

GEORGIAN MEDICAL NEWS

ISSN 1512-0112

NO 1 (346) Январь 2024

ТБИЛИСИ - NEW YORK



ЕЖЕМЕСЯЧНЫЙ НАУЧНЫЙ ЖУРНАЛ

Медицинские новости Грузии
საქართველოს სამედიცინო სიახლენი

GEORGIAN MEDICAL NEWS

Monthly Georgia-US joint scientific journal published both in electronic and paper formats of the Agency of Medical Information of the Georgian Association of Business Press.
Published since 1994. Distributed in NIS, EU and USA.

GMN: Georgian Medical News is peer-reviewed, published monthly journal committed to promoting the science and art of medicine and the betterment of public health, published by the GMN Editorial Board since 1994. GMN carries original scientific articles on medicine, biology and pharmacy, which are of experimental, theoretical and practical character; publishes original research, reviews, commentaries, editorials, essays, medical news, and correspondence in English and Russian.

GMN is indexed in MEDLINE, SCOPUS, PubMed and VINITI Russian Academy of Sciences. The full text content is available through EBSCO databases.

GMN: Медицинские новости Грузии - ежемесячный рецензируемый научный журнал, издаётся Редакционной коллегией с 1994 года на русском и английском языках в целях поддержки медицинской науки и улучшения здравоохранения. В журнале публикуются оригинальные научные статьи в области медицины, биологии и фармации, статьи обзорного характера, научные сообщения, новости медицины и здравоохранения. Журнал индексируется в MEDLINE, отражён в базе данных SCOPUS, PubMed и ВИНТИ РАН. Полнотекстовые статьи журнала доступны через БД EBSCO.

GMN: Georgian Medical News – საქართველოს სამედიცინო სიახლენი – არის ყოველთვიური სამეცნიერო სამედიცინო რეცენზირებადი ჟურნალი, გამოიცემა 1994 წლიდან, წარმოადგენს სარედაქციო კოლეგიისა და აშშ-ის მეცნიერების, განათლების, ინდუსტრიის, ხელოვნებისა და ბუნებისმეტყველების საერთაშორისო აკადემიის ერთობლივ გამოცემას. GMN-ში რუსულ და ინგლისურ ენებზე ქვეყნდება ექსპერიმენტული, თეორიული და პრაქტიკული ხასიათის ორიგინალური სამეცნიერო სტატიები მედიცინის, ბიოლოგიისა და ფარმაციის სფეროში, მიმოხილვითი ხასიათის სტატიები.

ჟურნალი ინდექსირებულია MEDLINE-ის საერთაშორისო სისტემაში, ასახულია SCOPUS-ის, PubMed-ის და ВИНТИ РАН-ის მონაცემთა ბაზებში. სტატიების სრული ტექსტი ხელმისაწვდომია EBSCO-ს მონაცემთა ბაზებიდან.

WEBSITE

www.geomednews.com

К СВЕДЕНИЮ АВТОРОВ!

При направлении статьи в редакцию необходимо соблюдать следующие правила:

1. Статья должна быть представлена в двух экземплярах, на русском или английском языках, напечатанная через **полтора интервала на одной стороне стандартного листа с шириной левого поля в три сантиметра**. Используемый компьютерный шрифт для текста на русском и английском языках - **Times New Roman (Кириллица)**, для текста на грузинском языке следует использовать **AcadNusx**. Размер шрифта - **12**. К рукописи, напечатанной на компьютере, должен быть приложен CD со статьей.

2. Размер статьи должен быть не менее десяти и не более двадцати страниц машинописи, включая указатель литературы и резюме на английском, русском и грузинском языках.

3. В статье должны быть освещены актуальность данного материала, методы и результаты исследования и их обсуждение.

При представлении в печать научных экспериментальных работ авторы должны указывать вид и количество экспериментальных животных, применявшиеся методы обезболивания и усыпления (в ходе острых опытов).

4. К статье должны быть приложены краткое (на полстраницы) резюме на английском, русском и грузинском языках (включающее следующие разделы: цель исследования, материал и методы, результаты и заключение) и список ключевых слов (key words).

5. Таблицы необходимо представлять в печатной форме. Фотокопии не принимаются. **Все цифровые, итоговые и процентные данные в таблицах должны соответствовать таковым в тексте статьи**. Таблицы и графики должны быть озаглавлены.

6. Фотографии должны быть контрастными, фотокопии с рентгенограмм - в позитивном изображении. Рисунки, чертежи и диаграммы следует озаглавить, пронумеровать и вставить в соответствующее место текста **в tiff формате**.

В подписях к микрофотографиям следует указывать степень увеличения через окуляр или объектив и метод окраски или импрегнации срезов.

7. Фамилии отечественных авторов приводятся в оригинальной транскрипции.

8. При оформлении и направлении статей в журнал МНГ просим авторов соблюдать правила, изложенные в «Единых требованиях к рукописям, представляемым в биомедицинские журналы», принятых Международным комитетом редакторов медицинских журналов - <http://www.spinesurgery.ru/files/publish.pdf> и http://www.nlm.nih.gov/bsd/uniform_requirements.html В конце каждой оригинальной статьи приводится библиографический список. В список литературы включаются все материалы, на которые имеются ссылки в тексте. Список составляется в алфавитном порядке и нумеруется. Литературный источник приводится на языке оригинала. В списке литературы сначала приводятся работы, написанные знаками грузинского алфавита, затем кириллицей и латиницей. Ссылки на цитируемые работы в тексте статьи даются в квадратных скобках в виде номера, соответствующего номеру данной работы в списке литературы. Большинство цитированных источников должны быть за последние 5-7 лет.

9. Для получения права на публикацию статья должна иметь от руководителя работы или учреждения визу и сопроводительное отношение, написанные или напечатанные на бланке и заверенные подписью и печатью.

10. В конце статьи должны быть подписи всех авторов, полностью приведены их фамилии, имена и отчества, указаны служебный и домашний номера телефонов и адреса или иные координаты. Количество авторов (соавторов) не должно превышать пяти человек.

11. Редакция оставляет за собой право сокращать и исправлять статьи. Корректур авторам не высылаются, вся работа и сверка проводится по авторскому оригиналу.

12. Недопустимо направление в редакцию работ, представленных к печати в иных издательствах или опубликованных в других изданиях.

При нарушении указанных правил статьи не рассматриваются.

REQUIREMENTS

Please note, materials submitted to the Editorial Office Staff are supposed to meet the following requirements:

1. Articles must be provided with a double copy, in English or Russian languages and typed or computer-printed on a single side of standard typing paper, with the left margin of 3 centimeters width, and 1.5 spacing between the lines, typeface - **Times New Roman (Cyrillic)**, print size - 12 (referring to Georgian and Russian materials). With computer-printed texts please enclose a CD carrying the same file titled with Latin symbols.

2. Size of the article, including index and resume in English, Russian and Georgian languages must be at least 10 pages and not exceed the limit of 20 pages of typed or computer-printed text.

3. Submitted material must include a coverage of a topical subject, research methods, results, and review.

Authors of the scientific-research works must indicate the number of experimental biological species drawn in, list the employed methods of anesthetization and soporific means used during acute tests.

4. Articles must have a short (half page) abstract in English, Russian and Georgian (including the following sections: aim of study, material and methods, results and conclusions) and a list of key words.

5. Tables must be presented in an original typed or computer-printed form, instead of a photocopied version. **Numbers, totals, percentile data on the tables must coincide with those in the texts of the articles.** Tables and graphs must be headed.

6. Photographs are required to be contrasted and must be submitted with doubles. Please number each photograph with a pencil on its back, indicate author's name, title of the article (short version), and mark out its top and bottom parts. Drawings must be accurate, drafts and diagrams drawn in Indian ink (or black ink). Photocopies of the X-ray photographs must be presented in a positive image in **tiff format**.

Accurately numbered subtitles for each illustration must be listed on a separate sheet of paper. In the subtitles for the microphotographs please indicate the ocular and objective lens magnification power, method of coloring or impregnation of the microscopic sections (preparations).

7. Please indicate last names, first and middle initials of the native authors, present names and initials of the foreign authors in the transcription of the original language, enclose in parenthesis corresponding number under which the author is listed in the reference materials.

8. Please follow guidance offered to authors by The International Committee of Medical Journal Editors guidance in its Uniform Requirements for Manuscripts Submitted to Biomedical Journals publication available online at: http://www.nlm.nih.gov/bsd/uniform_requirements.html
http://www.icmje.org/urm_full.pdf

In GMN style for each work cited in the text, a bibliographic reference is given, and this is located at the end of the article under the title "References". All references cited in the text must be listed. The list of references should be arranged alphabetically and then numbered. References are numbered in the text [numbers in square brackets] and in the reference list and numbers are repeated throughout the text as needed. The bibliographic description is given in the language of publication (citations in Georgian script are followed by Cyrillic and Latin).

9. To obtain the rights of publication articles must be accompanied by a visa from the project instructor or the establishment, where the work has been performed, and a reference letter, both written or typed on a special signed form, certified by a stamp or a seal.

10. Articles must be signed by all of the authors at the end, and they must be provided with a list of full names, office and home phone numbers and addresses or other non-office locations where the authors could be reached. The number of the authors (co-authors) must not exceed the limit of 5 people.

11. Editorial Staff reserves the rights to cut down in size and correct the articles. Proof-sheets are not sent out to the authors. The entire editorial and collation work is performed according to the author's original text.

12. Sending in the works that have already been assigned to the press by other Editorial Staffs or have been printed by other publishers is not permissible.

**Articles that Fail to Meet the Aforementioned
Requirements are not Assigned to be Reviewed.**

ავტორთა საქურაღებოლ!

რედაქციაში სტატიის წარმოდგენისას საჭიროა დაიცვათ შემდეგი წესები:

1. სტატია უნდა წარმოადგინოთ 2 ცალად, რუსულ ან ინგლისურ ენებზე დაბეჭდილი სტანდარტული ფურცლის 1 გვერდზე, 3 სმ სიგანის მარცხენა ველისა და სტრიქონებს შორის 1,5 ინტერვალის დაცვით. გამოყენებული კომპიუტერული შრიფტი რუსულ და ინგლისურენოვან ტექსტებში - **Times New Roman (Кириллица)**, ხოლო ქართულენოვან ტექსტში საჭიროა გამოვიყენოთ **AcadNusx**. შრიფტის ზომა – 12. სტატიას თან უნდა ახლდეს CD სტატიით.

2. სტატიის მოცულობა არ უნდა შეადგენდეს 10 გვერდზე ნაკლებს და 20 გვერდზე მეტს ლიტერატურის სიის და რეზიუმეების (ინგლისურ, რუსულ და ქართულ ენებზე) ჩათვლით.

3. სტატიაში საჭიროა გაშუქდეს: საკითხის აქტუალობა; კვლევის მიზანი; საკვლევი მასალა და გამოყენებული მეთოდები; მიღებული შედეგები და მათი განსჯა. ექსპერიმენტული ხასიათის სტატიების წარმოდგენისას ავტორებმა უნდა მიუთითონ საექსპერიმენტო ცხოველების სახეობა და რაოდენობა; გაუტკივარებისა და დაძინების მეთოდები (მწვავე ცდების პირობებში).

4. სტატიას თან უნდა ახლდეს რეზიუმე ინგლისურ, რუსულ და ქართულ ენებზე არანაკლებ ნახევარი გვერდის მოცულობისა (სათაურის, ავტორების, დაწესებულების მითითებით და უნდა შეიცავდეს შემდეგ განყოფილებებს: მიზანი, მასალა და მეთოდები, შედეგები და დასკვნები; ტექსტუალური ნაწილი არ უნდა იყოს 15 სტრიქონზე ნაკლები) და საკვანძო სიტყვების ჩამონათვალი (key words).

5. ცხრილები საჭიროა წარმოადგინოთ ნაბეჭდი სახით. ყველა ციფრული, შემაჯამებელი და პროცენტული მონაცემები უნდა შეესაბამებოდეს ტექსტში მოყვანილს.

6. ფოტოსურათები უნდა იყოს კონტრასტული; სურათები, ნახაზები, დიაგრამები - დასათაურებული, დანომრილი და სათანადო ადგილას ჩასმული. რენტგენოგრაფიების ფოტოასლები წარმოადგინეთ პოზიტიური გამოსახულებით **tiff** ფორმატში. მიკროფოტოსურათების წარწერებში საჭიროა მიუთითოთ ოკულარის ან ობიექტივის საშუალებით გადიდების ხარისხი, ანათალებების შედეგების ან იმპრეგნაციის მეთოდი და აღნიშნოთ სურათის ზედა და ქვედა ნაწილები.

7. სამამულო ავტორების გვარები სტატიაში აღინიშნება ინიციალების თანდართვით, უცხოურისა – უცხოური ტრანსკრიპციით.

8. სტატიას თან უნდა ახლდეს ავტორის მიერ გამოყენებული სამამულო და უცხოური შრომების ბიბლიოგრაფიული სია (ბოლო 5-8 წლის სიღრმით). ანბანური წყობით წარმოდგენილ ბიბლიოგრაფიულ სიაში მიუთითეთ ჯერ სამამულო, შემდეგ უცხოელი ავტორები (გვარი, ინიციალები, სტატიის სათაური, ჟურნალის დასახელება, გამოცემის ადგილი, წელი, ჟურნალის №, პირველი და ბოლო გვერდები). მონოგრაფიის შემთხვევაში მიუთითეთ გამოცემის წელი, ადგილი და გვერდების საერთო რაოდენობა. ტექსტში კვადრატულ ფხიხლებში უნდა მიუთითოთ ავტორის შესაბამისი N ლიტერატურის სიის მიხედვით. მიზანშეწონილია, რომ ციტირებული წყაროების უმეტესი ნაწილი იყოს 5-6 წლის სიღრმის.

9. სტატიას თან უნდა ახლდეს: ა) დაწესებულების ან სამეცნიერო ხელმძღვანელის წარდგინება, დამოწმებული ხელმოწერითა და ბეჭდით; ბ) დარგის სპეციალისტის დამოწმებული რეცენზია, რომელშიც მითითებული იქნება საკითხის აქტუალობა, მასალის საკმაობა, მეთოდის სანდოობა, შედეგების სამეცნიერო-პრაქტიკული მნიშვნელობა.

10. სტატიის ბოლოს საჭიროა ყველა ავტორის ხელმოწერა, რომელთა რაოდენობა არ უნდა აღემატებოდეს 5-ს.

11. რედაქცია იტოვებს უფლებას შეასწოროს სტატია. ტექსტზე მუშაობა და შეჯერება ხდება საავტორო ორიგინალის მიხედვით.

12. დაუშვებელია რედაქციაში ისეთი სტატიის წარდგენა, რომელიც დასაბეჭდად წარდგენილი იყო სხვა რედაქციაში ან გამოქვეყნებული იყო სხვა გამოცემებში.

აღნიშნული წესების დარღვევის შემთხვევაში სტატიები არ განიხილება.

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EFFECT OF RELIGIOUS FASTING ON THE SERUM LEVEL OF PRE-HAPTOGLOBIN-2 AND SOME OTHER BIOCHEMICALS

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Abstract.

Background and objectives: During the month of Ramadan, which falls on the ninth month of the Hijri Calendar, Muslims are obligated to observe religious fasting. The goal of the study was to examine the impact of fasting on various blood parameters, specifically zinc, magnesium, pre-haptoglobin-2, serum copper, total cholesterol, and HDL-cholesterol levels.

Methods: In a study, a group of volunteers consisting of 20 men and 10 women agreed to partake in the fast, abstaining from food and drink for approximately 14-15 hours each day. The researchers collected two blood samples from each participant, one before the start of Ramadan fasting and another after 29 days of fasting, serum was separated and analysed for specified parameters.

Results: Serum zinc levels showed a significant ($p < 0.05$) decrease after fasting. On the other hand, serum magnesium levels exhibited a significant ($p < 0.05$) increase. Regarding pre-haptoglobin-2, there was a small, insignificant increase observed after 29 days of fasting. However, the study did not identify any significant changes in serum copper, total cholesterol, or HDL-cholesterol levels. Based on these findings, the study concludes that Ramadan fasting may necessitate zinc supplementation or an increase in the consumption of zinc-rich foods. Furthermore, it suggests a decrease in the intake of high-fat foods. These recommendations aim to counteract the observed decrease in serum zinc levels during fasting.

Key words. Fasting, Religion, Zinc, Magnesium, Pre-haptoglobin-2, Zonulin.

Introduction.

Religious fasting of the Ramadan month is obligatory for Muslim people around the world. This month is the ninth month in the Islamic Hijri calendar, so may occur in a different season each year [1-3]. Religious fasting of Ramadan in this study was from 23 March to 20 April of 2023, fasting hours were 14 to 15 each day.

Different studies reported the beneficial fasting effect of Ramadan on GIT hormone and gut microbiota [1-4]. Pre-haptoglobin-2 or called zonulin, when increased cause loosening of tight junction in intestinal mucosa and hence increase intestinal permeability [5], on the other hand, a change of intestinal microbiota and an increase of pathogenic bacteria leads to an increase in this protein [6]

Zinc an important trace element for insulin activity [7], immunity and neurological function [8,9] has been reported to affect intestinal integrity [10], and microbiota diversity [11] and has an indirect correlation with pre-haptoglobin-2 (zonulin) protein [12]. On the other hand, copper an important metal for neurotransmitter synthesis, mitochondrial respiration, and

cytosolic redox reactions [13,14], may compete with zinc for intestinal absorption, hence increasing zinc intake decreases copper absorption and vice versa [15]. While magnesium element is used as a cofactor for enzymes responsible for glucose and lipid metabolism [16]. The increase in magnesium level leads to an increase in insulin sensitivity and a decrease in serum total cholesterol [17,18].

Concerning serum lipid profile, there are different studies find the effect of Ramadan religious fasting on these parameters, but their results were contradicted [7,19-21]. However, this is the first study aimed to find the effect of Ramadan fasting on intestinal permeability and level of zonulin (Pre-haptoglobin-2) and some trace elements (zinc, magnesium, and copper) which may be affected by intestinal function as well as total cholesterol and HDL-cholesterol serum levels.

Materials and Methods.

A total of 30 healthy volunteers (10 women and 20 men) were enrolled in this study, their ages between 20 to 34 years, while their body mass was between 20.6-36.4. They have no documented chronic health problems (apparently healthy), and they were not on any drugs or dietary supplements. They agree to provide us with blood samples before starting Ramadan month by one to two days as the first blood sample, the second blood sample was on the 29 days of Ramadan month.

The blood after collection was centrifuged and the serum was divided into two parts, by plain tubes. One plain tube for each volunteer was stored at -20°C for later measuring of pre-haptoglobin-2 protein (Zonulin), and the second plain tube of serum for each volunteer was used immediately for determination of serum zinc, copper, magnesium, total cholesterol, and HDL cholesterol.

Serum copper is determined by colorimetric method with Di_Br_PAESA method by kit manufactured by LTA (Italy). Serum Magnesium is determined by Fuji Film dry chemistry analyzer by using the kit (Fuji-Dri-Chem Slide Mg-P III) Fuji Film corporation (Japan). Serum zinc is determined colorimetrically using the kit Supplied by Camp Medica (Romania). HDL-cholesterol and serum total cholesterol were determined colorimetrically by direct method using kit supplied from BIOLABO (France).

Serum samples that have been stored at -20°C , after end of Ramadan month have been determined by ELISA technique using ELISA kit for determination of zonulin(pre-haptoglobin-2). The kit supplied by biont company catalo NO: YLA1319U. Human zonulin ELISA Kit.

Statistical analysis was made by SPSS 23- 2015 version, using paired t-test and Wilcoxon matched pair signed rank test. The graphs are determined by Excel Program.

Results.

The mean±SD of both age and BMI for all volunteers were 26.11±6.16 and 28.03±4.49, respectively. The impact of Ramadan fasting on various biochemical markers in the body has been a subject of interest for researchers and healthcare professionals. This study focused on the changes in zinc and magnesium serum levels after 29 days of Ramadan fasting. The findings revealed a significant decrease in zinc serum levels while observing a significant increase in serum magnesium levels, as determined by paired t-test analysis. These results shed light on the potential alterations in mineral homeostasis during prolonged fasting. On the other hand, the significant increase in serum magnesium levels suggests an adaptive response to maintain magnesium homeostasis during fasting. The observed changes in zinc and magnesium serum levels emphasize the importance of monitoring and understanding the effects of Ramadan fasting on micronutrient status (Figure 1).

Discussion.

Various studies discussed the effect of religious fasting during Ramadan on body metabolism and other related parameters. As millions of Muslim people around the world have to fast each day this month for several hours from sunrise to sunset. In this study, fasting hours were between 14-15 hours.

This study revealed that only zinc and magnesium serum levels showed significant changes after Ramadan fasting according to paired t-test, also pre-haptoglobin-2 (zonulin) showed a small insignificant increase in its level from the level before starting of Ramadan, and the two measurements are directly correlated, also pre-haptoglobin-2 level before fasting is directly correlated with the body mass index. The other parameters showed slight changes, but they are insignificant.

Total serum cholesterol showed a small insignificant increase after Ramadan fasting, while HDL-c showed an insignificant slight decrease. Our result is not in agreement with Urooj A et

al. [19], who showed that HDL-c is significantly increased in men and women after the end of a month of fasting, while our result agrees with Urooj et al in that total serum cholesterol is not significantly changed. Also, our result does not agree with Zare A et al. [22], who showed a significant decrease in total serum cholesterol and a significant increase in HDL-c, after 25 days of Ramadan fasting.

Our study is in agreement with Khan et al., concerning total serum cholesterol, but HDL-c in Khan et al. study showed a significant increase [20]. However, their study was conducted in Pakistan and their type of food during Ramadan may be different from our Ramadan traditional food in Iraq. On the other hand, our result agrees with the result of another study conducted in Erbil-Iraq [23] concerning total serum cholesterol, but HDL-c in their study again showed a significant increase, the difference in HDL-c change may be attributed to that most of their volunteers were from teaching staff of Salahaddin University and they are aware of a healthy diet. On the other hand, Celik A et al. [24] showed an increase in cholesterol after the end of Ramadan fasting, while AL-Hourani HM [21] showed a significant decrease in HDL-c after Ramadan fasting.

The contradicted results of different studies concerning total cholesterol and HDL-c may be attributed to the type of traditional Ramadan food that are different in different countries. Most of our traditional food during Ramadan depends on a high-fat diet and a high-caloric diet.

Another explanation of decrease HDL-c and increase total cholesterol though insignificant, is the associated significant decrease in serum zinc level after a month of fasting. It has been reported that an increase in serum zinc is associated with a decrease in serum cholesterol and an increase in HDL-c [25].

Concerning magnesium, its serum level showed a small significant increase after 29 days of fasting at a p-value of 0.02. The two measurements before and after fasting were within normal range. This increment may be related to the

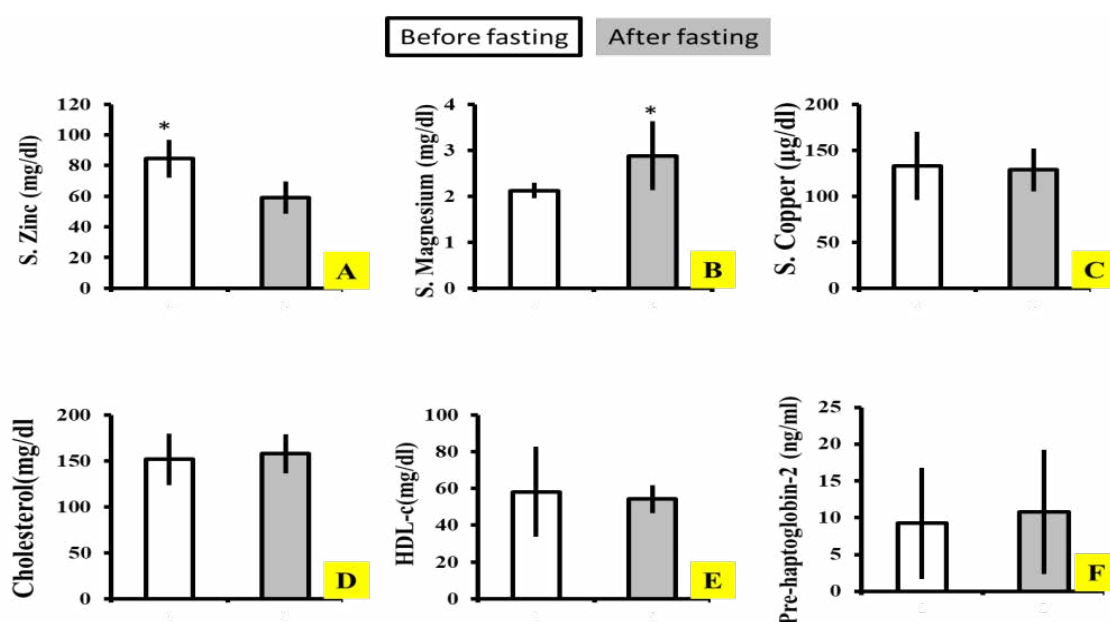


Figure 1. Ramadan fasting has reduced serum zinc and increased serum magnesium levels with no effects on serum copper, cholesterol, HDL, and pre-haptoglobin-2. Data expressed as mean±SD, *P<0.05 using paired t-test.

increased intake of magnesium-containing food during Ramadan, especially since a study completed in Lebanon in 2020 revealed that magnesium intake during Ramadan is higher than magnesium intake from regular food intake daily in months other than Ramadan [26]. On the other hand, another study conducted in Tehran showed that magnesium intake with food during Ramadan is less than its intake on other days [27]. also, a study about food intake during Ramadan in Qatar (may-June 2019) revealed that calcium intake is increased during Ramadan than in other months [28], which means a decrease in magnesium intake during Ramadan because low magnesium intake is usually coupled with high calcium intake, as they compete on the same absorption site [29].

Another explanation for a slightly significant increase in serum magnesium is the movement of magnesium from inside to outside the cell due to lower insulin levels during Ramadan fasting because of fasting for 15 hours, while higher insulin levels on non-fasting days direct magnesium to the entrance inside the cell [30].

Zinc is decreased upon 29 days of fasting at a p-value of 0.0001, this result is not in agreement with Mrad S et al. [31] who conduct their study in Tunisia, their volunteers were of chronic obstructive pulmonary disease male and found no significant changes in serum zinc before after Ramadan fasting. Our result may be attributed to lower zinc intake during Ramadan. However, according to a study by Sajjadi et al. [27], who found that zinc intake during Ramadan fasting is not significantly changed from before Ramadan and from the recommended daily allowance [27]. On the other hand, a study conducted in Erbil-Iraq in 2016 showed a significant decrease in vitamin D levels after fasting during Ramadan which may explain the decrease of zinc in our study [23], because vitamin D is important to induce zinc transporters [32] so that decrease of zinc is attributed to decrease in vitamin D level. Another study showed that zinc level in serum is not related to the amount of zinc intake but is usually related to protein metabolism and inflammation [33]. it has been reported that fasting increase the activity of antioxidant enzyme such as superoxide dismutase that requires zinc for activation [34] also, fasting in human induce growth hormone secretion which requires zinc for its signalling and binding with growth hormone receptors [35,36]. so, the suggestion of a decrease in zinc level after 29 days of fasting may be related to a decrease in zinc absorption due to a decrease in vitamin D level, or due to an increase in body utilization of zinc during fasting due to the up-regulation of antioxidant system or other metabolic process in the body.

Serum copper level is decreased after 29 days of fasting, but the decrease is insignificant. According to Sajjadi et al. [27], copper dietary intake during Ramadan fasting is significantly lesser than the mean standard diet. Copper is absorbed from the stomach and duodenum by special transporting protein, and after absorption goes to the liver (higher copper content is in the liver). The copper is then transported to the circulation as a bound form with ceruloplasmin [37]. The most important cause of copper deficiency is bariatric surgery [38] which takes several years before the copper body store is depleted [39]. therefore, in this study, the amount of copper is not altered significantly, although of a possible decrease in copper intake

during Ramadan fasting, because the amount of copper stored in the liver can replenish any decrease in copper intake.

Concerning pre-haptoglobin-2 (zonulin), there is a direct correlation between BMI and pre-haptoglobin-2 before fasting. The increase in haptoglobin-2 level may be attributed to a decrease in zinc concentration, as low zinc level is associated with an increase in oxidative stress and zinc deficiency is reported to be associated with diarrhoea due to an increase of intestinal permeability [12,40,41]. The possible increase in fat diet content may also explain the increase of serum pre-haptoglobin-2 (zonulin) because a high-fat diet can change bacterial flora composition and decrease the quantity and quality of intestinal mucosa and increase loosing of tight junction [42]. Another study found that high fat, protein, and sodium-containing diet have a direct correlation with zonulin concentration [43,44]. However, in our study, we did not find a direct correlation between total cholesterol and serum pre-haptoglobin-2, but we found a direct correlation between pre-haptoglobin-2 with body mass index, the same result is detected by other studies [43,45]. On the other hand, another study reported that glucagon level is correlated with prehaptoglobin2 [44], which may explain the increase of zonulin in our study after 29 days of fasting, as glucagon tends to increase in the fasting state.

The result of this study may explain the flare-up of GIT problems during Ramadan fasting in patients with gastrointestinal problems [46,12], but not in healthy individuals. However, the condition of increased pre-haptoglobin-2 and decreased zinc during Ramadan fasting may be treated by intake of zinc supplements, prebiotic and probiotic supplements [47] with a decrease in high-fat diet.

Conclusion.

Ramadan fasting, a month-long religious observance practised by Muslims worldwide, brings about certain dietary changes and considerations. One such consideration is the requirement for zinc supplementation or an increase in the consumption of foods containing zinc. Zinc is an essential mineral that plays a crucial role in various physiological processes within the body. During the fasting period, individuals may experience a decrease in zinc levels due to reduced intake or altered eating patterns. Therefore, it becomes necessary to ensure an adequate intake of this mineral to maintain optimal health. Zinc is involved in immune function, wound healing, and cell division, making it vital for overall well-being. To meet the increased zinc requirement during Ramadan fasting, individuals can suggest zinc supplementation under the guidance of healthcare professionals or choose to consume foods rich in zinc. Some excellent dietary sources of zinc include lean meats, seafood, legumes, nuts, seeds, and whole grains. In addition to zinc, another dietary consideration during Ramadan fasting is the decrease in the intake of high-fat foods. Fasting during Ramadan often involves abstaining from food and drink from dawn until sunset, which can impact one's eating habits. It is common for individuals to consume more calorie-dense and high-fat foods during non-fasting hours to compensate for the fasting period. However, excessive consumption of high-fat foods can lead to weight gain and negatively impact overall health. Therefore, it is advisable to choose a balanced diet during non-fasting hours,

incorporating moderate amounts of healthy fats from sources such as avocados, nuts, and olive oil. By being mindful of zinc intake and moderating high-fat food consumption, individuals can maintain a nutritious and well-rounded diet during Ramadan fasting, supporting their health and well-being throughout this sacred month.

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