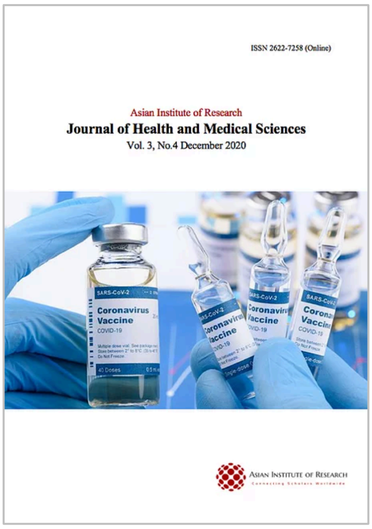

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Effect of Egg Consumption on Serum Protein Levels of Some Secondary School Students in Ibadan, Nigeria

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Abstract
Background: Eggs are sources of protein, fats and micronutrients that play an important role in basic nutrition. Objectives: This study was designed to assess the effect of egg consumption on serum protein levels of some secondary school students of two local Government areas in Ibadan. Method: This study involved 154 students selected using random selection sampling method, aged between 13 and 23 years. Teachers were exempted from the study. Protein Level was measured using standard methods in all the subjects at baseline and two weekly for eight weeks. Test group of subjects were given one boiled averaged sized egg to eat daily and the control group was given 100mls of water to drink daily for one month. All measurements were recorded in the recording book. Data was analyzed using descriptive statistic. Results &Interpretations: The ages 16 to 19 years constituted the highest age group. There were 49(63.64%) male subject and 50(64.4%) female. The mean BMI of test group± was 23.06kg/m^2±0.32 and 23.15kg/m^2±0.33for control. Moreover, in the male test group there was progressive significant increase in mean TP from baseline with 6.94g/dl±0.08 to 7.57g/dl±0.07 at 8 weeks of study period ($p<0.05$). The mean Albumin increased progressively and significantly from 4.01g/dl±0.03 to 5.29g/dl+0.04 after 8 weeks of study period ($p<0.05$). Conclusions: There is increase in total Protein and Albumin levels in the subjects who ingested egg and the increase is higher in females than males. Egg consumption improved Protein level.

Keywords: Egg, Total Protein, Albumin, Water

INTRODUCTION

Eggs are sources of protein, fats and micronutrients that play an important role in basic nutrition. However, eggs are traditionally associated with adverse factors in human health, mainly due to their cholesterol content. Nowadays, however, it is known that the response of cholesterol in human serum levels to dietary cholesterol consumption depends on several factors, such as ethnicity, genetic makeup, hormonal factors and the nutritional status of the consumer.

There is also scientific evidence that eggs contain other biologically active compounds that may have a role in the therapy and prevention of chronic and infectious diseases. The presence of compounds with antimicrobial, immunomodulator, antioxidant, anti-cancer or anti-hypertensive properties have been reported in eggs

(Abeyrathne et al, 2013). Lysozyme, ovomucoid, ovoinhibitor and cystatin are biologically active proteins in egg albumen, and their activity prolongs the shelf life of table egg (Rokonjac et al, 2014). Some of these protective substances are isolated and produced on an industrial scale as lysozymes and avidin. Additionally, eggs are an important source of lecithin and are one of the few food sources that contain high concentrations of choline (Herron and Fernandez, 2004, Zeisel et al, 2003). Lecithin, as a polyunsaturated phosphatidylcholine, is a functional and structural component of all biological membranes, which acts in the rate-limiting step of the activation of membrane enzymes such as superoxide dismutase. It has been suggested that ineffective activation of these antioxidant enzymes would lead to increased damage of membranes by reactive oxygen species. In addition, lecithin increases the secretion of bile, preventing stagnation in the bladder and, consequently, decreases the lithogenicity (Herron and Fernandez, 2004).

However, as a component of egg lecithin, choline has numerous important physiologic functions, which include the synthesis of phospholipids, the metabolism of methyl and cholinergic neurotransmission, and it is a required nutrient that is essential for the normal development of the brain (Jung et al, 2012).

Another important nutritional component from eggs is phosvitin, a phosphoglycoprotein present in egg yolk and represents about 7% of yolk proteins. It has a specific amino-acid composition, comprised of 50% serine, and 90% of which are phosphorylated. This specific structure makes phosvitin a strong metal chelator and, by this mechanism, it acts as an important melanogenesis inhibitor to control excessive melanin synthesis in the melanocytes of animal and human skin (Jung et al, 2012). It was suggested that egg-yolk phosvitin has the potential to be used as a natural bioactive compound as a hyper-pigmentation inhibitor for human skin (Jung et al, 2012).

Other interesting egg components from the nutritional point of view are the carotenoids. Carotenoids are natural pigments in hen egg yolks that confer its yellow color, which can range from very pale yellow to dark brilliant orange. Egg carotenoids represent less than 1% of yolk lipids, and are mainly composed of carotene and xanthophylls (lutein, cryptoxanthin and zeaxanthin) (Kassis et al, 2010, Skrivan and Englamaierova, 2014, Rakonjac et al, 2014).
The total concentration of lutein and zeaxanthin is 10 times greater than of cryptoxanthin and carotene, combined, (Rakonjac et al, 2014) and are not endogenously synthesized by the human body and tissue levels therefore depend on dietary intake. These natural compounds found in the bodies of animals, and in dietary animal products, are ultimately derived from plant sources in the diet, mainly from dark green leafy plants (Kelly et al, 2014). Lutein and zeaxanthin content of eggs depends on different factors, such as the feed given to laying hens, or the husbandry system. Thus, variable contents of these carotenoids in non-enriched eggs were recently reported, varying about 167–216 μg/yolk for lutein and about 85–185 μg/yolk for zeaxanthin (Skrivan and Englamaierova, 2014, Kelly et al, 2014). Additionally, a greater serum response to lutein was reported following the consumption of eggs compared with the consumption of dietary lutein supplements or vegetables (Skrivan and Englamaierova, 2014, Kelly et al, 2014). This could be related with the fact that carotenoids depend on a lipophilic environment for optimal gastrointestinal uptake (Kelly et al, 2014). Consequently, eggs are a very important food source of these carotenoids, especially in the case of people that consume low amounts of vegetables with a high content of these substances (as occurs in western developed countries).

These carotenoids are, perhaps, best known for their function in the neural retina, where they are found in high concentration and, along with their isomer mesozaexanthin, are termed macular pigment (Bovier et al, 2014). Lutein and zeaxanthin are known to serve light-absorbing and blue-filtering optical functions, as well as antioxidant and anti-inflammatory functions, and thereby, is considered to play a role reducing immune-mediated macular degeneration and age-related cataract formation (Rakonjac et al, 2014, Kelly et al, 2014 Bovier et al, 2014).

There is little of knowledge on egg consumption with relationship to protein levels and gender difference in this environment. Many previous studies obtained from literature search are from the Western world and none were from this region. Our eating habits and culture differ from the western world, coupled with the variant degree of malnutrition we observe in Ibadan.

The aim of this study is to determine the effect of egg consumption on serum Total Protein measurements among secondary school students and gender differences if any. This will serve as a basis for advice against the development of protein energy malnutrition in the nearest future.

MATERIALS AND METHODS

This study involved cross-sectional selection of 154 secondary students living in Ibadan, an urban city in Oyo state, South-West, Nigeria, aged between 12 and 23 years. They were from four secondary schools in Ibadan North and South Local Government areas. Teachers in the schools were exempted from this study because they were not part of the study groups.

The weight of subjects were recorded in kilograms (to the nearest 1.0 kg) without them wearing any heavy clothing like a coat, jacket, shoes or agbada, using a calibrated bathroom scale (Soehnle Waagen GmbH and Co. KG,D 71540 Murrhardt/Germany) positioned on a firm horizontal surface.

Height in meters of subjects were measured (to the nearest 0.1m) using a stadiometer. Subjects stood erect, without shoes and headgears, on a flat surface with the heels and occiput in contact with the stadiometer(Prestige HM0016D) (India) and to the nearest 0.1 meter.

The body mass index (B.M.I) was subsequently calculated using the formula: weigh (kg)/ height^2 (metres^2).
There were two groups of students (control and test group). Each test subject was given one average sized egg daily for 30 days. The control group was given one cup of water (100ml) daily for 30 days. 5mls of blood was taken from each subject into a plain bottle after an overnight fasting. Estimation of serum protein levels were done in each of the subject as described below:

Total Protein was estimated according to the method described by Bradford (1976)

Principle: 100 mg Coomassie Brilliant Blue G-250 was dissolved in 50 mL 95% ethanol (C_2H_5OH). Thereafter, 100 mL of 85% phosphoric acid (H_3PO_4) was carefully added under stirring, before H_2O was added to a total volume of 1 L. The solution was filtered and kept at 4 °C. For the measurements, 100 µL extract and 5 mL Bradford solution were mixed and incubated for 5 min and absorbance was read at 595 nm (Siro et al, 2008).

Serum Albumin was estimated by Dye- binding Method.

Principle: Albumin at pH 4.2 sufficiently cationic to bind the anionic dye bromcresol green (BCG) to form a blue-green colored complex. At pH 4.2 Albumin + BCG BCG complex. The intensity of the blue-green color is directly proportional to albumin concentration in the specimen. It was determined by measuring the increase in absorbance at 620 - 630 nm.

Ethical Approval and Informed Consent

Ethical clearance for the study was obtained from the Health Research Ethics Committee (HREC) University College Hospital (UCH), Ibadan. All participants (154) of this study signed an informed consent form, in accordance to the committee regulations, before answering the questionnaire and taking their anthropometric measurements. Data was recorded on a proforma.

Statistical analysis: The data obtained was analyzed using the computer statistical programme package SPSS version 25.0. Student t test was used to compare variability between male and female. Probability value of **P** less than 0.05 was considered statistically significant.

Results:

The study involved 154 students randomly selected with their age group between 13 and 23 years. There were 77 students in each of the control and test groups. The age group 16 to 19 years constituted the highest age group. There were 49(63.64%) male subjects and 50(64.4%) female in this age group (table1). The mean BMI of test group was 23.06kg/m2±0.32 and for the control group was 23.15kg/m2±0.33 (tables 1 and 2).

Moreover, in the male test group there was progressive significant increase in mean TP at baseline with 6.94g/dl±0.08 to 7.57g/dl±0.07 at 8 weeks of study period ($p<0.05$). The mean Albumin increased progressively and significantly from 4.01g/dl±0.03 to 5.29g/dl+0.04 after 8 weeks of study period ($p<0.05$) while in the female test group there was progressive and significant increase in mean TP at baseline with 7.08g/dl±0.09 to 7.59g/dl±0.07 at 8 weeks of study period ($p<0.05$). The mean Albumin increased progressively and significantly from 4.04g/dl±0.04 to 5.32g/dl±0.06 after 8 weeks of study period ($p<0.05$). (tables 3).

It was also observed in the control male group that there was negligible increase of TP from baseline with 7.04g/dl±0.07 to 7.11g/dl±0.05 at 8 weeks of egg study period. The mean Albumin was nearly the same value at 4.02g/dl±0.04 and 4.01g/dl±0.03 after 8 weeks of study period while in the female control group. There was no increase in mean TP at baseline with 7.00g/dl0.07 to 7.07g/dl±0.04 at 8 weeks of study period. The mean Albumin is the same value at baseline 4.03g/dl±0.04 and 4.03g/dl±0.14 after 8 weeks of the study period (table 4).

Table1: Showing demographic characteristics of the participants.

Variable	Total (n=154)	Test (n=77)	Control (n=77)
Age			
12-15 years	34 (22.1)	18 (23.4)	16 (20.8)
16-19 years	99 (64.3)	49 (63.6)	50 (64.9)
20-23 years	21 (13.6)	10 (13.0)	11 (14.3)
Gender			
Male	75 (48.7)	40 (51.9)	35 (45.5)
Female	79 (51.3)	37 (48.1)	42 (54.5)

Table 2: Comparison of baseline characteristics in participants with variability of the Protein levels.

Variable	Test	Control	T	P
Weight	60.44±1.29	60.34±1.25	0.059	0.953
BMI	23.06±0.32	23.15±0.33	-0.198	0.843
TP	7.10±0.06	7.12±0.05	-0.154	0.878
Albumin	4.02±0.03	4.03±0.04	-0.172	0.857

Table 3: Male and female participants of control group with variability in Protein levels over the study period.

Variables	Baseline	2wks	4wks	6wks	8wks	F	P
Weight female	58.38+1.64	62.04+1.86	60.51+1.84	61.92+1.89	60.11+1.41	0.749	0.545
Weight male	62.69+1.88	61.17+1.53	61.33+1.72	63.47+2.00	63.32+2.18	0.232	0.908
BMI female	24.12+0.47	26.39+1.21	25.85+1.26	26.03+1.01	25.49+1.00	1.292	0.278
BMI male	21.99+0.40	22.09+0.99	22.20+1.11	22.46+0.99	22.91+1.13	0.262	0.890
TP female	7.00+0.07	7.12+0.06	7.19+0.10	6.91+0.08	7.07+0.04	0.782	0.432
TP male	7.04+0.07	7.12+0.07	6.71+1.10	7.05+0.07	7.11+0.05	1.349	0.262
Albumin female	4.03+0.04	4.06+0.05	4.00+0.03	4.01+0.04	4.03+0.04	0.724	0.422
Albumin male	4.02+0.04	4.04+0.05	4.00+0.04	4.00+0.04	4.01+0.03	0.831	0.489

Table 4: Male and female participants of test group with variability in Protein levels over the study period.

Variables	Baseline	2wks	4wks	6wks	8wks	F	P
Weight female	58.46+1.77	59.32+1.75	60.35+1.72	61.81+1.72	62.03+1.69	153.924	0.000*
Weight male	62.28+1.84	64.03+1.80	64.70+1.85	65.20+1.79	65.85+1.78	105.381	0.000*
BMI female	24.11+0.48	24.90+0.49	25.39+0.54	29.00+0.55	26.51+0.53	108.689	0.000*
BMI male	22.09+0.37	22.74+0.37	23.16+0.40	23.55+0.40	24.13+0.37	114.199	0.000*
TP female	7.08+0.09	7.21+0.08	7.32+0.08	7.45+0.07	7.59+0.07	121.242	0.000*
TP male	6.94+0.08	7.12+0.08	7.23+0.07	7.37+0.07	7.57+0.07	196.989	0.000*
Albumin female	4.04+0.04	4.15+0.05	4.53+0.05	5.14+0.06	5.32+0.006	152.185	0.000*
Albumin male	4.01+0.03	4.10+0.04	4.50+0.04	5.08+0.03	5.29+0.04	166.481	0.000*

DISCUSSIONS

In this study, we found that there was progressive increase in Total Protein level and Albumin. This is in agreement with the study done by Herron and Fernandez in 2004 on egg consumption. The increased serum protein also showed that egg eating is beneficial to health (Eilat-Adar et al, 2013). The slight level change in control group signified physiological variations in protein level over time (Natoli et al, 2007).

The increase in TP in female which was slightly higher than male in the study group suggests that female may be less active than males, hence, according to Phillips et al,1993, male displayed an increased estimate of whole-body protein anabolism in their study. Testosterone plus Growth Hormone also increase absolute fat free-mass[14]. This is in contrast to the study done by Mauras et al,2003 who affirmed the preponderance in TP higher in male subjects which they claimed may be due to physical activity level and leucine oxidation during aerobic exercise (Mauras et al,2003). Anabolic stimuli like feeding and exercise turnover between male and female, however, making the rate of burning fat higher in males than female subjects (Mauras et al,2003).

Despite their above mentioned nutritional benefits, egg consumption was traditionally associated with adverse factors for human health and nutrition. In this sense, egg whites contain anti-nutritional factors, among which are proteins such as ovomucoid that can inhibit trypsin.

Taking into account the presence of all these components, eggs can be considered a nutritious inclusion in the diet for people of all ages and at different stages of life, but they may play a particularly useful role in the diets of those at risk of low-nutrient intakes (Natoli et al, 2007). Owing to their high nutritional value, eggs are also an important food that should be included in the planning of diets for patients, and are especially valuable in feeding people with gout, because it is a source of protein that does not add purines. Additionally, for people in sports training, egg proteins may have a profound effect on the training results, because, by its inclusion in the diet, it could be possible to enhance skeletal muscles synthesis (Herron and Fernandez, 2004). It is well established that essential amino acids stimulate skeletal muscle protein synthesis in animal and human models, and the protein in egg has the highest biological value (Glynn et al, 2010). Fifteen grams of egg white protein contain about 1300 mg of leucine (the third most common amino acid in egg, after glutamic and aspartic acids), and is also an abundant source of branched amino acids and aromatic amino acids. Recent data showed that leucine induces a maximal skeletal muscle protein anabolic response in young people, which suggests that egg white protein intake might have an important effect on body mass accretion (Hida et al, 2012). Specifically, leucine stimulates skeletal muscle synthesis independently of all other amino acids in animal models and is a potent stimulator of the cell hypertrophy mammalian target of rapamycin complex pathway. Additionally, leucine decreases muscle protein breakdown and breakdown-associated cellular signaling and mRNA expression (Glynn et al, 2010).

The increasing demand for functional foods during recent decades can be explained by the increasing cost of healthcare, the steady increase in life expectancy and the desire for an improved quality of life in later years. Functional foods may improve the general condition of the body, decrease the risk of some diseases and may even be used to cure some illnesses. Taking into account the progressive aging of the population of developed countries, functional foods are a good alternative for controlling health costs, because medical services for the aging population are rather expensive (Siro et al, 2008).

Limitations of the study:

Prospective study over years and inability to measure TP over long period of time and the other underlying health challenges in the subjects which were not identified at the time of study may be cofounding variables. This is an interesting issue for future investigations. However, continuous research is needed to validate our findings.

CONCLUSION

There is increase in Protein levels in the subjects who ingested egg and the increase is higher in female subjects than males. There is preponderance increase Albumin level in female subjects compared to male subjects. Egg consumption, however improved Protein levels in the study group.
The research has proven that egg consumption improves TP and has a beneficial role on general health. Based on the outcome of this research, Government should introduce egg into the meals of secondary students to improve the wellbeing of the youth in the country at large.

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Conflict of Interest
No conflict of interest.

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Self

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