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Original article:

Effect of egg consumption on albumin globulin ratio of some healthy secondary school students in Ibadan, Nigeria

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Abstract:

Background: Albumin and globulin are main components of serum protein. The level of albumin and globulin partially represents the nutrition status and immune system.

Objectives: This study was designed to assess the effect of egg consumption on albumin globulin ratio of some healthy secondary school students of two local Government areas in Ibadan.

Design: This study involved 160 students selected using random selection sampling method, aged between 13 and 23 years. Teachers were exempted from the study. Albumin Globulin ratio (AGR) was calculated from Albumin and Globulin levels 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. Data was analyzed using descriptive statistic.

Results: The age group 16 to 19 years constituted the highest age group. There were 49(61.20%) in the test group and 50(62.5%) in the control group for that age group. In female control group the mean AGR clinically increased but not statically significant at baseline of 1.19±0.004 to 1.29±0.005. In the male test group, the mean AGR increased significantly from 1.21±0.005 to 1.30±0.004 while in female it increased significantly from 1.23±0.005 to 1.31±0.005 after 8 weeks of study period ($p<0.05$).

Conclusions: There is increase in Albumin Globulin Ratio in the subjects who ingested egg and the mean increase is the same on both sexes. Egg consumption improved Albumin Globulin Ratio.

Key words: Egg, Albumin, Globulin, Albumin/Globulin

Introduction:

Two major types of proteins present in the serum are albumin and the globulin. Albumin is the major type of serum protein component[1]. The role of Albumin is, however, controversial as yet and Albumin use may be based more on custom than on a scientific basis, due to its limited availability and high cost, it is important that the use of Albumin is limited to hint for which it is efficacious[2]. Albumin was synthesized in abundant amount in the liver, form about 60% of all serum proteins[3], its water-soluble protein with important functions in regulating the volume of blood by preserving the oncotic pressure (colloid osmotic pressure) of the blood compartment[4] and also Albumin has a function as carrier for many hydrophobic molecules, such as bile salts, steroid hormones, free fatty acids as (apoprotein), unconjugated bilirubin, metals (Ca, Zn, and Cu), and some drugs including phenylbutazone, warfarin, and phenytoin[5]. Serum Globulins divided into: alpha (α) and beta (β) Globulins are synthesized exclusively in the liver and gamma (γ) Globulin is synthesized by B-lymphocytes; all types of Globulins are broken down by the

liver[6]. Gamma Globulin presents as a largest proportion from other Globulin types[7]. Many confusing factors may effect on the levels of "Albumin and Globulin" which may influence the accuracy and efficiency in detection of them. A novel prognostic index, the Albumin/Globulin ratio (AGR), was specified and notified[8, 9]. AGR is a component of them and suggested to be more steady and authoritative than serum Albumin or Globulin alone.[10, 11]

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[12]. Lysozime, ovomucoid, ovoinhibitor and cystatin are biologically active proteins in egg albumen, and their activity prolongs the shelf life of table eggs[13]. Some of these protective substances are isolated and produced on an industrial scale as lysozymes and avidin.

There is little of knowledge on egg consumption with relationship to albumin Globulin ratio and gender difference in this environment. Many previous studies obtained from literature search are from the Western world and none were from this region.

The aim of this study is to determine the effect of egg consumption on Albumin Globulin ratio among healthy secondary school students and gender differences if any. This will serve as a basis for a novel prognostic index in the nearest future.

Methodology:

This study involved cross-sectional selection of 160 healthy 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 thirty days. The control group was given one cup of water (100ml) daily for thirty days. 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)[14].

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.[15]

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.

Globulin level was estimated using serum Globulin electrophoresis (free electrophoresis, the inhibition of antiglobulin antiserum method, and the gel diffusion precipitin method).

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 (160) 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 160 students randomly selected with their age group between 12 and 23 years. There were 80 students in each of the control and test groups. The age group 16 to 19 years constituted the highest age group. There were 49(61.20%) in the test group and 50(62.5%) in the control group for that age group. The mean BMI of test group was 23.06kg/m2±0.32 and for the control group was 23.15kg/m2±0.33 (table 1).

In the control male group, there was slight clinical increase but not statistically significant in TP at baseline with 7.04g/dl±0.07 to 7.11g/dl±0.05 at 8 weeks of egg study period. The mean Albumin increased progressively from 3.86g/dl±0.04 to 4.04g/dl±0.03 after 8 weeks of study period in male while in female the mean albumin increased progressively but not statistically significant from 3.81g/dl±0.04 to 3.99g/dl±0.02 after 8 weeks of study period. In the male there was increase in mean Albumin Globulin ratio at baseline with 1.22+0.008 to 1.31±0.004 at 8 weeks of study period. The mean Albumin Globulin ratio in female clinically increased but not statically significant at baseline of 1.19±0.004 to 1.29±0.005 after 8 weeks of the study period (tables 2 and 3).

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 3.79g/dl±0.04 to 4.28g/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 3.91.05g/dl±0.04 to 4.31g/dl±0.04 after 8 weeks of study period ($p<0.05$) The mean Globulin increased progressively and

significantly from 3.14.05g/dl±0.04 to 3.28g/dl±0.03 after 8 weeks of study period ($p<0.05$) in male while in female the mean Globulin increased progressively and significantly from 3.1705g/dl±0.04 to 3.28g/dl±0.03 after 8 weeks of study period ($p<0.05$). The mean Albumin Globulin ratio increased progressively and significantly from 1.21±0.005 to 1.30±0.004 after 8 weeks of study period ($p<0.05$) in male while in female the mean Albumin Globulin ratio increased progressively and significantly from 1.23±0.005 to 1.31±0.005 after 8 weeks of study period ($p<0.05$) (table 4).

Table 1: Demographical characteristics of the study groups

Variable	**Total (n=160)**	**Test group (n=80)**	**Control group (n=80)**
Age (years)			
12-15	37 (23.1)	19 (23.8)	18 (22.5)
16-19	99 (61.9)	49 (61.2)	50 (62.5)
20-23	24 (15.0)	12 (15.0)	12 (15.0)
Gender			
Male	80 (50.0)	40 (50.0)	40 (50.0)
Female	80 (50.0)	40 (50.0)	40 (50.0)

Variable	**Test group**	**Control group**	**t**	**P**
BMI(kg/m^2)	**23.06±0.32**	**23.15±0.33**	**-0.198**	**0.843**
TP(g/dl)	7.10±0.06	7.12±0.05	-0.154	0.878
Albumin (g/dl)	3.85±0.03	3.83±0.03	0.314	0.754
Globulin (g/dl)	3.16±0.03	3.18±0.02	-0.700	0.485
Alb/Glob	1.22±0.004	1.21±0.004	0.645	0.467

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Table 2: Male Participants in the study group with variability of protein parameters and ratio over the study-Control (C)/Test group.

Variables	Baseline	2wks	4wks	6wks	8wks	F	p
BMI C	21.99±0.40	22.09±0.99	22.20±1.11	22.46±0.99	22.91±1.13	0.262	0.890
Test	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 C	7.04±0.07	7.12±0.07	6.71±0.10	7.05±0.07	7.11±0.05	1.349	0.262
Test	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 C	3.86±0.04	3.97±0.04	3.99±0.09	3.98±0.04	4.04±0.03	1.384	0.258
Test	3.79±0.04	4.00±0.05	4.07±0.04	4.17±0.04	4.28±0.04	316.242	0.000*
Globulin C	3.17±0.04	3.15±0.03	2.72±0.22	3.07±0.03	3.08±0.02	3.285	0.072
Test	3.14±0.04	3.12±0.04	3.16±0.03	3.20±0.03	3.28±0.03	35.859	0.000*
Alb/GlobC	1.22±0.008	1.26±0.003	1.24±0.025	1.30±0.005	1.31±0.004	0.118	0.734
Test	1.21±0.005	1.28±0.005	1.29±0.004	1.30±0.003	1.30±0.004	78.100	0.000*

*Significant at $p<0.05$

Table 3: Female Participants in the study group with variability of protein parameters and ratio over the study-Control (C)/Test group

Variables	Baseline	2wks	4wks	6wks	8wks	F	p
BMI C	24.12±0.47	26.39±1.21	25.85±1.26	26.03±1.01	25.49±1.00	1.292	0.278
Test	24.11±0.48	24.90±0.49	25.39±0.54	26.00±0.55	26.51±0.53	108.689	0.000*
TP C	7.00±0.07	7.12±0.06	7.19±0.10	6.91±0.08	7.07±0.04	0.782	0.432
Test	7.08±0.09	7.21±0.08	7.32±0.08	7.45±0.07	7.59±0.07	121.242	0.000*
AlbuminC	3.81±0.04	3.96±0.03	4.09±0.13	3.90±0.05	3.99±0.02	2.538	0.097
Test	3.91±0.05	4.01±0.05	4.11±0.05	4.20±0.04	4.31±0.04	167.047	0.000*
GlobulinC	3.19±0.03	3.16±0.03	3.11±0.13	3.01±0.04	3.08±0.02	1.195	0.297
Test	3.17±0.04	3.20±0.04	3.20±0.04	3.26±0.03	3.28±0.03	18.833	0.000*
Alb/GlobC	1.19±0.004	1.26±0.004	1.43±0.10	1.29±0.006	1.29±0.005	2.507	0.108
Test	1.23±0.005	1.25±0.004	1.28±0.005	1.29±0.006	1.31±0.005	50.509	0.000*

*Significant at $p<0.05$

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Table 4: Test Group of Male (M) and Female (F) Participants in the study group with variability of protein parameters and ratio over the study

Variables	Baseline	2wks	4wks	6wks	8wks	F	p
BMI(kg/m^2)M	22.09±0.37	22.74±0.37	23.16±0.40	23.55±0.40	24.13±0.37	114.199	0.000*
F	24.11±0.48	24.90±0.49	25.39±0.54	26.00±0.55	26.51±0.53	108.689	0.000*
TP (g/dl)M	6.94±0.08	7.12±0.08	7.23±0.07	7.37±0.07	7.57±0.07	196.989	0.000*
F	7.08±0.09	7.21±0.08	7.32±0.08	7.45±0.07	7.59±0.07	121.242	0.000*
AlbuminM	3.79±0.04	4.00±0.05	4.07±0.04	4.17±0.04	4.28±0.04	316.242	0.000*
F	3.91±0.05	4.01±0.05	4.11±0.05	4.20±0.04	4.31±0.04	167.047	0.000*
GlobulinM	3.14±0.04	3.12±0.04	3.16±0.03	3.20±0.03	3.28±0.03	35.859	0.000*
F	3.17±0.04	3.20±0.04	3.20±0.04	3.26±0.03	3.28±0.03	18.833	0.000*
Alb/GlobM	1.21±0.005	1.28±0.005	1.29±0.004	1.30±0.003	1.30±0.004	78.100	0.000*
F	1.23±0.005	1.25±0.004	1.28±0.005	1.29±0.006	1.31±0.005	50.509	0.000*

*Significant at $p<0.05$

Discussion:

In this study, we found that there were progressive increase in Total Protein level and Albumin Globulin Ratio in the study group; this is in agreement with the study done by Herron and Fernandez in 2004[16] on egg consumption. The increased also showed that egg eating is beneficial to health[17]. The slight level change in control group signified physiological variations in protein level over time[18]There are no much sex differences in the Albumin Globulin Ratio (AGR). It should be noted that the set of students are healthy, hence these findings. AGR should be part of general health check up to determine the nutritional status or to screen for and help diagnose certain liver and kidney disorders as well as other diseases. High AGR level may indicate infection, inflammatory disease or immune disorder. Normal AGR is slightly over 1 as demonstrated in this study. The finding is in contrast to study done by Rahman and Begum, 2005[19] where they studied serum total protein, albumin and AGR in different groups of protein energy malnutrition and normal children. In their study there were 20 healthy children and 30 children suffered from protein energy malnutrition. They found the AGR to be lower in protein energy malnutrition children.

Albumins and globulin are the main components of serum proteins. Albumins reflect the nutrition status of the human body, which are functioning as the regulators of colloid osmotic pressure of blood. Moreover, they also bind cations, fatty acids, bilirubin, hormones and pharmaceuticals and act like the transporters. Besides, it also involves in various sorts of physiological activities of human bodies. Lower albumin levels indicated poor nutrition status which had been reported to predict poor survival in various types of cancers in the previous studies[20, 21,22, 23, 24]. Globulin family has several members including alpha, beta, and gamma globulins. Among them, gamma globulin accounts for the largest proportion. It is known as immunoglobulin or antibody and secreted by B cells of the adaptive immune system. Therefore, it plays an important role in immunity. An increased level of globulin has been proved

to be related to chronic inflammation. [25, 26, 27] Chronic inflammation increases the acute phase proteins in human bodies (eg: C-reactive protein, serum amyloid, complement C3, fibrinogen, ceruloplasmin et.al.). They are all parts of globulins which are markers of chronic inflammation when they are elevated in various levels. It reflects the accumulation of various pro-inflammatory cytokines, such as interleukin (IL, especially IL-6 and IL-1β) and tumor necrosis factor. [28, 29]

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[18]. 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[16]. 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[30]. 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[31]. 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[30].

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[15]

Limitations of the study:

Prospective study over years and inability to measure AGR 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 Albumin Globulin Ratio in the subjects who ingested egg and there are no sex differences. Egg consumption, however improved Albumin Globulin Ratio in the study group.

The research has proven that egg consumption improves AGR 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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