Rosas-Nexticapa, Marcela; Caballero-Rodríguez, Diana Alejandra; Herrera-Meza, Socorro; Acosta-Mesa, Héctor-Gabriel; Santiago-Roque, Isela; Figueroa-Valverde, Lauro; García-Cervera, Elodia; Pool-Gómez, Eduardo; Cervantes-Ortega, Catalina; Mateu-Armand, Virginia

SUPPLEMENTATION EFFECT OF OMEGA-3 FATTY ACIDS IN OVERWEIGHT AND OBESE MEXICAN SCHOOLCHILDREN


Asociación Interciencia
Caracas, Venezuela

Available in: http://www.redalyc.org/articulo.oa?id=33953313011
SUPPLEMENTATION EFFECT OF OMEGA-3 FATTY ACIDS IN OVERWEIGHT AND OBESE MEXICAN SCHOOLCHILDREN


SUMMARY

Overweight and obesity are considered global health problems. In Mexico, the prevalence of overweight and obesity among children is growing. Specifically, Veracruz is the Mexican state with the highest rates of childhood overweight and obesity. The present study focuses on evaluating the effect of omega-3 fatty acids (ω-3) supplements in overweight and obese schoolchildren living in Xalapapan, Veracruz, Mexico. A total of 121 children, aged 10-12 years, were recruited from five public elementary schools from Xalapa city. The schoolchildren were diagnosed as being overweight or obese and divided into four groups in order to be daily supplemented with 2 or 3 gummies (70 or 105mg of DHA) and 10 or 15g of salmon per day. Supplementation was carried out for three months. Anthropometric measurements (weight, height, BMI, waist-hip ratio) were taken, and serum parameters such as glucose, triglycerides, cholesterol, HDL, VLDL and LDL were determined. The results showed no significant differences in body weight, height, BMI, waist-hip ratio and fat percentage after supplementation. In glucose, percentage change in all supplementations demonstrated no statistical difference. Cardiovascular risk biomarkers decreased: serum CHO, LDL, VLDL, TG and AI, while serum HDL increased. Supplementation of ω-3 fatty acids in children had a beneficial effect on dyslipidemia and, thus, would reduce the expectation of developing cardiovascular diseases.

Introduction

Overweight and obesity are considered global health problems (García-Solís et al., 2016). According to the National Health and Nutrition Survey (ENSANUT, 2012), in Mexico the prevalence of overweight and obesity in schoolchildren (5-11 years) was 19.8 and 34.4%, respectively, of which 36.9% were boys and 34.4% respectively, of children (5-11 years) was 19.8% and 14.6% among children. Obesity is the main risk factor for developing cardiovascular disease, hypercholesterolemia, hypertriglyceridemia, insulin resistance and type 2 diabetes mellitus, as well as hypertension, arteriosclerosis and premature death from ischemic heart disease (Pajuelo et al. 2003; Durá-Travé and Sánchez-Valverde, 2005). Current sedentary lifestyles, nutritionally-deficient fast-food diets, obesity and genetic factors lead to high cholesterol and other risk factors which are related to heart diseases and affect the coronary arteries (Carretero et al. 2005; Valdés and Gómez, 2006). If these health problems are not treated, damage will continue into adult life. As a result of this situation, it is necessary to implement measures in order to improve the health of children in Mexico, not only by changing eating habits and promoting physical activity, but also through feeding supplementation to help decrease the effects caused by overweight and obesity among children. The consumption of polyunsaturated fatty acids plays an important role in human health (Portillo-Reyes et al. 2014). It is well established that omega-3 (ω-3) fatty acid supplementation improves blood lipid concentrations (Pirillo and Catapano, 2013; Escobar et al. 2013), decreases serum cholesterol, VLDL (very low density

KEYWORDS / Children / Obesity / Omega-3 / Overweight / Schoolchildren / Supplemented /

Received: 04/07/2016. Modified: 09/10/2017. Accepted: 10/11/2017.

Marcela Rosas-Nexticapa. Biologic Pharmaceutical Chemist, Universidad Veracruzana (UV), Mexico. M.Sc. and Doctor in Food Science, Veracruz Institute of Technology (ITVer), Mexico. Professor, UV, Mexico. Address: Facultad de Nutrición, UV. Médicos y Odontólogos s/n, Col. Unidad del Bosque, C.P. 91010 Xalapa, Veracruz, México. e-mail: mrosas@uv.mx

Diana Alejandro Caballero-Rodriguez. M.Sc. in Nutrition and Food Security, UV, Mexico.

Socorro Herrera-Meza. Nutritionist and M.Sc. in Food Science, UV, Mexico. Doctor in Food Science, ITVer, Mexico. Professor, UV, Mexico.

Héctor-Gabriel Acosta-Mesa. Computer Systems Engineer, ITVer, Mexico. M.Sc. in Artificial Intelligence, UV, Mexico. Doctor in Artificial Intelligence, University of Sheffield, UK. Research Professor, UV, Mexico.

Isela Santiago-Roque. Master in Clinical Pharmacy, Universidad de La Habana, Cuba. Lecturer, UV, Mexico.

Lauro Figueroa-Valverde. M.Sc. in Molecular Pharmacology, Instituto Politécnico Nacional, Mexico. Doctor in Biological Sciences, Universidad Autónoma Metropolitana, Mexico. Research Professor, Universidad Autónoma de Campeche (UACam), Mexico.

Elodia García-Cervera. M.Sc. in Food Science Technology, Universidad Autónoma de Yucatán (UADY), Mexico. Lecturer, UACam, Mexico.

Eduardo Pool-Gómez. M.Sc. in Biochemical Engineering, ITM, Instituto Tecnológico de Mérida, Mexico. Lecturer, UACam, Mexico.

Catalina Cervantes-Ortega. Nutritionist and Master in Health Systems Administration, UV, Mexico. Doctor in Government and Public Administration, Escuela Libre de Ciencias Políticas y Administración Pública de Oriente, Mexico. Lecturer, UV, Mexico.

Virginia Mateu-Armand. Nutritionist and Master in Clinical Research, UV, Mexico. Lecturer, UV, Mexico.

0378-1844/14/07/468-08 $ 3.00/0 OCTOBER 2017 • VOL. 42 Nº 10
Concerning body weight, a number of studies, both in animal and humans, have shown that ω-3 supplementation may not significantly reduce body weight (Buckley and Howe, 2010; Martínez-Victoria and Dólores-Yago, 2012; Du et al. 2015; Zhang et al. 2015). However, other authors have found a reduction in body weight if supplementation is combined with exercise and diet (Hill et al. 2007; Buckley and Howe, 2010; Noreen et al. 2010; López-Alarcon et al. 2011; Du et al. 2015; Simopoulos, 2016).

It has also been found that ω-3 offers certain protection from diabetes (Muley et al. 2014; Chen et al. 2015), hypertension (Arab-Tehrany et al. 2012), psoriasis (Rahman et al. 2013) and inflammation due to metabolic syndrome (Jalbert et al. 2013; Lee et al. 2013; Legrand-Poels et al. 2014), among other medical conditions.

Unfortunately, the consumption of seafood or ω-3 supplementation in Mexico is extremely low compared to other countries (Anuario, 2013). Some authors suggest that epidemic diseases related to obesity and metabolic syndrome in Mexico are due to the lack of these fatty acids in the diet of people (Chirput et al. 2001). Therefore, the purpose of this study was to evaluate the association between ω-3 fatty-acid supplementation in overweight and obese schoolchildren, and their anthropometric and serum lipids measurements, in one of the Mexican states where this problem is most severe.

Materials and Methods

Study design

A total of 121 schoolchildren aged between 10 and 12 years old were recruited from five public elementary schools in Xalapa, Veracruz, Mexico, with the support of the Edu-
Cultural Council of Veracruz. The children were diagnosed as being overweight or obese. The teachers, parents and schoolchildren were given an explanation of the experiment process, and written informed consent was received from the parents. The study was authorized by the Ethics Committee of Health Services of Veracruz (SEIC-001-16).

**Inclusion criteria:** Schoolchildren aged between 10 and 12 years old, diagnosed with overweight or obesity (Norma Oficial Mexicana, 1999). Data obtained from body mass index (BMI) was compared with the percentile tables for the Centers for Disease Control and Prevention (CDC, 2016), with the following parameters: normal weight (50-85 percentile), overweight (percentile 85-95) and obesity (>95 percentile). In the present study only schoolchildren diagnosed as obese and overweight participated.

**Exclusion criteria:** Schoolchildren with drug treatments, with a metabolic or any other disease previously diagnosed were excluded. Girls who had passed menarche and all children whose parents had not participated. Schoolchildren were randomly assigned based on weight and height (kg·m⁻²), and the result was compared to the percentile tables from the Centers for Disease Control and Prevention (CDC, 2016). Weight circumference was measured in the midline between the lower costal margin and the iliac crest, and waist:hip ratio (WHR) was calculated by dividing the waist by the hip measurements (Arjona-Villacaña et al. 2008).

**Anthropometric measurement:** Body mass index (BMI) was calculated by dividing the weight by height squared (kg·m⁻²), and the result was expressed as mean ±SE. DHA: docosahexaenoic acid, EPA: eicosapentaenoic acid, nd: not detected.

<table>
<thead>
<tr>
<th>Table I</th>
<th>FATTY ACID COMPOSITION OF DIET SUPPLEMENTED TO SCHOOLCHILDREN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatty acids</td>
<td>Gummies*</td>
</tr>
<tr>
<td>C12:0</td>
<td>18.96 ±0.03</td>
</tr>
<tr>
<td>C14:0</td>
<td>3.33 ±0.04</td>
</tr>
<tr>
<td>C16:0</td>
<td>40.18 ±0.02</td>
</tr>
<tr>
<td>C16:1</td>
<td>nd</td>
</tr>
<tr>
<td>C18:0</td>
<td>11.64 ±0.09</td>
</tr>
<tr>
<td>C18:1</td>
<td>5.67 ±0.08</td>
</tr>
<tr>
<td>C18:2</td>
<td>16.75 ±0.05</td>
</tr>
<tr>
<td>C20:0</td>
<td>nd</td>
</tr>
<tr>
<td>C24:0</td>
<td>nd</td>
</tr>
<tr>
<td>C20:5 (EPA)</td>
<td>2.05 ±0.02</td>
</tr>
<tr>
<td>C22:6 (DHA)</td>
<td>1.43 ±0.03</td>
</tr>
</tbody>
</table>

Percentage of total fatty acids. Values are expressed as mean ±SE. DHA: docosahexaenoic acid, EPA: eicosapentaenoic acid, nd: not detected.

**Analytical methods:** Serum glucose levels were measured using the glucose oxidase method (Lott and Turner, 1975). Serum triglyceride concentration was measured using a peroxide-coupled method for colorimetric determination (Bucolo and David, 1973). Serum cholesterol, VLDL and LDL were determined by enzymatic assay (Allain et al. 1974), and serum HDL was measured with a Tecos Diagnostics kit. Lipid profile results were compared using Kwi- terouch (1989).

**Statistical Analysis**

A Shapiro-Wilk normality test was carried out on each variable in order to verify if the data came from a normally-distributed population. During the statistical data exploration, it was observed that not all variables were normally distributed and, therefore, a non-parametric statistical significance test was applied (Moore and McCabe, 2009; Derrac et al. 2011). A paired Wilcoxon signed-rank difference test was developed in order to compare the samples from before and after supplementation. This is a non-parametric statistical hypothesis test used as an alternative to the paired t-test when the population cannot be assumed to be normally distributed as is the case in this study. Differences among the supplementation effects were tested using the Kruskal–Wallis analysis of variance followed by Tukey post-hoc tests for multiple mean comparison. Results are expressed as means ±standard error. Data was analyzed using MATLAB R2009a scientific software (the MathWorks™).

**Results**

A total of 121 children (65 girls and 56 boys) participated in the study. Of them, 97

<table>
<thead>
<tr>
<th>Table II</th>
<th>FREQUENCY OF OVERWEIGHT AND OBESITY AMONG GIRLS AND BOYS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnosis</td>
<td>Gender</td>
</tr>
<tr>
<td>Overweight</td>
<td>Girls</td>
</tr>
<tr>
<td>Obesity</td>
<td>50</td>
</tr>
<tr>
<td>Total</td>
<td>65</td>
</tr>
</tbody>
</table>

Figure 1. Dietary protocol. Schoolchildren were supplemented daily for a period of 3 months.
Values are reported as mean ± standard error. The statistical significance (p-value) was obtained using the nonparametric test of Wilcoxon. Different letters mean statistical difference between groups. B: before, A: after, BMI: body mass index, WHR: waist-hip ratio, F: fat, GLUC: serum glucose levels, CHO: serum cholesterol levels, HDL: serum high density lipoprotein levels, LDL: serum low density lipoprotein levels, VLDL: serum very low density lipoprotein levels, TG: serum triglyceride levels, AI: atherogenic index.

TABLE III
METABOLIC PARAMETERS EVALUATED IN CHILDREN BEFORE AND AFTER SUPPLEMENTATION WITH OMEGA-3

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Gummies (2)</th>
<th>Gummies (3)</th>
<th>Salmon (10g)</th>
<th>Salmon (15g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height (m)</td>
<td>55.98 ±2.04 a 56.56 ±1.90 a 0.57</td>
<td>50.03 ±1.44 a 50.59 ±1.41 a 0.85</td>
<td>51.68 ±1.71 a 52.27 ±1.45a 0.59</td>
<td>56.13 ±1.81 a 57.92 ±1.90 a 0.46</td>
</tr>
<tr>
<td>BMI (kg·m⁻²)</td>
<td>1.48 ±0.01 a 1.51 ±0.01 a 0.17</td>
<td>1.46 ±0.01 a 1.48 ±0.01 a 0.38</td>
<td>1.45 ±0.01 a 1.48 ±0.01 a 0.13</td>
<td>1.47 ±0.01 a 1.51 ±0.01 a 0.01</td>
</tr>
<tr>
<td>WHR (cm)</td>
<td>83.04 ±1.93 a 85.93 ±1.72 a 0.30</td>
<td>78.03 ±1.37 a 80.34 ±1.38 a 0.32</td>
<td>80.43 ±1.38 a 82.10 ±1.23 a 0.23</td>
<td>82.73 ±1.59 a 85.62 ±1.72 a 0.19</td>
</tr>
<tr>
<td>Body fat (%)</td>
<td>33.24 ±1.28 a 32.62 ±1.17 a 0.76</td>
<td>31.32 ±0.76 a 30.73 ±0.83 a 0.56</td>
<td>33.24 ±0.90 a 32.92 ±0.95 a 0.77</td>
<td>35.70 ±1.06 a 34.81 ±1.06 a 0.80</td>
</tr>
<tr>
<td>Gluc (mmol·l⁻¹)</td>
<td>4.53 ±0.12 a 5.17 ±0.16 b 0.00</td>
<td>4.55 ±0.09 a 5.04 ±0.09 b 0.00</td>
<td>4.93 ±0.25 a 5.20 ±0.11 b 0.02</td>
<td>4.65 ±0.11 a 5.15 ±0.12 b 0.00</td>
</tr>
<tr>
<td>CHO (mmol·l⁻¹)</td>
<td>4.31 ±0.18 a 3.55 ±0.13 b 0.00</td>
<td>4.09 ±0.14 a 3.50 ±0.12 b 0.00</td>
<td>4.37 ±0.19 a 3.52 ±0.15 b 0.00</td>
<td>4.46 ±0.15 a 3.35 ±0.09 b 0.00</td>
</tr>
<tr>
<td>HDL (mmol·l⁻¹)</td>
<td>0.94 ±0.05 a 1.34 ±0.06 b 0.00</td>
<td>0.95 ±0.05 a 1.40 ±0.06 b 0.00</td>
<td>0.87 ±0.04 a 1.37 ±0.06 b 0.00</td>
<td>0.89 ±0.05 a 1.40 ±0.05 b 0.00</td>
</tr>
<tr>
<td>LDL (mmol·l⁻¹)</td>
<td>2.71 ±0.17 a 1.71 ±0.11 b 0.00</td>
<td>3.00 ±0.16 a 1.55 ±0.10 a 0.00</td>
<td>2.62 ±0.17 a 1.62 ±0.12 b 0.00</td>
<td>2.70 ±0.14 a 1.46 ±0.09 b 0.00</td>
</tr>
<tr>
<td>VLDL (mmol·l⁻¹)</td>
<td>0.70 ±0.06 a 0.50 ±0.05 b 0.00</td>
<td>0.62 ±0.04 a 0.50 ±0.04 b 0.01</td>
<td>0.71 ±0.06 a 0.50 ±0.03 b 0.01</td>
<td>0.75 ±0.06 a 0.50 ±0.04 b 0.00</td>
</tr>
<tr>
<td>TG (mmol·l⁻¹)</td>
<td>1.50 ±0.12 a 1.04 ±0.09 b 0.00</td>
<td>1.40 ±0.09 a 1.08 ±0.08 b 0.01</td>
<td>1.60 ±0.13 a 1.10 ±0.07 b 0.00</td>
<td>1.70 ±0.14 a 1.11 ±0.09 b 0.00</td>
</tr>
<tr>
<td>AI</td>
<td>5.25 ±0.37 a 1.40 ±0.11 b 0.00</td>
<td>3.47 ±0.37 a 1.25 ±0.12 b 0.00</td>
<td>3.32 ±0.31 a 1.32 ±0.14 b 0.00</td>
<td>3.28 ±0.31 a 1.13 ±0.10 b 0.00</td>
</tr>
</tbody>
</table>

Values are reported as mean ± standard error. The statistical significance (p-value) was obtained using the nonparametric test of Wilcoxon. Different letters mean statistical difference between groups. B: before, A: after, BMI: body mass index, WHR: waist-hip ratio, F: fat, GLUC: serum glucose levels, CHO: serum cholesterol levels, HDL: serum high density lipoprotein levels, LDL: serum low density lipoprotein levels, VLDL: serum very low density lipoprotein levels, TG: serum triglyceride levels, AI: atherogenic index.

Children were overweight and 24 were obese (Table II). Statistical descriptors of metabolic parameters in children before and after supplementation with ω-3 fatty acids are shown in Table III. No significant differences in body weight, size, BMI, WHR and fat percentage (p>0.05) were observed.

A significant increase (p<0.05) was observed in all doses among both girls and boys when serum glucose was compared before and after supplementation. On the other hand, serum cholesterol, LDL, VLDL, TG and AI all showed significant decreases (p<0.05) before and after supplementation in all supplemented doses. In addition, a significant increase in serum HDL-cholesterol was found after supplementation with the four doses (p<0.00001) (Table III).

We analyzed the percentage of changes observed after supplementation for the different parameters evaluated in order to verify if there were significant differences after the consumption of the four supplements and the different doses (60 and 90mg of DHA in gummies and 10 or 15g of salmon). No significant differences were observed among supplementations and doses (p>0.05), as shown in Table IV.

In order to explore whether sex could be relevant to determine differences before and after supplementation, we verified if there were any significant differences in the metabolic parameters between girls and boys.
and boys after supplementation (Table V). Significant differences (p<0.05) were found when the children were supplemented with 90mg of DHA (3 gummies), specifically in serum HDL-cholesterol (girls 1.55 ±2.70 vs boys 1.23 ±3.45mmol l−1), serum HDL-cholesterol (girls 1.55 ±0.07 vs boys 1.29 ±0.09mmol l−1, p<0.05), serum VLDL (girls 0.3 ±0.02 vs boys 0.58 ±0.05mmol l−1, p<0.05), serum TG (girls 0.80 ±0.05 vs boys 1.30 ±0.11mmol l−1, p<0.05) and AI (girls 0.92 ±0.12 vs boys 1.49 ±0.16, p<0.05).

Discussion

It has been well established that ω-3 supplementation has potential health benefits, both in humans and in rats, in a number of diseases, including cardiovascular disorders, diabetes mellitus, some mental illnesses and inflammatory disorders, among others (Golub et al. 2011). The objective of the present study was to evaluate the effect of ω-3 fatty-acid supplementation through different doses of gummies and salmon, in overweight and obese schoolchildren.

Effects regarding ω-3 supplementation and reduction in body weight are controversial and the issue remains unclear. Some studies have suggested that ω-3 fatty acids consumption has no effect on reducing body weight in rats (Buckley and Howe, 2010) nor in humans (Martínez-Victoria and Dolores-Yago, 2012; Du et al. 2015; Zhang et al. 2015). On the other hand, other authors have found a relationship between supplementation with fish oil and reduction in fat mass and body weight in humans (Noreen et al. 2010), especially when combined with diet and exercise (Hill et al. 2007; Buckley and Howe, 2010; Noreen et al. 2010; Du et al. 2015; Simopoulos, 2016). In the present study no significant differences in body weight, height or BMI were found after supplementation among children at any of the doses applied (Table III). Some of these results are consistent with a study of Mexican obese children, 9-18 years old, supplemented with ω-3, where out of a total of 76 children, 16 lost weight and 27 children gained weight, while insulin resistance was decreased and changes in proinflammatory cytokines were observed (López-Alarcón et al. 2011).

Some studies show that fish oil can reduce waist-hip ratio (WHR) in humans (DeFina et al. 2010; Munro and Garg, 2013; Du et al. 2015). Nevertheless, in our study, no significant differences were observed in WHR in both girls and boys supplemented with any of the four different doses used (Table V).

In terms of serum glucose, no significant differences were observed among any of the groups. The percentage change in all supplementations demonstrated no statistical difference (Table IV). However, the effect of ω-3 fatty-acid supplementation on serum glucose is inconsistent. Some authors have found a protective and homeostatic association between ω-3 fatty-acid consumption and type 2 diabetes mellitus (Muley et al. 2014; Chen et al. 2015), while others observed no association whatsoever (Hartweg et al. 2009; Chen et al. 2015). Variations in results may relate to dosage and duration, ethnic population or trial design (Chen et al. 2015). It should be mentioned that the sugar supply provided by the gummies supplementation does not alter any metabolic parameter, since it does not exceed the recommended daily dose established in schoolchildren (10% of total caloric intake; WHO, 2015).

The effect of the consumption of ω-3 fatty acids on lowering serum cholesterol has been previously studied (Pirillo and Catapano, 2013). In our study, supplementation with ω-3 led to a significant decrease in total serum cholesterol. This reduction was observed with all doses used; however, children who consumed 90mg of DHA and 15g of salmon showed a greater decrease (-24.12 and -22.69%, respectively). Serum cholesterol was also found to decrease with 60mg of DHA (-15.81%) and 10g of salmon (-17.67%) (Table IV). Some authors have found that ω-3 fatty-acid supplementation produces an increase in LDL-cholesterol, and it has been suggested that the consumption of fatty acids has no therapeutic effect (Hockweg et al. 2009; Sperling and Nelson, 2015). In contrast, our results confirm a significant decrease in LDL cholesterol as a result of different supplementation doses (Figure 2). In addition, VLDL cholesterol was also decreased (60 and 90mg of DHA, -22.08 and -19.70%; 10g and 15g salmon, -21.34 and -29.96%, respectively). Similarly, some reports have suggested that ω-3 consumption lowers VLDL cholesterol in humans (Harris et al. 2008; Pirillo and Catapano, 2013).

In children, increased serum cholesterol, LDL and VLDL are related to the development of atherosclerotic and cardiovascular disease in adolescent and young adults (Lui et al. 2010; Delgadillo-Guerra and Romero-Hernández, 2013). Due to this, it is necessary to generate strategies to decrease cardiovascular risk factors and hyperlipidemia in children, so as to reduce the impact of this illness in adulthood (Delgadillo-Guerra and Romero-Hernández, 2013).

Figure 2. LDL distribution of each group before (B) and after (A) supplementation. Within each box, the central mark is the median, the edges of the box are the 25th and 75th percentiles, the whiskers extend to the most extreme data points not considered outliers, and outliers are plotted individually.

Figure 3. HDL distribution of each group before (B) and after (A) supplementation. Within each box, the central mark is the median, the edges of the box are the 25th and 75th percentiles, the whiskers extend to the most extreme data points not considered outliers, and outliers are plotted individually.
As expected, the children’s HDL-cholesterol serum levels showed no significant differences prior to the experiment; however, after the supplementation period, this parameter showed higher concentrations with 60 and 90mg of DHA (50.67 and 55.71%, respectively) and with 10 and 15g of salmon (65.57 and 71.28%, respectively) (Figure 3). Although this effect remains unclear, our results are consistent with other research that confirms that omega-3 fatty-acid supplementation can increase serum HDL-cholesterol (Ballesteros-Vázquez et al. 2012; Pirillo and Catapano, 2013; Singh et al. 2015).

Various authors have reported positive effects on triglyceride profiles as part of the ω-3 diet (Sauder et al. 2013; Chen et al. 2015; Leslie et al. 2015). According to our data, triglyceride levels were significantly diminished through supplementation with gummies (-25.82 and -19.38%, respectively) as well as with salmon (-24.52 and -29.32%, respectively) (Table V).

Atherosclerosis is a leading cause of death and disability. One of the indices that can help to predict cardiovascular risk is the atherogenic index (AI), which is related to plasma atherogenicity: people with high coronary risk exhibit an increase in AI (Singh et al. 2015). In our study, AI was significantly decreased at all dosage levels (Table IV), mostly in 15g of salmon (-56.43%). These results confirm that cardiovascular risk in schoolchildren decreased with omega-3 supplementation.

Conclusions

The supplementation of omega-3 fatty acids in overweight and obese children had beneficial effects on cardiovascular risk biomarkers and dyslipidemia. As such, supplemented doses may offer benefits for human health, such as the prevention of hyperlipidemia and a reduced risk of developing cardiovascular diseases. However, its impact on body weight, BMI and fat reduction in children requires further research.

ACKNOWLEDGMENTS

The first author acknowledges the financial support provided by the Mexican National Council for Education as part of PRODEP, for supporting the second year of the Thematic Networks Academic Collaboration UNACAM-CA-12 project. The second author acknowledges the financial support provided by CONACYT (scholarship number 6817).

REFERENCES


