

# Consumption and Purchasing Intent of Omega-3 Enriched Food Products by Lebanese Consumers

Running Title: Attitude of Lebanese Consumers towards Omega-3 Enriched Food

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**Abstract** In the modern nutrition patterns of many populations, consumers' intake of omega-3 oils does not reach the required levels. Eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) of the most potent omega-3 health benefits and commonly referred to as marine fatty acids, are not sufficiently consumed. This has led to numerous studies and attempts to produce foods enriched with omega-3 fatty acids. While applying fortification techniques, the most important challenge faced is to prevent the degradation of these fatty acids since both EPA and DHA are prone to oxidation. This study aims to predict the intention of Lebanese consumers towards the purchase of omega-3 enriched foods by applying the Theory of Planned Behavior Model. An online self-administered questionnaire was designed and conducted among Lebanese population. Results were collected throughout the month of August, 2021. Descriptive statistics, correlation and regression analyses were carried out using IBM SPSS Statistics 25. One hundred and eight (108) responses were received, 88% of which showed positive results on the intention of purchase of omega-3 enriched foods. Multiple linear regression analysis explained 30.4%

of the variance in intention ( $p < 0.001$ ), and attitude and behavioral beliefs were the significant determinants of intention. One limitation though is faced within the Lebanese consumers is their economic status; but in general, respondents show willingness to spend money and time to purchase such fortified food provided that promoters should emphasize on the multiple health benefits of such products.

**Keywords** Omega-3 Enriched Food, Behavioral Belief, Planned Behavior, Perceived Behavioral Control

## 1. Introduction

The polyunsaturated fatty acids omega-3 and omega-6 are essential nutrients which must be provided to the body from consumed food. They are designated as n-3 or n-6 referring to the double bond found on the 3<sup>rd</sup> or 6<sup>th</sup> carbon respectively, from the methyl end group [1]. While omega-6 fatty acids are generally pro-inflammatory, omega-3 fatty

acids possess anti-inflammatory properties [2]. Of the omega-3 fatty acids, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) have the most potent health benefits; they have been linked to decreased risk of cancer [3], reduced triglyceride [4] and blood pressure levels [5], promotion of heart [6,4], joint [7], and brain health, and to multiple benefits for infants during pregnancy [8]. EPA and DHA are commonly referred to as marine fatty acids as they are obtained from cold water fish such as Salmon and Herring [9].

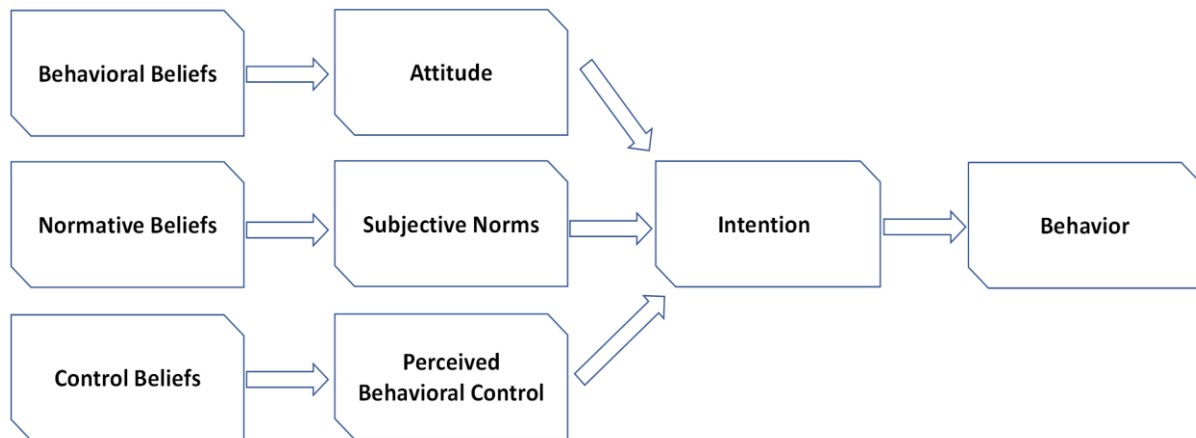
The current eating habits of many countries and the low intake of fish have made it challenging to obtain sufficient amounts of EPA and DHA. Thus, fortification of commonly consumed foods with omega-3 fatty acids has emerged as an innovative method to help consumers reach the required amounts that confer health benefits [10]. Dairy products are widely consumed and enjoyed by people of all ages, which makes them suitable delivery systems for an intended nutrient. Since milk and dairy products, which are unfortified, do not supply an adequate amount of n-3 PUFAs [11], there have been attempts to increase their content of n-3 PUFAs by either supplementation in ruminants feed or direct addition in dairy products, the latter being more efficient so far [12,13]. Milk and dairy products are thought to provide good delivery systems for n-3 fatty acids due to the nature of their consumption and storage. Ideal products for omega-3 fortification include those stored at low temperatures for a short period of time, and those stored in packages which prevent the passage of light and air [14]. These conditions suggest that dairy products serve as good candidates for omega-3 fatty acids fortification. Commercial dairy products that are fortified with omega-3 fatty acids, such as liquid milk and yogurt have already been developed [15].

On the other hand, fortification of foods with omega-3 fatty acids comes with some challenges. The main challenge in the addition of n-3 PUFAs to foods is ensuring that these fatty acids remain intact upon addition or fortification [15]. EPA and DHA are highly unsaturated lipids which makes them susceptible to oxidation, especially upon exposure to oxygen, which ultimately causes the oil to become rancid [15]. Oxidation of fish oil is linked to a fishy odor or taste, which is a reason why many consumers avoid including EPA and DHA in their diets [15]. Multiple methods are employed to control or reduce the oxidation of omega-3 fatty acids, such as deodorizing and refining the fish oil, the use of microencapsulation techniques, and the addition of antioxidants. In addition, proper packaging and storage of fortified food products could prevent or slow down the oxidation reactions [17]. It is noted here that studies assessing the oxidative stability of fish oil enriched yogurt

have found that yogurt had a much better oxidative stability than fish oil enriched milk [18]. Researchers observed that yogurt contained free amino acids and peptides which have been reported to have antioxidant properties. Moreover, the lower oxygen content of yogurt caused by the fermenting bacteria, compared to milk, was thought to be a contributing factor to the higher oxidative stability of fish oil enriched yogurt [18].

On another note, one of the most applied theories in human social and behavioral sciences is the Theory of Planned Behavior (TPB) [19]. The theory has received great attention in health sciences [19] and has been applied in nutrition-related behaviors such as in dairy intake [20] and in consumption of halal food [21], plant-based food alternatives [22], omega-3 [23] and vitamin enriched foods [24]. According to this theory, behavior of individuals is determined by their intention to perform this behavior. Intention itself, on the other hand, is affected by three factors: attitude towards the behavior, subjective norms (perceived social pressure), and perceived behavioral control (the degree to which people believe they can perform this behavior) [25]. Generally speaking, people's intention to perform a certain behavior is stronger when they have greater perceived control and their attitude and subjective norm are more favorable towards that behavior [19]. These three determinants (attitude, subjective norm and perceived behavioral control) in turn are formed, respectively, from three beliefs: (1) behavioral beliefs which are the individuals' subjective probability that performing the behavior will result in a certain outcome, (2) normative beliefs which are the beliefs that referent others such as a person's spouse or friend wants that individual to perform the behavior, and (3) control beliefs which are the beliefs about the presence of factors that may support or hamper the performance of the behavior [25]. Figure 1 is a schematic representation of the theory.

In the Lebanese population, very few studies have been conducted to investigate omega-3 intake. In a study conducted on Lebanese samples [26], fish consumption was found to be lower than the recommended Mediterranean diet intake. A second study revealed a high intake ratio of omega-6 to omega-3 fatty acids of 9:1, and revealed that EPA and DHA intake was significantly lower than the recommendation of 250 mg/day [27]. To date, no study has been conducted to investigate behavior of the Lebanese population in consumption of omega-3 enriched food products. The aim of this project is to determine the intention and behavior of Lebanese consumers towards purchase and consumption of omega-3 enriched food products, by applying the Theory of Planned Behavior model.



**Figure 1.** Theory of Planned Behavior Model (based on Ajzen, 2012)

## 2. Materials and Methods

### 2.1. Participants

Lebanese residents over 18 years of age were eligible to enter the study. A convenience sampling strategy was used to select the study sample. Individuals were sent the link to the electronic survey along with an invitation letter explaining the purpose of the study.

### 2.2. Questionnaire

An online questionnaire-based survey was conducted to evaluate people's knowledge and predict their intentions towards the consumption of omega-3 enriched foods. Survey questions were developed as informed in the study done by Patch et al. [23] employing the Theory of Planned Behavior. The questionnaire was reviewed to check for clarity and understandability. It was also tested for reliability before administration by introducing it to a group of 28 respondents who answered the questions twice, separated by a duration of 2 weeks. Adjustments were then made by deleting some of the questions and rephrasing others to achieve efficient and correct interpretation of questions.

The questionnaire was designed online and sent out to the public in both Arabic and English languages. It was divided into three main parts: (1) socio-demographics, (2) knowledge assessment and (3) purchase intention (TPB questions). In the first part, eight characteristics were included: age, gender, marital status, number of children, the highest level of education attained, work status, total monthly income, and physical activity. In the second part, six assessment questions were addressed: if the respondent has heard of omega-3 enrichment in food before, sources of omega-3 oils, difference in chemical nature between plant and animal sources, foods richest in omega-3 fatty acids, getting enough of omega-3 fats in daily diet, and

food category option preferred for enrichment in omega-3 oils. In the third part, 29 TPB model items were measured with a 5-point Likert scale ranging from +2 to -2. Table 1 shows the global questions, the scale used and one example of each belief item.

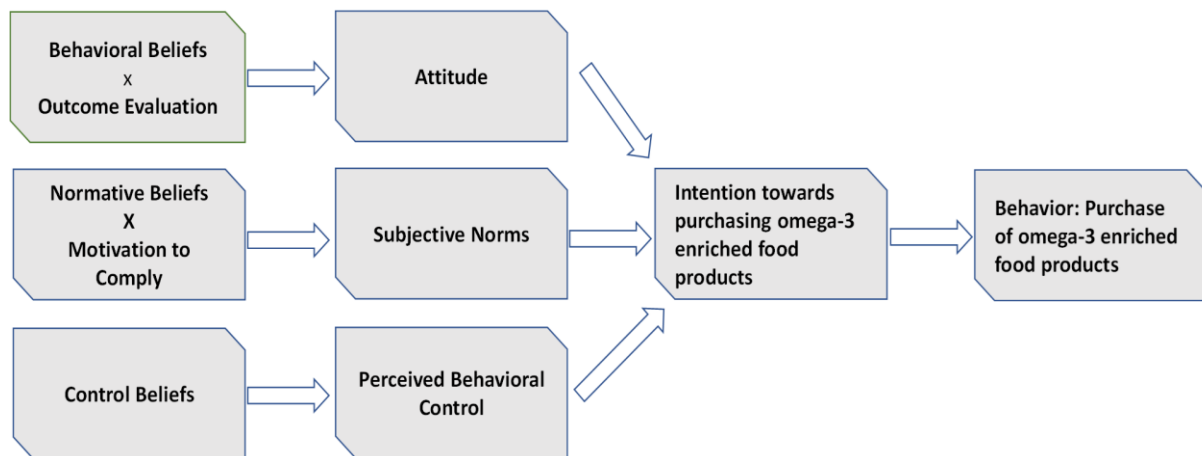
TPB model variables, as described earlier in Figure 1, include **Intention (I)** which is the dependent variable and direct antecedent of behavior, and **Attitude (A)**, **Subjective norms (SN)** and **Perceived behavioral control (PBC)** which are the independent variables. **I**, **A**, **SN** and **PBC** were all first measured with a global question. Beliefs related to each independent variable were then measured. As explained by Ajzen [20], in TPB model, behavioral beliefs are linked to outcomes which together produce a positive or negative attitude **A** towards the behavior. For each behavioral belief (**BB**), there was a corresponding **Outcome evaluation (OE)** statement. Five behavioral beliefs were assessed with the OE of each: lowering risk of cancer, improving cognitive function, having cardio protective effects, improving immunity and having a protective effect against COVID-19 disease.  $BB \times OE$  was computed (ranging from +4 to -4) for each belief, and then a mean was computed.

Similarly, for each normative belief (**NB**), there was a corresponding **Motivation to comply (MC)** statement which is combined together to produce an overall **SN** (social pressure). Five normative beliefs were chosen: family, friends, doctors, nutritionists and food industry.  $NB \times MC$  was also computed for each norm (ranging from +4 to -4), followed by computing the mean value.

As for **PBC**, 9 control beliefs (**CB**) were tested: availability in the supermarkets, control over purchase, time, taste, purchasing capacity, weight gain from use of product, economic status of the country and misleading nutritional labels. Result values for CB range from +2 to -2. Figure 2 shows a schematic representation of the model applied in this research.

**Table 1.** TPB variables and corresponding questions and scale used in the survey

TPB variable		Question/statement	Scale
Intention (I)		I intend to eat one or more foods with added omega-3 if available.	-Strongly agree -Agree -Neutral -Disagree -Strongly disagree
Attitude (A)	Global question	Overall, my attitude toward me eating foods with added omega-3 oils is	-Extremely favorable -Favorable -Neutral -Unfavorable -Extremely unfavorable
	Behavioral Beliefs (BB)	-How important is it to you that consuming omega-3 oils could lower the risk of several types of cancer?	-Extremely important -Important -Neutral -Unimportant -Extremely unimportant
	Outcome Evaluations (OE)	-I will purchase foods enriched with omega-3 oils because they could lower the risks of several types of cancer.	-Strongly agree -Agree -Neutral -Disagree -Strongly disagree
Subjective Norms (SN)	Global question	Most people in my life, whom I value their opinion, think I should eat foods enriched with omega-3 oils.	-Strongly agree -Agree -Neutral -Disagree -Strongly disagree
	Normative beliefs (NB)	-Most members of my family think I should eat foods enriched with omega-3 oils.	-Strongly agree -Agree -Neutral -Disagree -Strongly disagree
	Motivation to comply (MC)	-Generally speaking, I want to do what my family thinks I should do.	-Strongly agree -Agree -Neutral -Disagree -Strongly disagree
Perceived Behavioral control (PBC)	Global question	How much control do you have over whether you eat or do not eat foods with added omega-3 oils?	-Complete control -Partial control -Neutral -Little control -No control
	Control beliefs (CB)	-I have the purchasing capacity to buy food products enriched with omega-3 oils.	-Strongly agree -Agree -Neutral -Disagree -Strongly disagree



**Figure 2.** Graphical representation of TPB model applied in this research.

### 2.3. Data Analysis

Reliability testing of TPB variables was done by calculating Cohen's weighted kappa; questions which gave kappa < 0.4 were deleted. Descriptive statistics, based on percentages and means, were used in the analysis of socio-demographic characteristics. For correlations between TPB variables, and between sociodemographic variables and TPB variables, Spearman's correlation tests were applied. To predict the intention to purchase omega-3 enriched food products, multiple regression analysis was used. As TPB suggests, a stronger intention to perform the behavior results from more positive attitudes towards that behavior, stronger subjective norms and greater perceived behavioral control. To test the interaction of beliefs with intention, two steps in multiple regression were applied: in step 1, global measures of attitude, subjective norm and perceived behavioral control were entered into the model. In step2, behavioral beliefs (BB×OE), normative beliefs (NB×MC) and control beliefs were added into the model. All analyses were done using IBM SPSS Statistics 25.

## 3. Results

### 3.1. Socio-demographics

Socio-demographic analysis results are shown in Table 2. One hundred and eight (108) responses were received. Almost two-thirds of the respondents were in the age range of 22 to 40 (65.7%), 22.2% were above 40 and 12% were in the age range 18 to 21. More females (75.9%) than males (24.1%) responded and the mean body mass index (BMI) was 26.06 ( $\pm 5.2$ ) kg/m<sup>2</sup>. Almost half of the participants were married (52.8%), had one or more child (48.1%) and were employed (52.8%). The highest level of education attained was 33.3% with a Bachelor's degree, 27.8% with a Master's degree, 10.2% with a high school degree, 13% with vocational degrees and 14.8% with less than high school education. Most of the participants earned in the ranges of 1,000,000 L.L to 2,999,000 L.L (38%) and 500,000 L.L to 999,000 L.L (35.1%), and described their physical activity status as slightly/occasionally active (41.7%) and active (38.9%).

### 3.2. Knowledge Assessment

More respondents were familiar with the idea of food supplementation with omega-3 fats (57.4%) than those not familiar with it (42.6%). In addition, more respondents chose animal food sources (48.1%) over plant sources (17.6%) as the best source of omega-3 oils, and were aware of the difference in chemical nature of the oil between the two sources (50%), while 42.6% chose "I do not know" as an answer. "Fish and seafood" and nuts and seeds ranked the highest as foods richest in omega-3 oils and dairy products ranked the lowest. Fifty-nine percent of

respondents (59.3%) believed they were not getting enough omega-3 oils with their regular diets, eight percent (8.3%) believed they were getting enough, while thirty-two percent (32.4%) chose "I do not know as an answer". Meats were the top choice for foods to be enriched with omega-3 oils (31.5%), dairy products ranked second (25.9%) and bakery products the third (24.1%).

**Table 2.** Socio-demographic characteristics and lifestyle determinants [percentage (frequency); N=108].

Variables	Categories	% (n)
Gender	Females	75.9 (82)
	Males	24.1 (24)
Age	18-21	12 (13)
	22-30	42.6 (46)
	31-40	23.1 (25)
	41-50	12 (13)
	Above 50	10.2 (11)
Highest level of education attained	Less than high school	14.8 (16)
	High school	10.2 (11)
	License /LT /TS	13 (14)
	Bachelors	33.3 (36)
	Masters	27.8 (30)
	PhD	0.9 (1)
Marital status	Single	41.7 (45)
	Married	52.8 (57)
	Separated	5.6 (6)
Number of children	No children	51.9 (56)
	One or more child	48.1 (52)
Total monthly income	Less than 500000 L.L	13.9 (15)
	500000 L.L to 999000 L.L	31.5 (34)
	1000000 L.L to 2999000 L.L	38 (41)
	3000000 L.L to 5000000 L.L	7.4 (8)
	More than 5000000 L.L	9.3 (10)
Work status	Employed	52.8 (57)
	Unemployed	46.3 (50)
	Retired	0.9 (1)
Lifestyle and physical activity	Totally inactive	3.7 (4)
	Inactive	14.8 (16)
	Slightly/occasionally active	41.7 (45)
	Active	38.9 (42)
	Athletic	0.9 (1)

### 3.3. Descriptive Analysis of TPB Variables

Respondents to the intention to purchase omega-3 enriched foods showed overall positive results, where 88% of respondents reported agreeing and strongly agreeing to the intention to purchase, and 12% reported "neutral". The

mean values of TPB variable score results are given in Table 3. Attitude scores derived from the combination (multiplicative value) of Behavioral Beliefs and Outcome Evaluations (BB×OE) showed the highest scores for brain health, immunity and cardiac health (2.46, 2.17 and 2.06 respectively). The mean scores for consumption of omega-3 enriched foods Subjective Norms were higher for nutritionists, doctors and family (1.03, 0.96 and 0.53 respectively) than food industry and friends (0.38 and 0.34 respectively). Although family and nutritionists scored equally (0.72) in Normative Beliefs, participants showed higher Motivation to Comply with nutritionists (0.86) than family (0.19); Motivation to Comply with food industry and friends showed negative results. For Control Beliefs, the factor which resulted in the highest score was the economic status of the country (1.26). Time and purchasing capacity were the only factors that showed negative results in Control Beliefs (-0.17 and -0.07 respectively).

### 3.4. Correlations and Regression Analyses of TPB Variables

Spearman's correlation between TPB variables and the

demographic variables age, employment, income and education were calculated. Only the TPB variable Subjective Norm showed a significant negative correlation with age ( $r=-0.19$ ;  $p=0.05$ ) and with the highest level of education ( $r=-0.35$ ;  $p=0.01$ ); remaining variables of TPB and demographics did not show a relationship.

On the other hand, Attitude ( $r=0.49$ ;  $p=0.01$ ) and Perceived Behavioral Control ( $r=0.19$ ;  $p=0.05$ ) were significantly correlated to Intention. In addition, each set of beliefs (mean multiplicative value) was correlated with its corresponding global measures: Attitude and BB×OE were significantly correlated ( $r=0.46$ ;  $p=0.01$ ), and so were Subjective Norms with NB×MC ( $r=0.26$ ;  $p=0.01$ ) and Perceived Behavioral Control with CB ( $r=0.28$ ;  $p=0.01$ ).

In regression analysis (Table 4), only Attitude among TPB independent variables showed a significant positive association with intention to purchase omega-3 enriched foods. The regression model in step 1 explained 21.5% ( $p<0.001$ ) of the variance of intention in purchase of omega-3 enriched food products. In step 2, the model explained a higher percentage of variance of intentions (30.4%;  $p<0.001$ ).

**Table 3.** Mean scores for belief items related to consumption of omega-3 enriched foods [Mean (Standard deviation); N=108].

Variable	Mean (SD)		
	Behavioral beliefs (BB)*	Outcome evaluations (OE)*	BB×OE**
Lowering the risk of cancer	1.31 (0.75)	1.18 (0.72)	1.81 (1.63)
Improving brain health and cognitive function	1.53 (0.69)	1.43 (0.66)	2.46 (1.60)
Having cardio protective effects	1.42 (0.73)	1.25 (0.69)	2.06 (1.60)
Improving immunity against diseases	1.39 (0.80)	1.33 (0.67)	2.17 (1.56)
Protective effect against COVID-19 disease	1.01 (1.00)	1.03 (0.90)	1.56 (1.68)
	Normative beliefs (NB)*	Motivation to comply (MC)*	NB×MC**
Family	0.72 (0.82)	0.19 (1.23)	0.53 (1.43)
Friends	0.57 (0.85)	-0.17 (1.14)	0.34 (1.33)
Doctor	0.74 (0.79)	0.97 (0.75)	0.96 (1.28)
Nutritionist	0.72 (0.74)	0.86 (0.78)	1.03 (1.40)
Food industry	0.59 (0.89)	-0.07 (1.06)	0.38 (1.24)
	Control beliefs (CB)*		
Availability in the supermarkets	0.22 (1.06)		
Control over purchase	0.30 (1.10)		
Taste	0.59 (0.90)		
Gaining weight	0.69 (1.08)		
Price	0.54 (1.14)		
Purchasing capacity	-0.07 (1.13)		
Current economic status of Lebanon (August, 2021)	1.26 (1.00)		
Time	-0.17 (1.27)		
Misleading nutritional labeling	0.24 (1.05)		

\*Items scored between +2 to -2; \*\*Items scored between +4 to -4

**Table 4.** Linear regression of intentions onto TPB components

Variable	B	SE	Beta	Significance
<b>Step 1</b>				
Attitude	0.42	0.08	0.47	0.000
Subjective Norm	0.00	0.06	-0.01	0.96
Perceived Behavioral Control	0.04	0.05	0.07	0.404
<b>Step 2</b>				
Attitude	0.29	0.08	0.33	0.000
Subjective Norm	-0.11	0.06	-0.16	0.091
Perceived Behavioral Control	0.00	0.05	0.01	0.951
Mean of behavioral beliefs (BS x OE)	0.15	0.04	0.35	0.000
Mean of normative beliefs (NB x MC)	0.03	0.06	0.04	0.654
Mean of control beliefs (CB)	0.12	0.11	0.10	0.302

B: regression coefficient; SE: standard error; Step 1: adjusted R<sup>2</sup>=0.215 (p<0.001); Step 2: adjusted R<sup>2</sup>=0.304 (p<0.001)

## 4. Discussion and Conclusions

The results of this study show that although Attitude and Perceived Behavioral Control have a significant correlation with the intention to purchase omega-3 enriched foods, Attitude is the most significant factor in predicting this intention. This is similar to the results of the study done by [23] and [21] investigating attitudes and intentions toward purchasing novel foods enriched with omega-3 fatty acids and towards purchasing intention of halal food respectively. However, in this study, behavioral beliefs contributed to the explanation of the variance in intention, raising the level from 21.5% to 30%. This implies that belief variables of Attitude could have an unmediated effect on the intention to buy omega-3 enriched foods. The results of the regression analyses in this study are comparable to the study investigating halal food purchasing behavior in Malaysia by Shah [28] which has reported R<sup>2</sup>= 29%.

According to the results obtained from this study, attitudes towards purchasing omega-3 enriched foods were all positive and significant predictors to consume these foods. The beliefs of improving health by supporting brain health and cognitive function, improving immunity against diseases and having cardio protective effects showed the

most positive attitudes. This shows that promoters should emphasize the health benefits obtained from consumption of omega-3 enriched foods. This is supported by the findings that respondents did not perceive purchasing capacity and time to look for and obtain the product as barriers to purchasing omega-3 enriched foods (indicated by the negative results), suggesting they are willing to spend the money and time needed in order to purchase these foods, provided that they meet the expected goal of use. The only factor which showed a relatively high result as a control factor was the current economic status of Lebanon (August, 2021), which is time specific. Subjective Norms, on the other hand, did not show significant influence on the intention to buy omega-3 enriched foods.

The findings of this study also indicate that consumers should be more informed on the concept of food enrichment with omega-3 fatty acids, as 43% were unfamiliar with the production of such products and have no knowledge of the difference in the chemical nature of plant and animal sources and thus the benefits of one over the other. Respondents showed acceptable level of knowledge of the natural food sources of omega-3 oils, but almost 60% thought they weren't getting enough omega-3 oils in their diets. This could represent a supporting factor for consumers to purchase omega-3 enriched food products, especially in the food categories of meat, dairy and bakery products which were preferable with respect to respondents. It should be noted here that promotion of healthy eating habits could be advantageous in early years of life in primary and middle school years where nutritional education and counseling programs can be an effective approach to encourage healthy eating choices and behaviors [29,30]. Thus, promotion of consumption of omega-3 enriched foods should not be overlooked in this age group.

Our findings are limited in that they are based on a small sample size which does not allow us to generalize our results to all the Lebanese population. Nevertheless, this is the first study in Lebanon, to our knowledge, that explores the attitudes towards the purchase of omega-3 enriched foods; thus the study results provide insights on a relatively new topic. Further research on this topic, involving more elaborate questionnaires and larger sample sizes targeting individuals from all of the Lebanese provinces is recommended. Moreover, based on the results, researchers can likely develop omega-3 enriched Labneh, a traditional Lebanese food, which shows to be a suitable delivery system for omega-3 fatty acids.

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## Declaration of Interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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