ORIGINAL ARTICLE

DIETARY INTAKE, NUTRITIONAL STATUS AND COGNITIVE PERFORMANCE AMONG FISHERMEN'S CHILDREN: A REVIEW

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ABSTRACT

This paper highlights the dietary intake of fishermen's children, their nutritional status and cognitive performance. It will help to have a reasonable perspective of their dietary intake and their relationship with nutritional status and how it inevitably influences cognitive performance. This is relevant as it can provide the government and health authorities with insights into the execution of an action plan to improve the nutritional status of fishing communities, especially in Malaysia, where possible. A systematic search of the English scholarly papers on this subject was undertaken between 1997 and 2020. A total of 20 studies have been systematically chosen and reviewed. Studies are divided into two groups, based on the type of research conducted. Ten of the retrieved studies looked at dietary intake and nutritional status in fisherman's children, while another ten studies looked at cognitive performance in children and adolescents and the factors that contributed to it. In terms of dietary intake, three studies reported low energy consumption and low carbohydrate intake, one study reported high carbohydrate intake, four studies reported high protein intake, one study reported low fat intake, five studies reported low micronutrient intake (calcium, iron, vitamin A and vitamin C) and two studies reported high intake of niacin. As far as nutritional status is concerned, six studies recorded that children are stunted/underweight and three studies reported that children are obese/overweight. In comparison, one study recorded high cognitive performance, three studies reported average cognitive performance, and three studies reported poor cognitive performance. In the studies reviewed, it has been shown that there is a positive association between socio-economic status, dietary intake/nutritional status and cognitive performance among children in fishing communities in different regions. There is a need for nutrition education and intervention in these disadvantaged communities.

Keywords: Dietary intakes, Nutritional status, Cognitive Performance, Fishermen's children.

INTRODUCTION

Nutritional status refers to the condition of the human body influenced by the level of nutrients in the body and the ability of the level of nutrients to maintain the healthy body composition and function[1]. The nutritional status of an individual is influenced by several interrelated factors which include diet intake and physical activity. Malnutrition is a condition which results from imbalance in consumption of macronutrient and also micronutrient over a long period of time. Poor diet practices established during childhood have the potential to negatively impact growth of children and may increase the risk of diet related chronic disease such as obesity and cardiovascular diseases in later stages of life[2-3]. Aside from that, it also has an important and long-lasting influence on child cognitive development[4]. Adequate nutrients from diet are needed during the developmental stage for brain structure as well as function[5]. In addition to that, brain growth and development is most rapid and critical during the first 2 years of life, but development of the frontal lobes continues throughout early childhood[4].

Nutritional status of fishermen children is one of the main concerns due to the vulnerability of fishermen households towards food security. Previous studies showed that food insecurity was prevalent among fishing communities[6-8]. Fishing is one of the important global industries, however it is also one of the sectors with the highest incidence of poverty[9]. Fishermen were used to characterize as having low socioeconomic status[10-11] and poor standard of living[12]. Fishing communities depend on marine and coastal resources for their livelihood. Nevertheless, the fishing activities are susceptible to environmental changes such as rise of sea level, increased temperature on the sea surface and increased acidification of ocean which have reported to affect the abundance and distribution of fish species and also amount of fish caught by fishermen. Unpredictable fishing returns due to the environmental changes threaten their livelihood and may increase their vulnerability. Unlike the laborers from the other sectors, fishermen do not have monthly fixed income. Their income is primarily determined by the amount of fish caught through their fishing effort. Based on a study by Zainuddin et al.[13], the majority of fishermen's households earned an income between USD 250 to USD 500 and others earned between USD 500 to USD 700 which did not pass the Malaysian median household income. A study by Nursyazwin & Zein[4] also stated that the

level of fishermen's income is still far from the average national income per capita (MYR 3282) where their average earnings are between MYR 1853.47 to MYR 2595.39.

During monsoon season, the heavy rain and thunderstorm at the coast area and the rough and dangerous sea condition prevents the fishermen from fishing activities. Many of the fishermen at coastal areas begin to face financial problems in meeting their living needs during this period. According to Yaakob & Chau[15], the mean income of fishermen in east coast of Peninsular Malaysia during monsoon period reduced around 9 to 32% compared to normal period. Even though Malaysia government provides a monthly allowance of RM 200 to RM 300 for the fishermen, the allowance given is insufficient to cover the living expenses of the fishermen families, especially those whose children are still receiving education in school or university[16]. These cumulative pressures could produce significant consequences on household food security and susceptibility of the fishermen families especially the children to malnutrition. The decreased income level of fishermen increases the household vulnerability towards food insecurity[7]. Low-income level of fishermen constrained their purchasing power and decreased their household accessibility to healthy and nutritious food.

The objective of this study is to review previous studies on the nutritional status and dietary intake of the fishermen's children. Besides that, this study also reviewed the relationship between nutritional status, dietary intakes and cognitive development among the fishermen's children. The outcome from this study will help to provide better understanding on the nutritional status of the fishermen's children and identify gaps and deficiencies in previous work. This study will also contribute to the prioritization of research studies to address these gaps and implement policies and interventions aimed at improving the nutritional status of the fishing community.

METHODS

Identifying relevant studies
Studies published from 1997 to 2020 were searched from the electronic databases such as Science Direct, Taylor and Francis, Springer Link, PubMed, Elsevier and open database such as Google Scholar. The key terms "nutritional status", "malnutrition", "undernutrition", "overnutrition", "dietary intake", "nutrient intake", "food intake" and "diet" combined with the terms "fishermen's children" and "fishing community" and "cognitive performance" and "cognitive function" in duplicates were used during the search. The references from the retrieved journals were also searched for additional related studies. The searches were restricted to academic journals published in English languages. All types of research studies were included in the search except review papers and systematic reviews.

Study selection
Cross sectional studies that involved children or adolescents aged below 18 years old from fishing communities were included in this review as well as studies that focused specifically on mother or caregiver-child pairs. Studies on adults in fishing communities and also non-healthy participants (i.e. serious illness, physical disability) were excluded from this review. The reviewed studies were carefully selected if the studies provide information about the nutritional status, dietary or nutrient intake of the children from fishing communities and since few studies found cognitive performance among such groups, similar studies on children were taken into account to show association of the nutritional status with cognitive performance. As a final result, 20 studies are selected for this review.

Charting data
Studies are grouped into two categories according to the type of investigation undertaken. Ten of the retrieved studies examined the dietary intake and nutritional status in fishermen's children while ten studies examined the cognitive performance in children and adolescents and factors contributing to it. The study location(s), author(s), year of publication, and objective(s) of study, number of participants, research instrument(s) and findings on the nutritional status and dietary intake of the fishermen's children were summarized in Table 1.0 while the association of nutritional status and other factors contributing to the cognitive performance were shown in Table 2.0.

Table 1: Nutritional status and dietary intake of fishermen's children

Study	Study Location	Objective of the study	Study population	Research Instrument	Nutritional Status	Dietary Intake
Murillo-Castillo et al. (2020)	Kino Bay, a fishing community located in the Northwest of Mexico	To determine if food insecurity was associated with lower fruit and vegetables consumption and overweight and obesity in children from Mexican fishing communities	100 elementary-school children aged 6–12 years	Anthropometric measurements (wt. and ht.), Food frequency questionnaire of fruits and vegetables, The Mexican Scale of Food Security	Overweight: 25% Obese: 24% Severely obese: 8%	Lower consumption of fruits and vegetables
Gibson et al. (2020)	Komodo District, West Manggarai Regency, Indonesia	To investigate the contribution of fish and small-scale coastal fisheries livelihood activities to food and nutrition security	Sixty-six households participated in the study	Household survey, Focus groups discussions, Semi-structured interviews, Market survey, Anthropometric measurements (wt. and ht.)	Stunting: 50%	-High consumption of fish -Low consumption of vitamin A rich fruit & vegetables -High consumption of sweet and savoury snack
Capanzana et al. (2018)	Philippines	To analyse the nutritional status of Filipino children ages 0–60 months (0-5.0 years old) and 61–120 months (5.08–10.0 years old) in households headed by fisherfolks	3,423 young children and 16,398 school children participants	Anthropometric measurements (wt. and ht.)	Underweight: 19.9% Stunting: 30.3% Wasting: 7.9% Overweight: 5%	No related findings
Chua et al. (2018)	Terengganu, Malaysia	To assess diet quality and its association with nutritional status among 7 to 12 years old fishermen's children in Terengganu	100 fishermen's children	Questionnaire, Anthropometric measurements, healthy eating index (HEI) through 24-hr diet recall	Normal weight: 61%	-Low intake of energy, carbohydrates and fats -High intake of protein -Low intake of calcium -High intake of iron, vitamin A and C
Bandoh & Kenu (2017)	Ekumfi Narkwa, central region of Ghana	To examine the quality of food consumed in terms of nutrient adequacy of children in fishing community	250 children between 6 to 59 months	Dietary diversity questionnaire, Interview of caregivers	No related findings	Very low consumption of vitamin A rich foods. High Iron consumption from fish
Baker-French (2013)	Plurinational State of Bolivia	To examine the prevalence and correlates of household food insecurity, childhood stunting and maternal overweight in fisher populations in Bolivia's Northern Amazon Basin	304 urban and 327 rural households with a head female of childbearing age (15-49 years) during the low water (October-November) and 186 urban and 297 rural households	Anthropometric measurement (wt., ht.), Household Food Insecurity Access Scale, Household Hunger Scale, Household Dietary Diversity Score	Stunted: -34% (urban) -42% (rural)	More than one-quarter of respondents did not consumed any vegetables or vitamin A rich fruits or vegetables in the specified period

			during the high water (February-March) seasons			
Moshy et al. (2013)	Jibondo and Chole villages within Mafia Island Marine Park in Tanzania	To determine prevalence of underweight among the studied children and establish descriptions of their nutrition situation and the local perceptions of possible explanations for the underweight prevalence	104 and 52 children under five from Jibondo and Chole Island	In-depth interviews and Focus Group Discussions (FGDs), Weight-for-age analysis	Underweight: 60%	No related findings
Foo et al. (2006)	Tuaran District, Sabah, Malaysia	To determine the dietary intake of male and female adolescents in a fishing community	94 males and 105 females' adolescents aged 12-19 years old	Anthropometric measurement (wt., ht.), three days food record	Thin: -25.5% (Male) -14.3% (Female) Overweight: -6.4% (Male) -2.9% (Female)	The adolescent's intake of energy, calcium, iron and thiamine were below the RNI levels.
Hanazaki & Begossi (2003)	São Paulo Bagre and Pedrinhas, São Paulo State, Brazil	To analyse the association between household characteristics and the diet of two Brazilian fishing communities in regard to the consumption of animal protein, especially fish	14 households in São Paulo Bagre and 18 in Pedrinhas	24-hour diet recall	No related findings	Energy, vitamin C and calcium intake were below daily recommendations while protein, iron, niacin and phosphorus were above recommended levels
Khor & Tee (1997)	Peninsular Malaysia	To assess the nutritional status of children from the estates and rural community groups engaged in paddy farming, rubber planting, coconut cultivation and fishing	2,364 boys and 2,415 girls aged 18 years and below from the five communities	Anthropometric measurements (wt. and ht.)	Underweight: -33% (boys) -24.6% (girls)	No related findings

wt. = weight, ht. = height
RNI = Recommended Nutrient Intakes for Malaysia

Table 2.0: Cognitive in children and adolescents and factors associating to the performance

Study	Study Location	Objective of the study	Study population	Research Instrument	Cognitive performance	Contributing factors
Demetriou et al. (2020)	Major Thessaloniki area, Greece	To explore relations between academic performance, cognition, cognition self-evaluation and self-representation	408 participants from three SES group according to parent's education	Socio-economic status, academic achievements and Cognitive batteries	Performance varied as a function of tasks difficulty	Cognitive development positively contributes to school achievement instead
Nurliyana et al. (2020)	Seremban, Negeri Sembilan, Malaysia	To determine the influence of linear growth and home environment towards cognitive development in the first year of Malaysian infants	151 infants and mothers	Sociodemographic, anthropometry (birth wt., wt. and length), home environment, Bayley-III	Mean cognitive score is 94.54 (SD=12.00)	-Stunting and poor home environment quality affect cognitive performance -Study does not discuss relationship between SES with cognitive and home environment quality
Chin et al. (2020)	Klang Valley, Kuala Lumpur	To assess the dietary adequacy and cognitive performance of 120 homeless children age 7-12 years living in Klang Valley	120 homeless children age 7-12 years	24-hours dietary recall, Raven's Coloured Progressive Matrices (CPM)	70% had poor cognitive performance	There were no associations found between the energy, iron, Vitamin B12 adequacy and cognitive performance of homeless children except for zinc adequacy
Poh et al. (2019)	Malaysia	To determine the association between socioeconomic and nutritional status with cognitive performance in a nationally representative sample of Malaysian children	2406 Malaysian children aged 5 to 12 years, who had participated in the South East Asian Nutrition Surveys (SEANUTS)	Self-administered questionnaire, Raven's Coloured Progressive Matrices (CPM), Anthropometry	About a third (35.0%) of the children had above average non-verbal IQ while only 12.2% were categorized as having low/borderline IQ	Children with severe obesity, children from very low household income families and children whose parents had only up to primary level education had the highest prevalence of low/borderline non-verbal IQ
Sathe & Gokhale (2019)	Goa, India	To assess nutritional status and intelligence quotient of children from fisherman community	100 fishermen's children age 4-6 years, 53 boys and 47 girls	Anthropometry, 24-hours recall, The Draw-a-Person test	The mean IQ score among the children was (105.5 ± 11.6) under the moderate average IQ category	-Positive correlation with occupation and education of father, anthropometry of the children, height and MUAC -Increased consumption of soybean and fish correlated with better anthropometric measurements and higher IQ scores

Tai & Ali (2018)	Terengganu Malaysia	To determine the relationship between breakfast consumption and cognitive performance among fishermen's children	100 fishermen's children aged 7 to 12 years old	Dietary recall, Raven's Coloured Progressive Matrices (CPM)	-Grade V (intellectually impaired): 67% -Grade IV (below average): 27%	-There is no correlation between breakfast consumption (energy intake, selected macro- and micronutrients) and cognitive performance
Kim & Kang (2017)	Seoul, Korea	To explore dietary intake and cognitive function in healthy Korean children and adolescents	317 healthy children and adolescents	Anthropometry, food frequency questionnaire, cognitive function tests; central nervous system vital signs (CNSVS) and Continuous Performance Test (CPT)	Cognitive functions are closely related to healthy food consumptions	Vitamins B1, B6 and C, rice with mixed grains, and mushrooms are positively correlated with better cognitive function in contrast to processed carbohydrates
Haile et al. (2016)	Goba Town, Ethiopia	To determine how nutritional status and cognitive performance are associated with academic performance of school children in Goba Town, south east Ethiopia	131 school age students from primary schools	Sociodemographic, anthropometry, 24h dietary recall, Kaufman assessment battery for children, Raven's Coloured Progressive Matrices	No actual value for cognitive score was provided	-Weight for age z-score is positively associated with cognitive and school performance -All cognitive scores positively correlated with mathematic score
Asawa et al. (2014)	Kutch, Gujarat, India	To assess the intelligence quotient of fisherman schoolchildren of Kutch, Gujarat, India	304 fishermen's schoolchildren	Sociodemographic, anthropometry, Seguin form board (SFB)	Evident indicate low IQ among schoolchildren in fishermen community in Kutch	-Low SES -Low education level of parents -High body mass index
Nasir et al. (2012)	Peninsular Malaysia	To determine the relationship between child feeding practices, food habits, and anthropometric indicators with cognitive performance of pre-schoolers aged 4-6 years old in peninsular Malaysia	1933 pre-schoolers aged 4-6 years old in peninsular Malaysia based on department of statistics Malaysia, 2000	Sociodemographic, anthropometry, parent's nutrition knowledge, child feeding practices, food habits, Raven's Coloured Progressive Matrices (CPM)	-Mean cognitive score is 103.5 (SD=14.4) which is average. -Height-for-age and consumption of dinner were found to contribute significantly towards cognitive performance	Height-for-age, consumption of dinner and both short- and long-term nutritional status contribute positively to the performance

wt. = weight, ht. = height, SES = socioeconomic status, MUAC = Mid-Upper Arm Circumference

RESULTS

Proper nutrition is essential for children to enhance their growth and development in terms of physical, cognitive and psychosocial. Childhood malnutrition can negatively affect physical and mental health development and these impacts may last until adolescence or adulthood if no nutritional intervention is taken. Due to the low-income level of fishermen and seasonality of the fishing activities, fishermen's children are considered as a vulnerable group which have high susceptibility towards food insecurity and malnutrition. The results were focused on the dietary intake and nutritional status among the targeted population; relationship between dietary intake and socioeconomic status; relationship between dietary intake and nutritional status; as well as the relationship between dietary intake, nutritional status and cognitive development.

Dietary Intake

Dietary intakes of the fishermen's children have been investigated in this review. There are a total of six reviewed articles that mention dietary intakes. The dietary intakes were documented into three different categories which are energy, macronutrient and micronutrient intakes. Micronutrients that are included in this review are calcium, niacin, iron, vitamin A and vitamin C.

i. Energy intake

The energy intake of fishermen's children was examined in three studies[17-19]. From those studies, it is demonstrated that the energy intake of these children was significantly lower than the recommended levels. The reduced total energy intake of the fishermen's children could be due to the poor accessibility to food. A study by Baker-French[6] reported a high rate of household food insecurity among fishing communities in Bolivia's Northern Amazon which was highly correlated with the socio-economic status of the fishermen households. The amount of money spent to purchase food is dependent on the amount of the fishermen's household income[20]. Low-income level of fishermen constrained their purchasing power and decreased their household accessibility to healthy and nutritious food which eventually resulted in inadequate energy intake among their children. Additionally, some households reduce the amount of food cooked for meals and cook whatever food is available at home as coping strategies in the food insecurity situation[21].

ii. Macronutrient intake

Three studies recorded a low level of carbohydrate consumption among the fishermen's children[17-19]. Two studies reported that fat intake among fishermen children was lower than the recommendation[17,19]. Unlike the other macronutrients, the protein intake of the fishermen's children was found to be significantly higher than the recommended levels in three reviewed studies[17-19]. This is due to high consumption of fish and seafood that are more accessible among the fishing community compared to the other high protein sources such as milk products and red meat[17]. This was further supported by the sufficient intake of niacin among the children as niacin is a micronutrient that is found abundantly in fish and shellfish[18]. Besides that, Bandoh & Kenu[22] mention in their study that the children in Ghana have their protein requirement met by their diet which consist mainly of fish. Additional to that, a study by Gibson et al.[23] recorded high consumption of fish especially among the children. This shows that protein intake among the fishermen's children is highly adequate.

iii. Micronutrient intake

Six reviewed articles mention various micronutrient intake which included calcium, niacin, iron, vitamin A and vitamin C. Three reviewed articles mention that the calcium intake among fishermen's children was found to be lower than the recommended level[17-19]. Calcium is one of the major minerals in the human body which is responsible for proper bone mineralization which includes the formation and maintenance of the body skeleton structure and rigidity. A study by Foo et al.[17] mentions that only few people prefer or could afford to take milk or other dairy products, which have high calcium content. This can be supported by study from Chua et al.[19] where they stated that the low accessibility of milk products among the poor might be the cause of low milk and dairy product intake among the fishermen's children. Moreover, the rise in the price of food and non-alcoholic beverages over the past several years has denied access of low-income groups to milk and dairy products and subsequently deprived poor children of the essential nutrients in milk[19].

Two reviewed studies show that there is high level intake of niacin intake among the fishermen's children[17-18]. Niacin intake is closely related to the consumption of fish and seafood. Foo et al.[17] mention that fishing communities are more accessible to fish and seafood. Furthermore, Hanazaki & Begossi[18] stated in their study that niacin is a micronutrient that is found abundantly in fish and shellfish.

Next, there are three reviewed studies examining the intake of iron in the fishermen's children[17-19]. Foo et al.[17] found a significant low level of iron intake compared to the recommended daily dietary iron intake among the adolescents in a fishing community. However, two studies by Hanazaki & Begossi[18] and Chua et al.[19] reported a high iron intake among fishermen households. This claim can be supported by a study by Bandoh & Kenu[22] where they mention that seafood is a good source of iron, a high percentage of children in Ghana consuming flesh food especially fish and other sea foods are likely to increase their stores of iron. Different locations and ethnicity between these studies may influence the level of iron that is needed in their daily life.

There are six reviewed studies mentioning the intake of vitamin A[6,17-19,22-23]. Four of the reviewed studies reported that there is low vitamin A intake[6,18,22,23]. However, two studies by Foo et al.[17] and Chua et al.[19] found a significantly higher vitamin A intake among adolescents in the fishing community compared to the recommendation. Based on a study by Chua et al.[19], some of the sources of vitamin A are carrots, chicken eggs, chicken, sweet potatoes and Indian Mackerel (Ikan Kembung). Foo et al.[17] reported that the year-round consumption of raw local fruits and vegetables, and tuber products may contribute to high-level intake of vitamin A among the adolescents in a fishing community in Malaysia. In contrast, Baker-French[6] mentions that more than one-quarter of respondents did not consume any vegetables or vitamin A rich fruits or vegetables in the specified period. It is also supported by

Bandoh & Kenu[22] which they mention that the daily consumption of Vitamin A rich foods from both plant and animal sources daily was very low (10%) among the children where the daily consumption of fruits and vegetables was generally low; vitamin A rich fruits and vegetables - 11% (27 of 250), other fruits and vegetables- 31% (79 of 250), respectively. In addition to that, Gibson et al.[23] found that there is low consumption of vitamin A rich fruit and vegetables.

Vitamin C intake among the fishermen's children was examined in three studies[17-19]. An older study reported low vitamin C intake among children from fishermen households in Brazil[18]. On the other hand, Foo et al.[17] and Chua et al.[19] discovered that there is a higher vitamin C intake than recommended level among adolescents in the fishing community in Malaysia. Additional to that, there is adequate intake of vitamin C probably due to year-round consumption of raw local fruits and vegetables and tuber products[17]. It can be said that different study regions, dietary patterns and preference of the communities could be leading to the difference in vitamin intakes.

Nutritional status
Nutritional status of the fishermen's children was examined in seven studies from countries in Southeast Asia, India, South America, Mexico and East Africa[6,17,20,23-26]. Six out of seven studies recorded underweight among the fishermen's children ranged from 14.35% to 60%[6,17,20,23-24,26]. As mentioned in previous study by Foo et al.[17], the overall nutritional problem is low dietary intake generally leading to thinness in rapidly growing children. Morshy et al.[20] mention that reduced fish catches, low household income and decreased food security, were among the major causes of high levels of undernutrition among the children in fishing communities. This can be supported by Khor & Tee[24] where they mention there is a high prevalence of poverty among the fishing communities.

A study by Foo et al.[17] shows that there is also prevalence of overweight among the fishermen's children in Malaysia. The results of the study showed that the prevalence of overweight among the children did not exceed 10%. Foo et al.[17] mention that there is less concern for overweight as the proportion of those at risk of overweight is still small. However, two studies found that about half of the subjects are overweight and obese[25,27]. Murillo-Castillo et al.[25] mention that 81.5% of school children regularly consume sweetened beverages, 61.9% snacks, sweets, and desserts and 53.4% sweet cereals which probably contributes to overweight and obese. This can be supported by Gibson et al.[23] where they mention that there is high consumption of sweet and savoury snacks among the children. This shows that the quality of dietary intakes is also important to prevent malnutrition among the children.

Cognitive performance and factors influence
There are three reviewed studies recorded an average cognitive score[28-30] while there is one study that shows that children have above average non-verbal IQ[31]. Studies by Nasir et al.[28] and Nurliyana et al.[29] found that mean cognitive score among children in Peninsular Malaysia is within average; 103.5 (SD=14.4) and 94.54 (SD=12.00) respectively. A study conducted by Sathe & Gokhale[30], also showed an average IQ score among fishermen's children in Goa, India with a mean score of 105.5 (SD=11.6). Poh et al.[31] found that 35% of the children have above average non-verbal IQ with the score between 110-119. In contrast, there are three studies that show low cognitive performance[27,32-33]. A study by Asawa et al.[27] found that there was a low IQ index among schoolchildren in the fishermen community in Kutch, India. Tai & Ali[32] found that 67% of the respondents recorded grade V (intellectually impaired) and 27% of the respondents recorded grade IV (below average). A study by Chin et al.[33] found that 70% had a poor cognitive performance. According to Haile et al.[34], there was a statistically significant positive correlation between cognitive scores and average academic performance, although no value for cognitive score was provided. A broader perspective has been adopted by Demetriou et al.[35] who argue that performance varied as a function of tasks or cognitive functions difficulty level. This vary result of cognitive performances is influenced by many factors such as dietary intake, nutritional status, socioeconomic status and also parent's education.

There are four studies that mentioned the relationship between dietary intake and cognitive performance[30,32-33,36]. Based on the study by Sathe & Gokhale[30], there are positive correlations between iron, zinc, vitamin B12 and folic acid with performance. In addition to that, Kim & Kang[36] mention that vitamin B1, B6 and C are positively correlated with better cognitive function. This can also be supported by Chin et al.[33] where they found that there is an association between zinc adequacy and cognitive performance. Zinc plays a role in the central nervous system as a neurosecretory and cofactor[33]. Thus, it can cause developmental and intellectual delay due to its deficiency and can have a negative effect on IQ[30]. Contrary to the finding above, there are two reviewed studies that stated there are no correlation between certain diet adequacy and cognitive performance[32-33]. Tai & Ali[32] stated that there is no correlation between breakfast consumption (energy intake, selected macro- and micronutrient) and cognitive performance. This can be supported by a study by Chin et al.[33] where they found that there is no association between energy, iron and vitamin B12 and cognitive

performance. This is due to there being adequate intake for energy, iron, and vitamin B12 among the children but mostly are categorized in the borderline category for their cognitive performance[33].

Seven of the reviewed studies show there are positive relationships between nutritional status and cognitive development[27-31,34,36]. A study by Nasir et al.[28] mentions that height-for-age and consumption of dinner were found to contribute significantly towards cognitive performance. In the same study, they found that children with either underweight or overweight/obese have lower academic score compare to children with normal weight[28]. This can be supported by Haile et al.[34] where they discovered that weight-for-age z-score is positively associated with cognitive and school performance, especially among stunted children where they have impaired behavioural development in early life and have poorer cognitive ability than non-stunted children. Additionally, a study from Nurliyana et al.[29] also mentions that stunting can affect cognitive performance. Their study found that stunted infants experienced delayed motor developments which particularly inhibit their exploration and learning process from their surroundings which leads to poor cognitive performance[29]. Aside from stunting/underweight, overweight/obese can also affect the cognitive development[27,31,36]. Asawa et al.[27] mention in their study that overweight or high BMI leads to low cognitive performance. Addition to that, a study by Poh et al.[31] found that children with severe obesity are more likely to have poor non-verbal IQ. Obesity can harm the brain and compromise performance on intelligence tests[27]. Children with severe obesity may intensify the adverse effect of adiposity where higher adipose tissues can result in higher adipokines production, including leptin, thus increases insulin resistance and therefore promotes hyperinsulinemia, dyslipidemia, inflammation and endothelial dysfunction[31]. Hypertriglyceridemia (one of the dyslipidemias) will result in elevated peripheral leptin levels, which prevent the entry of leptin to the brain, thus harming brain development and consequently lowers cognitive performance[31]. This can be supported by study from Kim & Kang[36] where they mention that consumptions of fast foods may diminish cognitive performance.

Socioeconomic status (SES) is one of the concerns among the fishing community due to low and unstable income. Thus, there are six reviewed studies that show the relationship between SES, dietary intake and children's cognitive performance[27-28,31,33-35]. Three reviewed studies had reported that low SES can give an impact toward the children's cognitive development[27,31,35]. This can be supported with study from Nasir et al.[28], where they mention that socioeconomically disadvantaged children and food habits, consumption of dinner of less than five in a week, influence low cognitive scores and height and weight associated with the performance. Besides that, household financial constraints had been associated with such conditions as limited access to cognitively stimulating materials and limited preschool experiences for children[31]. Thus, have a lesser opportunity in learning and have fewer chances to expose themselves in cognitively challenging tasks causing lack of cognitive stimulation[33]. Furthermore, one reviewed study found that a higher wealth index is associated with better mathematics score of school age children[34].

Aside from SES, parent's education also reflected the cognitive performance among the children. There are two reviewed studies that show the relationship between parent's education and cognitive performance[30-31]. A positive association was found between the education of fathers and IQ levels of children[30]. Poh et al.[31] mention that a higher proportion of children whose parents had tertiary education were categorized as having superior non-verbal IQ. Parents with higher education may be more willing to invest time and money in caring for their children[37]. In addition, parents with higher education usually have higher health literacy and engage in quality interactions more frequently with their children, as compared to parents with lower education[31].

This shows the correlation between nutritional status, dietary intake and cognitive development. Certain essential nutrients are needed to help the development of the children's cognitive. Lacking a certain nutrient due to socioeconomic status may contribute to poor cognitive performance among the fishermen's children.

DISCUSSION

Based on the work undertaken in this study, opportunities for future research should include assessment of the nutritional status and dietary intake of fishermen children in their middle childhood. Future research should also concentrate on the investigation of the implications of the nutrients which have low levels of intake among the fishermen's children. It is suggested to conduct a longitudinal study on the diet and lifestyles pattern of children from fishing communities to examine their nutritional status more closely. Besides, future research might study the fishermen's children's status of more micronutrients which are crucial for growth and development during childhood such as vitamin D, zinc, iodine and folate. Other possible areas of future research would be to investigate the differences of diet and lifestyle of the fishermen's children during monsoon and non-monsoon period and its effects on their nutritional status. The effects of heavy metal pollutants and their effects on the health status and cognitive performance of the children also needed to consider as seafood are susceptible to

contaminants especially mercury. These studies then can be combined with socio-demographic data to assess the economic status and education level of the fishermen's community in Malaysia. Further correlations between nutritional and socio-economic status of fishermen's community with cognitive test scores to investigate factors contributing to such resulted performance hence determining the precise intervention necessary to improve nutritional, socio-economic status and school performance.

CONCLUSION

In conclusion, most of the studies indicated that poor socioeconomic status, nutritional status and cognitive performance applied to the children and adolescents in children in general and particularly fishing communities, even though they are in different regions. It can be seen that poor socioeconomic status can lead to food insecurity which can result in insufficient of some certain nutrients that are needed for children's development, specifically their cognitive development. The findings of the reviewed studies indicate the need for nutrition education and economic intervention among this vulnerable group. Government and health-related authorities should implement action plan and perhaps invite involvement of NGOs and other third party to introduce various types of interventions to recommend and increase consumption of vegetable, fruit, and dairy products among children fishing communities, while ensuring a method to generate income throughout the year without having to be fully dependent on sea procurements. It also suggests that public forums, nutrition education programmes and motivational programmes be organised in schools as well as in the fishing community, with a view to creating awareness among fishermen's parents about the value of financial security and good quality diets for their children and their impact on the learning process of their children.

Conflict of interest
The authors declare no potential conflict of interest.

ACKNOWLEDGMENT

REFERENCES

1. Jeejeebhoy KN, Detsky AS, Baker JP. Assessment of nutritional status. *Journal of Parenteral and Enteral Nutrition* 1990; 14(5): 193-196.

2. Walton E, Allen S. Malnutrition in developing countries. *Paediatrics and Child Health* 2011; 21(9): 418-424.

3. Mikkila V, Rasanen L, Raitakari OT, et al. Longitudinal changes in diet from childhood into adulthood with respect to risk of cardiovascular diseases: The Cardiovascular Risk in Young Finns Study. *European Journal of Clinical Nutrition* 2004; 58:1038-1045.

4. McAfee AJ, Mulhern MS, McSorlley EM, et al. Intakes and adequacy of potentially important nutrients for cognitive development among 5-year-old children in the Seychelles Child Development and Nutrition Study. *Public Health Nutrition* 2012; 15(9).

5. Benton D. The influence of dietary status on the cognitive performance of children. *Molecular nutrition & food research* 2010; 54(4): 457-470.

6. Baker-French SR. Food security and nutritional status in fishing communities in Bolivia's Northern Amazon: results of a household survey. Master Thesis, Faculty of Graduate and Postdoctoral Studies (Human Nutrition), University of British Columbia (Vancouver) 2013:1-172.

7. Makame MO, Kangalawe RYM, Salum LA. Climate change and household food insecurity among fishing communities in the eastern coast of Zanzibar. *Journal of Development and Agricultural Economics* 2015; 7(4): 131-142.

8. Rahman MA, Abka R, Rahman MS, et al. Poverty and food security analysis: A study of fishermen households in a selected area of Bangladesh. *Journal of the Bangladesh Agricultural University* 2013; 11(2): 293–299.

9. Stanford RJ, Wiryawan B, Bengen DG, et al. Exploring fisheries dependency and its relationship to poverty, A case study of West Sumatra, Indonesia. *Ocean and Coastal Management* 2013; 84: 140-152.

10. Panikkar KKP, Alagaraja K. Socio-economic status of fishermen community of Calicut area. *Marine Fisheries Information Service, Technical and Extension Series* 1981; 33: 2-12.

11. Ujjania NC, Patel AN. Socio-economic status of fishermen community of

Danti village in Valsad District (Gujarat) India. *Emerging Trends in Development Research* 2011; 18(1): 25-30.

12. Sivanesan R. Problems and prospects of fisherfolk in Kanyakumari District of Tamilnadu. *International Journal of Research in Management & Business Studies* 2014; 1(1): 7-12.

13. Zainudin LM, Zein A, Idris MH, et al. Socio-economic profile comparison of fishermen community in Kuala Marang and Seberang Takir, Terengganu, Malaysia. *Journal of Sustainability Science and Management* 2019; 14(6): 145-157.

14. Nursyazwin M, Zein A. Socio-economic profile and monthly income of fishermen in Marang, Terengganu. *Universiti Malaysia Terengganu Journal of Undergraduate Research* 2019; 1(1).

15. Yaakob O, Chau QP. Weather downtime and its effect on fishing operation in Peninsular Malaysia. *Jurnal Teknologi* 2005; 42(A): 13-26.

16. Ishak AM, Zainuddin MZ, Razak FA. Bajet 2016: Nelayan harap peruntukan ditambah. Berita Harian 2015. Available from: http://www.bharian.com.my/node/91021.

17. Foo LH, Khor GL, Tee ES, et al. Dietary intake of adolescents in a rural fishing community in Tuaran District, Sabah. *Malaysia Journal of Nutrition* 2006; 12(1): 11-21.

18. Hanazaki N, Begossi A. Does fish still matter? Changes in the diet of two Brazilian fishing communities. *Ecology of Food and Nutrition* 2003; 42(4-5): 279-301.

19. Shan CH, Ali A, Zakaria NS, et al. Assessment of diet quality and its association with nutritional status among fishermen's children in Terengganu. *Malaysia Applied Biology* 2018; 47(6): 137-144.

20. Moshy VH, Masenge TJ, Bryceson I. Undernutrition among under-five children in two fishing communities in Mafia Island Marine Park, Tanzania. *Journal of Sustainable Development* 2013; 6(6): 1.

21. Nik Mohd Sanusi NNN, Ali A, Kamarudin KS, et al. Assessment of food insecurity and food coping strategies among fishermen household during monsoon in Terengganu, Malaysia. *Malaysia Applied Biology* 2018; 47(6): 1-9.

22. Bandoh DA, Kenu E. Dietary diversity and nutritional adequacy of under-fives in a fishing community in the central region of Ghana. *BMC Nutrition* 2017; 3(2).

23. Gibson E, Stacey N, Sunderland TCH, et al. Dietary diversity and fish consumption of mothers and their children in fisher households in Komodo District, Eastern Indonesia. *PLoS ONE* 2020; 15(4).

24. Khor GL, Tee ES. Nutritional assessment of rural villages and estates in Peninsular Malaysia II. Nutritional status of children aged 18 years and below. *Malaysia Journal of Nutrition* 1997; 3: 21-47.

25. Murillo-Castillo KD, Frongillo EA, Corella-Madueño MA, et al. Food insecurity was associated with lower Fruits and vegetables consumption but not with overweight and obesity in children from Mexican fishing communities. *Ecology of Food and Nutrition* 2020.

26. Capanzana MV, Aguila DV, Gironella GMP, et al. Nutritional status of children ages 0–5 and 5–10 years old in households headed by fisherfolks in the Philippines. *Archives of Public Health* 2018; 76:24.

27. Asawa K, Pujara P, Thakkar JP, et al. Assessment of intelligence quotient among schoolchildren of fishermen community of Kutch, Gujarat, India. *International Maritime Health* 2014; 65(2): 73-78.

28. Nasir MTM, Norimah AK, Hazizi, AS, et al. Child feeding practices, food habits, anthropometric indicators and cognitive performance among pre-schoolers in Peninsular Malaysia. *Appetite* 2012; *58*(2): 525-530.

29. Nurliyana AR, Shariff ZM, Taib MNM, et al. Early growth and home environment are associated with cognitive development in the first year of life of Malaysian infants. *Early human development* 2020; 140.

30. Sathe N, Gokhale D. Intelligence Quotient and Nutritional Status of 4-6 Year Old Children from Fishermen Community of Goa, India. *Indian Journal of Public Health Research & Development* 2019; 10(7): 1594-1599.

31. Poh BK, Lee ST, Yeo GS, et al. Low socioeconomic status and severe obesity are linked to poor cognitive performance in Malaysian children. *BMC Public Health* 2019; 19(4): 541.

32. Tai SW & Ali A. Breakfast consumption and its relationship with cognitive performance among fishermen's children in Terengganu. *Malays. Applied Biology* 2018; 47(4): 24-34.

33. Chin KJ, Ali A, Yusof HM, et al. Does dietary adequacy reflect the cognitive performance of children? a study among the homeless children in Klang Valley, Malaysia. *IMJM* 2020; 19(3): 55-62.

34. Haile D, Nigatu D, Gashaw K, et al. Height for age z score and cognitive function are associated with Academic performance among school children aged 8–11 years old. *Archives of Public Health* 2016; *74*(1): 17.

35. Demetriou A, Kazi S, Makris N, et al. Cognitive ability, cognitive self-awareness, and school performance: From childhood to adolescence. *Intelligence* 2020; 79.

36. Kim, JY, Kang SW. Relationships between dietary intake and cognitive function in healthy Korean children and adolescents. *Journal of lifestyle medicine* 2017; *7*(1): 10.

37. Dotti Sani GM, Treas J. Educational gradients in parents' child-care time across countries, 1965–2012. *J Marriage Fam* 2016; 78(4):1083–1096.