

Evaluation of the Effect of Fish Oil Use on Receptive Language and Cognitive Processes in Healthy Turkish Children Aged between 2 and 12 Years Old

Utku Sayin^{1,*}, Tugba Zengin², Bulent Alioglu³, Ayse Esra Tapci²,
Esra Yazarli², Yildiz Dallar Bilge⁴

¹Department of Special Education, School of Education, Mustafa Kemal University, Alahan, Antakya, Hatay, Turkey

²Residence in Pediatrics, The Ministry of Health of Turkey, Ankara Training and Research Hospital, Department of Pediatrics, Ankara, Turkey

³The Ministry of Health of Turkey, Ankara Training and Research Hospital, Department of Pediatric Hematology, Ankara, Turkey

⁴The Ministry of Health of Turkey, Ankara Training and Research Hospital, Department of Pediatrics, Ankara, Turkey

Abstract Aim: The aim of this study is to evaluate the effects of fish oil supplementation on receptive language and cognitive process in children and to compare the results with children not having fish oil supplementation. **Background:** In literature some studies have showed fish oil can effect human's cognitive situation. 42 healthy children of 2-12 years old, who was given fish oil, were enrolled as experiment group. The control group included 20 healthy children also of 2-12 years old and they were not given fish oil. Cognitive functions and receptive language were assessed with the Peabody Picture Vocabulary Test (PPVT). After the simultaneously application to pre-test of experiment and control groups, fish oil was given for 4 weeks to the experiment group. Both of experiment and control groups were re-evaluated simultaneously with PPVT then 8 weeks of the pre-test application and after 4 weeks fish oil supplementation to experiment group. **Results:** At the end of the study, post-test scores of PPVT of the experimental group, which had used fish oil for 4 weeks, have been increased than the experimental group's pre-test, pre and post tests of the control group scores. There have had not effects of the sex and ages of the children on the PPVT scores of experiment group's cognitive functions. **Conclusion:** EPA and DHA found in fish oil has a positive contribution on cognitive functioning in children. Regarding this issue, further studies need to be done on such topics as the optimal use of omega-3 fatty acids, the dose according to age, the type of fatty acid to be used and the duration of use.

Keywords Fish oil, Children, Peabody Picture Vocabulary Test (PPVT)

1. Introduction

Fish oils are sources of docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA) which are members of omega-3 fatty acids group (Guilliams; 2005: 21). DHA and EPA are long-chain omega-3 fatty acids and are essential nutrients which improve the quality of life due to many effects (Kidd; 2007: 207).

The study, which had been on puppies, showed the high-DHA group had significantly better results for reversal task learning, visual contrast discrimination, and early psychomotor performance than did the moderate-DHA and low-DHA groups (Zicker, Jewell, Yamka; 2012: 583). On the other hand epidemiological studies on humans, show that weekly consumption of fish abundant in omega-3 fatty

acids has a protective effect on cognition during aging (Nugent et.al.; 2011; 287).

In many studies, it has been shown that the use of EPA and DHA together in children, consequently reduces motor and developmental coordination disorders, improves reading and writing disorders and decreases learning difficulties (Richardson, Montgomery; 2005: 1363-1364; Richardson, Puri; 2002: 233; Stevens et.al.; 2003: 1007-1008).

The majority of studies showed that the use of omega-3 fatty acids have positive effects of neurodevelopmental functions. Intake of DHA during pregnancy helps prenatal and postnatal brain development of children. EPA intake is more effective on behavior and mood. Both DHA and EPA show their effects by producing neuroprotective metabolites. In many studies, a combination of DHA and EPA was shown to be useful in cases such as attention deficit/hyperactivity, autism, dyspraxia, dyslexia and aggression (Kidd; 2007: 208; McNamara, Carlson; 2006: 339; Bodnar, Wisner; 2005: 680-682; Amminger; 2007: 551).

* Corresponding author:

usayin@mku.edu.tr (Utku Sayin)

Published online at <http://journal.sapub.org/fph>

Copyright © 2015 Scientific & Academic Publishing. All Rights Reserved

The use of DHA / EPA has shown to be beneficial in the development of visual and sensory functions during perinatal period. In addition, it has also been reported by many researchers that the use of DHA / EPA has a positive contribution to the development of cognitive functions, improvement of behavior management and control of mood (Kidd; 2007: 208). In addition there was a clear benefit of omega-3 supplementation among patients with major depressive episode without comorbid anxiety disorders (Lespérance et.al.; 2011: 1054).

The aim of this study is to evaluate the effects of fish oil supplementation on cognitive process in children using the Peabody Picture Vocabulary Test (PPVT) and to compare the results with children not having fish oil supplementation.

2. Materials and Methods

In this study work group was established with purposeful sampling. PPVT was preferred as measurement tool due to it is not required verbal response and ease of application. The test included 100 cards each consisting of four images and a registration form. During the test, a word said to the child and he was asked to show the appropriate picture out of the four pictures on each card. Each correct answer was given 1 point. The sum of the scores consisted of the raw scores of the test. To find the raw score, the sequence number of the child's last known word was noted and the sum up of his mistakes was subtracted from that number. The obtained raw score was re-calculated according to the age of the child and according to the region the child was living and his receptive language age was removed. PPVT is a test that gives information about language, behavior and emotional disorders, as well as information about the cognitive level (Simons, Siderides, Protopapas, Mouzaki; 2011: 1). Budoff and colleagues showed that, test performance of the cognitive process of PPVT, is consistent with the Stanford-Binet (Budoff, Purseglove; 1963: 756).

Peabody Picture Vocabulary Test (PPVT), has been developed by Dunn and Dunn in 1959 and its aim is to determine the verbal skills of children between the ages of 2-12 years old (Dunn, Dunn; 1997). In 1972, the test was adapted into Turkish by Katz and colleagues. PPVT parallel form reliability ranged .64 with .84. Criterion validity of the correlation values of the test, has been determined to be between .82 and .86 with the Stanford-Binet Intelligence Test and between .41 and .74 with the Wechsler Intelligence Scale for Children (Girli, Atasoy; 2010: 994).

In their study on students of four levels (nursery, kindergarten, Grade 1 and 2 classes), Carjaval and colleagues (1992), used the Peabody Picture Vocabulary Test - Revised (PPVT-R) and the Wechsler Preschool and Primary Scale of Intelligence-Revised (WISC-R) and they found that there is statistically significant correlation between the two instruments administered (Carjaval, Parks, Logan, Page; 1992: 23).

3. Procedure

In this study, pre-test, post-test 2X2 split-plot experimental and control groups, quasi-experimental design was preferred. This study was started after confirmation of the ethics committee of Ankara Training and Research Hospital.

At the beginning of the research, experimental and control groups were evaluated with PPVT by our child development clinic (pre-test). After pre-test application, in the experimental group "for between 2-6 years old children as 5ml and 10ml for between 6-12 years old children" were given fish oil during 4 weeks. We used the "Seven Seas" named fish oil with cherry which was include 9.2 gr. pure fish oil, 828 mg EPA, 736 mg DHA, 4000 IU Vitamin A, 400 IU vitamin D and 10 IU vitamin E and 347 kJoul in 10 ml. This syrup is made by Abdi İbrahim Medicine Industry which is a Turkish company. This fish oil syrup was used on experimental group for 4 weeks while no intervention applied to control group in this period. After the application of fish oil supplements to experimental group was finished, both groups were waited for 4 weeks to do post-tests.

The research was done in the Republic of Turkey, Ministry of Health, Ankara Training and Research Hospital with 42 healthy children aged 2-12 years old who were volunteers and who wanted to use fish oil were enrolled. The control group included 20 healthy children similarly features with experimental group. The experimental group's age mean was 76,5±32,6 months and control group age mean was 77,4±29,8 months. The control group include 9 (45.0% of the control group) girls and 11 (55.0 % of the control group) boys while experimental group was comprised with 19 (45.2 % of the experiment group) girls and 23 (54.2 % of the experiment group) boys (Table 1).

4. Statistical Analysis

Data analysis was performed using SPSS for Windows 16.0 package program. Shapiro Wilk test was used to investigate whether the variables are closed to normal distribution of continuous variables. After descriptive analyses, Two-Factor Anova Test for Mixed Measuring was used to determine significant difference between groups, Mann-Whitney U Test and Pearson Correlation Coefficient were applied to detect effect of children's age and gender to PPVT scores of experimental group.

5. Results

In this study, experiment group's PPVT post-test scores have significantly increased according to pre-test of experiment group's score and control group's pre-test and post-test scores ($F=8.148$; $p=.006<0.05$). The mean of post-test of PPVT score of control group has been 87.05±28.0, while experiment group score has been

93.30±34.8. According to this table there is not significant difference between both groups PPVT scores in pre-test. These results have showed that fish oil supplement is beneficial for cognitive functions of children (Table 2).

The comparison of experiment group' pre and post tests PPVT scores according to gender of children; girls' and boys' PPVT post-test scores are more than pre-test scores. The mean of PPVT scores of girls' were increase from pre-test to post-test (respectively 77.82 and 83.64) also boys' post-test scores' mean more than pre-test scores (respectively 89.69 and 100.91) but this is not statistically significant increase. Between gender there is not any significant differences for PPVT scores in this table. According to these results gender

has no effects to these scores in %95 confidence interval (respectively p=.239; .100> 0.05) for both groups. But we can see that the post-test scores of both gender has increased with fish oil supplements also there is not any significant differences between gender (Table 3).

According to correlation analysis of the between difference of pre-test and post-test of experiment group's PPVT scores and ages of children, we have not determined any significant relation (r=.081; p=.620>0.05). Age of children has not been related factor for PPVT scores in group of fish oil supplement. We have thought that the fish oil prepares are benefit to all ages children who are older than 2 old years with this result (Table 4).

Table 1. Demographic characteristics of the experimental group and the control group

| Variables | Experimental group | | Control group | | Total | |
|---------------------|--------------------|----------|---------------|----------|-------------|----------|
| Gender | n | % | n | % | n | % |
| <i>Girls</i> | 19 | 45.2 | 9 | 45.0 | 28 | 45.16 |
| <i>Boys</i> | 23 | 54.8 | 11 | 55.0 | 34 | 54.84 |
| Total | 42 | 100.0 | 20 | 100.0 | 62 | 100.0 |
| <i>Age (months)</i> | 76.5±32.6 | | 77.4±29.8 | | 76.81±31.45 | |

Table 2. Comparison of the experiment and the control groups' pre-test, post-test PPVT scores with Two-Factor Anova Test for Mixed Measuring

| | Group | n | \bar{X} | S | Variance Source | Sum Σ | df | Sum \bar{X} | F | P |
|-----------|------------|----|-----------|-------|-----------------|--------------|----|---------------|--------|-------|
| Pre-test | Experiment | 42 | 84.54 | 32.6 | Group | 366.67 | 1 | 366.67 | -0.182 | 0.672 |
| | Control | 20 | 83.45 | 27.1 | Error | 121172.0 | 60 | 2019.5 | | |
| | Total | 62 | 84.19 | 30.7 | Between Group | 121538.7 | 61 | | | |
| Post-test | Experiment | 42 | 93.30 | 34.8 | Measure | 1035.21 | 1 | 1035.2 | 46.72 | .000 |
| | Control | 20 | 87.05 | 28.0 | Group* Measure | 180.50 | 1 | 180.5 | 8.148 | .006* |
| | Total | 62 | 91.29 | 32.7 | Error | 1329.21 | 60 | 22.153 | | |
| | | | | | In Group | 2544.92 | 62 | | | |
| | | | | Total | 124083.6 | 123 | | | | |

*<0.05

Table 3. Comparison of the experiment group pre-test and post-test of PPVT scores between gender with Mann Whitney U Test

| Test | Gender | n | \bar{X} | S | Rank \bar{X} | Rank Σ | P |
|-----------|--------|----|-----------|-------|----------------|---------------|------|
| Pre-test | Girl | 17 | 77.82 | 28.73 | 17.97 | 305.50 | .239 |
| | Boy | 23 | 89.69 | 32.98 | 22.37 | 514.50 | |
| Post-test | Girl | 17 | 83.64 | 31.94 | 16.97 | 288.50 | .100 |
| | Boy | 23 | 100.91 | 34.51 | 23.11 | 531.50 | |

*<0.05

Table 4. Comparison of experiment group's difference of pre-test and post-test of PPVT scores according to ages of children with Correlation Analysis

| Difference of PPVT Pre-Test and Post-Test | | | | | |
|---|----|-----------|------|----------------|------|
| | n | \bar{X} | r | r ² | P |
| Age | 40 | 8.920 | .081 | .6561 | .620 |

*<0.05

6. Discussion

In our study, PPVT was performed to investigate the effect of fish oil use on cognitive process. The end of the study, post-test of experiment group showed an increase according to the pre-test and pre-test and post-test of control group. However, the change between the first and the second measurements increase in the experiment group had no significant relation with ages of children. Gender of children had not effect to PPVT scores in fish oil supplemented group.

Similar to our study, a study done by Ryan et al after the use of 4-month-DHA the children were evaluated by the PPVT and a significant positive correlation was found (Ryan, Nelson; 2008: 360).

Language is an integral part of the cognitive processes and it is an important element of cognitive functions such as thinking, memory, comprehension, attention, orientation and perception. Many research studies emphasized that the child's understanding and knowing the spoken language, is important for him to comprehend the language of reading and writing in the following years (Yazıcı, Temel; 2011: 145,153). Mann and Liberman reported the relationship between language skills in elementary school and the reading success later and stated that this relationship may have a significant impact on academic achievement (Mann, Liberman; 1984: 595-596).

A research conducted on children with developmental coordination disorder showed that the supplementation of omega-3 and omega-6 during a period of 3 months did not affect motor skills, but reported to have a positive effect on reading, writing, behaviors associated with attention deficit and hyperactivity (Richardson, Montgomery; 2005: 1363-1364).

A small number of studies showed that the use of omega-3 fatty acids had no effect on cognitive functions. There are studies showing that the use omega-3 fatty acids have no beneficial effects on cognitive functions. Karr et.al performed a study with university students to investigate the benefits of the use of a 4-week omega-3 fatty acids on cognitive functions and the results showed that effects of omega-3 fatty acids was subtherapeutic (Karr, Grindstaff, Alexander; 2012: 236). In another study, the use of DHA in patients with attention deficit and hyperactivity symptoms during a period of 2 months did not show any improvement symptomatically (Hirayama, Hamazaki, Terasawa; 2004: 470). Moreover, a study was done on 90 healthy children for time period of 8 weeks during which they were given doses of 400 mg and 1000 mg of DHA; the results did not support any benefit of DHA on cognitive functions (Kennedy et.al; 2009: 52).

7. Conclusions

As a result of this study, EPA and DHA found in fish oil affect the cognitive process in childhood. Many studies have been made on this subject and in our study it has been

found that the use of fish oil had a positive contribution of cognitive process. On the other hand children's age and gender have not had any effects on the receptive language and cognitive functions depend on fish oil.

According to these results we think that the fish oil can be used for nutrition of children. Especially countries which have far the sea or clean water resources, fish oil supplements should use for children' nutrition to gain their cognitive development. Maybe the fish oil components should use in kindergarden and elementary schools in these countries. We have to not forget that fish oil or preparates as like fish oil are not the main food source. But our study has showed that fish oil is the very good supplements for children's cognitive functions.

On the other side the results about ages of children show us that the EFA and DHA supplements which is 10ml for daily dose can used children who are older than 2 years old. Maybe, researchers should design different studies to determine cognitive effects of fish oils for toddlers and babies.

We need longitudinal style studies to determine fish oil application protocol and prosedure in children' nutrition. Regarding this issue, further studies need to be done on such topics as the optimal use of omega-3 fatty acids, the dose according to age, the type of fatty acid to be used and the duration of use. Results of this study may help to do extended studies in future.

ACKNOWLEDGEMENTS

We wish to thank families of children who have been subject to this study, and thanks to our hospital's direction.

Abbreviations

PPVT: Peabody Picture Vocabulary Test;
EPA: Eicosapentaenoic Acid;
DHA: Docosahexaenoic Acid.

REFERENCES

- [1] Amminger GP, Berger GE, Schafer MR, Klier C, Friedrich MH, Feucht M. (2007) Omega-3 Fatty Acids Supplementation in Children With Autism: A Doubleblind Randomized, Placebo-Controlled Pilot Study, *Biol Psychiatry*, 61, 551-553.
- [2] Bodnar LM, Wisner KL. (2005) Nutrition And Depression: Implications For Improving Mental Health Among Childbearing-Aged Women, *Biol Psychiatry*, 58, 679-685.
- [3] Budoff M, Purseglove EM. (1963) Picture Vocabulary Test Performance of Institutionalized Mentally Retarded Adolescents, *American Journal of Mental Deficiency*, 67 (5), 756-760.
- [4] Carjaval HH, Parks JP, Logan RA, Page GL. (1992)

- Comparisons of The IQ And Vocabulary Scores on Wechsler Preschool And Primary Scale of Intelligence-Revised And Peabody Picture Vocabulary Test-Revised, *Psychology in the Schools*, 29, 22-24.
- [5] Dunn, L. M., & Dunn, L. M. (1997) *Examiner's Manual for the PPVT-III: Peabody Picture Vocabulary Test Third Edition*, Circle Pines, MN: American Guidance Service, USA
- [6] Girli A, Atasoy S. (2010) Otizm Tanılı Kaynaştırma Öğrencilerine Uygulanan Bilişsel Süreç Yaklaşımına Dayalı Sosyal Beceri Programının Etkililiğinin İncelenmesi, *İlköğretim Online*, 9, 990-1006, <http://ilkogretim-online.org.tr/vol9say3/v9s3m14.pdf>. (download date: 12.17.2013)
- [7] Hirayama S, Hamazaki T, Terasawa K. (2004) Effect of Docosahexaenoic Acid-Containing Food Administration on Symptoms of Attention-Deficit/Hyperactivity Disorder- A Placebo-Controlled Double-Blind Study, *Eur J Clin Nutr*, 58, 467-473.
- [8] Karr JE, Grindstaff TR, Alexander JE. (2012) Omega-3 Polyunsaturated Fatty Acids and Cognition in A College-Aged Population, *Exp Clin Psychopharmacol*, 20, 236-242.
- [9] Kennedy DO, Jackson PA, Elliott JM, Scholey AB, Robertson BC, Greer J, Tiplady B, Buchanan T, Haskell CF. (2009) Cognitive And Mood Effects of 8 Weeks' Supplementation With 400 mg or 1000 mg of The Omega-3 Essential Fatty Acid Docosahexaenoic Acid (DHA) In Healthy Children Aged 10-12 Years, *Nutr Neurosci*, 12, 48-56
- [10] Lespérance F, Frasere-Smith N, StAndré E, Turecki G, Lespérance P, Wisniewski SR. (2011) The Efficacy of Omega-3 Supplementation for Major Depression: A Randomized Controlled Trial, *The Journal of Clinical Psychiatry*, 72 (8), 1054-1062
- [11] Mann VA, Liberman IY. (1984) Phonological Awareness And Verbal Short Term Memory, *Journal of Learning Disabilities*, 17, 592-599.
- [12] Guilliams T. (2005) The Use of Fish Oil Supplements in Clinical Practice: A Review, *JANA*, 1, 21-34.
- [13] Kidd PM. (2007) Omega-3 DHA and EPA for Cognition, Behavior, and Mood: Clinical Findings and Structural-Functional Synergies With Cell Membrane Phospholipids, *Altern Med Rev*, 12, 207-227.
- [14] McNamara RK, Carlson SE. (2006) Role of Omega-3 Fatty Acids in Brain Development And Function: Potential Implications For The Pathogenesis And Prevention of Psychopathology, *PLEFA*, 75, 329-349.
- [15] Nugent S, Croteau E, Pifferi F, Fortier M, Tremblay S, Turcotte E, Cunnane SC. (2011) Brain and Systemic Glucose Metabolism in The Healthy Elderly Following Fish Oil Supplementation, *PLEFA*, 85 (5), 287-291
- [16] Richardson AJ, Montgomery P. (2005) The Oxford Durham study: A randomized, Controlled Trial of Dietary Supplementation With Fatty Acids in Children With Developmental Coordination Disorder, *Pediatrics*, 115, 1360-1366.
- [17] Richardson AJ, Puri BK. (2002) A Randomized Double-Blind, Placebo-Controlled Study of The Effects of Supplementation With Highly Unsaturated Fatty Acids on ADHD-Related Symptoms in Children With Specific Learning Difficulties, *Progress in Neuro-Psychopharmacology and Biological Psychiatry*, 26, 233-239.
- [18] Ryan AS, Nelson EB. (2008) Assessing The Effect Of Docosahexaenoic Acid on Cognitive Functions in Healthy, Preschool Children: A Randomized, Placebo-Controlled, Double-Blind Study, *Clin Pediatr (Phila)*, 47, 355-362.
- [19] Stevens LJ, Zhang W, Peck L, Kuczek T, Mahon A, Kuczek T, Grevstad N, Mahon A, Zentall SS, Arnold LE, Burgess JR. (2003) EFA Supplementation in Children With Inattention, Hyperactivity, And Other Disruptive Behaviours, *Lipids*, 38, 1007-1021.
- [20] Simons PG, Siderides GD, Protopapas A, Mouzaki A. (2011) Psychometric Evaluation of a Receptive Vocabulary Test for Greek Elementary Students, *Assessment for Effective Intervention*, 20 (10), 1-17
- [21] Yazıcı Z, Temel ZF. (2011) İki dilli ve Tek Dilli Çocuklarda Dil Gelişimi Okuma Olgunluğu İlişkisi, *Mehmet Akif Ersoy Üniversitesi Eğitim Fakültesi Dergisi*, 11, 145-158.
- [22] Zicker SC, Jewell DE, Yamka RM. (2012) Evaluation of Cognitive Learning, Memory, Psychomotor, Immunologic, and Retinal Functions in Healthy Puppies Fed Foods Fortified With Docosahexaenoic Acid-Rich Fish Oil From 8 to 52 Weeks of Age, *Journal of The American Veterinary Medical Association*, 241 (5), 583-594.