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ЕЖЕМЕСЯЧНЫЙ НАУЧНЫЙ ЖУРНАЛ

Медицинские новости Грузии

საქართველოს სამედიცინო სიახლენი

GEORGIAN MEDICAL NEWS

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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 ВИНИТИ 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 ВИНИТИ 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. Корректура авторам не высылается, 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 compu-ter-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 საყურადღებოდ!

რედაქციაში სტატიის წარმოდგენისას საჭიროა დავიცვათ 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. რენტგენოგრამების ფოტოასლები წარმოადგინეთ პოზიტიური გამოსახულებით **tiff** ფორმატში. მიკროფოტოსურათების წარწერებში საჭიროა მიუთითოთ ოკულარის ან ობიექტივის საშუალებით გადიდების ხარისხი, ანათალების შეღებვის 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 ფჩხილებში 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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ASSOCIATION BETWEEN GLYCATED HEMOGLOBIN AND ELEVATED THYROID HORMONES LEVELS IN PATIENTS WITH TYPE 2 DIABETES MELLITUS

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Abstract.

Introduction and objective: Hyperthyroidism is more common in patients with type 2 diabetes mellitus (T2DM) than in those without diabetes. Excess circulating thyroid hormones in hyperthyroidism are associated with poor glycemic control, including hyperglycemia and insulinopenia. This study aimed to determine the association between the serum glycated hemoglobin (HbA1c) and thyroid hormonal profile (FT3, FT4, TSH) in Type 2 diabetic patients.

Methodology: A cross-sectional and case control study examined HbA1c, FT3, FT4 and TSH in 189 Type 2 diabetic patients with good and poor glycemic status, analyzed the associations of these biomarkers for predicting hyperthyroidism using Cox proportional hazard and support vector machine analyses. The methods are conducted following the manufacturer's instructions, spectrophotometric assays are used to measure HbA1c and FBG, while electro chemiluminescent assays are used to measure TSH, FT3, and FT4.

Results: This study was conducted on 97 Type 2 diabetic patients with poor glycemic status compared to 92 good glycemic status patients. The age range of participants is between 21 to 72 years and classified according to WHO age group classification into three age categories, young adults (21 – 30), middle-aged adults (31 – 45), old-aged adults (> 45) and the duration of the disease is between (4 – 15) years. FBG ($p = 0.001$), HbA1c ($p = 0.016$), TSH ($p = 0.009$), FT3 ($p = 0.048$), and FT4 ($p = 0.038$) results among Type 2 diabetic patients revealed significant differences between the means of good and poor glycemic state (P.value< 0.05). The correlation between thyroid markers, glycemic parameters and the diabetes duration, revealed significant moderate a negative correlation between TSH and FBG ($R = -0.34$, $p = 0.001$), HbA1c ($R = -0.27$, $p = 0.02$), and diabetes duration ($R = -0.21$, $p = 0.036$), The scatter matrix plot showed strong a positive correlation between FT3 and FBG ($R = 0.54$, $p = 0.03$), HbA1c ($R = 0.36$, $p = 0.004$), and the diabetes duration ($R = 0.41$, $p = 0.05$), FT4 was also strong positively correlated with FBG ($R = 0.46$, $p = 0.029$), HbA1c ($R = 0.33$, $p = 0.028$), and the diabetes duration ($R = 0.39$, $p = 0.048$), indicated that increased FT3 and FT4 levels are associated with poor glycemic status and longer diabetes duration.

Conclusion: Concluded from this study, well-controlled Type 2 Diabetes reduced the risk of hyperthyroidism, relatively high HbA1c and low TSH levels may increase the risk of hyperthyroidism; therefore, the combination of these indicators can serve as a biomarker for identifying healthy individuals from those who would later develop hyperthyroidism.

Key words. Type 2 diabetes, lower risk, hyperthyroidism, HbA1c.

Introduction.

The association between glycated hemoglobin (HbA1c) levels and thyroid hormone abnormalities in patients with Type 2 Diabetes Mellitus (T2DM) is a critical area of endocrinological research. Diabetes and thyroid dysfunction are two prevalent endocrine disorders that often coexist, with each condition influencing the other in complex ways. Elevated HbA1c levels, a marker of long-term glycemic control, have been linked to altered thyroid function, including both hypothyroidism and hyperthyroidism. Thyroid hormones play a significant role in carbohydrate metabolism, insulin sensitivity, and erythropoiesis, all of which can impact HbA1c levels. Conversely, hyperglycemia in diabetic patients may disrupt the hypothalamic-pituitary-thyroid axis, further complicating thyroid hormone regulation [1-3]. The relationship between HbA1c and TSH in the development of hyperthyroidism is complex, the interplay between these factors can have significant implications for patient care and disease management. In this study investigated the effectiveness of well-controlled type 2 diabetes by measuring HbA1c and TSH concerning the incidence risk of hyperthyroidism through a cross-sectional study involving diabetic patients [4,5]. The role of TSH in this relationship may be explored, as TSH plays a key role in thyroid function and its potential link to the development of hyperthyroidism in the context of diabetes mellitus [6,7]. The findings from this study could have important implications for the management of diabetes and the prevention of hyperthyroidism in diabetic patients [8-10]. Understanding the potential relationship between HbA1c, TSH, and the development of hyperthyroidism may lead to improved screening, monitoring and management strategies for these conditions [11-13]. The findings may ultimately help healthcare professionals in providing more targeted and effective care for diabetic patients at risk of developing hyperthyroidism [14,15].

Materials and Methods.

A cross-sectional study conducted at Thumbay Hospital Ajman, UAE, the study received institutional review board

(IRB) approval before the collection of specimens. 189 patient's participants included both males and females, 92 good glycemic patient's participants compared with 97 poor glycemic type 2 diabetic patients, The participants' age ranged between 21 to 72 years, and they were divided into three age categories: young adults (21 – 30), middle-aged adults (31 – 45), old-aged adults (> 45) classified according to the WHO age group classification. The assays were performed using Roche Cobas C311 and Cobas e 411 Analyzers, and the validation procedure was done according to the college of American pathologists (CAP) and electrochemiluminescence immunoassay (ECLIA) for precision, accuracy, and linearity. For the fasting blood glucose (FBG) test, plasma was examined after obtaining a blood sample in a fluoride oxalate anticoagulant (gray tube). The Roche Cobas C311 analyzer was used to detect glucose and HbA1c in blood plasma, quantified using a spectrophotometer. To perform the Thyroid Stimulating Hormone (TSH), Free Triiodothyronine (FT3), and Free Thyroxine (FT4) tests, another blood sample was taken, and the Cobas e 411/601 Analyzer was used. This analyzer is an automated immunoassay, and the results of the tests were quantified using electrochemiluminescence. The results analyzed by using SPSS version 26, the mean and standard deviation (SD) were obtained. The "t" independent test, one-way analysis of variance (ANOVA) and linear regression were used for comparison and correlation analysis. The P-value was obtained to assess the significance of the results, with a P-value of <0.05 considered significant.

Results.

In this study the total patients' participant 189 males and females, 92 patients with good glycemic status were compared to 97 patients with poor glycemic status, considering factors such as age, diabetes duration, and various blood parameters. According to WHO age group classification, the patients' participant age was divided into three groups young adults (21 – 30), middle-aged adults (31 – 45), old-aged adults (> 45) and the duration of the disease is between (4 – 15) years (Tables 1 and 2). To compare the mean values between good and poor glycemic status, the t-independent test was used, the results revealed a statistically significant differences in the mean values of FBG (p = 0.001), HbA1c (p = 0.016), TSH (p = 0.009), FT3 (p = 0.048), and FT4 (p = 0.038) compared with good and poor glycemic status (P.value < 0.05) . The mean of circulating biomarkers and diabetes duration was compared used a one-way ANOVA. When the duration of diabetes increased, FBG showed a statistically significant decrease (p = 0.027), with the highest mean FBG level observed in those with 4–7 years of diabetes (126.5 ± 33.7 mg/dL). HbA1c (%) showed significant variation among the groups (p = 0.007), with the highest mean levels recorded in the 8–11 years group (7.1 ± 2.21%). TSH showed a significant decrease with increased diabetes duration (p = 0.011). FT3 also showed a significant relationship with the duration of diabetes (p = 0.05), with lower FT3 levels in the 8–11 years group compared to both the 4–7 years and 12–15 years groups. With longer diabetes duration, FT4 statically significant decreased (p = 0.041), with the highest levels observed in the 4–7 years group (123 ± 0.32 pmol/L). These findings demonstrated that prolonged diabetes duration is associated with alterations in thyroid hormonal levels and glycemic control (Tables 3 and 4). The correlation coefficient was used to determine the strength of the association between the thyroid hormonal profile, HbA1c, and diabetes duration. The correlation between thyroid markers, glycemic parameters the diabetes duration, revealed significant moderate a negative correlation between TSH and FBG (R = -0.34, p = 0.001), HbA1c (R = -0.27, p = 0.02), and diabetes duration (R = -0.21, p = 0.036), The scatter matrix plot showed strong a positive correlation between FT3 and FBG (R = 0.54, p = 0.03), HbA1c (R = 0.36, p = 0.004), and the diabetes duration (R = 0.41, p = 0.05), FT4 was also strong positively correlated with FBG (R = 0.46, p = 0.029), HbA1c (R = 0.33, p = 0.028), and the diabetes duration (R = 0.39, p = 0.048), indicating that increased FT3 and FT4 levels are associated with poor glycemic status and longer diabetes duration (Figures 1,2 and Table 5).

Discussion.

The study aimed to investigate the relationship between Glycated Hemoglobin and Elevated Thyroid Hormones Levels in type 2 diabetes mellitus. The study revealed significant relationship between HbA1c, thyroid hormones, and glycemic control in type 2 diabetes mellitus. A moderate positive correlation was observed between FBG, HbA1c, and thyroid hormones FT3 and FT4, while TSH levels showed a negative correlation with FBG, HbA1c, Additionally, longer diabetes duration was associated with poor glycemic status and thyroid dysfunction. These results, aligned with a study published in the Bulletin of the National Research Centre observed Positive Correlation Between FBG, HbA1c, and Thyroid Hormones FT3, FT4 in T2DM patients. Specifically, HbA1c correlated positively with

Table 1. *Overall characteristics of patient's participant.*

Demographic	**Variable**	**Age Range/ (years)**	**Patient participant N = 189**	
			Number	**%**
Age groups	**Young age**	(21 – 30)	30	16
	Middle- age	(31 – 45)	86	45
	Old-aged	(> 45)	73	39
Gender	**Male**	(21 – 72)	87	46
	Female	(23- 68)	102	54
Duration of Diabetes	**(4 – 7) years**	(27 – 66)	79	42
	(8 – 11) years	(31 – 72)	91	48
	(12 – 15) years	(22 – 69)	19	10
Glycemic status	**Good**	(28 – 72)	92	49
	Poor	(22 – 69)	97	51

Table 2. *Demographic Characteristics of Diabetes Duration and Glycemic Status.*

Demographic		**Age group / Years**					
		Young Adults (21 – 30)		**Middle-aged adults** (31 – 45)		**Old-aged adults** (> 45)	
		Number	**%**	**Number**	**%**	**Number**	**%**
Duration of Diabetes	**(4 – 7) years**	8	4	29	15	42	22
	(8 – 11) years	13	7	53	28	25	14
	(12 – 15) years	9	5	4	2	6	3
Glycemic status	**Good**	14	7	45	24	33	18
	Poor	16	8	41	21	40	22

Table 3. *Comparison of Biomarkers Between Good and Poor Glycemic Status.*

Biomarkers	**Glycemic status**		**P. value**
	Good glycemic status Less than 7 %	**Poor glycemic status More than 7%**	
	Mean ± SD	**Mean ± SD**	
FBG mg/dl	105.2 ± 26.05	117.5 ± 26.9	0.001
HbA1c %	5.3 ± 1.9	7.87 ± 0.97	0.016
TSH mIU/L	2.14 ± 1.06	2.38 ± 1.31	0.009
FT3 pmol/L	1.59 ± 0.42	1.46 ± 0.40	0.048
FT4 pmol/L	108 ± 0.22	113 ± 0.24	0.038

• *T. independent test: used to obtain P. value.*
• *P.value < 0.05 (significance).*

Table 4. *Relationship Between Diabetes Duration and Circulating Biomarkers.*

Duration of diabetic disease	**Circulating Markers (Mean ± SD)**				
	FBG mg/dl	**HbA1c** %	**TSH** mIU/L	**FT_3** pmol/L	**FT_4** pmol/L
(4 – 7) years	126.5 ± 33.7	6.6 ± 1.05	2.40± 1.48	1.68 ± 0.65	123 ± 0.32
(8 – 11) years	113.4 ± 39.7	7.1 ± 2.21	2.03 ± 1.38	1.54 ± 0.53	113 ± 0.19
(12 – 15) years	111.9 ± 38.5	6.96 ± 2.06	1.65 ± 0.95	1.67 ± 0.50	110 ± 0.15
P. value	0.027	0.007	0.011	0.05	0.041

• *One-way ANOVA: used to obtain P. value.*
• *P.value < 0.05 (significance).*

Table 5. *Correlation of Thyroid Markers with Glycemic Parameters and Diabetes Duration.*

Variable	**FBG**		**HbA1c**		**Duration of diabetic disease**	
	(R)	**P. value**	**(R)**	**P. value**	**(R)**	**P. value**
TSH	-0.34	0.001	-0.27	0.02	-0.21	0.036
FT3	0.54	0.03	0.36	0.004	0.41	0.05
FT4	0.46	0.029	0.33	0.028	0.39	0.048

• *R= Correlation coefficient: used to measure how strong a relationship is between two variables.*
• *P.value < 0.05 (significance).*

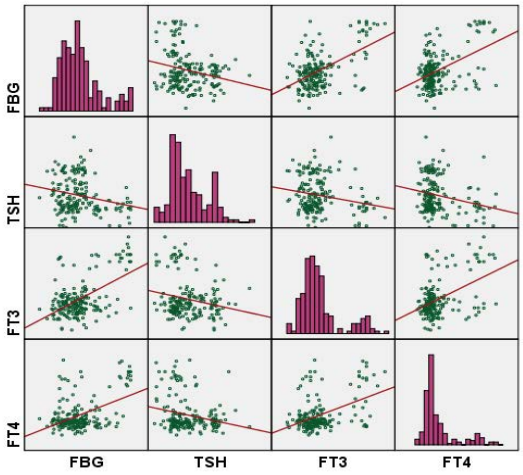

Figure 1. *Scatter matrix showed the correlation between the levels of TSH, FT3, FT4 and FBG.*

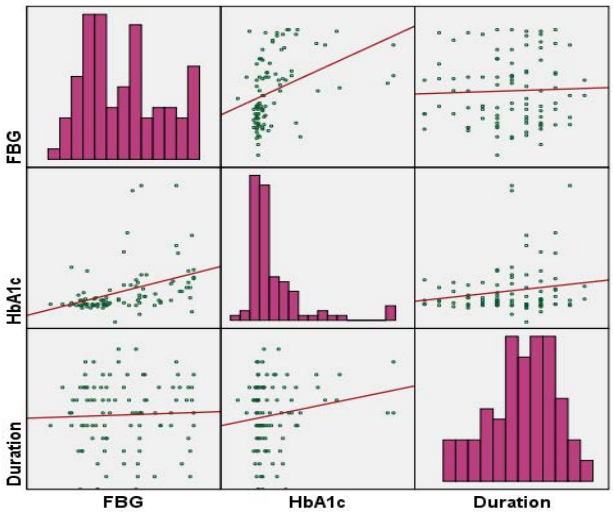

Figure 2. *Scatter matrix showed the correlation between the levels of FBG, HbA1c, and the duration of disease/ Years.*

FT4 in hyperthyroid diabetics (r = 0.379; P = 0.012) [18,19]. Glycemic status, as assessed by FBG and HbA1c, demonstrated significant differences with longer diabetes duration. This is aligned with prior studies reporting that prolonged diabetes is associated with worsening insulin resistance and pancreatic beta-cell dysfunction [20]. Interestingly, our results aligned with recent findings indicated that increased diabetes duration correlated with higher HbA1c levels, reflected the progressive nature of diabetes and its impact on metabolic regulation [21]. The interplay between thyroid function and diabetes had been widely studied, with thyroid dysfunction often observed in diabetic patients [22]. In our study, TSH levels were significantly decreased in patients with poor glycemic status and longer diabetes duration. This negative correlation between TSH and glycemic parameters supported by previous study suggested that hyperglycemia suppresses TSH secretion by affecting hypothalamic-pituitary-thyroid axis activity [23]. Our findings demonstrated a positive correlation between FT3, FT4, and both FBG and HbA1c, implied that elevated thyroid hormones contributed to poor glycemic control. This is aligned with the study reported that increased FT3 and FT4 levels are associated with insulin resistance and higher glucose levels in diabetic patients [24].

Conclusion.

Concluded from this study, well-controlled Type 2 Diabetes reduced the risk of hyperthyroidism, relatively high HbA1c and low TSH levels may increase the risk of hyperthyroidism; therefore, the combination of these indicators can serve as a biomarker for identifying healthy individuals from those who would later develop hyperthyroidism.

REFERENCES

1. Biondi B, Kahaly GJ, Robertson RP. Thyroid Dysfunction and Diabetes Mellitus: Two Closely Associated Disorders. Endocr Rev. 2019;40:789-824.
2. De Leo S, Lee SY, Braverman LE. Hyperthyroidism. Lancet. 2016;388:906-918.
3. Li H, Cui Y, Zhu Y, et al. Association of high normal HbA1c and TSH levels with the risk of CHD: a 10-year cohort study and SVM analysis. Sci Rep. 2017;7:45406.
4. Goldenberg R.M, Cheng A. Y. Y, Punthakee Z, et al. Use of glycated hemoglobin (A1C) in the diagnosis of type 2 diabetes mellitus in adults. Can J Diabetes. 2011;35:247-249.
5. Bertrand C, Blanchet E, Pessemesse L, et al. Mice lacking the p43 mitochondrial T3 receptor become glucose intolerant and insulin resistant during aging. PLoS One. 2013;8:e75111.
6. Shun CB, Donaghue KC, Phelan H, et al. Thyroid autoimmunity in Type 1 diabetes: systematic review and meta-analysis. Diabet Med. 2014;31:126-135.
7. Kalra S, Aggarwal S, Khandelwal D. Thyroid Dysfunction and Type 2 Diabetes Mellitus: Screening Strategies and Implications for Management. Diabetes Ther. 2019;10:2035-2044.
8. Nederstigt C, Corssmit EPM, de Koning EJP, et al. Incidence and prevalence of thyroid dysfunction in type 1 diabetes. J Diabetes Complicat. 2016;30:420-425.
9. Gu Y, Li H, Bao X, et al. The relationship between thyroid function and the prevalence of type 2 diabetes mellitus in euthyroid subjects. J Clin Endocrinol Metab. 2017;102:434-442.
10. Garmendia Madariaga A, Santos Palacios S, Guillén-Grima F, et al. The incidence and prevalence of thyroid dysfunction in Europe: a meta-analysis. J Clin Endocrinol Metab. 2014;99:923-931.
11. Centeno Maxzud M, Gómez Rasjido L, Fregenal M, et al. Prevalence of thyroid dysfunction in patients with type 2 diabetes mellitus. Medicina (Mex). 2016;76:355-358.
12. Subekti I, Pramono LA, Dewiasty E, et al. Thyroid dysfunction in type 2 diabetes mellitus patients. Acta Med Indones. 2017;49:10.
13. Ozair Maaz, Noor Saba, Raghav Alok, et al. Prevalence of thyroid disorders in North Indian Type 2 diabetic subjects: A cross-sectional study. Diabetes & Metabolic Syndrome: Clinical Research & Reviews. 2018;12:301-304.
14. Jali MV, Kambar S, Jali SM, et al. Prevalence of thyroid dysfunction among type 2 diabetes mellitus patients. Diabetes Metab Syndr. 2017;11:S105-S108.

15. Witting V, Bergis D, Sadet D, et al. Thyroid disease in insulin-treated patients with type 2 diabetes: a retrospective study. Thyroid Res. 2014;7:2.
16. Alexander EK, Pearce EN, Brent GA, et al. 2017 Guidelines of the American Thyroid Association for the diagnosis and management of thyroid disease during pregnancy and the postpartum. Thyroid. 2017;27:315-389.
17. Nishi M. Diabetes mellitus and thyroid diseases. Diabetol Int. 2018;9:108-112.
18. Banerjee A, Lnu J, Lnu P, et al. Lipoprotein Ratios: Correlation with Glycated Hemoglobin (HbA1c) Among Thyroid Disorders' Patients. Cureus. 2024;16:e54191.
19. Karar T, Alhammad RI, Fattah MA, et al. Relation between glycosylated hemoglobin and lipid and thyroid hormone among patients with type 2 diabetes mellitus at King Abdulaziz Medical City, Riyadh. J Nat Sci Biol Med. 2015;6:S75-9.
20. Abdallah M.S. Long-term glycemic control and its impact on metabolic parameters in type 2 diabetes patients. Journal of Endocrinology and Metabolism. 2022;45:245-260.
21. Chaker L. The impact of thyroid function on glycemic control in diabetes: A systematic review. Diabetes & Endocrinology Research. 2021;12:89-102.
22. Duntas L.H, Biondi B. The interconnections between diabetes mellitus and thyroid dysfunction. Nature Reviews Endocrinology. 2020;16:601-611.
23. Mohamed A.I. Oxidative stress and thyroid hormone alterations in patients with long-standing diabetes mellitus. Clinical Endocrinology. 2022;77:398-410.
24. Wang Y. The association between thyroid hormones and insulin resistance in type 2 diabetes mellitus: A population-based study. Journal of Diabetes Research. 2023;67:102-115.