

# Knowledge and Awareness of mothers and caregivers of Diabetic Children about clinical features and complications of Diabetic Ketoacidosis in Riyadh City: questionnaire study

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## Abstract

**Objectives:** Diabetic ketoacidosis (DKA) is a life-threatening metabolic disorder in which complications can be avoidable. The purpose of this study is to describe the knowledge of the Saudi caregivers for diabetic children about Juvenile Diabetes Mellitus, its signs and symptoms and prevention and its complications in children under their care.

**Setting and Participants:** A cross-sectional, questionnaire-based study design was conducted in Riyadh city in Saudi Arabia. A sample size of at least 412 was required. The total number of respondents that were included in the analysis was 414. The method of collection of data was done by data collectors.

**Results:** 399 caregivers participated in this study, most of whom were Saudi (376; 94.2%), and gained a university degree (300; 75.2%). The most commonly cited symptom of DM in children was raised blood sugar (225; 56.4%), while the most cited common cause was malnutrition (223; 55.9%), and the most commonly cited manifestation of diabetes was frequent urination (354; 88.7%).

**Conclusion:** This study showed that most type-1 diabetic caregivers had knowledge and awareness regarding DKA in Riyadh, Saudi Arabia. However, some gaps exist. Further studies would assess more factors to enhance the level of knowledge and awareness, and increase the effectiveness toward the right action and response regarding DKA.

**Keywords:** Diabetes Mellitus, DKA, Children, Caregivers, Emergency, Saudi Arabia

## Introduction

The prevalence of type 1 diabetes mellitus (T1DM) in Saudi Arabia is among the highest globally (1). In 2000, diabetes affected an estimated 171 million people worldwide; by 2011 this had increased to more than 366 million and numbers are expected to exceed 552 million by 2030 (1). One of the major and life-threatening complications of T1DM is diabetic ketoacidosis (DKA) as it may potentially lead to significantly higher rates of morbidity and mortality, along with impacting families and increasing the burden on healthcare systems (2, 3). Diabetic ketoacidosis (DKA) is an acute, serious, life-threatening complication of hyperglycemia, ketoacidosis, and ketonuria. It occurs when absolute or relative insulin deficiency prevents the ability of glucose to enter cells for using it as a metabolic fuel. As a result, the liver rapidly breaks down fat into ketones for use as a fuel source. The overproduction of ketones occurs, causing them to build up in the blood and urine and causing the blood to be acidic. DKA occurs primarily in type 1 diabetes patients, although it is not unusual in some type 2 diabetes patients. The insidious rise in polydipsia and polyuria are the most prominent early symptoms of DKA, beside which, other symptoms such as Malaise, generalized weakness, fatigue, nausea and vomiting, diffuse abdominal pain and decreased appetite are also seen (2–7).

Patients and their families have been the object of self-treatment and the administrators of their care. The health care team are the guides who set the stage and increase efforts, when targets are not reached. Rather than being the only diabetes health care team to initiate treatment, patients and parents are encouraged to evaluate their data, recognize patterns, resolve diet and activity issues, and to do so based on real blood glucose results (8,9). Effective integration of patient-centered strategies, such as shared-decision making, motivational interviewing techniques, shared medical appointments, and multidisciplinary team collaboration, into a dynamic model of diabetes care delivery holds promise in reaching glycemic targets and improving patients' quality of life.

Mothers with more knowledge about diabetes and better education maintained better glycemic control of their children, irrespective of their socio-economic status, and to enhance glycemic control and minimize acute and chronic complications of diabetes in children, knowledge and education of mothers is important (10,11).

The most common emergency case in a patient diagnosed with diabetes mellitus is Diabetic ketoacidosis (DKA). Surprisingly, it is more often we see these patients suffering from DKA type 1 diabetes. However, type 2 diabetes patients are never spared from the susceptibility of suffering from this unfortunate emergency. Otherwise, it was noticeable that type 2 DM patients with DKA were under the effect of certain situations such as post-operative, trauma, accident, or infectious diseases (7,12,13).

DKA is reported to be responsible for more than 100,000 hospital admissions per year in the US and accounts for 4% - 9% of all hospital discharge summaries among patients with diabetes. Alhawaish (2013) has estimated more than 500% acceleration in the expenses incurred for healthcare and treatment of diabetes since 2000 and costed the healthcare budget of Saudi Arabia roughly as 25 billion used exclusively for the management of diabetes.

Diabetic ketoacidosis diagnosis is based on the patient's plasma glucose concentration of 250 mg per dL or more and the bicarbonate level less than 18 mEq per L, and the pH level of 7.30 or less. The main course of treatment for DKA is intravenous insulin and fluid replacement therapy, and obviously with precise checkup and monitoring of the potassium levels. To reach the full level of treatment, it is required to educate patients to prevent the recurrence of such a case (14,15).

For example, a study by Alwan et al. (2017) that studied the awareness about diabetes mellitus among attendees of primary health care centers, in Makkah, Saudi Arabia reported that the main sources of information about diabetes were mass media (57.4%), health sector (29.9%) and educational sector (10.6%) and concluded there was a satisfactory level of knowledge about risk factors, symptoms, and risks of diabetes but not awareness of the diabetes associated secondary complications(16–18).

Moreover, illiteracy and low socioeconomic status were significantly associated with poor knowledge and practice of diabetic foot care (19,20), and that the level of education is the most significant predictor of knowledge regarding risk factors, complications and the prevention of diabetes (21).

This study aims to describe the knowledge of the Saudi caregivers of diabetic children about Diabetes Mellitus in children, its signs and symptoms and prevention and its complications in children under their care in Riyadh city.

## Methods

**Study design and subjects.** This study used a descriptive cross-sectional questionnaire-based design and was conducted in Riyadh city in Saudi Arabia, from August through to November 2020. 399 parents or caregivers of diabetic paediatric patients responded to the questionnaire. The inclusion criteria included being a caregiver for a diabetic child who resided in Saudi Arabia during the study period. As part of the online questionnaire, all the participants received an explanation of the study purpose and were requested to provide informed consent before filling out the online questionnaire. The participants were encouraged to complete the questionnaire voluntarily within the time interval of the study and at their convenience. Moreover, the participants were given the chance to seek the help of a person of their choice to help them fill out the form if they were unable to read or answer the form.

**Sample Size.** According to the Saudi Arabia General Authority for Statistics, there were 2,470,683 Saudi children aged  $\leq 19$  years living in Riyadh in 2020. Based on an acceptable error margin equivalent to 5% with a confidence interval of 95%, a sample size of at least 412 was required. The dataset included 431 participants. We excluded participants who were taking care of diabetic patients aged above 16, and if they refused, or did not know the responses to any of the variables of interest, or missing responses. The final sample size after exclusion was 399.

**Data Collection Tool.** The questionnaire was adapted with the permission of Othman et al. and translated into Arabic (22). The used self-administered questionnaire included 30 items on related knowledge and awareness of caregivers about DKA among their type 1 diabetic children and their action and responses. The questionnaire was presented in two major sections: 14 questions on general demographic characteristics, and 16 questions on DKA knowledge, attitudes, actions and responses.

**Data Analysis.** The data were collected from an online platform, tabulated by using Microsoft Excel 2016 and analysed using SPSS software version 26. The categorical variables were presented as percentages and frequencies. Both logistic regression tests and univariate chi-square analysis were conducted to determine the associations between the knowledge and attitude and the participants' general characteristics, as well as their attitude and response to the accepted level of knowledge, to obtain odds ratios for adjusted and unadjusted models. A P-value of  $<0.05$  was considered statistically significant. The Medical College Institutional Review Board, Al-Imam Muhammad Ibn Saud Islamic University, Riyadh, Saudi Arabia approved this study protocol.

## Results

**Demographic features**

Table 1 summarizes the demographic features of the participants, which show that most of the participants are 20–29-year-old (239; 60%), Saudi (376; 94.2%), and from the central and western regions of Saudi Arabia (130; 32.6%, and 171; 42.9%, respectively). Also most of them are university educated (300; 75.2%) and have a monthly income more than 5,000 Saudi riyals (298; 74.7%).

**Table 1. Demographic features categorized by the sex of the respondents (N = 399).**

Demographic feature	Female		Male		Total	
<b>Age group in years</b>						
less than 20 years	24	6.0%	12	3.0%	36	9.0%
20-29	150	37.6%	89	22.3%	239	59.9%
30-39	42	10.5%	4	1.0%	46	11.5%
40-49	42	10.5%	5	1.3%	47	11.8%
50 or more	23	5.8%	8	2.0%	31	7.8%
<b>Total</b>	<b>281</b>	<b>70.4%</b>	<b>118</b>	<b>29.6%</b>	<b>399</b>	<b>100.0%</b>
<b>Nationality</b>						
Non-Saudi	17	4.3%	6	1.5%	23	5.8%
Saudi	264	66.2%	112	28.1%	376	94.2%
<b>Region of Residence</b>						
Central	90	22.6%	40	10.0%	130	32.6%
Eastern	36	9.0%	11	2.8%	47	11.8%
Northern	8	2.0%	0	0.0%	8	2.0%
Southern	30	7.5%	13	3.3%	43	10.8%
Western	117	29.3%	54	13.5%	171	42.9%
<b>Educational level</b>						
Primary	1	0.3%	0	0.0%	1	0.3%
Intermediate	6	1.5%	3	0.8%	9	2.3%
Secondary	48	12.0%	16	4.0%	64	16.0%
University	212	53.1%	88	22.1%	300	75.2%
Master or PhD	14	3.5%	11	2.8%	25	6.3%
<b>Monthly Income</b>						
less than 5000 Riyals	62	15.5%	21	5.3%	83	20.8%
5000-10000 Riyals	82	20.6%	28	7.0%	110	27.6%
More than 10000 Riyals	125	31.3%	63	15.8%	188	47.1%
Prefer not to say	12	3.0%	6	1.5%	18	4.5%

### Knowledge about Diabetes Mellitus in children

More than half of the participants described DM in children as raised blood sugar level (225; 56.4%); 89 (22.3%) of them described it as a genetic disease, while 44 (11%) did not know what it was. When specifically asked about its causes, most of the participants referred to genetic factors and malnutrition (335; 84% and 223; 55.9%, respectively), while almost one-third referred to psychological factors affecting children as a possible cause (125; 31.3%).

As for the symptoms of DM in children, the most listed causes were frequent urination and excessive or frequent thirst (354; 88.7% and 311; 77.9%, respectively)

**Table 2. Knowledge of caregivers about the definition and causes of DM in children (N=399)**

Item of knowledge about DM in children	Freq.	%
<b>What is juvenile DM?</b>		
Disease that affects obese children	35	8.8%
Don't know	44	11.0%
Genetic disease that affects children	89	22.3%
Neuro-psychological disease that affects children under 10	6	1.5%
Raised blood sugar in children	225	56.4%
<b>Causes of diabetes mellitus in children</b>	<b>Freq.</b>	<b>%</b>
Genetic factors	335	84%
Hepatitis	35	8.8%
Malnutrition	223	55.9%
Obesity	21	5.3%
Other reasons	337	84.6%
Psychological factors affecting children	125	31.3%
<b>Symptoms of diabetes mellitus in children</b>	<b>Freq.</b>	<b>%</b>
Frequent urination	354	88.7
Excessive/Frequent thirst	311	77.9
Weight loss	189	47.4
Dryness and sweating	178	44.6
Loss of appetite	115	28.9
Sleeplessness	71	17.9

### Discussion

This research was conducted to assess caregivers' knowledge about type-1 diabetic children living in Riyadh Region. Most of the participants were in the age range of 30 - 49 years old (244; 59%), which is consistent with the overall age distribution of the Saudi population, of whom those in the same age group represent 37% of the population as per the latest census in 2016 (23,24). Also, most of the caregivers were non-diabetic (323; 78.0%), which seems to be consistent with the WHO's estimate of the prevalence of DM in KSA at 14.4% (1). However, there are recent studies that suggest a much higher prevalence of DM in the Saudi population at more than 30% (25–28). Half of the participants (207; 50.0%) were university graduates and employed, which is consistent with the national figures that estimate those who are currently studying at universities at more than two million and those employed at more than 3 million (24,29,30).

The diabetic status of the participants was highest among participants who are less than 20 years or more (25; 6.0%), which can be explained by the focus of the study, i.e. pediatric diabetes. DM was also highest among the unemployed (57; 13.8%), which may be seen as both

a cause and a result. For example, Weinstein (2004), Naeem (2015), and Dagenais (2016) suggested that unemployment can be a result of DM due to disability and early mortality by disease (31–33), while others have suggested that it may contribute to the development of DM as a result of diminished healthy choices, lack of movement, and reduction in income(33–35).

Most of the participants were unemployed and non-diabetic (154; 37.2%), which could be attributed to the caregivers being mostly women (mothers) who were not working. Moreover, given that the focus of the study is type 1, which is not hereditary, it is unlikely to find as many diabetic mothers.

Interestingly, all of the non-diabetics were educated 323 (10%) (P-value = 0.000). This finding is unlike Seiglie et al. (2020) who found that compared with no formal education; greater educational attainment was associated with an increased risk of diabetes across the 29 countries they included, after adjusting for BMI (36).

Regarding the awareness and knowledge of the caregivers regarding the symptoms, signs and complications of DKA, this study seems to reflect better results compared to previous studies, like that by Farran et al. (2020)

who found that 38.67% of our participants have a poor awareness regarding DKA complications (37). However, the percentages of those who reported DKA could lead to coma (285; 68.8%) are comparable to the 59.3% they found in the same study.

Although 46% know about DKA and 78.7% know that it is a life-threatening case for the child, yet it was still an alarming figure since 35% did not know about it. Moreover, 7.5% think it a simple case, and that requires diabetes self-management education at national levels in Saudi Arabia. Also, 66% agreed that a sign of DKA is vomiting but less apparent symptoms were less known; 28% and 34% suggested colic pain and disturbance of consciousness, respectively, which is worrying because they may indicate an emergency indication of DKA.

Caregivers' knowledge about how to prevent DKA was surprising since it was generally satisfactory at 88.9% yet those who thought they should wait and continue to monitor the blood glucose level was about 88.4%. This requires diabetes educators to educate pediatric patients and the caregivers about "sick day management". Similar conclusions were reached by other authors who studied diabetes in Saudi Arabia and elsewhere (36,38–40).

The patients with DKA are prone to dehydration since hyperglycemia, fever, excessive glycosuria and ketonuria increase fluid losses which must be replaced immediately (fluids should also contain water with salt if there are ongoing losses of fluids such as vomiting or diarrhea. Additionally, in the presence of loss of appetite or decreased blood glucose below approximately 10 mmol/L (180 mg/dL), sugar-containing fluids should also be considered to avoid starvation ketosis.

Diabetes Educators must inform caregivers that during the illness never stop insulin, and must do Self-monitoring of blood glucose and increase the dose if needed and if they do not improve and ketones become significantly positive, and then they must go to the emergency to prevent further complications of DKA. We notice that a range of 61% to 68% of the responded know the complications of DKA could be coma, swelling/edema and severe dehydration.

### Limitations

As would be expected with this kind of study, there are a few limitations. Although Riyadh is the capital city and the most populous region (about one third of the Saudi population from various regions live there); conducting this study in a single region is a limitation. There could be more geographical variation. Having the questionnaire online is another limitation, where some older caregivers may not be able to fill it n.. Finally, there was insufficient testing of validity and reliability of the study, which may have increased the power and reliability of our findings.

## Conclusions

Most caregivers in this study show knowledge and awareness regarding the signs and symptoms of DKA, however, they need further education since most of them have lack of knowledge of sick day management and how critical it is.

The main factors related to this positive reflection of knowledge and awareness were the level of education of the caregivers. These study findings suggest that it might be beneficial to educate caregivers of type-1 diabetic patients and the patients themselves about DKA self-management, using insulin, and monitoring of blood glucose to prevent complications. This study has potential limitations. Our study is a cross-sectional study. Therefore, difficulty in recalling is a possibility that could affect the validity of the results. Furthermore, we cannot generalize our result to the kingdom of Saudi Arabia, as this study is concerned with the Riyadh region only.

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## References

1. International Diabetes Federation. IDF Diabetes Atlas,2017. International Diabetes Federation. IDF Diabetes Atlas, 8th edn. Brussels, Belgium: International Diabetes Federation, 2017. <http://www.diabetesatlas.org>. International Diabetes Federation; 2017. 1–150 p.
2. Hamdy O. Diabetic Ketoacidosis (DKA): Practice Essentials, Background, Pathophysiology [Internet]. 2021 [cited 2021 Feb 20]. Available from: <https://emedicine.medscape.com/article/118361-overview>
3. Brink SJ, Miller M, Moltz KC. Education and multidisciplinary team care concepts for pediatric and adolescent diabetes mellitus. *Journal of Pediatric Endocrinology and Metabolism*. 2002;15(8):1113–30.
4. Fisher JN, Kitabchi AE. A randomized study of phosphate therapy in the treatment of diabetic ketoacidosis. *Journal of Clinical Endocrinology and Metabolism*. 1983;57(1):177–80.
5. Khoo CM. Diabetes Mellitus Treatment. In: *International Encyclopedia of Public Health*. Elsevier Inc.; 2016. p. 288–93.
6. Effect of intensive diabetes treatment on the development and progression of long-term complications in adolescents with insulin-dependent diabetes mellitus: Diabetes Control and Complications Trial. *The Journal of Pediatrics*. 1994;125(2):177–88.
7. Umpierrez GE, Jones S, Smiley D, Mulligan P, Keyler T, Temponi A, et al. Insulin analogs versus human insulin in the treatment of patients with diabetic ketoacidosis: A randomized controlled trial. *Diabetes Care*. 2009 Jul;32(7):1164–9.

8. Ergun-Longmire B, Clemente E, Vining-Maravolo P, Roberts C, Buth K, Greydanus DE. Diabetes education in pediatrics: How to survive diabetes. *Disease-a-Month*. 2021 Feb 2;101153.
9. Funnell MM, Brown TL, Childs BP, Haas LB, Hosey GM, Jensen B, et al. National standards for diabetes self-management education. Vol. 32, *Diabetes Care*. 2009. p. S87–94.
10. Tawfique A, Aboelmagd A, SYLWAN NM, 2021 undefined. Mothers' Knowledge and Reported Practices about Corona Virus Disease-19 (COVID-19) among their Children with Diabetes Mellitus. *researchgate.net* [Internet]. [cited 2022 May 16]; Available from: [https://www.researchgate.net/profile/Asmaa-Tawfik-7/publication/353803118\\_Mothers'\\_Knowledge\\_and\\_Reported\\_Practices\\_about\\_Corona\\_Virus\\_Disease-19\\_COVID-19\\_among\\_their\\_Children\\_with\\_Diabetes\\_Mellitus/links/61127b9d0c2bfa282a342c49/Mothers-Knowledge-and-Reported-Practices-about-Corona-Virus-Disease-19-COVID-19-among-their-Children-with-Diabetes-Mellitus.pdf](https://www.researchgate.net/profile/Asmaa-Tawfik-7/publication/353803118_Mothers'_Knowledge_and_Reported_Practices_about_Corona_Virus_Disease-19_COVID-19_among_their_Children_with_Diabetes_Mellitus/links/61127b9d0c2bfa282a342c49/Mothers-Knowledge-and-Reported-Practices-about-Corona-Virus-Disease-19-COVID-19-among-their-Children-with-Diabetes-Mellitus.pdf)
11. Megeid FYA, El-Sayed MMA. Health education intervention improves knowledge, attitude and practices of mothers of insulin dependent diabetes mellitus. *World Applied Sciences Journal*. 2012;
12. Kitabchi AE, Umpierrez GE, Miles JM, Fisher JN. Hyperglycemic crises in adult patients with diabetes. *Diabetes Care*. 2009 Jul;32(7):1335–43.
13. Alhowaish A. Economic costs of diabetes in Saudi Arabia. *Journal of Family and Community Medicine*. 2013;20(1):1.
14. Moini J. Diabetic Ketoacidosis. In: *Epidemiology of Diabetes* [Internet]. Elsevier; 2019 [cited 2021 Feb 20]. p. 147–51. Available from: <https://linkinghub.elsevier.com/retrieve/pii/B9780128168646000092>
15. Rawla P et al.AVE, 2017 undefined. Euglycemic diabetic ketoacidosis: a diagnostic and therapeutic dilemma. *edm.bioscientifica.com* [Internet]. [cited 2021 Feb 20]; Available from: <https://edm.bioscientifica.com/view/journals/edm/2017/1/EDM17-0081.xml>
16. Al-Shehri AM, Al-Alwan I. Accreditation and culture of quality in medical schools in Saudi Arabia. *Med Teach* [Internet]. 2013;35 Suppl 1(sup1):S8-14. Available from: <http://www.ncbi.nlm.nih.gov/pubmed/23581902>
17. Trachtenbarg DE. Diabetic ketoacidosis. *American Family Physician*. 2005 May 1;71(9):1705–14.
18. Kaabba A al, Alzuair B, et al.YAOJ of, 2021 undefined. Knowledge and Awareness of Caregivers about Diabetic Ketoacidosis among Type-1 Diabetic Children and Their Action and Response in Riyadh City. *scirp.org* [Internet]. [cited 2022 May 16]; Available from: <https://www.scirp.org/journal/paperinformation.aspx?paperid=109097>
19. Boulton AJM, Kirsner RS, Vileikyte L. Neuropathic diabetic foot ulcers. Vol. 351, *New England Journal of Medicine*. 2004. p. 48-55+109.
20. Dorresteijn JAN, Valk GD. Patient education for preventing diabetic foot ulceration. Vol. 28, *Diabetes/ Metabolism Research and Reviews*. 2012. p. 101–6.
21. Kaabba AF al, Alzuair BS, AlHarbi YF, Alshehri JA, Allowaihiq LH, Alrashid MH, et al. Knowledge and Awareness of Caregivers about Diabetic Ketoacidosis among Type-1 Diabetic Children and Their Action and Response in Riyadh City. *Open Journal of Endocrine and Metabolic Diseases* [Internet]. 2021 May 17 [cited 2022 Jun 13];11(5):119–28. Available from: <http://www.scirp.org/journal/PaperInformation.aspx?PaperID=109097>
22. Othman A, Ahmad M, al Qahtani A, Mahmood K, Aziz A, Asiri SM, et al. about Diabetic Ketoacidosis among Type-1 Diabetic Children and Their Action and Response in Emergency Conditions in Aseer Region of Saudi Arabia. *scholar.archive.org* [Internet]. [cited 2022 May 16]; Available from: <https://scholar.archive.org/work/onc27vrumbu3n3ypwspt2542u/access/wayback/https://pdfs.semanticscholar.org/5359/6b72ff6b3c8f32911753b687b7e88e56877b.pdf>
23. Saudi Ministry of Health. Kingdom of Saudi Arabia ANNUAL STATISTICAL BOOK [Internet]. Riyadh, Sau; 2017 [cited 2019 Oct 28]. Available from: [www.moh.gov.sa](http://www.moh.gov.sa)
24. Ministry of Health D of FM. The annual statistical book of the work of the Sharia Medical Panels in Saudi Arabia. 2015. 2015.
25. Al-Rubeaan K, Al-Manaa HA, Khoja TA, Ahmad NA, Al-Sharqawi AH, Siddiqui K, et al. Epidemiology of abnormal glucose metabolism in a country facing its epidemic: SAUDI-DM study. *Journal of Diabetes*. 2015 Sep 1;7(5):622–32.
26. Salman H, Abanamy A, medicine BGD, 1991 undefined. Childhood diabetes in Saudi Arabia. *Wiley Online Library* [Internet]. [cited 2022 Jun 16]; Available from: [https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1464-5491.1991.tb01567.x?casa\\_token=YNFAkoL5\\_QgAAAAA:KBTUWoiXPW6idezstXuNavqmSp-5n3TJx2Vvrsy7t\\_PWahSyPBSKEGN1NyrPvbVgYcp00Lumx2BDFg](https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1464-5491.1991.tb01567.x?casa_token=YNFAkoL5_QgAAAAA:KBTUWoiXPW6idezstXuNavqmSp-5n3TJx2Vvrsy7t_PWahSyPBSKEGN1NyrPvbVgYcp00Lumx2BDFg)
27. Al-Nozha M, Al-Maatouq M, Al-Mazrou Y. Diabetes mellitus in Saudi Arabia. 2004 [cited 2021 Feb 8]; Available from: <http://repository.nu.edu.sa/handle/123456789/2272>
28. Sciences ZNI journal of health, 2015 undefined. Burden of diabetes mellitus in Saudi Arabia. *ncbi.nlm.nih.gov* [Internet]. [cited 2022 Jun 16]; Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4633187/>
29. Alrukban MO, Albadr BO, Almansour M, Sami W, Alshuil M, Aldebaib A, et al. Preferences and attitudes of the Saudi population toward receiving medical bad news: A primary study from Riyadh city. *Journal of Family & Community Medicine* [Internet]. 2014 [cited 2021 Sep 22];21(2):85. Available from: <https://pubmed.ncbi.nlm.nih.gov/2581902/>
30. al Mansour MA. The prevalence and risk factors of type 2 diabetes mellitus (DMT2) in a semi-urban Saudi population. *International Journal of Environmental Research and Public Health*. 2020 Jan 1;17(1).
31. Weinstein AR, Sesso HD, Lee IM, Cook NR, Manson JAE, Buring JE, et al. Relationship of physical activity vs body mass index with type 2 diabetes in women. *J Am Med Assoc*. 2004 Sep 8;292(10):1188–94.
32. Atypical Presentation of Shaken Baby Syndrome ( Case Report ). Dr / Hanan Said - Dr / Hesham Fathy- Dr / Khalid Danish-Dr / Gihad Mohamed and Dr / Naeem Mirza King Khaled Military City Hospital King Fahad Military Medical Complex . December 2019. 2019;1–7.
33. Chow CK, Teo KK, Rangarajan S, Islam S, Gupta R, Avezum A, et al. Prevalence, awareness, treatment, and control of hypertension in rural and urban communities in high-, middle-, and low-income countries. *JAMA* -

- Journal of the American Medical Association. 2013 Sep 4;310(9):959–68.
34. Naeem Z. Burden of Diabetes Mellitus in Saudi Arabia. *International Journal of Health Sciences*. 2015 Sep;9(3):V–VI.
35. Weinstein AR, Sesso HD, Lee IM, Cook NR, Manson JAE, Buring JE, et al. Relationship of physical activity vs body mass index with type 2 diabetes in women. *J Am Med Assoc*. 2004 Sep 8;292(10):1188–94.
36. Seiglie JA, Marcus ME, Ebert C, Prodromidis N, Geldsetzer P, Theilmann M, et al. Diabetes prevalence and its relationship with education, wealth, and BMI in 29 low- And middle-income countries. *Diabetes Care*. 2020 Apr 1;43(4):767–75.
37. Farran RBA, et al BEJ of F, 2020 undefined. Level of awareness of diabetic ketoacidosis among diabetes mellitus patients in Riyadh. *ncbi.nlm.nih.gov* [Internet]. [cited 2022 May 16]; Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/pmc7491756/>
38. Deye, N., Vincent, F., Michel, P., Ehrmann, S., Da Silva, D., Piagnerelli, M., Laterre, P.-F. (2016). Changes in cardiac arrest patients' temperature management after the 2013 trial: Results from an international survey. *Annals of Intensive Care* 6(1). <http://doi.org/10.1186/s13613-015-0104-6>,
39. Al-Hussaini, M., & Mustafa, S. (2016). Adolescents' knowledge and awareness of diabetes mellitus in Kuwait. *Alexandria Journal of Medicine*, 52(1) 61–66. <http://doi.org/10.1016/j.ajme.2015.04.001>,
40. Pollach, G., Brunkhorst, F., Mipando, M., Namboya, F., Mndolo, S., & Luiz, T. (2016). The first digit law“ A hypothesis on its possible impact on medicine and development aid. *Medical Hypotheses*, 97 102–106. <http://doi.org/10.1016/j.mehy.2016.10.021>,
41. Asiedu, K., Kyei, S., Ayobi, B., Agyemang, F. O., & Ablordepey, R. K. (2016). Survey of eye practitioners preference of diagnostic tests and treatment modalities for dry eye in Ghana. *Contact Lens Anterior Eye*, 39(6) 411–415. <http://doi.org/10.1016/j.clae.2016.08.001>,
42. Barakat, K. H., Gajewski, M. M., & Tuszynski, J. A. (2012). DNA polymerase beta (pol  $\beta$ ) inhibitors: A comprehensive overview. *Drug Discovery Today*, 17(15–16) 913–920. <http://doi.org/10.1016/j.drudis.2012.04.008>,
43. Mocan, O., & Dumitraşcu, D. L. (2016). The broad spectrum of celiac disease and gluten sensitive enteropathy. *Clujul Medical*, 89(3) 335–342. <http://doi.org/10.15386/cjmed-698>, et al.
44. Development of limited sampling strategy for mycophenolic acid: Influence of post-transplant period and second peak. *Therapeutic Drug Monitoring*. 2013;
45. Boden S, Lloyd CE, Gosden C, Macdougall C, Brown N, Matyka K. The concerns of school staff in caring for children with diabetes in primary school. *Wiley Online Library* [Internet]. 2012 Sep [cited 2022 Jun 13];13(6):6–13. Available from: [https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1399-5448.2011.00780.x?casa\\_token=UJAr2XvniTEAAAAA:wmJ53WSuLsVTONmplwd-](https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1399-5448.2011.00780.x?casa_token=UJAr2XvniTEAAAAA:wmJ53WSuLsVTONmplwd-)