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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 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 ბაზებში.

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 საყურადღებო!

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, შემავსებელი და პროცენტული მონაცემები უნდა შეესაბამებოდეს ტექსტში მოყვანილს.

6. ფოტოსურათები უნდა იყოს კონტრასტული; სურათები, ნახაზები, დიაგრამები - დასათაურებული, დანომრილი და სათანადო ადგილას ჩასმული. რენტგენოგრაფიის ფოტოსურათები წარმოადგინეთ პოზიტიური გამოსახულებით **tiff** ფორმატში. მიკროფოტოსურათების წარწერებში საჭიროა მიუთითოთ ოკულარის ან ობიექტივის საშუალებით გადიდების ხარისხი, ანათალების 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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IMPACT OF GESTATIONAL DIABETES MELLITUS ON NEONATAL BIRTH WEIGHT, LENGTH, AND GESTATIONAL AGE: A RETROSPECTIVE CASE-CONTROL STUDY

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Abstract.

Gestational diabetes (GDM) in pregnant women leads to the development of macrosomia in newborns and also influences the characteristics of neonatal length development. It is worth noting that findings regarding the association between GDM and gestational age at birth vary, and there is no evidence to support treating GDM as an independent risk factor for determining gestational age at birth. The aim of this study was to determine the impact of GDM on neonatal physical parameters, including birth weight and length, as well as gestational age at birth. Data were collected using a standardized questionnaire. A total of 220 pregnant women were evaluated: 110 with GDM and 110 healthy pregnant women. The newborns of both groups - those with GDM and the healthy controls - were also assessed.

The data were processed using statistical analysis software. The chi-square (χ^2) test for comparative analysis; a p-value of < 0.05 was considered statistically significant. Our study showed that newborns of mothers with GDM are at higher risk of developing either very high or low birth weight; in contrast, newborns of healthy mothers are predominantly born with a normal weight (OR=0.25, $\chi^2= 11.28$, $p = 0.0036$).

GDM increases the risk of delivering newborns who are either very large or relatively short (95% CI=0.73; 3.68, OR=1.64, $\chi^2 = 6.19$, $p = 0.045$); however, it should be noted that although deviations in length from the norm were observed more frequently in the GDM group, the Odds Ratio analysis did not confirm a statistically significant association. The difference in the distribution of gestational age at birth between newborns of mothers with GDM and healthy mothers is not statistically significant ($\chi^2 = 1.33$, $p = 0.515$). The newborns are predominantly full-term, and the observed difference is minor and random in nature. Multivariate logistic analysis revealed statistical significance regarding weight ($P<0.001$), length ($P=0.007$), and gestational age at birth ($P=0.008$), while linear regression demonstrated a statistically significant effect of maternal age on fetal length ($\beta=0.051$; $p=0.025$).

Based on the study results, we can conclude that GDM is associated with extreme physical parameters in newborns. Among these parameters, an increased risk of high birth weight was found to be closely linked to GDM. A strong association was also established between GDM and the length of newborns; specifically, cases of both short and long newborns are observed more frequently among mothers with GDM.

Key words. GDM, macrosomia, gestational age at birth, newborn length, body mass index.

Introduction.

During pregnancy, placental hormones impair the effective utilization of maternal insulin, resulting in maternal hyperglycemia. Decreased peripheral tissue glucose uptake further exacerbates this hyperglycemic state. This condition is defined as gestational diabetes mellitus (GDM) [1,2]. The etiology of GDM differs substantially from that of type 1 diabetes mellitus (T1DM); GDM is driven by pregnancy-induced insulin resistance rather than absolute insulin deficiency. In the majority of cases, glucose metabolism normalizes postpartum, and GDM symptoms gradually regress [3].

The risk of developing GDM is heightened by several predisposing factors, including maternal overweight or obesity, a family history of type 2 diabetes mellitus (T2DM), advanced maternal age (women over 25 have a higher risk of developing GDM than younger women), and racial backgrounds (individuals of African American, American Indian, Asian American, Hispanic or Latin American, and Pacific Islander descent are at increased risk), though GDM can arise in any pregnancy [4,5]. Prior impaired glucose tolerance (prediabetes) represents a particularly critical risk factor for GDM onset.

Numerous studies have evaluated the impact of GDM on neonatal anthropometric indicators; however, findings vary considerably across populations, particularly regarding birth length and gestational age at birth. For example, a study in Chinese cohorts demonstrated a significant association between GDM and increased birth weight, but no significant correlation with neonatal length [6,7]. Similar investigation has been conducted in European and South Asian populations. Population-based studies have demonstrated that fetal growth patterns in GDM pregnancies exhibit ethnic heterogeneity. Specifically, fetal growth trajectories are reported to be slower in South Asian cohorts than in European cohorts despite maternal GDM [8]. These discrepancies may stem from variations in ethnicity, maternal body mass index (BMI), diagnostic criteria, and treatment protocols, among other factors. Notably, this issue remains insufficiently characterized within the Georgian population, highlighting the need for targeted research.

Fetal macrosomia is the most common intrauterine complication associated with GDM, characterized by a birth weight significantly above normative thresholds [9]. During the intrauterine period, fetal nutrition is supplied by nutrients derived from the maternal circulation. Consequently, maternal hyperglycemia accelerates transplacental glucose diffusion. In response to fetal hyperglycemia, the fetal pancreas upregulates insulin secretion. Fetal hyperinsulinemia stimulates lipogenesis and protein synthesis, resulting in excessive somatic growth and the development of macrosomia [10].

The combination of high maternal blood glucose and elevated fetal insulin levels causes fat accumulation, leading to fetal overgrowth ("Diabetes During Pregnancy - Women's Health," n.d.). It should also be noted that GDM exerts a certain influence on neonatal length parameters. It is known that both above-normal and below-normal body lengths occur at a higher frequency among neonates of mothers with GDM compared to those of healthy pregnancies [11].

Although GDM exerts a significant influence on various neonatal physical parameters, the majority of existing studies indicate that its impact on gestational age at birth is relatively limited [12,13]. GDM contributes to alterations in prenatal growth and development, among other complications attributable to its fetal impact. Accordingly, the primary objective of the study was to evaluate the impact of GDM on neonatal anthropometric parameters, specifically birth weight (kg), length (cm), and gestational age at birth.

Materials and Methods.

Under a cooperation agreement concluded with Batumi Shota Rustaveli State University (BSU), the study was conducted at the BAU International Hospital, Batumi Clinic. Scientific and clinical consultation throughout the research process was provided by the clinic's endocrinologist. Data collection commenced on September 20, 2024, and concluded on July 15, 2025; this time frame ensured a consistent and diverse case selection. The study adhered to international research ethics standards and received approval from the clinic's Ethics Committee (Resolution No. 15/09/2024, I/C identification code 445412152).

The study employed a retrospective case-control design. A total of 220 pregnant women were enrolled, divided into two groups: a control group of 110 healthy pregnant women with no history of metabolic or endocrine disorder, and a study group of 110 pregnant women with GDM, with diagnosis established through laboratory testing and clinical evaluation. Newborns of both pregnant women with GDM and healthy pregnant women were evaluated.

Inclusion and exclusion criteria were established for both the healthy and GDM groups. In particular, inclusion criteria for the GDM group were: uncomplicated pregnancy course through the first trimester, adult age (≥ 18 years), provision of informed consent to participate in the study, and, most importantly, a confirmed diagnosis of gestational diabetes established using a standardized testing protocol. ACOG supports a "two-step" approach (measurement of venous blood glucose one hour after administration of a 50-g glucose challenge test, performed at 24–28 weeks of gestation); a positive result is followed by a 100 g, 3-hour oral glucose tolerance test (OGTT). The diagnosis of GDM was established when two or more glucose values obtained during the 3-hour OGTT exceeded the established threshold values: fasting glucose < 95 mg/dL (5.3 mmol/L), 1-hour glucose < 180 mg/dL (10.0 mmol/L), 2-hour glucose < 155 mg/dL (8.6 mmol/L), and 3-hour glucose < 140 mg/dL (7.8 mmol/L). The Exclusion criteria for this group included chronic diseases, pre-existing forms of diabetes, and multiple gestations, Exclusion criteria also include pre-eclampsia, hypertension, and congenital fetal anomalies. The main inclusion criteria

for the healthy pregnant women were likewise adult age (≥ 18 years) and provision of informed consent to participate in the study; it was also required that healthy participants have neither gestational diabetes nor any other medical condition. Control-group participants were recruited from among healthy pregnant women who delivered at the clinic during the same study period, in order to minimize the risk of selection bias. Individual matching between cases and controls was not performed.

Data collection for both cohorts was carried out using a standardized questionnaire covering the following variables: (1) maternal demographic data: age, height, BMI; (2) characteristics of pregnancy course: possible complications, medical interventions; and (3) neonatal data: gestational age at birth (week), birth weight (kg) and birth length (cm). Maternal BMI was assessed using the hospital's medical records, which provided anthropometric measurements including maternal weight (kg) and height (m). Maternal weight was measured by qualified healthcare personnel using a standard medical scale, whereas BMI was calculated at the initial visit by the attending obstetrician-gynecologist. When necessary, BMI assessment was performed in consultation with an endocrinologist. BMI was calculated using the standard formula: $\text{BMI} = \text{kg/m}^2$. Neonatal anthropometric measurements were obtained by trained medical personnel using calibrated equipment: birth weight was measured using a calibrated infant scale, and birth length was measured using an infantometer.

Data collection followed a uniform methodology based on clinical documentation and patient questionnaires. The collected data were initially analyzed by calculating percentages using the formula: $\% = (n \div N) \times 100$, where n represents the number of participants with a given characteristic and N represents the total number of study participants. In addition to percentages, the margins of errors were calculated using the formula: $\pm \sqrt{(P \times (100 - P) / n)}$, where P denoted the percentage of individuals with a given characteristic and n represented the total number of participants. The data were also processed using statistical analysis software."

The chi-square (χ^2) test was applied to compare categorical variables between the two groups, assessing differences in distribution. Statistical significance of intergroup differences was determined using the p -value.

Results were interpreted in accordance with generally accepted principles of biostatistics, with $p < 0.05$ considered statistically significant. The odds ratio (OR) was also used in the statistical analysis to evaluate the association of GDM with perinatal outcomes—specifically, the extent to which GDM increases or decreases fetal parameters. It was calculated using the formula: $\text{OR} = (a \times d) / (b \times c)$. This measure is applicable when a 2×2 contingency table is available. In addition, multivariable logistic regression and linear regression analyses were performed to examine the associations between independent variables and study outcomes and to evaluate the effects of potential contributing factors. These statistical analyses were conducted using Jamovi statistical software, version 2.7.37.

Results.

Neonates in both the healthy and GDM groups were categorized according to birth weight into four distinct categories: > 4000

Table 1. Comparative analysis of birth weight categories of newborns from mothers with GDM and healthy mothers.

Newborn weight (g)	GDM		Newborns of healthy mothers		χ^2	P
	(n)	(%)	(n)	(%)		
>4000	19	17.27%±3.74	6	5.45%±2.26	11.28	0.0036
2500–4000	84	76.37%±3.49	102	92.73%±1.36		
1500–2500	7	6.36%±2.43	2	1.82%±1.78		
<1500	0	-	0	-		
Total	110	100%	110	100%		

Table 2. Distribution of newborn weight into two groups (normal and deviation from the norm).

Odds Ratio (OR)	Newborns of mothers with GDM	Newborns of healthy mothers
Normal range (2500–4000 g)	84	102
Deviation from the norm > 4000, 1500–2500, and <1500 g	26	8

Table 3. Characteristics of newborn weight distribution based on the mother's pre-pregnancy BMI.

Maternal pre-pregnancy BMI	Birth weight of newborns of mothers with GDM				Birth weight of newborns of healthy mothers				χ^2	P
	Normal range (2500–4000 g)		Deviation from the norm > 4000, 1500–2500, and <1500 g		Normal range (2500–4000 g)		Deviation from the norm > 4000, 1500–2500, and <1500 g			
	n	%	N	%	n	%	n	%		
Underweight (BMI < 18.5)	3	3.57%±1.86	1	3.85%±1.95	6	5.88%±2.35	0	-	48.74	<0.001
Healthy weight (BMI 18.5–24.9)	28	33.33%±4.89	8	30.77%±5.32	71	69.61%±4.49	7	87.50%±9.02		
Overweight (BMI 25–29.9)	23	27.38%±4.59	9	34.61%±5.61	22	21.57%±4.10	0	-		
Obesity (BMI > 30)	30	35.72%±5	8	30.77%±5.32	3	2.94%±1.68	1	12.50%±3.51		
Total	84	100%	26	100%	102	100%	8	100%		

Table 4. Characteristics of newborn weight distribution based on the mother's BMI recorded at 38–39 weeks of pregnancy

Maternal BMI at 38–39 weeks of pregnancy	Birth weight of newborns of mothers with GDM				Birth weight of newborns of healthy mothers				χ^2	P
	Normal range (2500–4000 g)		Deviation from the norm > 4000, 1500–2500, and <1500 g		Normal range (2500–4000 g)		Deviation from the norm > 4000, 1500–2500, and <1500 g			
	n	%	n	%	n	%	n	%		
Underweight (BMI < 18.5)	0	-	0	-	0	-	0	-	25.56	<0.001
Healthy weight (BMI 18.5–24.9)	4	4.77%±2.13	1	3.85%±1.95	17	16.67%±3.71	2	25%±4.94		
Overweight (BMI 25–29.9)	12	14.29%±3.54	4	15.38%±3.84	46	45.09%±4.93	4	50%±6.92		
Obesity (BMI > 30)	68	80.94%±5.08	21	80.77%±7.98	39	38.24%±4.82	2	25%±4.94		
Total	84	100%	26	100%	102	100%	8	100%		

Table 5. Binomial Logistic Regression.

Model Fit Measures			
Model	Deviance	AIC	R ² _{McF}
1	178	184	0.0622
<i>Note. Models estimated using sample size of N=220</i>			

Model Coefficients - Birth weight category				
Predictor	Estimate	SE	Z	p
Intercept	-2.50046	0.9120	-2.7418	.006
GDM	1.38182	0.4615	2.9944	.003
BMI	-0.00197	0.0365	-0.0540	.957
<i>Note. Estimates represent the log odds of "Abnormal Birth weight category = 1" vs. "normal Birth weight category = 0"</i>				

Table 6. Comparison of newborn length categories between mothers with GDM and healthy mothers.

Newborn length (CM)	Newborns of mothers with GDM		Newborns of healthy mothers		χ^2	P
	(n)	(%)	(n)	(%)		
>52	11	10%±2.98	11	10%±2.98	6.19	0.045
46-52	93	84.55±%2.43	99	90%±0.95		
32-45	6	5.45%±2.26	0	-		
Total	110	100%	110	100		

Table 7. Distribution of newborn length into two groups (normal and deviation from the norm).

Odds Ratio (OR)	Newborns of mothers with GDM	Newborns of healthy mothers
Normal range: 46–52 cm	93	99
Deviation from the norm (>52 and 32–45 cm).	17	11

Table 8. Comparison of gestational age at birth of newborns from mothers with GDM and healthy mothers.

Gestational age at birth (weeks)	Newborns of mothers with GDM		Newborns of healthy mothers		χ^2	P
	(n)	(%)	(n)	(%)		
Full-term (37–41)	105	95.45%±2.18	108	98.18%±2.80	1.33	0.515
Preterm (32–36 weeks)	5	4.55±2.07	2	1.82%±1.33		
Extremely preterm (<32)	0	-	0	-		
Total	110	100%	110	100%		

Table 9. Binomial Logistic Regression.

Model Fit Measures						
Model	Deviance	AIC	R ² _{McF}			
1	284	292	0.0692			
<i>Note.</i> Models estimated using sample size of N=220						
Model Coefficients – GDM						
Predictor	Estimate	SE	Z	p		
Intercept	26.24631	7.038	3.73	<.001		
Weight (g)	0.00179	4.74e-4	3.77	<.001		
Length (cm)	-0.37224	0.138	-2.71	.007		
Gestational age (weeks)	-0.35172	0.133	-2.64	.008		
<i>Note.</i> Estimates represent the log odds of "GDM = 1" vs. "NO GDM = 0"						

Table 10. Association of maternal age and GDM with fetal parameters.

Neonatal parameter (Outcome)	Predictor	β (Estimate)	SE	p-value	R ²
Birth weight (g)	Maternal age	11	6.64	0.099	0.025
	Healthy vs GDM	-107.4	70.34	0.128	
Length (cm)	Maternal age	0.051	0.0227	0.025	0.024
	Healthy vs GDM	0.165	0.2405	0.494	
Gestational age (weeks)	Maternal age	0.0006	0.0157	0.967	0.022
	Healthy vs GDM	0.364	0.1660	0.029	

g, 2500–4000 g, 1500–2500 g, and <1500 g. Infants born to mothers with GDM were more frequently observed in the high birth-weight category, whereas infants born to healthy controls accounted for a substantially larger proportion of those with normal birth weight. Low birth weight category was also more common among infants of mothers with GDM compared to controls. No cases of very low birth weight (<1500 g) were observed in either cohort (Table 1). Overall, infants of mothers with GDM demonstrated an increased risk of both very high and low birth weight, whereas infants of healthy mothers were predominantly born within the normal weight range. The distribution of birth-weight categories differed significantly

between groups ($\chi^2 = 11.28$, $p = 0.0036$), confirming a statistically significant association between maternal GDM status and neonatal birth weight (Table 1).

To calculate the odds ratio (OR), birth weight was dichotomized into two categories: normal birth weight (2500–4000 g) and birth weight deviation, the latter encompassing neonates weighing >4000 g, 1500–2500 g, and <1500 g. The calculated OR = 3.95 (95% CI: 1.74–8.97; $p = 0.001$), indicating that the odds of a birth weight outside the normal reference range were nearly fourfold higher among neonates born to mothers with gestational diabetes compared with those born to healthy controls (Table 2).

Neonatal birth weight categories were analyzed according to maternal BMI, considering both pre-pregnancy BMI and BMI at 38–39 weeks of gestation, to compare neonates born to mothers with GDM and those born to healthy controls. The distribution of neonatal birth weight is presented in Table 3. Across all maternal BMI categories, abnormal birth weight was observed more frequently among neonates born to mothers with GDM, whereas normal birth weight predominated among neonates of healthy mothers. This association was statistically significant ($\chi^2 = 48.74$, $P < 0.001$) (Table 3).

The distribution of neonatal birth weight according to maternal BMI at 38–39 weeks of gestation is presented in Table 4. Consistent with findings based on pre-pregnancy BMI (table 3), abnormal birth weight in relation to maternal BMI at 38–39 weeks of gestation was observed predominantly among neonates born to mothers with GDM. Analysis of the data according to maternal BMI at 38–39 weeks of gestation demonstrated a statistically significant association with neonatal birth weight distribution ($\chi^2 = 25.56$, $P < 0.001$) (Table 4).

Multivariable binomial logistic regression analysis was performed to evaluate the association between deviations in neonatal birth weight and maternal GDM and BMI. The model included GDM and maternal BMI as independent variables. The results showed that GDM was statistically significantly associated with deviations in neonatal birth weight from the norm ($\beta = 1.382$, $SE = 0.462$, $p = 0.003$). This association persisted after adjusting for maternal BMI. Furthermore, maternal BMI was not found to be a statistically significant factor for deviation in newborn birth weight from the norm ($\beta = -0.002$, $SE = 0.037$, $p = 0.957$). The model's McFadden R^2 was 0.0622 ($N = 220$) (Table 5).

Table 6 presents the distribution of neonatal birth length in the GDM and healthy control groups. Birth length was categorized into three groups: >52 cm, 46–52 cm, and 32–45 cm. A birth length >52 cm (long-length neonates) was recorded in 11 infants ($10 \pm 2.98\%$) born to mothers with GDM, as well as in the healthy group, demonstrating that neonates with a birth length >52 cm were represented at an equal percentage in both groups. A birth length of 46–52 cm (normal birth length) was observed in 93 infants ($84.55 \pm 2.43\%$) born to mothers with GDM and in 99 infants ($90 \pm 0.95\%$) born to healthy controls indicating that a normal birth length was more frequent among healthy mothers. A birth length of 32–45 cm (short-length neonates) was observed in 6 infants ($5.45 \pm 2.26\%$) born to mothers with GDM. It should be noted that of these six newborns, four were born at 34 weeks, one at 36 weeks, and the remaining one at 39 weeks, whereas no infants in the healthy group fell within this birth length category (Table 6). Accordingly, short-length neonates were observed exclusively among mothers with GDM, suggesting that GDM increases the risk of delivering both above-normal and below-normal length

neonates. The distribution of neonatal birth length $\chi^2 = 6.19$, $p = 0.045$ indicates statistical significance attributable to the influence of GDM. Notably, the majority of neonates in both groups had a normal birth length; however, both short-length and long-length neonates were more frequently observed among infants born to mothers with GDM (Table 6).

To calculate the odds ratio (OR), neonatal length was dichotomized into normal length versus length deviation, the latter encompassing lengths >52 cm and 32–45 cm. $OR = 1.64$. $OR > 1$ indicates that the odds of a length deviation from normal were approximately 1.6 times higher among neonates of mothers with GDM compared with those of healthy controls. However, association is not strong, representing a moderate-to-mild effect. 95% $CI = (0.73; 3.68)$. As can be seen from these data, the interval includes 1. Accordingly, the result is not statistically significant, despite $OR > 1$. Based on this, no meaningful difference between the groups was observed for this parameter (Table 7). These findings underscore the need for confirmatory studies with larger sample sizes to evaluate the potential relationship between GDM and neonatal length deviations.

Data were also stratified by gestational age at birth. Following this analysis, neonatal parameters for the healthy and GDM groups were distributed as follows. Among mothers with GDM, 105 infants ($95.45 \pm 2.18\%$) were born at term, compared with 108 infants ($98.18 \pm 2.80\%$) among healthy controls. Term infants predominated in both groups, with a slightly higher percentage in the healthy group. Preterm infants (32–36 weeks): Five infants ($4.55 \pm 2.07\%$) were recorded among mothers with GDM, compared with two infants ($1.82 \pm 1.33\%$) among healthy mothers. Preterm birth occurred more frequently among mothers with GDM, although the number of cases was small. Very preterm infants (<32 weeks): No cases were recorded in either group (Table 8). The distribution of gestational age at birth did not differ significantly between groups ($\chi^2 = 1.33$, $p = 0.515$). The majority of infants in both groups were born at term, and the observed difference was small and likely attributable to random variation (Table 8).

The data were further evaluated using multivariable logistic regression, performed with Jamovi statistical software. The analysis yielded a deviance of 284 and an AIC of 292, with $R^2_{McF} = 0.0692$, indicating that neonatal anthropometric parameters — birth weight, birth length, and gestational age at birth — are independently associated with maternal GDM status. Statistical significance was observed for weight ($P < 0.001$), length ($P = 0.007$), and gestational age at birth ($P = 0.008$) (Table 9).

Multivariable linear regression analysis was performed to assess the association between maternal age and neonatal parameters (birth weight, birth length, and gestational age at birth) in both cohorts. This analysis found a statistically significant effect of maternal age on neonatal length ($\beta = 0.051$; $p = 0.025$); No statistically significant association was observed between maternal age and birth weight ($p > 0.05$). Regarding gestational age at birth, maternal age showed no direct linear association; however, the intergroup difference between the GDM and control cohorts remained statistically significant ($\beta = 0.364$; $p = 0.029$) (Table 10).

Discussion.

The statistical analysis of neonatal data confirms that GDM increases the risk of extreme birth weight in newborns. Specifically, $OR = 3.95$ (95% $CI: 1.74–8.97$; $p = 0.001$) was observed, indicating that the odds of delivering an infant with a birth weight outside the normal reference range were nearly

fourfold higher among mothers with GDM compared with healthy controls. Similar findings are reported in the international literature. Large-scale studies have noted that GDM is associated with fetal macrosomia, with this risk being particularly elevated among pregnant women with high glycemic levels [14–18]. For example, one study conducted at 11 hospitals in northeastern Italy assessed the independent roles of pre-pregnancy BMI, gestational weight gain, and GDM in the risk of macrosomia in a cohort of 14,109 women with complete records. The findings indicated that maternal obesity, excessive gestational weight gain, and diabetes should be considered independent risk factors for neonatal macrosomia [14].

Similarly, another study examined 1,502 pregnancies and reported that maternal obesity combined with gestational weight gain exceeding the 2009 Institute of Medicine (IOM) guidelines doubled the likelihood of delivering a macrosomic infant compared to women with a normal BMI [16].

Systematic reviews and meta-analysis conducted in 2023 evaluated cohorts registered at clinics in the United Kingdom and China. The primary outcome measure was the incidence of macrosomic infants born to women with GDM, while secondary outcome measures included maternal pre-pregnancy BMI and maternal age [15]. The meta-analysis concluded that early screening and GDM control are pivotal in mitigating these perinatal risks, particularly neonatal macrosomia.

Likewise, a systematic review of national and international databases was conducted in Iran in 2019. Published epidemiological studies (cross-sectional, case-control, and cohort studies) were compared to determine whether GDM was associated with macrosomia. The resulting meta-analysis demonstrated a direct link between maternal GDM and elevated macrosomia rates in Iranian newborns [17].

Regarding low birth weight, our study found a modest increase in LBW incidence among infants of mothers with GDM compared to controls (6.36% vs. 1.82%); however, this association is not consistent across similar studies and may be attributable to compensatory fetal growth associated with concurrent complications [19]. A multicenter study conducted in the United States in 2007, involving a total of 25,505 pregnant women, found that maternal glucose level is strongly and continuously associated with birth weight [19].

A retrospective study conducted in Italy, involving 203 pregnant women (93 with GDM and 110 without GDM), confirmed a higher probability of macrosomic infants among women with GDM compared with healthy pregnant women [18].

Our findings, accounting for maternal BMI both pre-pregnancy ($\chi^2 = 48.74$, $P < 0.001$) and at 38–39 weeks of gestation ($\chi^2 = 25.56$, $P < 0.001$), where infants of mothers with GDM and healthy controls were compared by weight, revealed statistically significant results and confirmed the importance of maternal BMI in neonatal weight outcomes — infants of mothers with GDM in particular showed weight deviations from normal. Similar results are reported in contemporary studies [14,20,21]. A cohort study conducted in Saudi Arabia, involving a total of 531 pregnant women, similarly confirmed that neonatal macrosomia is influenced by both maternal BMI and GDM [20]. Comparable findings are reported by a multicenter study conducted across 96

hospitals in China, involving 64,735 pregnant women, whose main conclusion was that the combined effect of maternal GDM and BMI increased the risk of neonatal macrosomia [21].

The biological link between GDM and neonatal weight can be explained as follows: during GDM, a hyperglycemic state develops in the mother, resulting in excess glucose transfer to the fetus. The fetus responds to this condition through excessive insulin production by fetal pancreatic cells. The action of this insulin leads to a range of metabolic changes, resulting in increased fetal adiposity and, consequently, an overall increase in body mass. GDM is thus biologically closely linked to macrosomia [22]. Statistical analysis of neonatal length clearly shows that the majority of infants in both groups fall within the normal range. Infants with length below the normal reference range were recorded only among mothers with GDM, whereas the proportion of infants with length above the normal reference range was similar between the two groups.

Similar findings have also been reported in the international literature [8,23,24]. Specifically, a retrospective cohort study was conducted using birth data from a metropolitan maternity center in Sydney, New South Wales, Australia, covering deliveries that occurred between 2005 and 2009. The database included a total of 18,304 pregnant women, of whom women with singleton pregnancies and a gestational age at birth exceeding 24 weeks were eligible for inclusion. The study found that GDM is associated with neonatal growth parameters. Specifically, GDM, as an independent factor, was found to increase neonatal length and to be one of the major factors associated with the birth of long-bodied infants [24]. Along similar lines, a multicenter study conducted in Norway during 2008–2010, involving nearly 600 pregnant women, found that offspring of mothers with GDM were smaller in mid-pregnancy but grew more rapidly thereafter until birth compared with offspring of healthy mothers. This tendency was most pronounced among South Asian mothers with moderate to severe GDM. However, the most notable characteristic of these fetuses was not their large size at birth, but rather their smaller size in mid-pregnancy, prior to the diagnosis of GDM [8]. A further study in this area was conducted in the United Kingdom from 2007–2010, involving 10,705 singleton pregnancies (4,747 white European and 5,958 South Asian). This study found that in both ethnic groups, GDM was associated with early deviations in fetal size prior to GDM diagnosis, underscoring the need for new strategies to facilitate earlier diagnosis of gestational hyperglycemia than is possible with current approaches. The study also concluded that ethnicity-specific fetal growth criteria are important for identifying the pathological effects associated with hyperglycemia [23].

The association between GDM and neonatal length may be explained as follows: as noted above, GDM produces a hyperglycemic state in the mother, resulting in increased transplacental glucose transfer to the fetus, which in turn promotes excessive fetal growth. However, fetal growth under these conditions is not necessarily uniform and may be asymmetric. Growth restriction may occur during early fetal development and subsequently be followed by accelerated growth later in pregnancy, resulting in excessive growth during late gestation. Consequently, glucose dysregulation is thus a cause of both long-bodied and short-bodied fetuses at birth [25].

Some studies indicate that GDM is associated with macrosomia and abnormal fetal growth, which may be explained by disturbances in insulin-glucose homeostasis and excessive transplacental glucose transfer to the fetus [19]. A multicenter international cohort study, conducted across 15 centers in 9 countries — including the United States, United Kingdom, Canada, New Zealand, Australia, Belgium, Denmark, Iceland, and Sweden — confirmed that GDM was directly associated with macrosomia and abnormal fetal growth. This study was conducted between 2000–2006 and involved 25,505 pregnant women [19]. An increase in the number of short-length infant cases may be attributable to concurrent complications or to imbalances in vitamin intake and nutritional factors during pregnancy [26]. A retrospective study published in 2024, conducted across several hospitals in Israel and involving more than 11,000 pregnant women, also supports the conclusion that GDM is a contributing factor in reduced neonatal length [26].

In summary, our data confirm that GDM increases the probability of extreme fetal growth parameters, encompassing both birth weight and birth length, thereby underscoring the importance of maternal metabolic control for fetal development and delivery risk management.

Our data regarding gestational age at birth showed that GDM is not, in general, associated with a marked change in the risk of term delivery. Comparable findings have been reported in other studies, demonstrating that GDM is closely associated with fetal growth parameters such as weight and length, but is not significantly associated with gestational age at birth [27,28]. This may be attributable to advances in maternal monitoring and early-screening strategies, which help prevent prolonged or markedly shortened gestation. In this regard, a study conducted in the United States between 2014–2019, based on the National Vital Statistics System (NVSS) database and including data from more than 52,500 pregnant women, found that GDM is not a risk factor for gestational age at birth [28].

One of the large population-based cohort studies conducted in China, involving 105,528 pregnant women, showed that GDM was associated with preterm birth in general; however, no significant association was identified with very preterm birth (<32 weeks). Furthermore, recurrent GDM did not confer an additional increase in the risk of preterm birth [27].

Our study findings confirm that, despite the effect of GDM on neonatal physical parameters such as weight and length, gestational age at birth does not differ significantly between neonates born to mothers with GDM and those born to healthy pregnant mothers. This finding may be explained by timely clinical management and effective maternal metabolic control throughout pregnancy.

Study limitation.

The study is subject to limitations that are significant when interpreting the results. It was conducted using a small sample size in a single-center setting, which precludes generalizing the findings to the broader population. Furthermore, the retrospective nature of the data acts as a limiting factor, preventing the full demonstration or establishment of a cause-and-effect relationship. It should be noted that a number of confounding

factors were not taken into account during the study - including genetic predisposition, physical activity, socioeconomic status, and dietary habits - which could significantly influence the development of GDM and, consequently, the developmental characteristics of the newborn.

We cannot rule out the possibility that women with early-onset GDM underwent the OGTT at a later stage; given this, the impact of an early GDM diagnosis on infant growth may be underestimated.

Given the aforementioned limitations, it is desirable to verify the obtained results through broader, multicenter studies, which would enable us to draw much more robust and precise conclusions. Another limitation is the failure to assess the dietary factors of the pregnant women.

Conclusion.

Based on the study results, we can conclude that GDM is associated with extreme physical parameters in newborns; specifically, the findings indicate a strong association between GDM and macrosomia. A relatively minor association was also established between GDM and neonatal length; it was found that newborns of mothers with GDM more frequently fall into the categories of short or long stature, reflecting instability and the risk of extreme fetal growth. The weak association between GDM and newborn length is confirmed by Odds Ratio analysis, which failed to demonstrate a statistically significant association. As for gestational age at birth, it did not differ significantly compared to newborns of healthy pregnant women. A data analysis method - multivariable logistic regression - confirmed the impact of GDM on neonatal parameters such as weight and gestational age at birth, meanwhile, linear regression analysis led to the conclusion that maternal age indeed influences fetal length. The final conclusion highlights the necessity of early identification and management of GDM to ensure optimal physical outcomes for the newborn.

Declaration of interest.

The authors declare no conflict of interest.

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