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Studying the Relationship Between Obesity and Type 2 diabetes mellitus with Demographic, Behavioral, and Genetic Factors Among Children in Benghazi City in Libya

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دراسة العلاقة بين السمنة والسكري النوع الثاني مع العوامل الديموغرافية والسلوكية والوراثية لدى الأطفال في مدينة بنغازي

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Abstract:
This cross-sectional study aimed to analyze the relationship between obesity and type 2 diabetes mellitus(T2DM) and its association with demographic, behavioral, and genetic factors among in children from Benghazi city, Libya. The study included 104 children (aged 3–15 years) with a confirmed T2DM diagnosis. Data were collected by a structured questionnaire and HbA1c blood tests. The data was analyzed using the Statistical Package for the Social Sciences (SPSS) software employing Pearson's correlation coefficient. The results revealed that behavioral factors including frequent consumption of fast food, sugar-sweetened beverages and sweets combined with low levels of physical activity and shorter sleep duration were strongly associated with T2DM and obesity ($p < 0.001$). In contrast, demographic factors such as sex, age, and family history of obesity or diabetes did not show significant association with the conditions in this cohort. A significant correlation was confirmed between HbA1c levels and T2DM ($r = -0.56$, $p < 0.001$), reinforcing its role as a key diagnostic indicator.

Keywords: Obesity, Type 2 diabetes, behavioral factors, demographic factors.

الملخص:
تهدف هذه الدراسة إلى دراسة العلاقة بين السمنة وداء السكري من النوع الثاني عند الأطفال (3–15 سنة) في مدينة بنغازي مع العوامل الديموغرافية والسلوكية والوراثية. شملت العينة 104 طفلاً مصابين بالسكري النوع الثاني واعمارهم من 3 الى 15 سنة. وجُمعت البيانات عبر استبيان تضمن معلومات عن الجنس والوزن والطول والتاريخ العائلي والعادات الغذائية والنشاط البدني وساعات النوم، بالإضافة إلى قياس السكر التراكمي.(HbA1c) أُجري التحليل الإحصائي باستخدام معامل ارتباط بيرسون واختبارات الدلالة الاحتمالية (p-value) عبر برنامج SPSS. وأظهرت النتائج أن المتغيرات الديموغرافية مثل (الجنس والعمر والوزن والطول والتاريخ العائلي) لم تظهر علاقة ذات دلالة إحصائية بحالة المرض. بينما المتغيرات السلوكية مثل (استهلاك الوجبات السريعة والمشروبات المحلاة والحلويات وقلة النشاط البدني وقلة النوم

والتوتر أظهرت ارتباطاً قوياً مع ارتفاع مخاطر السمنة والسكري ($p < 0.001$). وجد ارتباط بين ارتفاع مستوى السكر التراكمي HbA1c والسمنة والاصابة بالسكري النوع الثاني($r = -0.56$) وقيمة ($p < 0.001$) ما يؤكد دوره كمؤشر تشخيصي.

الكلمات المفتاحية: السمنة والسكري النوع الثاني والجنس والعمر والوزن والطول والوجبات السريعة والمشروبات المحلاة والحلويات وقلة النشاط البدني وقلة النوم.

Introduction:

Childhood obesity represents a paramount public health crisis of the 21st century, constituting a critical etiological precursor to a spectrum of chronic metabolic diseases, with type 2 diabetes mellitus (T2DM) being among the most consequential. Global epidemiological data from the World Health Organization (WHO, 2023) delineate a pervasive trend, indicating that 39% of the adult population is overweight while 13% meet the criteria for obesity, a trajectory intrinsically linked to the escalating global burden of metabolic dysregulation, most notably T2DM (Ng et al., 2020).

The pathophysiological linkage between adiposity and diabetes is both profound and well-established, with obesity accounting for an estimated 80–85% of the attributable risk for T2DM development, thereby positioning it as the single most significant modifiable risk factor for disease prevention. The resultant economic impact is staggering, with the global cost of obesity and its comorbid conditions projected to approximate USD 2 trillion annually (OECD, 2021), underscoring the severe socioeconomic ramifications alongside the clinical toll.

Advancements in adipose tissue biology have fundamentally shifted our understanding of its role from a passive energy reservoir to that of a dynamic, active endocrine organ. Contemporary research demonstrates that visceral adipocytes secrete a plethora of bioactive hormones, cytokines, and proteins, collectively termed adipokines, that exert profound influences on systemic insulin sensitivity and glucose homeostasis (Kahn et al., 2019). Notably, proteins such as Retinol-Binding Protein 4 (RBP4) have been identified as key mediators propagated by expanded adipose tissue that directly contribute to the pathogenesis of insulin resistance (Yang et al., 2021).

This mechanistic evidence is reflected in disquieting epidemiological patterns. Data from the International Diabetes Federation (IDF, 2022) reveal extreme disparities in disease prevalence with nations such as Saudi Arabia and Kuwait reporting T2DM rates nearing 24%, among the highest globally, concurrent with obesity rates exceeding 35% of their populations. These figures highlight the urgent imperative for evidence-based, primary prevention strategies targeting the early-life determinants of adiposity to mitigate the impending tide of cardiometabolic morbidity (Elabadlah et al., 2023).

Research Problem:

the prevalence of obesity and type 2 diabetes in children is a significant medical challenge due to its direct impact on childern health. This is particularly evident in communities characterized by unhealthy dietary patterns and low physical activity. A central problem the insufficient awareness of the impact of behavioral factors (such as diet and inadequate sleep) compared to the more widely genetic predispositions. An accurate understanding of the underlying causes is crucial for enhancing diagnosis, treatment, and the prevention of related complications.

Research Significance:

The importance of this research stems from:

1. Minimizing the occurrence of obesity and type 2 diabetes in children.
2. Minimizing potential complications associated with the condition.
3. Addressing the research gap to elucidate the relative contributions of behavioral versus genetic factors in the development of type 2 diabetes in children.
4. Raising awareness of the risk factors for obesity and type 2 diabetes, which can aid in developing effective prevention and management strategies.
5. Improving children health outcomes through early diagnosis and timely intervention.

Research Objectives:

This research aims to investigate the relationship between obesity and type 2 diabetes in the pediatric population, as well as, Analyze the contributing factors including behavioral, genetic, and demographic to elucidate their roles i the development of these conditions. This research seeks to contribute to the development of strategies for prevention, early diagnosis, and appropriate management of the condition.

Methodology:

Research Design:

This study was designed to investigate the relationship between obesity and type 2 diabetes mellitus in a pediatric population in the specialized diabetes clinics in Benghazi. Additionally, the study aimed to identify other potential risk factors including behavioral, demographic and genetic variables.

Sampling Method and Study Population:

The study included 104 children with a confirmed diagnosis ofT2DM, recruited from specialized diabetes clinics in Benghazi between March 2024 to September 2024.The participants weights ranged from 19–50 kg and their ages ranged from 3–15 years The main goal was to determine the relationship between obesity and type 2 diabetes mellitus in children and to identify the risk factors associated with both conditions in this population.

Ethical Considerations:

Ethical clearance for the study was granted by the specialized diabetes clinics in Benghazi Ethics Committee. Written informed consent was obtained from the parents or legal guardians of all child following a comprehensive explanation of the study's objectives, methods, and potential benefits.

Instruments of Data Collection:

The study utilized the following research instruments:

1. **Questionnaire:**

A structured questionnaire was specifically designed to collect comprehensive data about child with type 2 diabetes mellitus, **included:**

- Demographic information: Age, sex, weight, and height (for BMI calculation).
- Genetic predisposition**:** Family history of obesity and/or diabetes.
- Dietary patterns**:** Frequency of consumption of fast food, sweets, and sugar-sweetened beverages.
- Lifestyle factors**:** Levels of physical activity and average daily sleep duration. (See Appendix 1).

2. **Blood Tests:**

Blood samples were collected from children to measure Glycated hemoglobin (HbA1c) levels. These values were obtained from medical records to assess glycemic control. All samples were analyzed in the laboratory of the specialized diabetes clinics in Benghazi using standardized protocols.

Data Analysis:

The data collected from the questionnaires were analyzed using the Statistical Package for the Social Sciences (SPSS) software. Statistical analysis including Pearson's correlation and significance testing were performed with the significance level at $\alpha = 0.05$ and $\alpha = 0.01$. Correlations were considered stastically significant if the observed P-value was less than 0.05.

Results and Discussion:

The data presented in Tables (1) revealed no statistically significant association (a p-value less than 0.3) between obesity and Type 2 diabetes mellitus with gender and age in children. The results indicated that demographic and genetic factors alone might not be sufficient to predict the risk of obesity or type 2 diabetes mellitus. Our data are consistent with previous studies, which demonstrated that age, sex and genetic factors might not be decisive factors in the development of type 2 diabetes mellitus and obesity in children. (Kelsey et al., 2014)

Table (1) showed no statistically significant association between weight and height categories with the prevalence of obesity and Type 2 diabetes mellitus in children. No significant association was between height and diagnosis ($p = 0.093$). Although obesity (BMI ≥ 95%) is a major risk factor for Type 2 diabetes mellitus. The results are not consistent with reports that suggested may reflect the influence of other factors such as metabolism or the geographical distribution of fat (Weiss et al., 2004).

The data presented in Table (1) showed no statistically significant association ($p = 0.983$) between a family history of diabetes and the child's diagnosis with the prevalence of obesity and Type 2 diabetes mellitus in children. These results may reflect sample limitations or the influence of protective factors such as physical activity. Our data are not consistent with previous studies linking family history to an increased risk of diabetes (Dabelea et al., 2017).

The data in Table (1) revealed statistically significant association between the child's dietary habits (e.g., consumption of sugary drinks) and the risk of obesity and Type 2 diabetes mellitus ($p < 0.001$, $r = 0.474$). This is because sugar in these beverages elevate blood glucose levels and increase pancreatic stress. These data is consistent with reports indicating that sugary drink consumption is associated with a 26% increased risk of Type 2 diabetes mellitus in children. (Malik et al., 2010).

On the other hand, the results indicated statistically significant association between diabetes diagnosis and the consumption of sweets and chocolates ($r = 0.450$, $p < 0.001$). The results indicate that a diet high in free sugars is a key risk factor for Type 2 diabetes mellitus in children. Our data are consistent with previous studies which demonstrated consumption of sweets and chocolates increases the risk of obesity and insulin resistance. (Basu et al. (2013). On a related note, the data indicated a

consumption of fast food (rich in saturated fats and simple carbohydrates) was associated with an increased risk of obesity and Type 2 diabetes mellitus in children. ($p < 0.001$, $r = 0.336$). The result indicated a child consumes fast food increased risk of obesity and insulin resistance. These data consistent with previous reports which found that consuming fast food more than twice a week increases the risk of type 2 diabetes by 27% (Hu et al. 2011).

The data in Table (1) showed that statistically significant association between physical inactivity and obesity and Type 2 diabetes mellitus in children. ($r = 0.586$, $p < 0.001$). This result is because physical activity enhances insulin sensitivity and improves glucose metabolism. Oue data are consistent with previous studies which suggest that association between higher sugar consumption with physical inactivity to significantly increases the risk of obesity and diabetes. (Ludwig et al., 2018 and (Knowler et al., 2002).

Table (1) showed statistically significant association between sleep duration and stress with the risk of diabetes in children ($p < 0.000$, $r = 0.38$). This result is because sleep deprivation disrupts hormonal balance leading to heightened appetite and impaired blood sugar regulation. These data are consistent with reports indicating that sleep deprivation and chronic stress can lead to hormonal imbalances that increase the risk of obesity and diabetes. (Tam et al. 2010 and Chaput et al., 2010).

The data presented in Table (1) revealed a statistically significant association between HbA1c levels and Type 2 diabetes mellitus diagnosis in children ($r = -0.558$, $p < 0.001$). These results are consistent with the criteria established by the World Health Organization indicating which identify elevated HbA1c is a critical indicator for diagnosing prediabetes and diabetes. (WHO, 2020 and American Diabetes Association, 2023).

Table (1): Correlation analysis between demographic/behavioral variables and diabetes diagnosis in children using Pearson's correlation coefficient

Variables	p-value	Correlation Coefficient (r)	Interpretation
Gender	0.576	0.057	No significant association
Age	0.070	0.316	No significant association
Weight	0.069	0.271	No significant association
Height	0.075	0.308**	No significant association
Family history of obesity	0.177	0.133	No significant association
Family history of type 2 diabetes	0.588	0.054	No significant association
Weekly sugary drink consumption	0.000	0.474**	significant association
Weekly sweets/chocolate consumption	0.000	0.450**	significant association
Weekly fast-food consumption	0.000	0.336**	significant association
Daily physical activity	0.000	0.586**	significant association
Daily sleep duration	0.000	0.381**	significant association
HbA1c levels	0.000	0.654**	significant association

*Correlation is significant at $p < 0.05$
** Correlation is significant at $p < 0.01$

Conclusion:

This cross-sectional study among children with T2DM in Benghazi revealed significant associations between behavioral factors such as consumption of fast food, sugar-sweetened beverages, sweets combined with low levels of physical activity and shorter average daily sleep duration and obesity and diabetes in children. A significant correlation was confirmed between HbA1c levels and T2DM. Therefore, the findings suggest that modifiable lifestyle behaviors are predominant correlates of T2DM and obesity in this pediatric group.

In contrast, demographic factors including sex, weight, age and Family history did not demonstrate a statistically significant independent association. It is critical to interpret the non-significance of weight with caution, as the condition of obesity, defined by elevated BMI, is inherently a central risk factor in the pathophysiology of T2DM.

Recommendations:

1. The necessity of following a healthy diet and reduce the consumption of fast food, sugar-sweetened beverages, and sweets.
2. Encourage engaging in physical activity for at least 60 minutes daily.
3. Ensure 8–10 hours of sleep for children and minimize stress.
4. Maintain a healthy weight in children and monitor HbA1c levels in at risk individuals.
5. Expand the study scope to include a larger sample of children for more comprehensive and accurate results.

6. Raise awareness among mothers for early detection of obesity and type 2 diabetes mellitus that may affect children health.
7. Improve monitoring of children to reduce the risk obesity and type 2 diabetes mellitus.

Refrance:

1. American Diabetes Association. (2023). Standards of Medical Care in Diabetes—2023. Diabetes Care, 46(Supplement 1), S1–S270. https://doi.org/10.2337/dc23-S001
2. Basu, S., Yoffe, P., Hills, N., & Lustig, R. H. (2013). The relationship of sugar to population-level diabetes prevalence: An econometric analysis of repeated cross-sectional data. PLOS ONE, 8(2), e57873. https://doi.org/10.1371/journal.pone.0057873
3. Chaput, J.-P., & Sjödin, A. M. (2010). Sleep duration and obesity in children: A systematic review and meta-analysis of prospective cohort studies. Journal of Paediatrics and Child Health, 46(7-8), 362–364. https://doi.org/10.1111/j.1440-1754.2010.01834.x
4. Dabelea, D., Mayer-Davis, E. J., Saydah, S., Imperatore, G., Linder, B., Divers, J., Bell, R., Badaru, A., Talton, J. W., Crume, T., Liese, A. D., Merchant, A. T., Lawrence, J. M., Reynolds, K., Dolan, L., Liu, L. L., & Hamman, R. F. (2014). Prevalence of type 1 and type 2 diabetes among children and adolescents from 2001 to 2009. JAMA, 311(17), 1778–1786. https://doi.org/10.1001/jama.2014.3201
5. Elabadleh, A., Alsharif, F., & Zain, M. (2023). Obesity and diabetes trends in the Middle East: Challenges and public health strategies. Journal of Health Policy and Management, 12(3), 115–124.
6. Hu, F. B. (2011). Globalization of diabetes: The role of diet, lifestyle, and genes. Diabetes Care, 34(6), 1249–1257. https://doi.org/10.2337/dc11-0442
7. International Diabetes Federation. (2021). IDF Diabetes Atlas (10th ed.). Brussels, Belgium: International Diabetes Federation. Retrieved from https://diabetesatlas.org/
8. Kahn, S. E., Hull, R. L., & Utzschneider, K. M. (2006). Mechanisms linking obesity to insulin resistance and type 2 diabetes. Nature, 444(7121), 840–846. https://doi.org/10.1038/nature05482
9. Kelsey, M. M., Zaepfel, A., Bjornstad, P., & Nadeau, K. J. (2014). Age-related consequences of childhood obesity. Gerontology, 60(3), 222–228. https://doi.org/10.1159/000356023
10. Knowler, W. C., Barrett-Connor, E., Fowler, S. E., Hamman, R. F., Lachin, J. M., Walker, E. A., & Nathan, D. M. (2002). Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. New England Journal of Medicine, 346(6), 393–403. https://doi.org/10.1056/NEJMoa012512
11. Ludwig, D. S., Peterson, K. E., & Gortmaker, S. L. (2001). Relation between consumption of sugar-sweetened drinks and childhood obesity: A prospective, observational analysis. The Lancet, 357(9255), 505–508. https://doi.org/10.1016/S0140-6736(00)04041-1
12. Malik, V. S., Popkin, B. M., Bray, G. A., Després, J. P., & Hu, F. B. (2010). Sugar-sweetened beverages and risk of metabolic syndrome and type 2 diabetes: A meta-analysis. Diabetes Care, 33(11), 2477–2483. https://doi.org/10.2337/dc10-1079
13. Ng, M., Fleming, T., Robinson, M., Thomson, B., Graetz, N., Margono, C., Mullany, E. C., Biryukov, S., Abbafati, C., Abera, S. F., Abraham, J. P., Abu-Rmeileh, N. M. E., Achoki, T., AlBuhairan, F. S., Alemu, Z. A., Alfonso, R., Ali, M. K., Ali, R., Guzman, N. A., Gakidou, E. (2014). Global, regional, and national prevalence of overweight and obesity in children and adults during 1980–2013: A systematic analysis for the Global Burden of Disease Study 2013. The Lancet, 384(9945), 766–781. https://doi.org/10.1016/S0140-6736(14)60460-8
14. OECD. (2021). Obesity Update 2021. OECD Publishing. https://www.oecd.org/health/obesity-update.htm
15. Tam, C. H. T., Li, A. M., & Chan, M. H. M. (2010). Stress and metabolic disorders in children. Pediatric Diabetes, 11(2), 127–134. https://doi.org/10.1111/j.1399-5448.2009.00562.x
16. Weiss, R., Dziura, J., Burgert, T. S., Tamborlane, W. V., Taksali, S. E., Yeckel, C. W., Allen, K., Lopes, M., Savoye, M., Morrison, J., Sherwin, R. S., & Caprio, S. (2004). Obesity and the metabolic syndrome in children and adolescents. New England Journal of Medicine, 350(23), 2362–2374. https://doi.org/10.1056/NEJMoa031049
17. World Health Organization. (2020). WHO guidelines on physical activity and sedentary behaviour. World Health Organization. https://www.who.int/publications/i/item/9789240015128
18. World Health Organization. (2021). Obesity and overweight. World Health Organization. https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight
19. Yang, Q., Graham, T. E., Mody, N., Preitner, F., Peroni, O. D., Zabolotny, J. M., Kotani, K., Quadro, L., & Kahn, B. B. (2005). Serum retinol binding protein 4 contributes to insulin resistance in obesity and type 2 diabetes. Nature, 436(7049), 356–362. https://doi.org/10.1038/nature03711