardiorespiratory fitness associated with less bodily pain, lumbar and sciatic pain [27], and reduced pain disability [28]. A randomized controlled trial involving 300 obese and overweight women showed that performing aerobic exercise for 30 min three times a week, following the ACSM guidelines, for a total period of 37 weeks resulted in reduced gestational weight gain at less than 25 weeks of gestation, and lowered neonatal birth weight [29].

A recent meta-analysis showed a significant reduction in gestational hypertensive disorders and hypertension, as well as cesarean birth in women who performed aerobic exercise 30–60 min 2–7 times per week [30]. Likewise, in 2017, a systematic review suggested that the practice of physical activity between about 30–60 min 3–7 times per week in obese and overweight women resulted in a reduction in the incidence of preterm birth, greater than in women not obese or overweight but sedentary [31]. In the same line, another systematic review and meta-analysis in 2016 suggested that normal-weight pregnant women who practiced aerobic exercise for 35–90 min 3–4 times per week resulted in a higher incidence of vaginal delivery and a significantly lower incidence of cesarean birth, with a significantly lower incidence of Gestational Diabetes Mellitus (GDM) and hypertensive disorders [32]. The latest study states that mothers with previous pathologies not associated with pregnancy—such as chronic hypertension, type 1 diabetes, and type 2 diabetes—who performed physical exercise according to the ACSM recommendations reduced the odds of cesarean birth by 55% chance and did not increase the risk of adverse maternal and neonatal outcomes [33].

According to specialists, the practice of physical exercise is safe, and evidence suggests that the fetus is not deprived of substrate during periods of maternal physical activity [34].

Paying attention to the contraindications before and during the exercise is key, which are addressed below. In view of these studies, we can presume that compliance with the ACSM recommendations for cardiovascular exercise results in [20]:

Higher incidence of: Vaginal delivery.

Lower incidence of: Excessive gestational weight gain, gestational diabetes mellitus, gestational hypertensive disorders, preterm birth, cesarean birth, and lower birth weight.

However, when it comes to prescribing physical exercise, we must consider a series of physiological alterations, a consequence of pregnancy, which require individualizing the prescription of physical exercise. Therefore, pregnant women will experience an increase in:

- The heart rate, stroke volume, cardiac output, tidal volume, and blood pressure with respect to baseline
- Alterations in thermoregulation in which the core temperature increases.
- Process of hemoconcentration, an increase in the red series, given a loss of plasma volume. Finally, given the same training load, absolute energy expenditure is increased for a pregnant woman.

Thus, contraindications in carrying out a physical exercise program would be determined by [35]:

- Uncontrolled type I diabetes, thyroid disease, or other serious cardiovascular, respiratory, or systemic disorders.
- Persistent second or third trimester bleeding, ruptured membranes, previous spontaneous abortion, preterm labor or previous preterm birth, hypertensive disorders of pregnancy, incompetent cervix.
- Growth-restricted fetus, anemia (Hb: 100 g/L), high-order multiple gestation, malnutrition or eating disorder, placenta previa after 28th wk, twin pregnancy after 28th wk, persistent second or third trimester bleeding.

While exercising, red flags to discontinue exercise during pregnancy will be determined by [36]:

- Vaginal bleeding, abdominal pain, regular painful contractions, amniotic fluid leakage, dyspnea before exertion, dizziness, headache, chest pain, muscle weakness affecting balance, calf pain or swelling.

The benefits for the mother are clear, but regarding the life of the newborn, there are several.

Physical activity is safe. In fact, physical exercise can mitigate the negative consequences of excess maternal body weight on infant birth size [19]. This optimization in weight, as a consequence of physical exercise, is explained by the increase in the functional capacity of the placenta to provide nutrients via increased placental surface area, perfusion balance and blood flow [37]. Authors noted an asymmetric reduction in birth weight of exercising mothers, a difference that was entirely accounted for by a reduction of neonatal fat mass with no changes in lean mass compared with the offspring of matched controls [38].

There is an inconsistency in the literature because authors have shown a relationship between maternal physical activity and low birth weight. However, in most of the studies analyzed, a lack of control of caloric intake can be observed; in addition, they focus on lean, healthy, active women [39]. Therefore, the results cannot be generalized to a larger sample.

Regarding the long-term child health benefits that exercise can exert during the pregnancy phase, the authors suggest that physical activity may trigger beneficial adaptations to environmental stressors [40]. Recent studies in animal and human models show that newborns with large gestational age are more likely to be overweight in stages of childhood, adolescence, and adulthood [41]. In contrast, newborns with small gestational age are more likely to have insulin resistance and type 2 diabetes mellitus, cardiovascular diseases, and increased adipose tissue [42].

In summary, physical activity is an excellent tool to prepare women for a pregnancy without complications, predisposing the newborn to the best possible health conditions. Specialists in physical exercise are responsible for individualizing and studying each case.

However, sole compliance with the recommendations of the ACSM of cardiovascular physical exercise already supposes significant improvements both for the mother and the newborn.

Nutrition is another of the essential tools along with physical exercise in the pre–post pregnancy stages, both for the mother and for the embryo and its future health and development. Both are modifiable factors, however, there is still a clear lack of information and guidelines in this regard. Regarding nutrition, similar to exercise, the scientific literature is scarce, and there are some methodological inconsistencies and lack of prospective studies that allow for statements beyond establishing causal relationships.

Following the recent review of Marshall et al. in 2021 [43], we can summarize the importance of proper nutrition during and after pregnancy, and its effects on the newborn.

Firstly, authors suggest an adequate and individualized diet, balanced in micro and macronutrients. This contributes significantly during pregnancy to the optimal development of the fetus and favorable obstetrical outcomes [44]. Thus, a healthy pregnancy and optimal perinatal outcomes require a balanced diet. These types of diets are rich in fruits and vegetables, whole grains and legumes, and rich monounsaturated fats, while avoiding simple sugars, meats, and processed products as well as trans and saturated fats [45]. Furthermore, restrictive-type diets are detrimental to the health of both the mother and the newborn. These diets can lead to an incorrect energy balance, leading to catabolism, nutrient deficiencies and ketosis [46]. The types of diet models, both recommended and not, are discussed below [43].

Mediterranean diet: This diet is on the recommended list due the high inclusion of plant-based foods, vegetables, grains, legumes, spices, olive oil, fish, unprocessed meats, poultry, and red wine with up to 40% of the calories coming from healthy fats.

Low sodium diet (hypertension model diet): This diet is on the recommended list due to a highly balanced carbohydrates ratio of 58%, low intake of fats of around 28%, and moderate protein intake of 18%. The diet is rich in fiber, calcium, magnesium, potassium, and phosphorus. Special attention should be paid to possible vitamin D deficit.

Flexitarian diet: This is also a recommended diet. It is one based mainly on the consumption of raw foods and vegetables. The meals are rich and they look for the widest possible spectrum of foods, generally more than five in the same meal. Excessive consumption of vegetables can lead to a deficit of calcium, vitamin B12, and iron.

Nordic diet: Fruits, vegetables, legumes, potatoes, whole grains, nuts, seeds, rye bread, fish, seafood, low-fat dairy, herbs, spices, and canola oil. It is a diet with exclusions towards red meats and animal fats. Sugar and sweeteners are excluded as much as possible, as well as processed food and refined foods.

Atkins, Paleo, Vegan and Ketogenic diets: These are totally contraindicated nutritional strategies. Mainly due to the amount of food that they restrict, these diets can generate a micronutrient deficit. Low carbohydrate intake, conversely, induces a ketogenic state. All of these diets produce a deficit of vitamin C, B folate, calcium, magnesium, and fiber.

In general terms, the consequences of malnutrition during pregnancy are directly developed with anomalies in the weight of the fetus, generally less than 2500 g, small for gestational age, fetal growth restriction, and large for gestational age. All of these factors are related to the appearance of traditional Western and metabolic diseases in later stages of development and adulthood [47]. Special focus needs to be asserted from a behavioral point of view. The nutritional habits of pregnant adolescents are very different from those of older women. Therefore, adolescents face greater socioeconomic difficulties and a lifestyle that requires professional and social support [48] to optimize their diets, behaviors, and other aspects of their health and social care before, during, and after their pregnancies. Therefore, pregnancy at an early age requires extra attention in the nutritional and behavioral field. Furthermore, the "prevention before conception" [19] is key. Current scientific evidence suggests that the mother's BMI, independent of their age, is directly related to gestational weight gain. Although the ideal time to improve body weight and nutrition-related lifestyles is well

before conception occurs [49], nutritional and physical activity interventions should begin as soon as possible, as long as there are no contraindications such as those outlined above.

The regular consumption of vitamins and minerals, as well as supplements to reach the recommended amounts of folic acid [50], among others, are recommended at least 2–3 months before conception and continuing throughout the pregnancy until the cessation of lactation or at least 4–6 weeks after delivery. While pregnant, women should consume an average of two portions per week of ocean fish, avoiding large predator fish such as tuna or swordfish. When unable to achieve this recommendation, daily intake of at least 300 mg omega-3 docosahexaenoic acid (DHA) by taking a supplement providing at least 200 mg omega-3 DHA per day, in addition to the dietary DHA intake, is recommended [51]. Its regular consumption has been found to reduce the risk of early preterm birth prior to 34 weeks of gestation [52].

Whereas there is a risk of poor and deficient micronutrient nutrition, dietary supplementation with iron, vitamin D, vitamin B_{12}, iodine, and vitamin A is encouraged. Indeed, women of reproductive age are advised to consume at least 400 µg of folic acid per day as supplements or fortified foods [51], with folate supplements to be continued during at least the first 16 weeks of pregnancy. Regarding B vitamins, they are of high importance to lifelong health; folate, vitamin B_{12}, and vitamin B_6, together with choline, are involved in the regulation of DNA methylation status, and deficiencies of these micronutrients may contribute to long-term effects on offspring health through epigenetic pathways. Thus, when the diet is insufficient due to the consumption of quality vegetables and meat products, supplementation is necessary [53]. Regarding vitamin D, it is essential for maintaining maternal calcium homeostasis and thereby for fetal bone development [54].

The importance of vitamin D for fetal skeletal development is of highly importance. Its deficiency has been related to low birth weight, increased risk of neonatal hypocalcemia, cardiac failure, and reduced bone density in childhood. Dietary vitamin D intake usually reaches only about 2–4 µg per day. Yet, when the intake comes from supplements, it should be at least of 400 IU per day, and the total intake should be in the range of 1000–2000 IU per day from dietary sources [51]. In general terms, at the beginning of the pregnancy the energy intake differs very little from pre-pregnancy. Women should increase 85 kcal per day during the first trimester, 285 during the second, and 475 during the last trimester [51]. Because physical activity tends to be much lower during the third trimester in comparison to the earlier trimesters, dietary intake should not increase by more than a 10% at the end of the pregnancy [52]. However, it should be noted that these recommendations are different according to the initial nutritional status and physical activity.

4. Physical Activity in Neonatal Maturation

Overweight and obesity levels have recently become a matter of concern in the newborn period [55]. In those early stages, physical activity evolves and increases over the first year. Newborns' movements seem to not have a clear objective or pattern, although they usually start by arm waving and leg kicking (until they are 5 months old), sway, bounce, and rock back and forth in a seated position (until they are 10 months old), and crawling both with their belly on the floor (4–8 months old), or in a hand-knee position (7–11 months old) [56].

Stimuli to enhance physical activity through these basic movements have been demonstrated to help growth in infancy. One of the methods used is parental counselling for the parents to stimulate their children's movement. Those infants who followed this approach had less adipose tissue, weight, and smaller abdominal circumference [57,58]. Physical activity in early ages is very important for a correct growth of children's bones, muscles, and adipose tissue [57,59,60]. Despite the movements of newborns seeming too basic to influence the body composition, the percentage of body fat is inversely related to physical activity observed in infants [61,62]. Moreover there has been found to be a negative association between physical activity and weight gain [56]. Physical activity should be addressed since the most early stage of life because it has an impact on a child's body

composition, which also persists in teenage years and adult life [57,59,60]. Physical activity during pregnancy also helps to maintain better body composition in the neonates [19,63].

Physical activity is important in maturation since it helps the newborn to give and receive more attention, which ends up with them having more opportunities to learn and to develop mentally [56]. Regarding sex differences, boys develop approximately 0.2 more standard deviations of physical activity than girls in infancy [64], although these differences were smaller when caregiver observations were used to measure them [56].

To enhance physical activity, above all, preterm, passive, or assisted physical exercise have been reported to give advantages to the children's growth. Passive exercises are those which are produced for an external force, in this case the newborn caregiver [57]. The advantages are quite similar to those in other newborns (bone mass, mineral content, fat-free mass), plus weight gain and limbs length [65–70]. The interventions are not homogeneous and consisted of passive resistance (5–10 min/day) [65] and flexor-extension of the limbs (10 min, 3 times a day) [66,67], with a length of 3–8 weeks of duration [68].

One of the main limitations to assess physical activity in infants is the cost of use for adequate instruments. The main instruments are questionnaires, observations, and motion sensors [56,71]. Traditionally, questionnaires have been used to assess temperament, personality and psychobiological behaviors [56]. Observations have been less used, and the need to standardize codification systems also presents some drawbacks [56,72]. Motion sensors, such as accelerometers, have the advantage of being able to assess the activity with an objective, quantitative approach, but they still work better with older ages because the basic patterns used in infancy are not as similar to those developed after one-year old with the ability of walking [71,73,74]. The costs involved with this system could be higher, but there is evidence that a period of 3 days, 24 h/day, is enough to assess physical activity in infancy [75].

Although this topic is of great importance for the correct development and maturation of infants, research is still scarce and there is a need for further studies to better analyze the implications of physical activity and maturation in newborns [56,76].

5. Nutrition in Neonatal Maturation

According to the last section, nutrition in neonatal maturation has traditionally been focused mostly on preterm infants [77–79]. There is a consensus about the importance of breastfeeding as the most adequate way of providing the nutrients the infants need, since it helps to develop a barrier against infections (especially gastrointestinal and respiratory), a decreased risk of overweight and diabetes, and increases intelligence [80–82]. One of the main advantages of breast milk is its positive effects on cognition due to their long-chain polyunsaturated fatty acid composition [83]. However, there is no evidence of its benefits on asthma, allergy, blood pressure, adiposity, height, and body mass index [84–86]. It is also important to highlight the evidence regarding the importance of early breastfeeding to significantly improve survival rates of newborns [87] in Ghana [88], Nepal [89], and India [90].

A possible substitute for breastfeeding are infant formulas, which attempt to gather all the nutrients that breastmilk has, such as low glycemic carbohydrates [77]. However, whenever possible, natural consumption of breast milk is recommended. Recent studies talk about the importance of this in the maturation and growth of the microbiota of the subject. Sensitivity and development of asthma and allergies have been related to the lack of its consumption [91]. A supplementation of docosahexaenoic acid seems to help breast-feeding women and infant formulas to improve child neurodevelopment and allergy risks [52]. Bone mineralization and bifidobacterial also seem to be increased because of triacylglycerol due to infant formulas [92], although breastfeeding continues to be the best possible option for infant nutrition [77].

Several authors have examined the importance of epigenetics as the underlying mechanisms that early nutrition enhances [93]. There is evidence of the importance of nutrition in newborns to avoid overweight, cardiovascular diseases, diabetes, and other chronic

diseases [94]. The influence of breastmilk in the composition of gut microbiota helps to develop the immune system to fight against diseases throughout life [95], and the enhancement of bifidobacterial diversity is associated with a better immune system and less allergy development [96]. Early nutrition through breastfeeding also prevents the development of metabolic diseases and obesity through inflammation reduction and fighting against insulin resistance [78,93,97].

The neurocognitive and behavioral development are key factors during the earliest periods of infancy [93]. A correct development of the central nervous system is crucial, and evidence supports its link to nutrition through the microbiota–gut–brain axis [98]. The use of prebiotics or probiotics has been found to be promising to prevent behavioral deficits, and gut microbiota can enhance the central nervous system, neurotransmitter performance, and an early brain development [99,100]. Early gut colonization can easily be promoted by breastfeeding, and it can modulate epigenetic changes to improve immunological maturation [93]. The relationship between the immune system and the neurocognitive development has been proven through the presence of cytokine receptors on neurons and glial cells [101], especially in neurodegenerative diseases [102–104] and because of aging [105]. The alteration of nutrition in early stages can ultimately affect the hypothalamic neural circuits controlling reproductive function [106]. The previous ideas support the importance of the relationship about a correct nutrition to promote microbiota development that helps to enhance the immune system to improve the neurocognitive growth in early infancy [93].

Vitamin A supplementation has been traditionally studied with regards to its expected benefits on the immune system, but the current evidence does not recommend newborn vitamin A supplementation unless it is justified because of a deficiency (e.g., in South Asia) [87].

As a practical application, nutrition education should be correctly addressed during pregnancy and its contents should be updated according to the last scientific evidence [107].

6. Physical Activity and Nutritional Status in Childhood

The success for a correct development of the newborn lies in an adequate intervention in modifiable factors such as nutrition and physical exercise. However, the most crucial stages of development are those between 0 and 4 years old, which are the ones that will be addressed below. Despite the effects and health benefits of physical activity and nutrition, during these ages, it has been overlooked because it the time of life when children are habitually "active enough" and, therefore, quite healthy. Yet, authors suggest that most of the western chronic and metabolic adulthood diseases have their origins at very young ages. With the World Health Organization estimating that around 42 million children under five years old are already overweight, it seems that "active enough" is really not enough.

Indeed, studies that focus on the measurement and quantification of physical activity at these ages suggest that levels of physical activity are low and insufficient, especially regarding moderate to vigorous intensity, which is precisely the most suitable intensities of physical activity for this age group, and which have the greatest impact on health [108]. One systematic review concludes that only 54% of the children were meeting the minimum requirements of activity for these ages: 60 min of structured and 60 min of unstructured physical activity every day [109]. However, studies in these age groups are limited, and, as a result, the construction of concise and objective guides is also limited.

Most of the scientific information focuses on school-aged children and youth (5–17 years) as well as adults ($\geq$18 years), where there is concise and detailed information on the benefits of physical activity, in particular moderate-to-vigorously intense physical activity. However, there is a gap regarding the ages of 0–4 years. This is an essential and critical period for physical, cognitive, social, and emotional development, thus clarifying the frequency, intensity, time/duration, and type of physical activity is needed for healthy growth and development is of great importance [110]. Furthermore, the most recent guide [111] by Timmons and colleagues suggest that infants (1 year) should be physically active several

times daily, ages comprehended between 1 and 4 years should accumulate at least 180 min per day of physical activity at any intensity during the day, progressing to add to 60 min per day of energetic play by 5 years of age; the current Canadian, Australian, and United Kingdom guidelines are similar [112].

The authors suggest that there is a direct relationship between levels of physical activity and its benefits. Among the benefits, higher activity levels were associated with lower skinfold thickness. Physical activity was negatively related to triceps skinfold thickness, suggesting that the impact of physical activity is most pronounced on peripheral adiposity rather than whole-body adiposity [113]. Benefits regarding BMI and body fat percentage are prospective, and authors found that higher activity at the baseline was associated with smaller gains in BMI, with evidence of a dose response relationship between physical activity and BMI and skinfold thickness [114]. Indeed, higher physical activity during the preschool years was associated with better measures of adiposity up to 7 years later. In addition, being physically active at 3 years old was related to a lower percentage of body fat [115].

Authors suggest a positive effect on bone quality and mineral density, suggesting an optimization in the production of osteoblasts in the developmental stage. Indeed, increased activity was associated with increases in tibia circumference at post-intervention [116] with a reminiscence effect lasting up to 12 months.

Regarding improvements in tone and motor control, the authors suggest that passive cycling for 2 months during the first year of life resulted in motor (body control balance, grasping) and adaptive (hand–eye coordination) development [117]. Interestingly, authors also suggest that there was an increase in language development, defined by the authors as forms of communications by facial expression, sounds, and vocalizations, suggesting cognitive improvements. On the same age timeline, the authors found that an enhanced physical activity program delivered in a nursery setting increments fundamental movement skills compared with those in the control group, although there was not an increase in habitual physical activity levels [118]. Similarly, in preschoolers, dance classes two times per week resulted in improvements in the Test of Gross Motor Development compared to controls [119]. Furthermore, authors also suggest an increase in psychosocial abilities and health, suggesting gains in their social competence and externalizing behavior.

Regarding cardiometabolic health, the authors suggest reductions in total cholesterol, HDL/total cholesterol ratio, and greater reductions in triglycerides by only being physically active [120]. In a more recent study, 56 min of physical activity per day in preschoolers of moderate physical intensity translated to better metabolic status as assessed from a composite score of various cardiovascular disease risk factors [121].

In summary, we can conclude that regular physical activity and healthy dietary habits are two ways to lower the chance of developing risk factors for chronic lifestyle diseases. Kids who are active on a regular basis display higher level of aerobic and muscular fitness, decreased body fat, stronger bones, and also better mental health and well-being. Thus, it is vital that adults provide opportunities for children and adolescents to be physically active and make good nutrition choices.

However, the hypothesis of how much exercise, and the adequate and perfect doses, continues to exist. At these ages, it seems that objectifying these doses can even be considered absurd. Rather than focus on the quantification and objectification of physical activity at these ages, efforts should focus on modifying and instilling healthy lifestyle habits. The current trend towards a sedentary lifestyle is settling in at younger ages. It is the object of the parents and the efforts of the researchers to promote adherence tools to physical activity, which is where the efforts should be focused. Future research should focus on this type of tool. A clear example would be the use of gamification and virtual reality at these ages, with games such as PokemonGO [122], which have proven to be an effective tool to simply overexpress the values of physical activity in childhood and adulthood inclusively.

Similar to physical activity and its promotion, regarding nutrition in childhood, it should follow the same line and actively promote healthy habits and behaviors. Indeed,

this age gap is crucial for development, where there is a higher demand for energy and the micro and macronutrients that are related to rapid development and growth. However, the WHO figures 42 million children under 5 years old are already overweight, and according to The Center for Disease Control and Prevention, children are consuming around 40% of their total daily kcal from processed, saturated, and fast food [123]. Therefore, nutrition at this age is essential. Early brain and neural cognitive development occur during the fifth and sixth years of life, with much of this development occurring before the age of 2 years [124]. As mentioned previously, an excess of weight and adipose tissue at an early age translates into the appearance and perpetuation of chronic diseases in adulthood. This 40% of calories are high in sodium and contain preservatives and lack the nutrition content needed for a healthy diet. These calories are also empty carbohydrates such as sugar and unhealthy fats while lacking in the healthy essential ingredients for the body.

Below is a breakdown of caloric importance and essential micro and macronutrients and their roles in childhood-aged development.

Regarding caloric computation, both a plus and a caloric deficit may lead to lasting long-term effects even after diet correction, so caloric and nutritional individualization is essential [125]. A nutritional deficit and malnutrition can lead to problems in the cognitive, neural, and motor development of the individual. This would be due to the limitations, especially of essential micronutrients, for the morphological development of the brain and a correct melaninization [126]. Children exposed to conditions of poverty who were in a state of malnutrition showed worse IQ levels, as well as a higher incidence of behavioral problems in the future [127]. Authors also suggested that fasting and a prolonged stage of caloric deficit resulted in lower amounts of energy overall which then contributed to lower cognitive functioning [128]. This would mean a worse academic performance and less possibilities and development in the future.

Problems also appear with an excess of calories, mainly related with overweight and obesity. Both also affect cognition, mainly explained by impaired insulin receptor signaling, which results in low levels of leptin in the brain and inefficient glucose metabolism [129]. In one longitudinal study of 9 years that considered the BMI in ages between 4 and 8 years old, authors showed impairment in gross motor skills was higher among obese male children than those of a normal weight. It was observed that there was also a relationship between higher BMI and an attenuation in the ability to concentrate [130]. In the same line, other authors have linked high caloric diets to impairments in cognitive functioning, specifically in terms of mathematic comprehension [131], and decreased visual spatial organization [132]. Given the negative consequences of childhood obesity, it is important to gain a better understanding of factors contributing to overeating and obesity in children in order to develop effective treatments and prevention strategies such as limiting daily calorie intake [133]. Regarding micronutrients, the consumption of vitamins and enzyme complexes is essential, especially to build neural connections during development. Authors emphasize the importance of a correct balance of micronutrients from the early stages (newborn), during the first few months of life; when they are not sufficiently supplied, deficits can lead to lasting issues [134].

Regarding vitamin B complexes, specifically B12, a deficit can produce severe physical and psychological impairment. In this line, a study assessed a group of 60 adults who were categorized as mildly cognitively impaired and B12 deficient. After injections of 1 mg of B12 a day for one week, the sample group was then assessed again for cognitive ability, returning to normal levels [135]. In a similar study, after intervention of B12 supplementation, 47.2% of the patients showed cognitive improvement [136]. Therefore, its importance in the development and maintenance of cognitive function is essential during development.

Regarding vitamin D, it has been observed that countries with less exposure to the sun are deficient in it, and therefore have a greater tendency to experience rickets in infancy, the formation of autoimmune diseases, and, if left untreated, various types of cancers as well [137]. A recent meta-analysis analyzes the effect of vitamin D deficiency during childhood, and the risk of dementia onset. Authors suggest that vitamin D works similarly

to neurosteroids in the brain, including the regulation of calcium levels and potentially protecting against neurodegenerative processes that are associated with the cognitive decline seen in dementia [138]. Prospective studies in animal models suggest that optimal levels of vitamin D are associated with improved cognitive function and better cognitive aging [139].

In relation to cognitive function, vitamin C plays a crucial role as well, since it reduces oxidants in the brain and ultimately protects against lesions forming. It functions as a natural regulator for neurotransmitters such as dopamine and norepinephrine, thus a deficiency could lead to neurological impairment [140]. In childhood, a recent study suggests that when regularly given a probiotic with vitamin C, respiratory tract infections tend to decrease and show higher recovery time [141]. It has been noted that if an unhealthy diet is recognized early after birth, health problems are likely to be prevented through the appropriate amendments to dietary habits that can carry into adulthood. Yet, attention to nutrition and the product itself from the earliest ages is essential.

Regarding macronutrients, one of the most important proteins, they are of special attention in development stages due to their molecular structure; they are essential and are the basis for the production of neurotransmitters such as norepinephrine, melatonin, and serotonin, as well as for optimal growth and muscle development [142]. A study evaluated the consumption of a snack rich in protein, rich in fat, or simply fasting. The authors demonstrated after intervention that, in addition to appetite control improvements, snacks high in protein tended to reduce confusion and increase cognitive flexibility [143]. A similar study in adults verified the efficiency in information processing and cognitive performance after ingesting a drink rich in sugars, proteins, and fats. Authors found that after consumption of the protein drink, working memory performance and episodic memory increased [144]. Carbohydrates, in addition to protein, also have an important role in information processing and cognition. Compared to previous studies, when looking into non-memory cognitive tasks, carbohydrates have been shown to improve cognitive abilities. A study analyzing the consumption of a drink rich in glucose was found to increase verbal and figural fluency. This may indicate that glucose may selectively enhance certain cognitive functions. Indeed, an acute state of hypoglycemia in diabetic patients results in difficulties in processing visual and auditory information [145]. However, within the consumption of carbohydrates, the consumption of foods with a low glycemic index is recommended, avoiding monosaccharides and refined foods [146]. This is due to the dysregulations and metabolic alterations that it can produce, as mentioned above.

Regarding fats, excluding the aqueous part of the brain, this is composed of 60% of long-chain omega fatty acids DHA and EPA, which are essential to the formation of gray matter, the central nervous system, and cognitive performance [147]. Authors suggest that supplementation with DHA over a 6-month period results in improved overall memory and reaction times [148]. Similarly, when long-chain omega fatty acids are consumed during pregnancy, improvements in children's language development are seen [149]. Indeed, when there is a DHA deficiency during periods of brain development such as early childhood, plasticity and brain function can be impaired in adulthood. Researchers believe that adequate levels of dietary DHA are crucial for building long-term neural resilience for optimal brain performance [150].

Regarding nutrition, it is essential to carry out interventions and consider the family environment as the main axis to modify behaviors and nutritional habits. In this sense, education is a central pillar. Parents exhibit behaviors that children observe and follow.

7. The Impact of Physical Activity in Cognitive Development

Cognitive function is defined as mental processes that contribute to the improvement of perception, memory, and intellect [151]. According to this, the literature considered language, academic achievement, attention, working memory, and executive functioning as measurements of cognition [152]. Childhood and adolescence represent a period of rapid growth in which a correct cognitive development in this stages implies the appearance and

improvement of cognitive abilities within multiple domains [153]. In this line, physical activity has been postulated as a determining factor in cognitive and neural development among children [154]. Thus, greater short- and long-term cognitive development has been correlated in children with higher levels of physical activity [152]. Moreover, this fact has been shown to improve cognitive functioning and academic achievement in school-aged children [155] by improving executive functions and during-tasks behaviors [156]. Thus, no evidence exists that increased time of physical activity in school has an adverse effect on this parameter [157]. In addition, physical activity alters neurogenesis and angiogenesis, improves central nervous system metabolism [158], and increases the availability of brain-derived neurotrophic factors (BDNF), insulin-like growth factor-1 (IGF-1), and vascular endothelial growth factor (VEGF) [159].

Despite this, the influence of physical activity on cognitive development in childhood is not well understood [160], and certain types of physical activity, such as aerobic exercise, may improve cognitive functioning due to physiological changes produced in the brain [161]. However, studies assessing the association between physical and cognitive functions in preschool stage (<6 years old) are limited [162]. Mavilidi et al. [163] showed that 6 weeks of integrated physical activity conditions including task-relevant physical activities and nonintegrated physical activity conditions involving task-irrelevant physical activities improved cognitive outcomes in comparison to conventional sedentary style of teaching. Despite this, two systematic reviews [153] concluded that evidence to support a positive effect of physical activity on cognition during early childhood is low due to weak experimental quality and a high risk of reporting bias using PRISMA guidelines [164].

In relation to preadolescence (6 to 13 years old), strong evidence for an effect of physical activity on cognitive outcomes in children has been well established [165]. Fisher et al. reported significant increases in aspects of cognition and executive functioning in children (6 years old) who underwent a 10-month intervention consisting of 2 h per week of intense aerobic physical education compared to children exposed to standard physical education. In accordance [166], it was shown that there was a more significant improvement on simple reaction and choice response times in 7- and 10-year-old boys after 30 min of aerobic exercise on cycle ergometer than in the control group. In relation, Reed et al. [167] reported that physical activity (30 min a day 3 days a week for 4 months) integrated within the elementary school curriculum (8 to 9 years old) enhanced fluid intelligence and certain academic achievement scores in comparison to the control group. The results of these studies are reinforced by different systematic reviews and meta-analyses that have reported significant benefits of physical activity in different cognitive outcomes [164]. Álvarez-Bueno et al. [168] concluded that physical activity interventions are useful strategies to improve non-executive cognitive functions, core executive functions, and higher-level executive functions. Moreover, de Greff et al. [169] reported a significant effect of physical activity on executive functions, attention, and academic performance among preadolescents. In accordance, Álvarez-Bueno et al. [170] showed that physical education improves classroom behaviors and benefits several aspects of academic achievement. Additionally, physical activity performed during this stage can cause changes in brain structure by increasing white matter compared to inactive subjects [171].

In adolescents, there has not been much high-quality evidence reporting that physical activity has a positive effect on cognition [164]. Esteban-Cornejo et al. [172] reported that 70% of the studies included in their sample (a total of 20) observed a positive relationship between physical activity and cognitive or academic results. According to academic achievements, Spruit et al. [173] reported a significant effect of physical activity on this parameter in his meta-analysis. However, the observed effect size was very small (Cohen's d = 0.367).

Moreover, physical activity during childhood can help develop motor skills [111], which has been associated with cognition improvement [174]. Thus, Adamo et al. [175] reported a significantly greater increase in locomotor skill scores in children (3 to 5 years-old) who carried out a 6-month-long physical activity program compared to the control

group. Laukkanen et al. [176] reported an improvement in motor skills after 12 months of physical activity intervention in 6-year-old children. In contrast, it has been reported that not doing physical exercise prevents the full development of motor skills in late childhood [177]. In accordance with this, current lifestyles cause children to have very high levels of sedentary habits, which can affect the development of motor and mental health problems at this stage [178]. Therefore, physical activity programs should be promoted during critical stages of growth and development such as childhood and adolescence to achieve significant improvements in cognitive function.

8. The Impact of Nutrition in Cognitive Development

Nutrition or dietary factors are just as important as physical activity to cause improvements at the cognitive level [179]. The overall well-being and nutritional development of children are established during childhood, and are of special importance in the first 8 years of life [180]. It has been suggested that there is rapid growth and development of the brain from gestation to the first two years of life, which can be affected by a poor diet [181]. However, the relationship between nutrition and mental development is equally important both in early life and in later life [182]. Due to cognitive development being influenced by interactions between the brain and its environment [183], nutrition during early stages of life has been considered one of the most important environmental factors influencing cognitive performance and brain development. In this line, a longitudinal study reported that diets rich in saturated fats and refined sugars (Western diet) can impede the correct cognitive development and the obtaining of academic achievements [184]. Moreover, research has focused attention on poor nutrient intake as another important factor that can negatively affect cognitive development in children [160]. In this sense, it has been reported that a deficiency in the intake of vitamin B12 can have negative implications on cognitive development in children [185]. However, it is difficult to establish the importance of the deficit of this type of nutrient on cognitive development since very few RCTs have been carried out in children [181].

Based on dietary patterns, it is possible that a healthy diet based on fruits and vegetables, lean protein, and whole grains may promote cognitive abilities through changes in cellular processes, neuroplasticity, or epigenetic mechanisms [160]. Florence et al. [186] reported that lower fat and higher fruit and vegetable intakes were associated with better academic achievements in in 5200 Canadian children (10 to 11 years-old). Moreover, Gispert-Llaurado et al. [187] conducted an observational study and found a reduction in problems related to attention and behavior in 586 European children (7 to 9 years old) who consumed two fish meals per week. Following a healthy dietary pattern, the Mediterranean diet is characterized by a high consumption of vegetables, legumes, cereals, fish, fruits, and nuts, and a balanced consumption of eggs, milk, and meat [188]. Thus, following this type of diet has reported numerous benefits on different cognitive and health parameters in children. Haapala et al. [189] reported an improvement in reading skills in 161 Finnish children (6 years-old) after a physical activity and dietary intervention. However, it is possible that the power of these results is limited by the influence of other important parameters that may influence the development of healthy dietary patterns in children and that have not been controlled, such as socioeconomic status, gender, age, educational level, level of physical activity, or the consumption of breakfast [160,190,191], among others.

Thus, Burrows et al. [192] established in their systematic review the notion that breakfast consumption has become a positive predictor, and the consumption of fast food and sugary drinks have become negative predictors of academic performance in school-age children. In this line, Scientific evidence suggests that sugary drinks and sweet snacks rich in refined carbohydrates are associated with cognitive dysfunction. However, Bleiweiss-Sande et al. [193] reported that no significant relationships between healthy and less healthy consumption patterns and cognitive measures can be assumed. In fact, future research should focus on conducting RCTs in children to discover causality for the improvement in cognitive abilities through diet. However, such research will need to

control for other factors, such as those mentioned above, that may influence adherence to healthy dietary patterns in children and adolescents.

9. Practical Statements

Present review has certain limitations. The variability in study design and measurement tools is a fact that has limited study conclusions. However, after analyzing the information, we can highlight the following practical applications summarized in these key points.

- Breastfeeding is the most important factor of nutrition in newborns because it enhances immune system, nervous system development, and microbiota.
- Passive exercises are recommended for newborns since they foster correct growth, especially among preterm newborns.
- There is weak evidence for cognitive benefits of physical activity in preschool children.
- Increased physical activity may provide motor and cognitive benefits across preadolescence.
- Aerobic exercise seems to be the most used type of activity to improve cognitive processes in childhood and adolescence.
- There seems to be an association between diet in early childhood and cognitive function.
- Poor dietary patterns are associated with increased brain dysfunction.

10. Conclusions

Physical activity and nutrition are the basic pillars of the correct development and maturation of a child. Factors associated with development as a species such as breastfeeding, the correct intake of micro and macronutrients, and the performance of both passive and active physical activity will modulate the correct motor and cognitive development in preschool age, childhood, and adolescence.

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References

1. Clemente-Suárez, V.J.; Beltrán-Velasco, A.I.; Ramos-Campo, D.J.; Mielgo-Ayuso, J.; Nikolaidis, P.A.; Belando, N.; Tornero-Aguilera, J.F. Physical activity and COVID-19. The basis for an efficient intervention in times of COVID-19 pandemic. *Physiol. Behav.* **2022**, *244*, 113667. [CrossRef]
2. Martínez-González, M.B.; Arenas-Rivera, C.; Cardozo-Rusinque, A.; Morales-Cuadro, A.; Acuña-Rodríguez, M.; Turizo-Palencia, Y.; Clemente-Suárez, V. Psychological and Gender Differences in a Simulated Cheating Coercion Situation at School. *Soc. Sci.* **2021**, *10*, 265. [CrossRef]
3. Beltrán-Velasco, A.I.; Mendoza-Castejón, D.; Fuentes-García, J.P.; Clemente-Suárez, V.J. Behavioural, psychological, and physiological stress markers and academic performance in immigrant and non-immigrant preschool and school students. *Physiol. Behav.* **2020**, *225*, 113081. [CrossRef]
4. Zama, A.M.; Uzumcu, M. Fetal and Neonatal Exposure to the Endocrine Disruptor Methoxychlor Causes Epigenetic Alterations in Adult Ovarian Genes. *Endocrinology* **2009**, *150*, 4681–4691. [CrossRef] [PubMed]
5. Ekamper, P.; van Poppel, F.; Stein, A.D.; Lumey, L.H. Independent and additive association of prenatal famine exposure and intermediary life conditions with adult mortality between age 18–63 years. *Soc. Sci. Med.* **2014**, *119*, 232–239. [CrossRef] [PubMed]

6. Tobi, E.W.; Slieker, R.C.; Luijk, R.; Dekkers, K.F.; Stein, A.D.; Xu, K.M.; Slagboom, P.E.; van Zwet, E.W.; Lumey, L.H.; Heijmans, B.T.; et al. DNA methylation as a mediator of the association between prenatal adversity and risk factors for metabolic disease in adulthood. *Sci. Adv.* **2018**, *4*, 2375–2548. [CrossRef]
7. Ravelli, A.C.; van der Meulen, J.H.; Osmond, C.; Barker, D.J.; Bleker, O.P. Obesity at the age of 50 y in men and women exposed to famine prenatally. *Am. J. Clin. Nutr.* **1999**, *70*, 811–816. [CrossRef]
8. Roseboom, T.; de Rooij, S.; Painter, R. The Dutch famine and its long-term consequences for adult health. *Early Hum. Dev.* **2006**, *82*, 485–491. [CrossRef]
9. Painter, R.; Osmond, C.; Gluckman, P.; Hanson, M.; Phillips, D.; Roseboom, T. Transgenerational effects of prenatal exposure to the Dutch famine on neonatal adiposity and health in later life. *BJOG Int. J. Obstet. Gynaecol.* **2008**, *115*, 1243–1249. [CrossRef]
10. Micha, R.; Rogers, P.J.; Nelson, M. Glycaemic index and glycaemic load of breakfast predict cognitive function and mood in school children: A randomised controlled trial. *Br. J. Nutr.* **2011**, *106*, 1552–1561. [CrossRef]
11. Fleming, T.P.; Kwong, W.Y.; Porter, R.; Ursell, E.; Fesenko, I.; Wilkins, A.; Miller, D.J.; Watkins, A.; Eckert, J.J. The Embryo and Its Future. *Biol. Reprod.* **2004**, *71*, 1046–1054. [CrossRef] [PubMed]
12. Pratesi, A. Skeletal muscle: An endocrine organ. *Clin. Cases Miner. Bone Metab.* **2013**, *10*, 11–14. [CrossRef] [PubMed]
13. Mendoza-Castejón, D.; Clemente-Suárez, V.J. Autonomic Profile, Physical Activity, Body Mass Index and Academic Performance of School Students. *Sustainability* **2020**, *12*, 6718. [CrossRef]
14. Clemente-Suárez, V.; Ramos-Campo, D.; Mielgo-Ayuso, J.; Dalamitros, A.; Nikolaidis, P.; Hormeño-Holgado, A.; Tornero-Aguilera, J. Nutrition in the Actual COVID-19 Pandemic. A Narrative Review. *Nutrients* **2021**, *13*, 1924. [CrossRef] [PubMed]
15. Clemente-Suárez, V.; Navarro-Jiménez, E.; Ruisoto, P.; Dalamitros, A.; Beltran-Velasco, A.; Hormeño-Holgado, A.; Laborde-Cárdenas, C.; Tornero-Aguilera, J. Performance of Fuzzy Multi-Criteria Decision Analysis of Emergency System in COVID-19 Pandemic. An Extensive Narrative Review. *Int. J. Environ. Res. Public Health* **2021**, *18*, 5208. [CrossRef] [PubMed]
16. Clemente-Suárez, V.; Navarro-Jiménez, E.; Jimenez, M.; Hormeño-Holgado, A.; Martinez-Gonzalez, M.; Benitez-Agudelo, J.; Perez-Palencia, N.; Laborde-Cárdenas, C.; Tornero-Aguilera, J. Impact of COVID-19 Pandemic in Public Mental Health: An Extensive Narrative Review. *Sustainability* **2021**, *13*, 3221. [CrossRef]
17. Clemente-Suárez, V.J.; Hormeño-Holgado, A.; Jiménez, M.; Benitez-Agudelo, J.C.; Navarro-Jiménez, E.; Perez-Palencia, N.; Maestre-Serrano, R.; Laborde-Cárdenas, C.C.; Tornero-Aguilera, J.F. Dynamics of Population Immunity Due to the Herd Effect in the COVID-19 Pandemic. *Vaccines* **2020**, *8*, 236. [CrossRef]
18. Clemente-Suárez, V.J.; Martínez-González, M.B.; Benitez-Agudelo, J.C.; Navarro-Jiménez, E.; Beltran-Velasco, A.I.; Ruisoto, P.; Arroyo, E.D.; Laborde-Cárdenas, C.C.; Tornero-Aguilera, J.F. The Impact of the COVID-19 Pandemic on Mental Disorders. A Critical Review. *Int. J. Environ. Res. Public Health* **2021**, *18*, 10041. [CrossRef]
19. Ferraro, Z.M.; Gaudet, L.; Adamo, K.B. The Potential Impact of Physical Activity During Pregnancy on Maternal and Neonatal Outcomes. *Obstet. Gynecol. Surv.* **2012**, *67*, 99–110. [CrossRef]
20. Berghella, V.; Saccone, G. Exercise in pregnancy! *Am. J. Obstet. Gynecol.* **2017**, *216*, 335–337. [CrossRef]
21. Liu, J.; Laditka, J.N.; Mayer-Davis, E.J.; Pate, R.R. Does Physical Activity During Pregnancy Reduce the Risk of Gestational Diabetes among Previously Inactive Women? *Birth* **2008**, *35*, 188–195. [CrossRef]
22. Kramer, M.S.; McDonald, S.W. Aerobic exercise for women during pregnancy. *Cochrane Database Syst. Rev.* **2006**, *3*, CD000180. [CrossRef]
23. De Oliveria Melo, A.S.; Silva, J.L.P.; Tavares, J.S.; Barros, V.O.; Leite, D.F.B.; Amorim, M.M.R. Effect of a Physical Exercise Program During Pregnancy on Uteroplacental and Fetal Blood Flow and Fetal Growth. *Obstet. Gynecol.* **2012**, *120*, 302–310. [CrossRef] [PubMed]
24. Price, B.B.; Amini, S.B.; Kappeler, K. Exercise in Pregnancy. *Med. Sci. Sports Exerc.* **2012**, *44*, 2263–2269. [CrossRef]
25. Nakamura, A.; van der Waerden, J.; Melchior, M.; Bolze, C.; El-Khoury, F.; Pryor, L. Physical activity during pregnancy and postpartum depression: Systematic review and meta-analysis. *J. Affect. Disord.* **2019**, *246*, 29–41. [CrossRef] [PubMed]
26. Barakat, R.; Pelaez, M.; Lopez, C.; Montejo, R.; Coteron, J. Exercise during pregnancy reduces the rate of cesarean and instrumental deliveries: Results of a randomized controlled trial. *J. Matern. Neonatal Med.* **2012**, *25*, 2372–2376. [CrossRef]
27. Pennick, V.; Liddle, S.D. Interventions for preventing and treating pelvic and back pain in pregnancy. In *Cochrane Database of Systematic Reviews*; Pennick, V., Ed.; John Wiley & Sons, Ltd.: Chichester, UK, 2013.
28. Marín-Jiménez, N.; Acosta-Manzano, P.; Borges-Cosic, M.; Baena-García, L.; Coll-Risco, I.; Romero-Gallardo, L.; Aparicio, V.A. Association of self-reported physical fitness with pain during pregnancy: The Gestafit Project. *Scand. J. Med. Sci. Sports* **2019**, *29*, 1022–1030. [CrossRef] [PubMed]
29. Wang, C.; Wei, Y.; Zhang, X.; Zhang, Y.; Xu, Q.; Sun, Y.; Su, S.; Zhang, L.; Liu, C.; Feng, Y.; et al. A randomized clinical trial of exercise during pregnancy to prevent gestational diabetes mellitus and improve pregnancy outcome in overweight and obese pregnant women. *Am. J. Obstet. Gynecol.* **2017**, *216*, 340–351. [CrossRef]
30. Magro-Malosso, E.R.; Saccone, G.; di Tommaso, M.; Roman, A.; Berghella, V. Exercise during pregnancy and risk of gestational hypertensive disorders: A systematic review and meta-analysis. *Acta Obstet. Gynecol. Scand.* **2017**, *96*, 921–931. [CrossRef]
31. Magro-Malosso, E.R.; Saccone, G.; di Mascio, D.; di Tommaso, M.; Berghella, V. Exercise during pregnancy and risk of preterm birth in overweight and obese women: A systematic review and meta-analysis of randomized controlled trials. *Acta Obstet. Gynecol. Scand.* **2017**, *96*, 263–273. [CrossRef]

32. Di Mascio, D.; Magro-Malosso, E.R.; Saccone, G.; Marhefka, G.D.; Berghella, G.D. Exercise during pregnancy in normal-weight women and risk of preterm birth: A systematic review and meta-analysis of randomized controlled trials. *Am. J. Obstet. Gynecol.* **2016**, *215*, 561–571. [CrossRef] [PubMed]
33. Adesegun, D.; Cai, C.; Sivak, A.; Chari, R.; Davenport, M.H. Prenatal Exercise and Pre-gestational Diseases: A Systematic Review and Meta-analysis. *J. Obstet. Gynaecol. Canada* **2019**, *41*, 1134–1143.e17. [CrossRef] [PubMed]
34. Gavard, J.A.; Artal, R. Effect of Exercise on Pregnancy Outcome. *Clin. Obstet. Gynecol.* **2008**, *51*, 467–480. [CrossRef] [PubMed]
35. Davies, G.A.L.; Wolfe, L.A.; Mottola, M.F.; MacKinnon, C. Joint SOGC/CSEP Clinical Practice Guideline: Exercise in Pregnancy and the Postpartum Period. *Can. J. Appl. Physiol.* **2003**, *28*, 329–341. [CrossRef]
36. Aguilar-Cordero, M.J.; Sánchez-García, J.C.; Rodriguez-Blanque, R.; Sánchez-López, A.M.; Mur-Villar, N. Moderate Physical Activity in an Aquatic Environment During Pregnancy (SWEP Study) and Its Influence in Preventing Postpartum Depression. *J. Am. Psychiatr. Nurses Assoc.* **2019**, *25*, 112–121. [CrossRef]
37. Jackson, M.R.; Gott, P.; Lye, S.J.; Knox Ritchie, J.W.; Clapp, J.F. The effects of maternal aerobic exercise on human placental development: Placental volumetric composition and surface areas. *Placenta* **1995**, *16*, 179–191. [CrossRef]
38. Clapp, J.F.; Capeless, E.L. Neonatal morphometrics after endurance exercise during pregnancy. *Am. J. Obstet. Gynecol.* **1990**, *163*, 1805–1811. [CrossRef]
39. Clapp, J.F.; Kim, H.; Burciu, B.; Schmidt, S.; Petry, K.; Lopez, B. Continuing regular exercise during pregnancy: Effect of exercise volume on fetoplacental growth. *Am. J. Obstet. Gynecol.* **2002**, *186*, 142–147. [CrossRef]
40. May, L.E.; Glaros, A.; Yeh, H.W.; Clapp, J.F.; Gustafson, K.M. Aerobic exercise during pregnancy influences fetal cardiac autonomic control of heart rate and heart rate variability. *Early Hum. Dev.* **2010**, *86*, 213–217. [CrossRef]
41. Gillman, M.W.; Rifas-Shiman, S.; Berkey, C.S.; Field, A.E.; Colditz, G.A. Maternal Gestational Diabetes, Birth Weight, and Adolescent Obesity. *Pediatrics* **2003**, *111*, e221–e226. [CrossRef]
42. Barker, D.J.P. The Developmental Origins of Insulin Resistance. *Horm. Res. Paediatr.* **2005**, *64*, 2–7. [CrossRef] [PubMed]
43. Marshall, N.E.; Abrams, B.; Barbour, L.A.; Catalano, P.; Christian, P.; Friedman, J.E.; Hay, W.W.; Hernandez, T.L.; Krebs, N.F.; Oken, E.; et al. The importance of nutrition in pregnancy and lactation: Lifelong consequences. *Am. J. Obstet. Gynecol.* **2021**. [CrossRef] [PubMed]
44. Cox, J.T.; Phelan, S.T. Nutrition During Pregnancy. *Obstet. Gynecol. Clin.* **2008**, *35*, 369–383. [CrossRef] [PubMed]
45. Danielewicz, H.; Myszczyszyn, G.; Dębińska, A.; Myszkal, A.; Boznański, A.; Hirnle, L. Diet in pregnancy—More than food. *Eur. J. Pediatr.* **2017**, *176*, 1573–1579. [CrossRef]
46. Chatzi, L.; Torrent, M.; Romieu, I.; Garcia-Esteban, R.; Ferrer, C.; Vioque, J.; Kogevinas, M.; Sunyer, J. Mediterranean diet in pregnancy is protective for wheeze and atopy in childhood. *Thorax* **2008**, *63*, 507–513. [CrossRef] [PubMed]
47. Jia, Z.; Shi, B.; Chen, C.; Shi, J.; Wu, J.; Xu, X. Maternal malnutrition, environmental exposure during pregnancy and the risk of non-syndromic orofacial clefts. *Oral Dis.* **2011**, *17*, 584–589. [CrossRef] [PubMed]
48. Rundle, R.; Soltani, H.; Duxbury, A. Exploring the views of young women and their healthcare professionals on dietary habits and supplementation practices in adolescent pregnancy: A qualitative study. *BMC Nutr.* **2018**, *4*, 45. [CrossRef]
49. Larsen, V.G.; Ierodiakonou, D.; Jarrold, K.; Cunha, S.; Chivinge, J.; Robinson, Z.; Geoghegan, N.; Ruparelia, A.; Devani, P.; Trivella, M.; et al. Diet during pregnancy and infancy and risk of allergic or autoimmune disease: A systematic review and meta-analysis. *PLoS Med.* **2018**, *15*, e1002507. [CrossRef]
50. Scholl, T.O.; Johnson, W.G. Folic acid: Influence on the outcome of pregnancy. *Am. J. Clin. Nutr.* **2000**, *71*, 1295S–1303S. [CrossRef]
51. Koletzko, B.; Godfrey, K.M.; Poston, L.; Szajewska, H.; Van Goudoever, J.B.; De Waard, M.; Brands, B.; Grivell, R.M.; Deussen, A.R.; Dodd, J.M.; et al. Nutrition During Pregnancy, Lactation and Early Childhood and its Implications for Maternal and Long-Term Child Health: The Early Nutrition Project Recommendations. *Ann. Nutr. Metab.* **2019**, *74*, 93–106. [CrossRef]
52. Koletzko, B.; Boey, C.C.; Campoy, C.; Carlson, S.E.; Chang, N.; Guillermo-Tuazon, M.A.; Joshi, S.; Prell, C.; Quak, S.H.; Sjarif, D.R.; et al. Current Information and Asian Perspectives on Long-Chain Polyunsaturated Fatty Acids in Pregnancy, Lactation, and Infancy: Systematic Review and Practice Recommendations from an Early Nutrition Academy Workshop. *Ann. Nutr. Metab.* **2014**, *65*, 49–80. [CrossRef]
53. Godfrey, K.M.; Costello, P.M.; Lillycrop, K.A. The developmental environment, epigenetic biomarkers and long-term health. *J. Dev. Orig. Health Dis.* **2015**, *6*, 399–406. [CrossRef]
54. Bischoff-Ferrari, H.A. Vitamin D—Role in Pregnancy and Early Childhood. *Ann. Nutr. Metab.* **2011**, *59*, 17–21. [CrossRef] [PubMed]
55. Ogden, C.L. Prevalence of High Body Mass Index in US Children and Adolescents, 2007–2008. *JAMA* **2010**, *303*, 242. [CrossRef] [PubMed]
56. Worobey, J. Physical activity in infancy: Developmental aspects, measurement, and importance. *Am. J. Clin. Nutr.* **2014**, *99*, 729S–733S. [CrossRef] [PubMed]
57. Alves, J.G.B.; Alves, G.V. Effects of physical activity on children's growth. *J. De Pediatr.* **2019**, *95*, 72–78. [CrossRef]
58. De Vries, A.; Huiting, H.; van den Heuvel, E.; L'Abée, C.; Corpeleijn, E.; Stolk, R. An activity stimulation programme during a child's first year reduces some indicators of adiposity at the age of two-and-a-half. *Acta Paediatr.* **2015**, *104*, 414–421. [CrossRef] [PubMed]

59. Fraser, B.J.; Schmidt, M.D.; Huynh, Q.L.; Dwyer, T.; Venn, A.J.; Magnussen, C.G. Tracking of muscular strength and power from youth to young adulthood: Longitudinal findings from the Childhood Determinants of Adult Health Study. *J. Sci. Med. Sport* **2017**, *20*, 927–931. [CrossRef]
60. Twisk, J.W.R. Physical Activity Guidelines for Children and Adolescents. *Sports Med.* **2001**, *31*, 617–627. [CrossRef]
61. Li, R.; O'Connor, L.; Buckley, D.; Specker, B. Relation of activity levels to body fat in infants 6 to 12 months of age. *J. Pediatr.* **1995**, *126*, 353–357. [CrossRef]
62. Slining, M.M.; Adair, L.; Goldman, B.; Borja, J.; Bentley, M. Infant temperament contributes to early infant growth: A prospective cohort of African American infants. *Int. J. Behav. Nutr. Phys. Act.* **2009**, *6*, 51. [CrossRef]
63. Harrod, C.S.; Chasan-Taber, L.; Reynolds, R.M.; Fingerlin, T.E.; Glueck, D.H.; Brinton, J.T.; Dabelea, D. Physical Activity in Pregnancy and Neonatal Body Composition. *Obstet. Gynecol.* **2014**, *124*, 257–264. [CrossRef] [PubMed]
64. Campbell, D.W.; Eaton, W.O. Sex differences in the activity level of infants. *Infant Child Dev.* **1999**, *8*, 1–17. [CrossRef]
65. Moyer-Mileur, L.J.; Brunstetter, V.; McNaught, T.P.; Gill, G.; Chan, G.M. Daily Physical Activity Program Increases Bone Mineralization and Growth in Preterm Very Low Birth Weight Infants. *Pediatrics* **2000**, *106*, 1088–1092. [CrossRef] [PubMed]
66. Diego, M.A.; Field, T.; Hernandez-Reif, M. Preterm infant weight gain is increased by massage therapy and exercise via different underlying mechanisms. *Early Hum. Dev.* **2014**, *90*, 137–140. [CrossRef] [PubMed]
67. Litmanovitz, I.; Erez, H.; Eliakim, A.; Bauer-Rusek, S.; Arnon, S.; Regev, R.H.; Sirota, G.; Nemet, D. The Effect of Assisted Exercise Frequency on Bone Strength in Very Low Birth Weight Preterm Infants: A Randomized Control Trial. *Calcif. Tissue Res.* **2016**, *99*, 237–242. [CrossRef] [PubMed]
68. Schulzke, S.M.; Kaempfen, S.; Trachsel, D.; Patole, S.K. Physical activity programs for promoting bone mineralization and growth in preterm infants. *Cochrane Database Syst. Rev.* **2014**, *4*, CD005387. [CrossRef] [PubMed]
69. Stalnaker, K.A.; Poskey, G.A. Osteopenia of Prematurity: Does Physical Activity Improve Bone Mineralization in Preterm Infants? *Neonatal Netw.* **2016**, *35*, 95–104. [CrossRef] [PubMed]
70. Shaw, S.C.; Sankar, M.J.; Thukral, A.; Natarajan, C.K.; Deorari, A.K.; Paul, V.K.; Agarwal, R. Assisted Physical Exercise for Improving Bone Strength in Preterm Infants Less than 35 Weeks Gestation: A Randomized Controlled Trial. *Indian Pediatr.* **2017**, *55*, 115–120. [CrossRef] [PubMed]
71. Loprinzi, P.D.; Cardinal, B.J. Measuring Children's Physical Activity and Sedentary Behaviors. *J. Exerc. Sci. Fit.* **2011**, *9*, 15–23. [CrossRef]
72. Carranza Carnicero, J.A.; Pérez-López, J.; del Carmen González Salinas, M.; Martínez-Fuentes, M.T. A longitudinal study of temperament in infancy: Stability and convergence of measures. *Eur. J. Pers.* **2000**, *14*, 21–37. [CrossRef]
73. Van Cauwenberghe, E.; Gubbels, J.; De Bourdeaudhuij, I.; Cardon, G. Feasibility and validity of accelerometer measurements to assess physical activity in toddlers. *Int. J. Behav. Nutr. Phys. Act.* **2011**, *8*, 67. [CrossRef] [PubMed]
74. Chen, H.; Xue, M.; Mei, Z.; Oetomo, S.B.; Chen, W. A Review of Wearable Sensor Systems for Monitoring Body Movements of Neonates. *Sensors* **2016**, *16*, 2134. [CrossRef] [PubMed]
75. Pitchford, E.A.; Ketcheson, L.R.; Kwon, H.-J.; Ulrich, D.A. Minimum Accelerometer Wear Time in Infants: A Generalizability Study. *J. Phys. Act. Health* **2017**, *14*, 421–428. [CrossRef]
76. Kuzik, N.; Poitras, V.J.; Tremblay, M.S.; Lee, E.-Y.; Hunter, S.; Carson, V. Systematic review of the relationships between combinations of movement behaviours and health indicators in the early years (0–4 years). *BMC Public Health* **2017**, *17*, 109–122. [CrossRef]
77. Harding, J.E.; Cormack, B.E.; Alexander, T.; Alsweiler, J.M.; Bloomfield, F.H. Advances in nutrition of the newborn infant. *Lancet* **2017**, *389*, 1660–1668. [CrossRef]
78. Wiedmeier, J.E.; Joss-Moore, L.; Lane, R.H.; Neu, J. Early postnatal nutrition and programming of the preterm neonate. *Nutr. Rev.* **2011**, *69*, 76–82. [CrossRef]
79. Henderickx, J.G.E.; Zwittink, R.D.; Van Lingen, R.A.; Knol, J.; Belzer, C. The Preterm Gut Microbiota: An Inconspicuous Challenge in Nutritional Neonatal Care. *Front. Cell. Infect. Microbiol.* **2019**, *9*, 85. [CrossRef]
80. Victora, C.G.; Bahl, R.; Barros, A.J.D.; Franca, G.V.A.; Horton, S.; Krasevec, J.; Murch, S.; Sankar, M.J.; Walker, N.; Rollins, N.C.; et al. Breastfeeding in the 21st century: Epidemiology, mechanisms, and lifelong effect. *Lancet* **2016**, *387*, 475–490. [CrossRef]
81. Kramer, M.S.; Chalmers, B.; Hodnett, E.D.; Sevkovskaya, Z.; Dzikovich, I.; Shapiro, S.; Collet, J.-P.; Vanilovich, I.; Mezen, I.; Ducruet, T.; et al. Promotion of Breastfeeding Intervention Trial (PROBIT). *JAMA* **2001**, *285*, 413–420. [CrossRef]
82. Jacobi, S.K.; Odle, J. Nutritional Factors Influencing Intestinal Health of the Neonate. *Adv. Nutr. Int. Rev. J.* **2012**, *3*, 687–696. [CrossRef]
83. Morales, E.; Bustamante, M.; Gonzalez, J.R.; Guxens, M.; Torrent, M.; Mendez, M.; Garcia-Esteban, R.; Julvez, J.; Forns, J.; Vrijheid, M.; et al. Genetic Variants of the FADS Gene Cluster and ELOVL Gene Family, Colostrums LC-PUFA Levels, Breastfeeding, and Child Cognition. *PLoS ONE* **2011**, *6*, e17181. [CrossRef]
84. Kramer, M.S.; Matush, L.; Vanilovich, I.; Platt, R.; Bogdanovich, N.; Sevkovskaya, Z.; Dzikovich, I.; Shishko, G.; Mazer, B. Effect of prolonged and exclusive breast feeding on risk of allergy and asthma: Cluster randomised trial. *BMJ* **2007**, *335*, 815. [CrossRef]
85. Kramer, M.S.; Matush, L.; Vanilovich, I.; Platt, R.W.; Bogdanovich, N.; Sevkovskaya, Z.; Dzikovich, I.; Shishko, G.; Collet, J.P.; Martin, R.M.; et al. Effects of prolonged and exclusive breastfeeding on child height, weight, adiposity, and blood pressure at age 6.5 y: Evidence from a large randomized trial. *Am. J. Clin. Nutr.* **2007**, *86*, 1717–1721. [CrossRef]

86. Martin, R.M.; Kramer, M.S.; Patel, R.; Rifas-Shiman, S.L.; Thompson, J.; Yang, S.; Vilchuck, K.; Bogdanovich, N.; Hameza, M.; Tilling, K.; et al. Effects of Promoting Long-term, Exclusive Breastfeeding on Adolescent Adiposity, Blood Pressure, and Growth Trajectories. *JAMA Pediatr.* **2017**, *171*, e170698. [CrossRef] [PubMed]
87. Christian, P.; Mullany, L.C.; Hurley, K.M.; Katz, J.; Black, R.E. Nutrition and maternal, neonatal, and child health. *Semin. Perinatol.* **2015**, *39*, 361–372. [CrossRef] [PubMed]
88. Edmond, K.M.; Zandoh, C.; Quigley, M.A.; Amenga-Etego, S.; Owusu-Agyei, S.; Kirkwood, B.R. Delayed Breastfeeding Initiation Increases Risk of Neonatal Mortality. *Pediatrics* **2006**, *117*, e380–e386. [CrossRef]
89. Mullany, L.C.; Katz, J.; Li, Y.M.; Khatry, S.K.; LeClerq, S.C.; Darmstadt, G.L.; Tielsch, J. Breast-Feeding Patterns, Time to Initiation, and Mortality Risk among Newborns in Southern Nepal. *J. Nutr.* **2008**, *138*, 599–603. [CrossRef]
90. Garcia, C.R.; Mullany, L.C.; Rahmathullah, L.; Katz, J.; Thulasiraj, R.D.; Sheeladevi, S.; Coles, C.; Tielsch, J. Breast-feeding initiation time and neonatal mortality risk among newborns in South India. *J. Perinatol.* **2010**, *31*, 397–403. [CrossRef] [PubMed]
91. Fleddermann, M.; Rauh-Pfeiffer, A.; Demmelmair, H.; Holdt, L.; Teupser, D.; Koletzko, B. Effects of a Follow-On Formula Containing Isomaltulose (Palatinose™) on Metabolic Response, Acceptance, Tolerance and Safety in Infants: A Randomized-Controlled Trial. *PLoS ONE* **2016**, *11*, e0151614. [CrossRef] [PubMed]
92. Yao, M.; Lien, E.L.; Capeding, M.R.; Fitzgerald, M.; Ramanujam, K.; Yuhas, R.; Northington, R.; Lebumfacil, J.; Wang, L.; DeRusso, P.A. Effects of Term Infant Formulas Containing High sn-2 Palmitate with and Without Oligofructose on Stool Composition, Stool Characteristics, and Bifidogenicity. *J. Craniofacial Surg.* **2014**, *59*, 440–448. [CrossRef]
93. Indrio, F.; Martini, S.; Francavilla, R.; Corvaglia, L.; Cristofori, F.; Mastrolia, S.A.; Neu, J.; Rautava, S.; Spena, G.R.; Raimondi, F.; et al. Epigenetic Matters: The Link between Early Nutrition, Microbiome, and Long-term Health Development. *Front. Pediatr.* **2017**, *5*, 178. [CrossRef]
94. Koletzko, B.; Brands, B.; Poston, L.; Godfrey, K.; Demmelmair, H. Early nutrition programming of long-term health. *Proc. Nutr. Soc.* **2012**, *71*, 371–378. [CrossRef] [PubMed]
95. Weng, M.; Walker, W.A. The role of gut microbiota in programming the immune phenotype. *J. Dev. Orig. Health Dis.* **2013**, *4*, 203–214. [CrossRef]
96. Sjögren, Y.M.; Tomicic, S.; Lundberg, A.; Böttcher, M.F.; Björkstén, B.; Sverremark-Ekström, E.; Jenmalm, M.C. Influence of early gut microbiota on the maturation of childhood mucosal and systemic immune responses: Gut microbiota and immune responses. *Clin. Exp. Allergy* **2009**, *39*, 1842–1851. [CrossRef] [PubMed]
97. Sharma, A.M.; Staels, B. Peroxisome Proliferator-Activated Receptor γ and Adipose Tissue—Understanding Obesity-Related Changes in Regulation of Lipid and Glucose Metabolism. *J. Clin. Endocrinol. Metab.* **2006**, *92*, 386–395. [CrossRef]
98. Mahony, S.M.O.; Stilling, R.; Dinan, T.; Cryan, J.F. The microbiome and childhood diseases: Focus on brain-gut axis. *Birth Defects Res. Part C Embryo Today Rev.* **2015**, *105*, 296–313. [CrossRef]
99. Maqsood, R.; Stone, T.W. The Gut-Brain Axis, BDNF, NMDA and CNS Disorders. *Neurochem. Res.* **2016**, *41*, 2819–2835. [CrossRef] [PubMed]
100. Keunen, K.; van Elburg, R.M.; van Bel, F.; Benders, M.J.N.L. Impact of nutrition on brain development and its neuroprotective implications following preterm birth. *Pediatr. Res.* **2014**, *77*, 148–155. [CrossRef] [PubMed]
101. Deverman, B.E.; Patterson, P.H. Cytokines and CNS Development. *Neuron* **2009**, *64*, 61–78. [CrossRef]
102. Collins, L.M.; Toulouse, A.; Connor, T.J.; Nolan, Y.M. Contributions of central and systemic inflammation to the pathophysiology of Parkinson's disease. *Neuropharmacology* **2012**, *62*, 2154–2168. [CrossRef]
103. Lampron, A.; ElAli, A.; Rivest, S. Innate Immunity in the CNS: Redefining the Relationship between the CNS and Its Environment. *Neuron* **2013**, *78*, 214–232. [CrossRef]
104. Soliman, M.L.; Combs, C.K.; Rosenberger, T.A. Modulation of Inflammatory Cytokines and Mitogen-activated Protein Kinases by Acetate in Primary Astrocytes. *J. Neuroimmune Pharmacol.* **2012**, *8*, 287–300. [CrossRef] [PubMed]
105. Villeda, S.A.; Luo, J.; Mosher, K.I.; Zou, B.; Britschgi, M.; Bieri, G.; Stan, T.M.; Fainberg, N.; Ding, Z.; Eggel, A.; et al. The ageing systemic milieu negatively regulates neurogenesis and cognitive function. *Nature* **2011**, *477*, 90–94. [CrossRef] [PubMed]
106. Caron, E.; Ciofi, P.; Prevot, V.; Bouret, S.G. Alteration in Neonatal Nutrition Causes Perturbations in Hypothalamic Neural Circuits Controlling Reproductive Function. *J. Neurosci.* **2012**, *32*, 11486–11494. [CrossRef] [PubMed]
107. Girard, A.W.; Olude, O. Nutrition Education and Counselling Provided during Pregnancy: Effects on Maternal, Neonatal and Child Health Outcomes. *Paediatr. Perinat. Epidemiol.* **2012**, *26*, 191–204. [CrossRef] [PubMed]
108. Timmons, B.W.; LeBlanc, A.G.; Carson, V.; Gorber, S.C.; Dillman, C.; Janssen, I.; Kho, M.E.; Spence, J.C.; Stearns, J.A.; Tremblay, M.S. Systematic review of physical activity and health in the early years (aged 0–4 years). *Appl. Physiol. Nutr. Metab.* **2012**, *37*, 773–792. [CrossRef] [PubMed]
109. Tucker, P. The physical activity levels of preschool-aged children: A systematic review. *Early Child. Res. Q.* **2008**, *23*, 547–558. [CrossRef]
110. Carson, V.; Lee, E.-Y.; Hewitt, L.; Jennings, C.; Hunter, S.; Kuzik, N.; Stearns, J.A.; Unrau, S.P.; Poitras, V.J.; Gray, C.; et al. Systematic review of the relationships between physical activity and health indicators in the early years (0-4 years). *BMC Public Health* **2017**, *17*, 33–63. [CrossRef]

111. Timmons, B.W.; Naylor, P.-J.; Pfeiffer, K.A. Physical activity for preschool children—how much and how? This article is part of a supplement entitled Advancing physical activity measurement and guidelines in Canada: A scientific review and evidence-based foundation for the future of Canadian physical activity guidelines co-published by Applied Physiology, Nutrition, and Metabolism and the Canadian Journal of Public Health. It may be cited as Appl. Physiol. Nutr. Metab. 32(Suppl. 2E) or as Can. J. Public Health 98(Suppl. 2). *Appl. Physiol. Nutr. Metab.* **2007**, *32*, S122–S134. [CrossRef]
112. Tremblay, M.S.; LeBlanc, A.G.; Carson, V.; Choquette, L.; Gorber, S.C.; Dillman, C.; Duggan, M.; Gordon, M.J.; Hicks, A.; Janssen, I.; et al. Canadian Physical Activity Guidelines for the Early Years (aged 0–4 years). *Appl. Physiol. Nutr. Metab.* **2012**, *37*, 345–356. [CrossRef] [PubMed]
113. Wells, J.; Ritz, P. Physical activity at 9–12 months and fatness at 2 years of age. *Am. J. Hum. Biol.* **2001**, *13*, 384–389. [CrossRef] [PubMed]
114. Moore, L.L.; Nguyen, U.-S.D.T.; Rothman, K.J.; Cupples, L.A.; Ellison, R.C. Preschool Physical Activity Level and Change in Body Fatness in Young Children: The Framingham Children's Study. *Am. J. Epidemiol.* **1995**, *142*, 982–988. [CrossRef] [PubMed]
115. Ku, L.C.; Shapiro, L.R.; Crawford, P.B.; Huenemann, R.L. Body composition and physical activity in 8-year-old children. *Am. J. Clin. Nutr.* **1981**, *34*, 2770–2775. [CrossRef] [PubMed]
116. Specker, B.; Binkley, T. Randomized Trial of Physical Activity and Calcium Supplementation on Bone Mineral Content in 3- to 5-Year-Old Children. *J. Bone Miner. Res.* **2003**, *18*, 885–892. [CrossRef] [PubMed]
117. Porter, L.S. The Impact of physical-physicological activity on infants' growth and development. *Nurs. Res.* **1972**, *21*, 210–219. [CrossRef]
118. Reilly, J.; Jackson, D.; Montgomery, C.; Kelly, L.; Slater, C.; Grant, S.; Paton, J. Total energy expenditure and physical activity in young Scottish children: Mixed longitudinal study. *Lancet* **2004**, *363*, 211–212. [CrossRef]
119. Venetsanou, F.; Kambas, A. How can a traditional Greek dances programme affect the motor proficiency of pre-school children? *Res. Dance Educ.* **2004**, *5*, 127–138. [CrossRef]
120. Sääkslahti, A.; Numminen, P.; Varstala, V.; Helenius, H.; Tammi, A.; Viikari, J.; Välimäki, I. Physical activity as a preventive measure for coronary heart disease risk factors in early childhood. *Scand. J. Med. Sci. Sports* **2004**, *14*, 143–149. [CrossRef]
121. Metcalf, B.S.; Jeffery, A.N.; Hosking, J.; Voss, L.D.; Sattar, N.; Wilkin, T.J. Objectively Measured Physical Activity and Its Association With Adiponectin and Other Novel Metabolic Markers. *Diabetes Care* **2009**, *32*, 468–473. [CrossRef]
122. Ruiz-Ariza, A.; Casuso, R.A.; Suarez-Manzano, S.; Martínez-López, E.J. Effect of augmented reality game Pokémon GO on cognitive performance and emotional intelligence in adolescent young. *Comput. Educ.* **2018**, *116*, 49–63. [CrossRef]
123. Kharofa, R.Y.; Kalkwarf, H.J.; Khoury, J.C.; Copeland, K.A. Are Mealtime Best Practice Guidelines for Child Care Centers Associated with Energy, Vegetable, and Fruit Intake? *Child. Obes.* **2016**, *12*, 52–58. [CrossRef]
124. Nyaradi, A.; Li, J.; Hickling, S.; Foster, J.; Oddy, W.H. The role of nutrition in children's neurocognitive development, from pregnancy through childhood. *Front. Hum. Neurosci.* **2013**, *7*, 97. [CrossRef] [PubMed]
125. Khan, N.A.; Raine, L.B.; Donovan, S.M.; Hillman, C.H., IV. The Cognitive Implications of Obesity and Nutrition in Childhood. *Monogr. Soc. Res. Child Dev.* **2014**, *79*, 51–71. [CrossRef] [PubMed]
126. Rosales, F.J.; Reznick, J.S.; Zeisel, S.H. Understanding the role of nutrition in the brain and behavioral development of toddlers and preschool children: Identifying and addressing methodological barriers. *Nutr. Neurosci.* **2009**, *12*, 190–202. [CrossRef]
127. Prado, E.L.; Dewey, K.G. Nutrition and brain development in early life. *Nutr. Rev.* **2014**, *72*, 267–284. [CrossRef] [PubMed]
128. Nasir, M.T.M.; Norimah, A.K.; Hazizi, A.S.; Nurliyana, A.R.; Loh, S.H.; Suraya, I. Child feeding practices, food habits, anthropometric indicators and cognitive performance among preschoolers in Peninsular Malaysia. *Appetite* **2012**, *58*, 525–530. [CrossRef]
129. Farr, S.A.; Banks, W.A.; Morley, J.E. Effects of leptin on memory processing. *Peptides* **2006**, *27*, 1420–1425. [CrossRef]
130. Mond, J.M.; Stich, H.; Hay, P.; Kraemer, A.; Baune, B.T. Associations between obesity and developmental functioning in pre-school children: A population-based study. *Int. J. Obes.* **2007**, *31*, 1068–1073. [CrossRef] [PubMed]
131. Li, J.; O'Connell, A.A. Obesity, High-Calorie Food Intake, and Academic Achievement Trends Among U.S. School Children. *J. Educ. Res.* **2012**, *105*, 391–403. [CrossRef]
132. Li, Y.; Dai, Q.; Jackson, J.C.; Zhang, J. Overweight Is Associated with Decreased Cognitive Functioning among School-age Children and Adolescents. *Obesity* **2008**, *16*, 1809–1815. [CrossRef]
133. Werthmann, J.; Jansen, A.; Vreugdenhil, A.C.E.; Nederkoorn, C.; Schyns, G.; Roefs, A. Food through the child's eye: An eye-tracking study on attentional bias for food in healthy-weight children and children with obesity. *Health Psychol.* **2015**, *34*, 1123–1132. [CrossRef] [PubMed]
134. Swaminathan, S.; Edward, B.S.; Kurpad, A.V. Micronutrient deficiency and cognitive and physical performance in Indian children. *Eur. J. Clin. Nutr.* **2013**, *67*, 467–474. [CrossRef]
135. Chauhan, K.; Agarwal, A. Vitamin B12 supplementation and cognitive scores in geriatric patients having Mild Cognitive Impairment. *Funct. Foods Health Dis.* **2016**, *6*, 578. [CrossRef]
136. Kalita, J.; Misra, U.K. Vitamin B12 deficiency neurological syndromes: Correlation of clinical, MRI and cognitive evoked potential. *J. Neurol.* **2008**, *255*, 353–359. [CrossRef] [PubMed]
137. Genuis, S.J.; Schwalfenberg, G.K.; Hiltz, M.N.; Vaselenak, S.A. Vitamin D Status of Clinical Practice Populations at Higher Latitudes: Analysis and Applications. *Int. J. Environ. Res. Public Health* **2009**, *6*, 151–173. [CrossRef] [PubMed]

138. Sommer, I.; Griebler, U.; Kien, C.; Auer, S.; Klerings, I.; Hammer, R.; Holzer, P.; Gartlehner, G. Vitamin D deficiency as a risk factor for dementia: A systematic review and meta-analysis. *BMC Geriatr.* **2017**, *17*, 1–13. [CrossRef] [PubMed]
139. Latimer, C.S.; Brewer, L.D.; Searcy, J.L.; Chen, K.-C.; Popović, J.; Kraner, S.D.; Thibault, O.; Blalock, E.M.; Landfield, P.W.; Porter, N.M. Vitamin D prevents cognitive decline and enhances hippocampal synaptic function in aging rats. *Proc. Natl. Acad. Sci. USA* **2014**, *111*, E4359–E4366. [CrossRef]
140. Hansen, S.N.; Tveden-Nyborg, P.; Lykkesfeldt, J. Does Vitamin C Deficiency Affect Cognitive Development and Function? *Nutrients* **2014**, *6*, 3818–3846. [CrossRef] [PubMed]
141. Garaiova, I.; Muchova, J.; Nagyova, Z.; Wang, D.; Li, J.; Orszaghova, Z.; Michael, D.R.; Plummer, S.F.; Ďuračková, Z. Probiotics and vitamin C for the prevention of respiratory tract infections in children attending preschool: A randomised controlled pilot study. *Eur. J. Clin. Nutr.* **2014**, *69*, 373–379. [CrossRef]
142. Hörnell, A.; Lagström, H.; Lande, B.; Thorsdottir, I. Protein intake from 0 to 18 years of age and its relation to health: A systematic literature review for the 5th Nordic Nutrition Recommendations. *Food Nutr. Res.* **2013**, *57*. [CrossRef]
143. Leidy, H.J.; Todd, C.B.; Zino, A.Z.; Immel, J.E.; Mukherjea, R.; Shafer, R.S.; Ortinau, L.C.; Braun, M. Consuming High-Protein Soy Snacks Affects Appetite Control, Satiety, and Diet Quality in Young People and Influences Select Aspects of Mood and Cognition. *J. Nutr.* **2015**, *145*, 1614–1622. [CrossRef]
144. Jones, E.K.; Sunram-Lea, S.; Wesnes, K. Acute ingestion of different macronutrients differentially enhances aspects of memory and attention in healthy young adults. *Biol. Psychol.* **2012**, *89*, 477–486. [CrossRef] [PubMed]
145. Dye, L.; Lluch, A.; Blundell, J.E. Macronutrients and mental performance. *Nutrition* **2000**, *16*, 1021–1034. [CrossRef]
146. Stephen, A.; Alles, M.; De Graaf, C.; Fleith, M.; Hadjilucas, E.; Isaacs, E.; Maffeis, C.; Zeinstra, G.; Matthys, C.; Gil, A. The role and requirements of digestible dietary carbohydrates in infants and toddlers. *Eur. J. Clin. Nutr.* **2012**, *66*, 765–779. [CrossRef]
147. Montesinos, J.; Guardia-Laguarta, C.; Area-Gomez, E. The fat brain. *Curr. Opin. Clin. Nutr. Metab. Care* **2020**, *23*, 68–75. [CrossRef] [PubMed]
148. Rogers, L.K.; Valentine, C.J.; Keim, S.A. DHA supplementation: Current implications in pregnancy and childhood. *Pharmacol. Res.* **2012**, *70*, 13–19. [CrossRef] [PubMed]
149. Sheppard, K.W.; Boone, K.M.; Gracious, B.; Klebanoff, M.A.; Rogers, L.K.; Rausch, J.; Bartlett, C.; Coury, D.L.; Keim, S.A. Effect of Omega-3 and -6 Supplementation on Language in Preterm Toddlers Exhibiting Autism Spectrum Disorder Symptoms. *J. Autism Dev. Disord.* **2017**, *47*, 3358–3369. [CrossRef]
150. Bhatia, H.S.; Agrawal, R.; Sharma, S.; Huo, Y.-X.; Ying, Z.; Gomez-Pinilla, F. Omega-3 Fatty Acid Deficiency during Brain Maturation Reduces Neuronal and Behavioral Plasticity in Adulthood. *PLoS ONE* **2011**, *6*, e28451. [CrossRef]
151. Lubans, D.; Richards, J.; Hillman, C.; Faulkner, G.; Beauchamp, M.; Nilsson, M.; Kelly, P.; Smith, J.; Raine, L.; Biddle, S. Physical Activity for Cognitive and Mental Health in Youth: A Systematic Review of Mechanisms. *Pediatrics* **2016**, *138*, e20161642. [CrossRef]
152. Zeng, N.; Ayyub, M.; Sun, H.; Wen, X.; Xiang, P.; Gao, Z. Effects of Physical Activity on Motor Skills and Cognitive Development in Early Childhood: A Systematic Review. *BioMed Res. Int.* **2017**, *2017*, 1–13. [CrossRef] [PubMed]
153. Carson, V.; Hunter, S.; Kuzik, N.; Wiebe, S.A.; Spence, J.C.; Friedman, A.; Tremblay, M.S.; Slater, L.; Hinkley, T. Systematic review of physical activity and cognitive development in early childhood. *J. Sci. Med. Sport* **2015**, *19*, 573–578. [CrossRef] [PubMed]
154. Sibley, B.A.; Etnier, J.L. The Relationship between Physical Activity and Cognition in Children: A Meta-Analysis. *Pediatr. Exerc. Sci.* **2003**, *15*, 243–256. [CrossRef]
155. Biddle, S.J.H.; Asare, M. Physical activity and mental health in children and adolescents: A review of reviews. *Br. J. Sports Med.* **2011**, *45*, 886–895. [CrossRef]
156. Booth, J.; Tomporowski, P.; Boyle, J.; Ness, A.; Joinson, C.; Leary, S.; Reilly, J. Associations between executive attention and objectively measured physical activity in adolescence: Findings from ALSPAC, a UK cohort. *Ment. Health Phys. Act.* **2013**, *6*, 212–219. [CrossRef]
157. Rasberry, C.N.; Lee, S.M.; Robin, L.; Laris, B.A.; Russell, L.A.; Coyle, K.K.; Nihiser, A.J. The association between school-based physical activity, including physical education, and academic performance: A systematic review of the literature. *Prev. Med.* **2011**, *52* (Suppl. 1), S10–S20. [CrossRef]
158. Singh, A.S.; Saliasi, E.; Van Den Berg, V.; Uijtdewilligen, L.; De Groot, R.H.M.; Jolles, J.; Andersen, L.B.; Bailey, R.; Chang, Y.-K.; Diamond, A.; et al. Effects of physical activity interventions on cognitive and academic performance in children and adolescents: A novel combination of a systematic review and recommendations from an expert panel. *Br. J. Sports Med.* **2019**, *53*, 640–647. [CrossRef]
159. Cotman, C.W.; Berchtold, N.C.; Christie, L.-A. Exercise builds brain health: Key roles of growth factor cascades and inflammation. *Trends Neurosci.* **2007**, *30*, 464–472. [CrossRef]
160. Tandon, P.S.; Tovar, A.; Jayasuriya, A.T.; Welker, E.; Schober, D.J.; Copeland, K.; Dev, D.A.; Murriel, A.L.; Amso, D.; Ward, D.S. The relationship between physical activity and diet and young children's cognitive development: A systematic review. *Prev. Med. Rep.* **2016**, *3*, 379–390. [CrossRef]
161. Best, J.R. Effects of physical activity on children's executive function: Contributions of experimental research on aerobic exercise. *Dev. Rev.* **2010**, *30*, 331–351. [CrossRef] [PubMed]
162. Quan, M.; Zhang, H.; Zhang, J.; Zhou, T.; Zhang, J.; Zhao, G.; Fang, H.; Sun, S.; Wang, R.; Chen, P. Preschoolers' Technology-Assessed Physical Activity and Cognitive Function: A Cross-Sectional Study. *J. Clin. Med.* **2018**, *7*, 108. [CrossRef] [PubMed]

163. Mavilidi, M.-F.; Okely, A.D.; Chandler, P.; Paas, F. Effects of Integrating Physical Activities into a Science Lesson on Preschool Children's Learning and Enjoyment. *Appl. Cogn. Psychol.* **2017**, *31*, 281–290. [CrossRef]
164. Erickson, K.I.; Hillman, C.; Stillman, C.M.; Ballard, R.M.; Bloodgood, B.; Conroy, D.E.; Macko, R.; Marquez, D.X.; Petruzzello, S.J.; Powell, K.E.; et al. Physical Activity, Cognition, and Brain Outcomes: A Review of the 2018 Physical Activity Guidelines. *Med. Sci. Sports Exerc.* **2019**, *51*, 1242–1251. [CrossRef]
165. Fisher, A.; E Boyle, J.M.; Paton, J.Y.; Tomporowski, P.; Watson, C.; McColl, J.H.; Reilly, J.J. Effects of a physical education intervention on cognitive function in young children: Randomized controlled pilot study. *BMC Pediatr.* **2011**, *11*, 97. [CrossRef] [PubMed]
166. Ellemberg, D.; St-Louis-Deschênes, M. The effect of acute physical exercise on cognitive function during development. *Psychol. Sport Exerc.* **2010**, *11*, 122–126. [CrossRef]
167. Reed, J.A.; Einstein, G.; Hahn, E.; Hooker, S.P.; Gross, V.P.; Kravitz, J. Examining the Impact of Integrating Physical Activity on Fluid Intelligence and Academic Performance in an Elementary School Setting: A Preliminary Investigation. *J. Phys. Act. Health* **2010**, *7*, 343–351. [CrossRef] [PubMed]
168. Álvarez-Bueno, C.; Pesce, C.; Cavero-Redondo, I.; Sánchez-López, M.; Martínez-Hortelano, J.A.; Martínez-Vizcaíno, V. The Effect of Physical Activity Interventions on Children's Cognition and Metacognition: A Systematic Review and Meta-Analysis. *J. Am. Acad. Child Adolesc. Psychiatry* **2017**, *56*, 729–738. [CrossRef]
169. De Greeff, J.W.; Bosker, R.J.; Oosterlaan, J.; Visscher, C.; Hartman, E. Effects of physical activity on executive functions, attention and academic performance in preadolescent children: A meta-analysis. *J. Sci. Med. Sport* **2018**, *21*, 501–507. [CrossRef]
170. Álvarez-Bueno, C.; Pesce, C.; Cavero-Redondo, I.; Sánchez-López, M.; Garrido-Miguel, M.; Martínez-Vizcaíno, V. Academic Achievement and Physical Activity: A Meta-analysis. *Pediatrics* **2017**, *140*, e20171498. [CrossRef] [PubMed]
171. Bustamante, E.E.; Williams, C.F.; Davis, C.L. Physical Activity Interventions for Neurocognitive and Academic Performance in Overweight and Obese Youth. *Pediatr. Clin.* **2016**, *63*, 459–480. [CrossRef] [PubMed]
172. Esteban-Cornejo, I.; Tejero-Gonzalez, C.M.; Sallis, J.F.; Veiga, O.L. Physical activity and cognition in adolescents: A systematic review. *J. Sci. Med. Sport* **2015**, *18*, 534–539. [CrossRef] [PubMed]
173. Spruit, A.; Assink, M.; van Vugt, E.; van der Put, C.; Stams, G.J. The effects of physical activity interventions on psychosocial outcomes in adolescents: A meta-analytic review. *Clin. Psychol. Rev.* **2016**, *45*, 56–71. [CrossRef] [PubMed]
174. van der Fels, I.M.J.; Te Wierike, S.C.M.; Hartman, E.; Elferink-Gemser, M.T.; Smith, J.; Visscher, C. The relationship between motor skills and cognitive skills in 4–16 year old typically developing children: A systematic review. *J. Sci. Med. Sport* **2015**, *18*, 697–703. [CrossRef]
175. Adamo, K.; Wilson, S.; Harvey, A.L.J.; Grattan, K.P.; Naylor, P.-J.; Temple, V.; Goldfield, G.S. Does Intervening in Childcare Settings Impact Fundamental Movement Skill Development? *Med. Sci. Sports Exerc.* **2016**, *48*, 926–932. [CrossRef] [PubMed]
176. Laukkanen, A.; Pesola, A.J.; Heikkinen, R.; Sääkslahti, A.K.; Finni, T. Family-Based Cluster Randomized Controlled Trial Enhancing Physical Activity and Motor Competence in 4–7-Year-Old Children. *PLoS ONE* **2015**, *10*, e0141124. [CrossRef]
177. Myer, G.D.; Faigenbaum, A.D.; Edwards, N.M.; Clark, J.F.; Best, T.M.; Sallis, R.E. Sixty minutes of what? A developing brain perspective for activating children with an integrative exercise approach. *Br. J. Sports Med.* **2015**, *49*, 1510–1516. [CrossRef]
178. Bidzan-Bluma, I.; Lipowska, M. Physical Activity and Cognitive Functioning of Children: A Systematic Review. *Int. J. Environ. Res. Public Health* **2018**, *15*, 800. [CrossRef] [PubMed]
179. Gómez-Pinilla, F. Brain foods: The effects of nutrients on brain function. *Nat. Rev. Neurosci.* **2008**, *9*, 568–578. [CrossRef]
180. Robinson, L.R.; Bitsko, R.H.; Thompson, R.A.; Dworkin, P.H.; McCabe, M.A.; Peacock, G.; Thorpe, P.G. CDC Grand Rounds: Addressing Health Disparities in Early Childhood. *MMWR Morb. Mortal. Wkly. Rep.* **2017**, *66*, 769–772. [CrossRef]
181. Bryan, P.D.J.; Osendarp, P.D.S.; Hughes, M.D.; Calvaresi, M.E.; Baghurst, P.D.K.; Van Klinken, P.D.J.-W. Nutrients for Cognitive Development in School-aged Children. *Nutr. Rev.* **2004**, *62*, 295–306. [CrossRef]
182. Benton, D. The influence of dietary status on the cognitive performance of children. *Mol. Nutr. Food Res.* **2010**, *54*, 457–470. [CrossRef]
183. Isaacs, E.; Oates, J. Nutrition and cognition: Assessing cognitive abilities in children and young people. *Eur. J. Nutr.* **2008**, *47*, 4–24. [CrossRef]
184. Jacka, F.N.; Cherbuin, N.; Anstey, K.J.; Sachdev, P.S.; Butterworth, P. Western diet is associated with a smaller hippocampus: A longitudinal investigation. *BMC Med.* **2015**, *13*, 1–8. [CrossRef]
185. Refsum, H.; Yajnik, C.S.; Gadkari, M.; Schneede, J.; Vollset, S.E.; Örning, L.; Guttormsen, A.B.; Joglekar, A.; Sayyad, M.G.; Ulvik, A.; et al. Hyperhomocysteinemia and elevated methylmalonic acid indicate a high prevalence of cobalamin deficiency in Asian Indians. *Am. J. Clin. Nutr.* **2001**, *74*, 233–241. [CrossRef]
186. Florence, M.D.; Asbridge, M.; Veugelers, P.J. Diet Quality and Academic Performance. *J. Sch. Health* **2008**, *78*, 209–215. [CrossRef] [PubMed]
187. Gispert-Llaurado, M.; Perez-Garcia, M.; Escribano, J.; Closa-Monasterolo, R.; Luque, V.; Grote, V.; Weber, M.; Torres-Espínola, F.; Czech-Kowalska, J.; Verduci, E.; et al. Fish consumption in mid-childhood and its relationship to neuropsychological outcomes measured in 7–9 year old children using a NUTRIMENTHE neuropsychological battery. *Clin. Nutr.* **2016**, *35*, 1301–1307. [CrossRef] [PubMed]

188. Chacón-Cuberos, R.; Zurita-Ortega, F.; Martínez-Martínez, A.; Olmedo-Moreno, E.M.; Castro-Sánchez, M. Adherence to the Mediterranean Diet Is Related to Healthy Habits, Learning Processes, and Academic Achievement in Adolescents: A Cross-Sectional Study. *Nutrients* **2018**, *10*, 1566. [CrossRef]
189. Haapala, E.A.; Eloranta, A.-M.; Venäläinen, T.; Jalkanen, H.; Poikkeus, A.-M.; Ahonen, T.; Lindi, V.; Lakka, T.A. Diet quality and academic achievement: A prospective study among primary school children. *Eur. J. Nutr.* **2016**, *56*, 2299–2308. [CrossRef] [PubMed]
190. Von Stumm, S. You are what you eat? Meal type, socio-economic status and cognitive ability in childhood. *Intelligence* **2012**, *40*, 576–583. [CrossRef]
191. Adolphus, K.; Lawton, C.L.; Champ, C.L.; Dye, L. The Effects of Breakfast and Breakfast Composition on Cognition in Children and Adolescents: A Systematic Review. *Adv. Nutr. Int. Rev. J.* **2016**, *7*, 590S–612S. [CrossRef]
192. Burrows, T.; Goldman, S.; Pursey, K.; Lim, R. Is there an association between dietary intake and academic achievement: A systematic review. *J. Hum. Nutr. Diet.* **2016**, *30*, 117–140. [CrossRef] [PubMed]
193. Bleiweiss-Sande, R.; Chui, K.; Wright, C.; Amin, S.; Anzman-Frasca, S.; Sacheck, J.M. Associations between Food Group Intake, Cognition, and Academic Achievement in Elementary Schoolchildren. *Nutrients* **2019**, *11*, 2722. [CrossRef] [PubMed]