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DIET QUALITY AND COGNITIVE PERFORMANCE OF FISHERMEN'S CHILDREN IN SELECTED REGION OF TERENGGANU, MALAYSIA: A CROSS-SECTIONAL STUDY

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ABSTRACT

Fishermen's children are vulnerable to food insecurity as well as undernourishment which may influence their cognitive performance. Nevertheless, there is a deficiency in terms of pertinent studies that have been done in Malaysia with regards to their diet quality and cognitive performance. Thus, this cross-sectional study was carried out to determine the diet quality and cognitive performance among 7 to 11 years-old fishermen's children in Terengganu. A total of 95 respondents were selected and their dietary intake was attained through two days of 24 hr dietary recall and later analyzed using Nutritionist Pro application. The diet quality of the respondents was assessed using the Healthy Eating Index (HEI) while the cognitive performance was determined through 36-items of Raven's Coloured Progressive Matrices. Results have shown that the respondents' mean total HEI score was 50.41 ± 5.26 out of 100 points indicating poor diet quality. The level of cognitive performance is below average. Unfortunately, no significant association was found between the total HEI score and cognitive performance of the respondents (p=0.16). In the future, more studies need to be carried out on the relationship between diet quality and cognitive performance among these respondents for better understanding.

Key words: Diet quality, cognitive performance, fishermen's children, Terengganu, Malaysia

INTRODUCTION

Recently, an extensive amount of literature has grown up around the theme of poor nutritional status among children in Malaysia predominantly the vulnerable groups (Chua *et al*., 2018; Tai *et al*., 2018). Increasing concern with the notion that the fishermen's children are being disadvantaged from adequate nutrients or better diet quality has prompted the researcher to come out with this study. One of the major circumstances of the vulnerable groups is substantially related to the low income and parents' occupation (Wong *et al*., 2014). A study conducted in the key areas in the East Coast of Malaysia reported that about two-thirds of the fishermen households were below the monthly poverty line income (Yeo *et al*., 2007). This problem has affected the family members, especially the children who should get adequate nutrients, education, and a better life for their future. The climate on the east coast of Peninsular Malaysia is affected by the northeast monsoon which is usually established in early November and ends in March every year (Yaakob & Chau, 2005). The majority of fishermen began to face financial problems in meeting their living needs during this period. Some of the fishermen lived in secluded poverty which in turn has increased the defenselessness of their families to the peril of social pressure, natural disaster, and food insecurity (Chuenpagdee & Jentoft, 2011; Makame *et al*., 2015; Nik *et al.,* 2018). Yaakob and Chau (2005) revealed that the mean income of fishermen on the east coast of Peninsular Malaysia during the monsoon period reduced from 9 to 32% compared to the normal period. Even though the Malaysian government provides a monthly allowance of RM 200 to 300 for the fishermen, the allowance given is insufficient to cover the living expenses of the families especially those whose children are still receiving education in school (Ishak *et al*., 2015). Previous studies showed that food insecurity was prevalent

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among fishermen communities (Baker-French, 2013; Rahman *et al*., 2013; Makame *et al*., 2015; Nik *et al.*, 2018). Reduced household income, food insecurity, and increased women's responsibilities are among the factors that have contributed to nutrition problems among children in fishing communities (Foo *et al*., 2006). A study by Pal *et al*. (2010) showed a significant relationship between household income and malnutrition in the fishing community in the coastal Bay of Bengal, Bangladesh. In Malaysia, several studies reported that the prevalence of undernutrition was higher in children from low family income groups (Cheah *et al*., 2012; Wong *et al*., 2014).

Extensive research has shown that diet quality plays a prominent role in cognitive function (Haapala *et al*., 2015; Nyaradi *et al*., 2015; Wright *et al*., 2016) as well as academic performance (Florence *et al*., 2008) during child growth. It is believed that healthier foods improved the executive functioning of the brain through many mechanisms. Vitamins like B and C, minerals like zinc are co-factors for enzymes that synthesize neurotransmitters, thus influencing cognition in children (McIsaac *et al*., 2015; Cohen *et al*., 2016). Furthermore, studies have found that fishermen's children have a greater susceptibility to poor cognitive performance. This poor cognition can be affected by gender, nutrition, quality of the school, physical activity, and socio-economic condition (Florence *et al*., 2008). Hence, the main aim of this study is to determine the diet quality of the fishermen children and its relation to their cognitive performance. Being part of the precedence in the Nutrition Research Priorities (NRP) in Malaysia 2016-2020 which is "Monitoring and Evaluation of National Food and Nutrition Security, Nutritional Status and Programs", this study aligned its urgencies with the declared national's priorities.

MATERIALS AND METHODS

This cross-sectional study was conducted in Kuala Nerus and Kuala Terengganu which are located in the state of Terengganu on the eastern coast of Peninsular Malaysia. Fishing is one of the major economic activities in both districts. Kuala Terengganu is the district with the highest number of fishermen among all districts in Terengganu (N=3011, 28.9%) (Aisyah *et al*., 2014). The sampling method used for area sampling was convenience sampling while the sampling method used in sample sampling was snowball sampling. The sample size involved in this study was calculated using Cochran's formula (1963). Given the 95% confidence level, 9.5% margin of error, the prevalence of malnutrition among children in a fishing community in Peninsular Malaysia was 28.8%, and after taking 10% of attrition into account, the final minimum sample size of this study was 95. The inclusion criteria for this study are; the children of fishermen aged 7-11 years old, without physical disabilities, not on any specialized or restricted diet, and able to communicate in Malay. Verbal and also written informed consent were obtained from the guardian of the children before the study. This study was approved by the Human Ethics Board of Committees of Universiti Malaysia Terengganu (UMT/JKEPM/2017/4).

Research instruments

The questionnaire used in this study consisted of three sections. The first section comprises socio-demographic information, the second part of the questionnaire required two days of 24 hr dietary recall and later dietary data was used to determine the diet quality through the Healthy Eating Index (HEI). The HEI scoring system was adjusted based on the Malaysian Dietary Guidelines for Children and Adolescents (2014). HEI consist of ten components and the number of recommended servings depends on an individual's energy requirement. The scores of each component in HEI are specified with a range from zero to ten. A score of ten was given if the respondents fulfill the maximum requirement (full compliance) in one day. Zero marks were given if the respondents did not consume any serving in that particular component (component one to five) or did not fulfill the minimum requirement for any one of the six to ten components (lack of compliance). For the intakes in between, the score was calculated proportionately. Component one to five assesses the degree of compliance of the children diet to the five major group namely grains (bread, cereal, rice, and pasta), vegetables, fruits, dairy (milk, yogurt, and cheese), and meat (meat, poultry, fish, dried bean, eggs, and nuts). By using the Nutritionist Pro software, the respondents' dietary intake data were classified into five groups according to the "Food Guide Pyramid Summary". The five-food group corresponds to the first five components in HEI and the serving size consumed was also analyzed. Component six to nine processes the compliance with a recommendation for total fat, saturated fat, cholesterol, and sodium intake. The last components in HEI measure the variety of food in the diet. For the last component, food variety was determined by calculating the average number of different foods consumed by the respondents in a day manually from the respondents' diet record food guide summary and counted only for those foods with at least one-half of a serving from any of the five food groups (Chua *et al.,* 2018). The serving size was referred from the Malaysian Dietary Guidelines for Children and

Adolescents (2014). The respondents were given a maximum of ten marks for food variety if they consumed eight or more different items of food in one day. If three or less different items of food were consumed, then zero marks will be given. The score was calculated proportionately for the intermediate intakes. The possible composite HEI score range from a minimum score of zero to a maximum score of 100. A total score of above 80 is classified as good, a score between 51 and 80 indicated the need for improvements in the diet quality, and a score of less than 51 is considered as poor.

The last section is the cognitive assessment determined through Raven's Colored Progressive Matrices (Raven's CPM) consisting of 36 questions. Raven's CPM is a non-verbal intelligence assessment used to determine individual cognitive performance. The test is composed of three sets/scales (A, AB, and B) with 12 items each, making the total questions is 36. The items are organized in ascending order of difficulty, which consists of drawing with the missing part. The individual needs to complete the task by choosing one among six alternative responses. Every correct response will get one mark and zero marks for each wrong response. The minimum score is zero and the maximum is 36 (Raven, 2004). The total raw score for each respondent was referred to a standard table, where the percentile rank of each respondent was determined concerning his/her biological age. Respondents were categorized into five grades based on their percentile rank; > 95th Grade I (intellectually superior), > 75th Grade II (definitely above average), 25th – 75th Grade III (intellectually average), < 25th Grade IV (below average), and < 5th Grade V (intellectually impaired). The association between diet quality and cognitive performance was assessed using the Chi-square test, with a significance level set at $p<0.05$.

RESULTS AND DISCUSSION

Socio-demographic characteristics

There are 39% of boys and 56% of girls who participated in this study, which was relatively equally distributed. All participants are Malay due to the study's area where Malays made up about 99.4% of fishermen population in Terengganu according to the Fishermen Socio-Economic and Household Data 2007/2008. Most of the respondents (44.2%) can be categorized as a poor household group as defined by Malaysia's standard categories of low income (Performance Management and Delivery Unit, 2010). In short, all these families were considered a low-income household group, as defined by the Malaysian standard. Surprisingly, only a minority of respondents received financial help from the government and private organizations although most of them were considered as a low-income group.

Diet quality

The average Healthy Eating Index (HEI) score was in poor condition as it only achieved 50.41 total score. The components in HEI that contribute to the poor diet quality among the fishermen's children were grains, vegetables, fruit, dairy products, meat, and food variety as shown in Table 2.

Most of the parents did not reach a higher education level which may afford them to lack education on nutrition that results in poor diet quality of the children as supported by Webber *et al.* (2018). Hiza *et al*. (2012) also showed that children's diet quality was affected by parent's educational level, especially the mother, where children in Australia have good diet quality when the mother has high schooling level. Education is said to relate to increased nutrition understanding, as well as an indicator of the ability to translate

Table 1. Socio-demographic characteristics of subjects (n=95)

Characteristics	Distribution n (%)
Gender	
Boys	39 (39%)
Girls	56 (56%)
Ethnicity	
Malay	95 (100%)
Age group (yr)	
7	24 (25.3%)
8	9 (9.5%)
9	11 (11.6%)
10	19 (20.0%)
11	32 (33.7%)
Parent's highest education level	
Primary school	20 (21.1%)
Lower secondary school	51 (53.7%)
Upper secondary school	22 (23.2%)
Diploma and above	2 (2.1%)
Number of total family members	
< 5	10 (10.6%)
5 – 10	80 (84.1%)
>10	5 (5.3%)
Household income	
< RM 440	2 (2.1%)
RM 440 – 749	42 (44.2%)
RM 750 – 999	38 (40%)
RM 1000 – 1999	13 (13.7%)
Financial receiver	
Yes	19 (20%)
No	76 (80%)

Table 2. Average score of age component and total HEI scores

HEI Components	Possible range of score	HEI scoring criteria		
		Requirement for minimum score of 0 (serving per day)	Requirement for minimum score of 10 (serving per day)	Average score Median (IQR)
Grain	0–10	0	5–7	4.62 (1.97)
Vegetable	0–10	0	3	0.83 (1.67)
Fruit	0–10	0	2	0.00 (2.50)
Dairy	0–10	0	2	0.00 (0.00)
Meat	0–10	0	2.5–3.5	5.46 (3.46)
Total fat	0–10	≥ 45% energy	≤ 30% energy	10.0 (1.79)
Saturated fat	0–10	≥ 15% energy	≤ 10% energy	10.0 (0.00)
Cholesterol	0–10	≥ 450 mg	≤ 300 mg	10.0 (0.00)
Sodium	0–10	≥ 2200 mg	≤ 1200 mg	8.95 (8.14)
Food variety	0–10	≤ 3 items	≥ 8 items	1.00 (3.00)
Total HEI score	0–100	–	–	50.41 (5.26)

nutrition knowledge into better dietary practices. Lower household-income was also related to lower dietary quality because of the unaffordability to buy enough and high-quality food for the family. This standpoint was supported by Robson *et al*. (2016) where a study in San Diego using the HEI method proved that parents' diet quality and energy intake were related to children's diet quality and energy intake.

Cognitive performance

From all respondents, only students of age 7 were in the 1st percentile while the rest of them are in the 5th percentile with the standard score of 75 respectively as shown in Table 3. The cognitive performance of the fishermen's children is also categorized into five grades based on percentile ranks.

A more comprehensive picture is presented in Table 4. Most of the students (66.3%) were categorized into Grade V where the percentile rank was less than or equal to 5th for their cognitive performance. Increasing in number from Grade II to IV, 2.1% were in Grade II, 4.3% were in Grade III and 27.4% were in Grade IV. These results indicate that most of the respondents were poor in cognitive performance. It is difficult to explain this result, but it might be related to their unconducive living environment (Whaley *et al.,* 2003; Ejekwu *et al.,* 2012), lower level of mother's educational attainment (Hutagalung & Isa, 2017), inadequate early childhood nutrition (Nurliyana *et al.,* 2016), prolonged undernutrition (Gashu *et al.,* 2016), exposure to unsafe levels of methyl mercury (Grandjean *et al*., 1998), and poor health status (Li *et al.,* 2008*)*. One study done on over 500 standard one to six schoolchildren in Kenya showed that diet, family condition, cultural and physical activity give a significant impact on the cognitive development of the schoolchildren (Whaley *et al.,* 2003) in which mirrors the vital role of one living environment. Hutagalung and Isa (2017) had proved that a mother's education plays a significant role in steering their children's cognitive development and ability. In their study among 100 preschool children in Kuala Lumpur aged five to seven years old had revealed that those children whose mothers who were educated at the SPM level exhibited lower general cognitive performance than that of whose mothers who had a degree education ($F=3.83$, $p<0.05$). Hutagalung and Isa (2017) comprehensively elucidated that mothers with higher education are capable to have greater aspiration and motivation towards their children's education, indulge more positive attitudes in preparing the conducive home environment, providing a good quality time of bonding with their children, and have deeper knowledge in having their children to achieve the optimum nutritional status. An experimental study has been done by Ejekwu *et al.* (2012) to grasp the different effects of nutrition on urban and rural area children in Nigeria. The cognitive performance of urban children is better than in rural areas, which is predominantly associated with the mother's education. Considering the importance of a mother's education, it can thus be suggested that these mothers of fishermen's children have/ need to be equipped with a parenting-skill enhancement for a better future for their children.

Prolonged undernutrition is other factors linked to poor cognitive performance. One cross-sectional study was done in Ethiopia, focusing on more than 500 of six to ten years old children, and remarkably found that nutrients deficiency could cause the poor cognitive performance of the children. One of the culprits was due to selenium inadequacy that helps in cognitive functioning (Gashu *et al.,* 2016). Gashu

Table 3. Distribution of total score in cognitive assessment of fishermen's children according to age group (n=95)

Age	n (%)	Total raw score Median (IQR)	Standard score	Percentile rank
7	24 (25.3%)	13.0 (12.0)	65	1th
8	9 (9.5%)	22.0 (11.0)	75	5th
9	11 (11.6%)	20.0 (8.0)	75	5th
10	19 (20.0%)	22.0 (6.0)	75	5th
11	32 (32.7%)	26.0 (6.0)	75	5th

Table 4. Cognitive performance of fishermen's children categorized into five grades based on percentile ranks (n=95)

Category	Percentile rank	n (%)
Grade I (intellectually superior)	$\geq 95^{th}$	0 (0%)
Grade II (definitely above average)	$\geq 75^{th}$	2 (2.1%)
Grade III (intellectually average)	$25^{th} - 75^{th}$	4 (4.3%)
Grade IV (below average)	$\leq 25^{th}$	26 (27.4)
Grade V (intellectually impaired)	$\leq 5^{th}$	63 (66.3)

Table 5. Association between diet quality and cognitive performance (n=95)

Cognitive score	HEI score n (%)		Fisher's Exact Test (p-value)
	< 51	≥ 51	
> 25th	5 (5.26)	1 (1.05)	0.16[a]
≤ 25th	48 (50.53)	41 (43.16)	

* significance at $p<0.05$.
[a] there are 4 cells (50.0%) have expected count less than 5, Fisher's Exact Test value is applied.

et al. (2016) indicated the importance of dietary intake towards cognitive performance and indirectly may help us to find new ways of shaping a rigorous diet assessment in gauging these fishermen's children's dietary intake. Their study seems to be consistent with other research that found that early life nutrition is significantly associated with growth and cognitive development (Nurliyana *et al.,* 2016). Noteworthy, cognitive performance can be affected through chemicals contained in the food. Methylmercury that usually found in seafood has widespread effects on cerebral function, which finally affects cognitive function. However, Grandjean *et al.* (1998) stated that it is still not dangerous to eat that seafood, especially from seawater because the chemical compound is at a safe level of concentration. In summary, it concluded that the longer-term effect of a healthier diet had a positive association with executive functioning. Unfortunately, this present study did not measure the level of mercury among the respondent.

Association of diet quality and cognitive performance

Fisher's Exact Test value indicates that there was no association between diet quality and cognitive performance among the fishermen's school children as shown in Table 5. This result agreed with the previous study by Haapala *et al*. (2017) which found that children's diet quality did not relate with the cognition of Finland children. In contrast, several studies stated that diet quality was associated with cognitive performance. The research was conducted in the U.S.A and it was proven that diet quality and cognitive function were likely related where higher diet quality was associated with better performance of the tests irrespective of race and poverty status (Wright *et al*., 2016). This finding is consistent with Haapala *et al*. (2015) who stated that poor scores in the cognition test by using Raven's CPM were associated with poor diet quality. The researchers also added that low consumption of fruits and vegetables was linked to

worse cognition. Other than that, higher cognitive performance was prospectively associated with healthy dietary choices which were related to diet quality (Crichton *et al*., 2015). Of more relevance to the present study, children with lower cognitive ability significantly consumed less fruit, vegetables grain, and fish (meat). This shows the importance of the intake of a balanced diet with a variety of food to make sure the quality of the diet is guaranteed. This broadly supports the work of other studies in this area that proved that a good quality diet helps in good cognitive performance (McIsaac *et al*., 2015; Cohen *et al*., 2016).

Several caveats need to be noted regarding the present study. The responses relating to the two-day dietary recall of the children were susceptible to recall bias which may invite under- or over-reporting phenomenon. With a small sample size, caution must be applied, as the findings might not be transferable to other fishermen's children in another region. While the findings should be interpreted with caution, the data accrued from this study can be used to design larger confirmatory studies. A further cross-national study is needed involving fishermen's children to conduct a comprehensive examination of their dietary intake, nutritional status, and cognitive performance. It is suggested that the association of these factors is investigated in future studies. Further studies are needed to better understand the risk assessment of the poor cognitive performance of these fishermen's children. Considerably, a further effort will help to achieve the benchmark for the National Plan of Action for Nutrition for Malaysia, NPANM (2016-2025), as it will determine the prevalence of undernourished children particularly the vulnerable groups. The NPANM could benefit from this study to monitor the trend nutritional status of children and can be more successful if it reaches the goal to have the prevalence of undernourished of not more than 11% by 2025.

CONCLUSION

Results show the respondents' mean total HEI score was 50.41 ± 5.26 out of 100 points indicating poor diet quality. Due to the low-household income, parents with poor educational background, lacking food availability, and unbalanced dietary intake, these may be the factors to the poor diet quality. Foods with a high content of sodium and cholesterol, with less consumption of fruit and vegetable, revealed that it affects the diet quality of the children. An individual from a low education level was disturbed by dint of deficiency of knowledge and awareness about nutrition, thus affecting the HEI score in measuring the diet quality. Since the children live in nearby coastal areas with climate change, the shortage of food cannot be avoided. On the other hand, most of the respondents had their level of cognitive performance below average. The majority fell in Grade IV and V, considered as intellectual below average. Unfortunately, no significant association was found between the total HEI score and cognitive performance of the respondents. In summary, diet quality was not correlated to cognitive performance among the respondents.

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