University of Khartoum
Faculty of Medicine
Postgraduate Medical Studies Board

KNOWLEDGE ATTITUDE AND PRACTICES AMONG DIABETIC CHILDREN AND THEIR RELATION TO GLYCAEMIC CONTROL

By
Dr. El Hadi Mohammed Ahmed
M.B.B.S (University of Khartoum)

A thesis Submitted in partial fulfillment for the requirements of the Degree of Clinical MD in Paediatrics and Child Health, October, 2003

Supervisor
Dr. El Tahir Medani El Shibly
MD, FRCPCH (London)
M.P.H (Harvard, America)
M.P.C.H, M.B.B.S (U. of K.)
(كُلُّ آمَنَّكَ عَلَى مَنِ اتَّقِيَ اللَّهُ)

 длин الله العظيم
 سورة فه (114)
### TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Dedication</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acknowledgment</td>
<td>II</td>
</tr>
<tr>
<td>List of Abbreviations</td>
<td>III</td>
</tr>
<tr>
<td>English Abstract</td>
<td>IV</td>
</tr>
<tr>
<td>Arabic Abstract</td>
<td>VII</td>
</tr>
<tr>
<td>List of Tables</td>
<td>IX</td>
</tr>
<tr>
<td>List of Figures</td>
<td>XI</td>
</tr>
</tbody>
</table>

#### CHAPTER ONE

1. INTRODUCTION AND LITERATURE REVIEW .............1

1.1. Historical background ................................5

1.1.1. Early clinical work (Diabetic Dark ages) ......5

1.1.2. Discovery of insulin .............................6

1.2. Classifications of diabetes mellitus in children .6

1.2.1. Type 1 diabetes ..................................7

1.2.2. Type 2 diabetes ..................................7

1.2.3. Secondary diabetes ..............................8

1.3. Epidemiological impact of type 1 DM in the world .8

1.4. Childhood diabetes in Sudan ........................9

1.4.1. Prevalence of type 1 diabetes in Sudan .........9

1.4.2. Pattern of type 1 diabetes in Sudan ..............9

1.4.3. Immunogenetics of Sudanese diabetic children ...11

1.4.4. Complications in Sudanese diabetic children ....13

1.4.5. Impact of dietary knowledge on diabetic control of Sudanese children .......14

1.5. Diabetes symptoms ...................................14

1.6. Aetiology and pathogenesis ........................15

1.7. Diagnosis of diabetes mellitus ......................16

1.8. Complications of diabetes mellitus ...............18

1.9. Diabetes mellitus control ........................17
1.9.1. Day to-day glucose variations 50 ............................17
1.9.2. Glycated hemoglobin ...........................................18

1.10. Attitude of patients towards diabetes ......................19
  1.10.1. Psychological aspects ......................................20
  1.10.2. Premorbid personality and experience of illness ......21
  1.10.3. Views on the cause of illness .........................22
  1.10.4. Perception of severity ..................................22
  1.10.5. Presence of physical symptoms .....................23
  1.10.6. Impact on lifestyle ......................................23
  1.10.7. Attitude of family and friends ..............24
  1.10.8. Attitude of caring professionals .............24
  1.10.9. What should the doctor do? .......................25

1.11. Treatment goals ....................................................26
  1.11.1. General treatment objectives .........................26
  1.11.2. Specific treatment goals ..............................26
  1.11.3. Standard goals ...........................................26

1.12. Insulin injection therapy ......................................27
  1.12.1. Storage of insulin ......................................28
  1.12.2. Self-insulin injections .................................28
  1.12.3. Injection sites ...........................................28
  1.12.4. Injection technique ....................................29

1.13. Dietary management ............................................29

1.14. Monitoring glycemic control ..................................31
  1.14.1. Blood glucose testing ..................................31
  1.14.2. Urine testing ............................................32
  1.14.3. Self-management education .........................32

1.15. Acute complications ............................................33
  1.15.1. Hyperglycemia/DKA and acute illnesses .............33
  1.15.2. Hypoglycemia ............................................35
1.16. Exercise and its effect on blood glucose level ................. 36
1.17. The care of children with diabetes in the school .............. 37
1.18. Continuing care ..................................................... 38
   1.18.1. Visit frequency ................................................... 38
   1.18.2. Medical history .................................................. 38
   1.18.3. Physical examinations ........................................... 39
   1.18.4. Laboratory evaluation .......................................... 39
   1.18.5. Management plan ............................................... 40
JUSTIFICATIONS .................................................................. 41
OBJECTIVES ...................................................................... 41

CHAPTER TWO

2. METHODS AND MATERIALS

2.1 Study design ............................................................... 42
2.2 Study area ................................................................... 42
2.3 Study duration .............................................................. 42

2.4 Study population ........................................................... 43
   2.4.1 Inclusion criteria ..................................................... 43
   2.4.2 Exclusion criteria .................................................... 43
2.5 Sample size and Sampling .............................................. 43
2.6 Research tools and measurements .................................... 44
   2.6.1 Structured standardized questionnaire ......................... 44
   2.6.2. EDTA Tubes, disinfectants, disposable syringes
          and tourniquet ......................................................... 47
   2.6.3 Storage of the sample ............................................. 47
   2.6.4 Laboratory investigations ....................................... 47
2.7 Statistical methods ....................................................... 48
2.8 Input of the author ........................................................ 49

2.9 Ethical consideration .................................................... 49
CHAPTER THREE

3. RESULTS

3.1 Socio-demographic characteristics ........................................50
   3.1.1 Age, Sex and Family Income .......................................50
   3.1.2 Level of education and School attendance .......................51

3.2 Diabetes-related variables ..................................................51
   3.2.1 Types, duration and family history of diabetes ...............51
   3.2.2 Place for follow up and regularity of care ......................51
   3.2.3 Circumstances of the diagnosis ...................................52
   3.2.4 Frequency of rehospitalization ..................................52
   3.2.5 Causes of rehospitalization ......................................52

3.3 General knowledge and attitudes towards diabetes ..............58
   3.3.1 Perceptions about causes of diabetes ............................58
   3.3.2 Insulin action and its organ of production ......................58
   3.3.3 Perception of severity of diabetes ................................59
   3.3.4 Disease curability with medical treatment .....................59
   3.3.5 Believes in alternative treatment ..................................59
   3.3.6 Overall aim of treatment .........................................60
   3.3.7 Satisfaction with the quality of medical care received ..60

3.4 Knowledge Related to Insulin Injections ............................66

3.5 Self care-practices related to insulin injections ..................66
   3.5.1 Insulin storage, frequency, self-administration and technique of injections ........................................66
   3.5.2 Doses of insulin injection ........................................67

3.6 Knowledge related to monitoring of diabetes .....................71

3.7 Practices related to monitoring of Diabetes .......................71
   3.7.1 Self-care: Home Blood Glucose Monitoring using blood and urine testing .................................................71
   3.7.2 Self-care: Laboratory blood testing .............................72
3.7.3 Keeping Log Diary .................................................72
3.7.4 Self care: frequency of HbA1c and Weight monitoring..72
3.8 Knowledge related to diabetic diet ................................77
3.9. Self care: meals frequency............................................. 77
3.10 Knowledge related to diabetic emergencies ....................80
  3.10.1 Recognition and responses to hyperglycemic
       and hypoglycemic symptoms and being unwell ........80
  3.10.2 Awareness of effect of infection on blood glucose ....80
3.11 Self care-prevention and/or treatment of diabetic
       emergencies.............................................................81
3.12 Knowledge related to physical exercise..........................81
3.13 Knowledge of long term complications ..........................81
3.14 Self-care: Diabetic Screening ......................................82
3.15. Knowledge and attitude score .................................88
   3.15.1. Effect of some socio-demographic variables on
           the overall knowledge and attitude score ........88
   3.15.2. Effect of some diabetes-related variables on the
           overall knowledge and attitude score ..............89
3.16. Compliance with insulin and dietary medical therapies
       among diabetic children..........................................92
   3.16.1. The impact of the overall knowledge and attitude
           score on level of compliance with medical therapy …92
3.17. Diabetic control among diabetic children .....................98
   3.17.1. Clinical control..............................................98
   3.17.2. Glycemic control.............................................98
   3.17.3. Effect of overall knowledge and attitude score on
           HbA1c control....................................................100
   3.17.4. Effect of compliance with medical
           therapy on HbA1c ..............................................100
3.17.5. Effect of overall knowledge and attitude score on
the level of weight control.................................101
3.17.6. Effect of the degree of compliance with
medical therapy on the level of weight control ......101

CHAPTER FOUR

4. DISCUSSION

4.1. General characteristics .................................110
  4.1.1. Sociodemographic characteristics .................110
  4.1.2. Diabetes-related variables in the study group ........113

4.2. Knowledge, attitude & practices among diabetic children...116
  4.2.1. General knowledge and attitude among diabetic
          children and their families.................................116
  4.2.2. Knowledge & self-care related to insulin injections...119
  4.2.3. Dietary knowledge and self-care .......................124
  4.2.4. Knowledge & self-care related to diabetes monitoring125
  4.2.5. Knowledge and self-care related to emergencies .....129
  4.2.6. Physical exercise .......................................130
  4.2.7. Awareness of long-term complications and
          self-care related ............................................131

4.3. Effect of the general characteristics on
      the overall knowledge and attitude score ...............132

4.4. Compliance with medical therapy and its relation
      to overall knowledge and attitude score ................134

4.5. Diabetic control and its relation to overall knowledge,
      attitude and compliance scores ..........................135

CONCLUSION.........................................................138
RECOMMENDATIONS..............................................140
REFERENCES .......................................................141
QUESTIONNAIRE
DEDICATION

TO
ALL MY FAMILY MEMBERS
MY PARENTS
MY WIFE NAJAT
MY INFANT ROA
FOR THEIR PATIENCY AND LOVE
TO
ALL MY TEACHERS
AND MY COLLEAGUES
FOR THEIR CONTINUOUS ADVICE AND SUPPORT
TO
ALL DIABETIC CHILDREN
FOR BRIGHTER TOMORROW
I am extremely grateful to my supervisor Dr. Etahir Medani Elshibly, Associate Prof. of paediatrics, University of Khartoum, for his continuous guidance, not only in how to cope with certain areas during conduction of this thesis, but also for his holistic approach regarding psychosocial and emotional support.

I would like to stress here my sincere gratitude and thankfulness to my co-supervisor Prof. Elmahadi Mohammed Ali, Ph.D Endocrinologist, for his expertise knowledge and advice received in the early face validity of the questionnaire and also for his personal facilitation for the investigation regarding HbA1c to be done in special diabetic centre (Jabir Abu-Eleiz).

My thanks also extended to all the children enrolled in this study, their parents, treating doctors especially to Dr. Bakhieta and Dr. Ilham in Jabir Abu-Eleiz Diabetic Centre, lab technicians and nurses for their continuous assistance and advice all through the stages of the study.

I also very grateful to Dr. Rowis Mohsen Salem, who was teaching me how to enter the data collected into the computer and how to use the Statistical Package of Social Sciences (SPSS) programme to perform some descriptive statistical tests. Which has great impact and cost-effectiveness in writing this thesis.

Lastly especial thanks to Miss Widad A/Magsood for her patience, enormous effort while typing for me this thesis.
# ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI</td>
<td>Body Mass Index</td>
</tr>
<tr>
<td>DCCT</td>
<td>Diabetes Control and Complications Trial.</td>
</tr>
<tr>
<td>DKA</td>
<td>Diabetic Ketoacidosis.</td>
</tr>
<tr>
<td>DM</td>
<td>Diabetes Mellitus</td>
</tr>
<tr>
<td>GAD</td>
<td>Glutamic Acid Decarboxylase.</td>
</tr>
<tr>
<td>HbA₁&lt;sub&gt;c&lt;/sub&gt;</td>
<td>Glycated Haemoglobin.</td>
</tr>
<tr>
<td>HLA</td>
<td>Human Leukocyte Antigen.</td>
</tr>
<tr>
<td>ICA</td>
<td>cytoplasmic Islet Cell Antibodies.</td>
</tr>
<tr>
<td>IDDM</td>
<td>Insulin Dependent Diabetes Mellitus.</td>
</tr>
<tr>
<td>IGT</td>
<td>Impaired Glucose Tolerance.</td>
</tr>
<tr>
<td>IU</td>
<td>International Unit.</td>
</tr>
<tr>
<td>MCH</td>
<td>Major Histocompatibility Complex.</td>
</tr>
<tr>
<td>MNT</td>
<td>Medical Nutritional Therapy.</td>
</tr>
<tr>
<td>NDDG</td>
<td>National Diabetes Data Group.</td>
</tr>
<tr>
<td>NIDDM</td>
<td>Non-Insulin Dependent Diabetes Mellitus.</td>
</tr>
<tr>
<td>OGTT</td>
<td>Oral Glucose Tolerance Test.</td>
</tr>
<tr>
<td>SMBG/HMBG</td>
<td>Self/Home-Monitoring of Blood Glucose.</td>
</tr>
<tr>
<td>SPSS</td>
<td>Statistical Package for Social Sciences.</td>
</tr>
<tr>
<td>UAE</td>
<td>Urinary Albumin Excretion rate.</td>
</tr>
<tr>
<td>UKPDS</td>
<td>United Kingdom Prospective Diabetes Study.</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organization.</td>
</tr>
</tbody>
</table>
Although health education is considered, as the cornerstone to diabetes management, but it is not in most time delivered properly. Education to diabetic patients would be more effective if we know their general characteristics, level of knowledge, attitude and self-care practices related to diabetes. Thus in this study the extend to which knowledge, attitude and compliance scores related to glycemic control was explored. This prospective cross-sectional study was conducted on 100 diabetic children attending the out-patient referred clinics of 4 major teaching hospitals and one special diabetic centre in Khartoum State, over a 6-months period which started in October 2002. Those seen sequentially in these clinics were enrolled in the study and interviewed by the author using prestructured questionnaire that contains items concerning knowledge, attitude and practices related to diabetes care. A scoring system was used to document the level of knowledge among our patients. The effect of some socio-demographic and diabetes related variables were assessed using chi-squared tests. As an index of glycemic control glycated haemoglobin was assayed and used as direct measure of control.
The results of this study confirmed almost all the general characteristics of our diabetic children described in the previous local studies. Where the mean age at onset was $8.7 \pm 3.89$ years. There was slight male preponderance with a male to female ratio of about 1.1:1. About two third of our diabetics were of poor family income. Family history was noted in more than 50% of our patients. There was great impact of diabetes on the schooling of our diabetic children regarding the attendance and school performance. There was high morbidity among our patients which was indicated by high frequency of hospital readmissions, the overall diabetic control was poor with high level of mean HbA1c ($10.8 \pm 3.15$). Where only 16% had good control ($\text{HbA1c} \leq 7.5\%$), 24% fair control ($\text{HbA1c} 7.6 \text{ - } 9.9\%$) and 60% poor control ($\text{HbA1c} \geq 10\%$). Generally low score levels of knowledge and attitude about diabetes, 56% had poor knowledge (according to the scoring system), 46% and 51% of poor compliance with medical insulin and dietary therapy respectively. Regarding the influence of general characteristics on attaining the higher knowledge. The analysis showed that, the score was significantly higher among diabetic children with higher educational levels ($P=0.004$), among patients who did enjoy continuity of care (regular vs not regular
P=0.030), and also among those who continue their care in special diabetic centre (P = 0.036). No statistically significant relationship existed between other characteristics and the knowledge attained. High knowledge and attitude score was found to have a positive impact on compliance with insulin medical therapy (P=0.003), but it was negatively related to the degree of dietary adherence although not reached degree of significance (P=0.066). Its known that good knowledge, attitude and compliance scores have a tremendous impact on glycemic control, this study fails to demonstrate this relationship although there is increased trends.

Evidence from this study suggest that there is a need for more effort to be done regarding the sustained active patient education, support and evaluation in order to increase patient involvement and self-reliance in the management of their disease. For achieving this goal brief guidelines are proposed.
alla محتوى

النموذج

على أسئلة في سكر

عند

やすく

لمداية تفاع

الموافقة

بتكرار

المرض

للمتابعة

على

سريع

بيث

بالعيادات

الهيموجلوبين

وينوي

الذين

الدراسة

إلى

المرض

الذين

صغير

المرض

الذين

التهاب

إلى

الوقت

المرض

الذين

المرض

الوقت

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

المرض

الأذن
لا يوجد نص يمكن قراءته بشكل طبيعي من الصورة المقدمة.
**LIST OF TABLES**

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table.1</td>
<td>Socio-demographic characteristics of the patients</td>
<td>53</td>
</tr>
<tr>
<td>Table.2</td>
<td>Diabetes-related characteristics</td>
<td>55</td>
</tr>
<tr>
<td>Table.3</td>
<td>Frequency of rehospitalization among diabetic children</td>
<td>56</td>
</tr>
<tr>
<td>Table.4</td>
<td>Knowledge of detailed insulin injections among patients</td>
<td>68</td>
</tr>
<tr>
<td>Table.5</td>
<td>Self-care: Insulin storage, dose frequency and technique of injections of the diabetic children</td>
<td>69</td>
</tr>
<tr>
<td>Table.6</td>
<td>Self-care: frequency of testing blood glucose level at home using blood and urine testing</td>
<td>75</td>
</tr>
<tr>
<td>Table.7</td>
<td>Frequency of testing blood glucose at laboratory</td>
<td>76</td>
</tr>
<tr>
<td>Table.8</td>
<td>Actions selected by diabetic children in the event of hyperglycaemia, hypoglycemia or being unwell</td>
<td>84</td>
</tr>
<tr>
<td>Table.9</td>
<td>Effect of some sociodemographic variables on the overall Knowledge and attitude score of diabetic children</td>
<td>90</td>
</tr>
<tr>
<td>Table.10</td>
<td>Effect of some diabetes-related variables on the overall Knowledge and attitude score of diabetic children</td>
<td>91</td>
</tr>
<tr>
<td>Table.11</td>
<td>Reasons for insulin omissions among diabetic children</td>
<td>95</td>
</tr>
<tr>
<td>Table.12a</td>
<td>Influence of the overall knowledge and attitude score on compliance with medical insulin therapy</td>
<td>96</td>
</tr>
<tr>
<td>Table.12b</td>
<td>Influence of the overall knowledge and attitude score on adherence with nutritional medical therapy</td>
<td>97</td>
</tr>
<tr>
<td>Table.13</td>
<td>Degree of knowledge and attitude score in relation to glycemic control measured by HbA1c</td>
<td>106</td>
</tr>
<tr>
<td>Table.14a</td>
<td>Effect of compliance with insulin medical therapy on glycemic control measured by HbA1c</td>
<td>107</td>
</tr>
</tbody>
</table>
Table.14b  Effect of compliance with nutritional medical therapy on glycemic control measured by HbA1c .......................108

Table.15  Overall knowledge and attitude score in relation to glycemic control measured by body mass index ......109
# LIST OF FIGURES

<table>
<thead>
<tr>
<th>Fig.</th>
<th>Description</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>School attendance among diabetic children</td>
<td>.54</td>
</tr>
<tr>
<td>2</td>
<td>Most frequent causes of rehospitalization</td>
<td>.57</td>
</tr>
<tr>
<td>3</td>
<td>Knowledge and perception of causes of diabetes</td>
<td>.61</td>
</tr>
<tr>
<td>4</td>
<td>Perception of severity of diabetes</td>
<td>.62</td>
</tr>
<tr>
<td>5</td>
<td>Thought about curability of diabetes</td>
<td>.63</td>
</tr>
<tr>
<td>6</td>
<td>Believes in alternative treatment other than insulin</td>
<td>.64</td>
</tr>
<tr>
<td>7</td>
<td>Understanding of the overall aim of treatment</td>
<td>.65</td>
</tr>
<tr>
<td>8</td>
<td>Insulin doses among diabetic children</td>
<td>.70</td>
</tr>
<tr>
<td>9</td>
<td>Knowledge about the best method for testing blood glucose level among diabetic children</td>
<td>.73</td>
</tr>
<tr>
<td>10</td>
<td>Knowledge about the optimal upper target blood glucose level among diabetic children</td>
<td>.74</td>
</tr>
<tr>
<td>11</td>
<td>Food selected by diabetic children as should eat</td>
<td>.78</td>
</tr>
<tr>
<td>12</td>
<td>Food selected by diabetic children as should not eat</td>
<td>.79</td>
</tr>
<tr>
<td>13</td>
<td>Knowledge about symptoms of hypo and hyperglycemia</td>
<td>.83</td>
</tr>
<tr>
<td>14</td>
<td>Knowledge about effect of infection on blood glucose</td>
<td>.85</td>
</tr>
<tr>
<td>15</td>
<td>Self-care practices for prevention and/or treatment of diabetic emergencies among diabetic children</td>
<td>.86</td>
</tr>
<tr>
<td>16</td>
<td>Knowledge about major complications of diabetes</td>
<td>.87</td>
</tr>
<tr>
<td>17</td>
<td>Degree of compliance with insulin and medical therapies</td>
<td>.94</td>
</tr>
<tr>
<td>18</td>
<td>Overall glycaemic control measured by HbA1c</td>
<td>.102</td>
</tr>
<tr>
<td>19</td>
<td>Nutritional status measured by body mass index</td>
<td>.103</td>
</tr>
<tr>
<td>20</td>
<td>Nutritional status measured by weight for age(centile)</td>
<td>.104</td>
</tr>
<tr>
<td>21</td>
<td>Nutritional status measured by height for age (centile)</td>
<td>.105</td>
</tr>
</tbody>
</table>
1. INTRODUCTION AND LITERATURE REVIEW

Diabetes mellitus is unlike other chronic diseases in that successful management requires the constant, active participation of the patient with the disease. Patient education has been proven to be an important method of management of such a community health problem.\(^{(1)}\) All patients if given proper guidance and education regarding diabetes care should be able to make significant improvement in their lifestyle which would be helpful in maintaining good glycemic control. Patients lack of understanding or attitude hinders proper guidance about disease. Health education concerns itself with attitude changes and lifestyle modifications. For this reasons indicators of successful health education are defined as gains in knowledge and understanding.\(^{(2)}\)

Living with diabetes requires knowledge and experience build up over time. The level and pace of learning vary greatly between individuals. It is important for health care professionals to appreciate the gaps between learning “knowledge”, understanding, “attitude” and doing “practice” and reasons why these occurs. The existence of “behaviour gap” i.e. the difference between what people know and do emphasizes that diabetes education can not be confined to the
provision of information alone, but must encompass the much more complicated task of persuading individuals to adopt and maintain all the steps required to put theory into practice.

The treatment of diabetes affects basic aspects of everyday life, such as diet, drugs may have to be self-administered and the level of control of the disease assessed on the basis of tests performed by the patient. He is often encouraged to make decisions about alteration in his own treatment. It is suspected that diabetic children find it difficult to comply with their treatment, especially when dietary measures were involved. This difficulty is reflected in their blood glucose level and body weight and may in great part be due to the lack of appropriate perception of the disease and its management resulting in poor compliance and hence suboptimal glycemic control.\(^{3}\)

Education is undoubtedly essential to achieve the high standard of self-management on which good diabetes control depends. It is self-evident that, diabetic patients who know little or nothing about their disease are unlikely to maintain good day to day control.\(^{4}\) The pivotal role of education and the vital need for its further development have been emphasized by numerous studies.\(^{5,6}\)
Main topics of discussion following diagnosis:

Several members of diabetes team are to be involved in educating the newly diagnosed child and his or her family, good communication between team members to ensure consistency in the information given to the family is important. The following topics should be discussed with the child and family following diagnosis:(7)

- Their pre-existing knowledge of diabetes.
- Our current knowledge of the cause of diabetes.
- The consequences of having diabetes and its lifelong implications.
- The concept of the diabetes team of professionals who will be involved in their care.
- The role of insulin in type 1 diabetes management.
- Practical details of insulin injections.
- Practical details regarding when and how to monitor and interpret blood glucose concentrations.
- Appropriate dietetic advice.
- The effect of exercise on carbohydrate and insulin requirements.
- The causes and consequences of hypoglycemia and how to treat it.
- When and how to measure urinary ketones.
- Management of diabetes during intercurrent illness.
- The honeymoon period of relatively reduced insulin requirements following diagnosis.
- Long term microvascular complications.
- Who to contact in an emergency (including phone numbers).
- Details of outpatient follow up.
- The importance of carrying identification, e.g. medical bracelets ...etc) indicating that the individual as diabetes.
• Additional sources of information about diabetes.
• Availability of support groups.
• Future developments.

Since optimal glycemic control reduces acute and chronic complications of diabetes, it is important that measures to improve diabetes care be adopted. Patient’s knowledge and attitudes may have considerable influence on the success of management so should be explored.\(^{(8,9)}\)

1.1. Historical background:

Diabetes mellitus has both ancient roots and expanding research base. Many current studies are helping to explain early observations of its nature and to develop better means of care. Diabetes comes from a Greek word that means to siphon. The most obvious sign of diabetes is excessive urination water passes through the body of a person with diabetes as if it were being siphoned from the mouth through the urinary system out of the body. It was the description in the first century AD by the Greek physician Aretaeus. Much later in the seventeenth century, the word mellitus from the Latin word meaning “honey” was added because of the sweet nature of the urine. This addition distinguished it from diabetes insipidus.
another disorder in which the passage of copious amount of urine was observed.\(^{(10)}\)

1.1.1. Early clinical work (Diabetic Dark ages):

Diabetes mellitus has long been associated with weight and heredity. Early clinicians, Rollo in England and Boushardat in France, observed that diabetes improved in overweight patients who lost weight.

Later the French clinician Lancereaux and his students described two kinds of diabetes: diabetes gras (Fat diabetes) and diabetes maigre (thin diabetes).\(^{(10)}\) All these observations preceded any knowledge about insulin or a relationship between the pancreas and diabetes. Throughout these times, which have been aptly called the (diabetic dark ages), patients had short lives and were maintained on a variety of semi-starvation regimen.\(^{(11)}\)

1.1.2. Discovery of insulin:

In the following years, evidence began to grow pointing to the pancreas as a primary organ involved in the disease process. Paul Langerhans, a young German medical student found special clusters or islets of cells scattered about the human pancreas that were different from the rest of the tissue. Although their function was still
unknown, these islet cells were named for their young discover the islet of Langerhans. Many researchers then focused their studies of diabetes on the pancreas. Finally in the period from 1921 to 1922 a University of Toronto Team discovered and successfully used the pancreatic regulatory agent from the (Island cell)- insulin.\(^{(12)}\)

### 1.2. Classifications of diabetes mellitus in children:

Diabetes mellitus is a syndrome of metabolic disease characterized by hyperglycemia. It is the most common endocrine metabolic disorder of childhood and adolescence, with important consequences of physical and emotional development. Three major forms of diabetes were identified.

#### 1.2.1. Type 1 diabetes:

In type 1 diabetes immune mediated (type 1A) the beta cells in the pancreas that produce insulin are gradually destroyed by autoimmune process, eventually insulin deficiency is absolute.\(^{(13)}\) Other patients have no evidence of autoimmunity and have no other known cause of beta-cell destruction, they are said to have idiopathic type IB diabetes mellitus.\(^{(14)}\) Most children with diabetes have type 1 diabetes and a lifetime dependence on exogenous insulin.

#### 1.2.2. Type 2 diabetes:
Patients with type 2 diabetes have insulin resistance, and their beta cells lack the ability to overcome this resistance. Although this form of diabetes previously was uncommon in children. Recent estimates suggest that type 2 diabetes mellitus may now account for as many as half of all new cases of diabetes in certain paediatric populations.\(^{(15)}\) In two studies conducted in the mid 1990s of persons aged 10 to 19 years, type 2 diabetes mellitus accounted for 33\(^{(16)}\) and 40\(^{(17)}\) of all diabetes in that age group. Virtually all published studies have found that mean body mass index (BMI) among children with type 2 diabetes mellitus is above the 95\(^{th}\) reference percentile for age.\(^{(18)}\)

1.2.3. Secondary diabetes:

This subclass contains a variety of types of diabetes for some of which the aetiologic relationship is known, e.g. diabetes secondary to pancreatic diseases such as cystic fibrosis; ingestion of certain drug or poisons.\(^{(19)}\)

1.3. Epidemiological impact of type 1 diabetes mellitus in the world:
Type 1 diabetes mellitus is a relatively common chronic condition affecting nearly 300,000 children and adults in the United States each year.\(^{(19)}\) It is one of the most common chronic illness of children, occurring in those less than 19 years of age with an incidence of about 18.2 per 100,000 children per year.\(^{(20)}\) There is a global variation worldwide in the incidence of children type 1 diabetes according to Diamond study conducted during 1990 to 1994. It is ranging from 0.1/100,000 per/year in China to 36.8/100,000 per year in Sardinia.\(^{(21)}\)

In Africa it is believed to be very uncommon and despite a few isolated epidemiological studies revealing high incidence rates in children, the picture remains uncertain. A relatively high prevalence of 0.33 per 1000 was also found in Nigerian school children age 5-17 years.\(^{(22)}\)

1.4. Childhood diabetes in Sudan:

1.4.1. Prevalence of type 1 diabetes in Sudan:

The magnitude of childhood diabetes in Sudan was first measured in 1987 by Elamin and his group.\(^{(23)}\) They established an organized diabetic clinic at the university hospital in Khartoum. They reported the incidence at that time to be 5.9/100,000, also they found that all
the children attending the clinic were in poor metabolic control, they suffered acute and long term complications, growth retardation, delayed sexual maturation, impaired vision, limited joint mobility, social and psychological problems besides high mortality rate. Most recent study showing that diabetes is increasing in Sudan surprisingly high incidence rates of 10.1 per 100,000 Sudanese children under 15 years were reported.\(^{(24)}\)

1.4.2. Pattern of type 1 diabetes in Sudan:

Study on the pattern of IDDM in Sudanese children in 1990 showed the mean age at diagnosis was 8.8 years and the peak incidence was in the middle and late childhood, 50% of diabetic children have positive family history, there was significant geographical and seasonal variations of diabetes at all time of onset. The majority of patients (85%) from the northern and central region, and the cold months form the majority of months of presentation, and the most common clinical presentation of IDDM was diabetic ketoacidosis. Elamin and his colleagues,\(^{(25)}\) also studied clinical course of diabetes and they demonstrated that patients had a severe and aggressive type of DKA occurring in 82% of children at presentation. The honeymoon period was not observed in the study the majority of
patients were controlled by single morning injection of soluble and intermediate acting insulin 30 minutes before breakfast. 31% of the children were routinely testing their urine whereas 52.7% were done by the parents. Only 21% of the children were recording their urine test for day monitoring, 51% of children were routinely inject the insulin, 16% of patients used to come regularly for follow up whereas 35.5% infrequent and 47.7% were not seen at all after discharge from hospital. Patients also have poor metabolic control indicated by high level of HbA1c, daily insulin dose of 2 IU/Kg/day. Moreover significant high mortality rate of 20% was found in the 5 years study.

ElKheir(26) studied a group of 70 diabetic children presenting with diabetic ketoacidosis, he found the male to female ratio 5:3, 26 patients (37.1%) were newly discovered and 35 patients (50%) had the disease for four year or less, more than 63% of these patients had more than 2 episodes of diabetic ketoacidosis, which indicated poor metabolic control. Regarding the presenting symptoms, the majority of patients (73%) showed the classical trait of polyuria, polydypsia and weight loss. Acute abdominal pain and vomiting were reported in 93% of the patients. The most common precipitating causes of DKA in this group were infections accounting for 39% of
cases and non-compliance in 16% of patients. Family history of diabetes was reported in 44% of patients, the frequency of diabetes was more common in the siblings of the diabetic children in comparison to their parents.

Abu-Samar\(^{(27)}\) in her MD thesis, studied the serum level of ketone bodies in diabetic children, presented with DKA and also she compared the sliding scale as mode of treatment versus fixed insulin dose of 0.2 unit/Kg given 6 hourly in treating DKA. She was found that 20.6% of her study sample were had mild ketonemia \(< 1\) mmol/L), 25% had moderate ketonemia \((1.1 – 3 \) mmol/L) and 54.4% had severe ketonemia \((> 3.0 \) mmol/L) at presentation, she also found that the fixed dose insulin regimen used in the treatment of DKA gave a significantly better glucose control at 24 hours of management compared to the sliding scale.

1.4.3. Immunogenetics of Sudanese diabetic children:

In general inheritance of human type 1 diabetes is polygenic, it has been estimated that over 50% of the inheritability is contributed by the HLA class genes.\(^{(28)}\) The first research in immunogenetics of type1 in Sudanese population was done by Almagzoub.\(^{(29)}\) He studied 72 well defined type1 diabetes and 59 healthy controls from the central
region of Sudan. The frequency of DR and DQ alleles in patients and controls was determined. He was found that a rare DR4/DQW2 haplotype occurring at increased frequency in the Sudanese type1 patients contributes to the overall association between DQW2 and disease.

Immunological markers of type1 diabetes were studied in 46 children. The cytoplasmic islet cell antibodies (ICA) and endogenous insulin secretion were studied in newly diagnosed type1 diabetics, 29(63%) of patients had ICA, which was found to be higher than those reported for African population. The ICA positive patients had significantly lower c-peptide concentrations, higher HbA1c level, high insulin requirement and higher prevalence of DKA at presentation. Also their results showed clear association between ICA and severity of diabetes at clinical onset.\(^{(30)}\)

Zaki\(^{(31)}\) studied the prevalence of glutamic Acid decarboxylase antibodies and thyroid antibodies in a comparative study. She was found that GAD autoantibodies were positive in significant titres in 46.1% of the diabetic children, 8% of the siblings and 3.2% of the control group, where the thyroid autoantibodies were not detected in the sera of the 3 comparative group except in two goiterous diabetic
females. She concluded that GAD as an autoantigen in type 1 is equally important in Sudanese diabetic children as in other Asian and European populations, but its role in disease prediction needs further study.

1.4.4. Complications in Sudanese diabetic children:

Daoud\(^{32}\) studied the acute and delayed complications of type I diabetes in children and adolescents, he was found that DKA was frequent (85%) six months prior to presentation. Rare hypoglycemic attacks, limited joint mobility was fairly common (54%) of patients. Neuropathy was detected in 6 patients all of them were female with average HbA1c more than 9.8% and mean duration of disease of > 5 years. Retinopathy was found in three patients all of them had HbA1c >9%. And duration > 5 years. Retinopathy was detected in two patients with HbA1c >8% and mean disease duration of 9 years. Sensorineural deafness was detected in two patients. He concluded that DKA was very common indicating poor glycemic control, while delayed diabetic complications were rare because most of the patients had short duration of illness.

Elamin and his group\(^{33}\) also investigated a group of 49 patients for the presence of microalbuminuria, 13 (26.5%) children had urinary
albumin excretion (UAE) rate greater than 20mg/L. UAE rate correlated positively with age at diagnosis and duration of diabetes. Those with microalbuminuria had high values for arterial blood pressure, HbA1c, daily insulin dose and serum cholesterol than diabetic with normal UAE.

1.4.5. Impact of dietary knowledge on diabetic control of Sudanese children:

In the field of health education, one interventional study was done assessing the effect of dietary education on the metabolic control of diabetic children. The results showed that there were significant changes after dietary education in the types of food consumed. There was an increase in ingestion of complex carbohydrate and fiber and a reduction in the consumption of lipids and proteins. Evidence of good metabolic control after diet modification was the significant reduction of HbA1c and daily requirements of insulin. (34)

1.5. Diabetes symptoms:

People with diabetes experience different symptoms. They depend on the rate of cell destruction which is quite variable, being rapid in some individuals (mainly infants and children) and slow in
others mainly adults.\textsuperscript{(35)} When is developed suddenly it usually presents with the classical symptoms of polyuria, polydipsia and unexplained weight loss. Some patients may present with diabetic ketoacidosis or diabetic coma as the first manifestation of the disease. Others may have no symptoms at all and their diabetes may be discovered accidentally during infection or on routine urine testing.\textsuperscript{(36)}

1.6. Aetiology and pathogenesis:\textsuperscript{(37)}

The precise cause of type1 diabetes is unknown, but there are a number of possible contributory factors:

**Autoimmune:** Several autoantibodies have been identified in newly diagnosed cases of type 1 diabetes. It also associated with other autoimmune disorders such as grave’s disease.

**Genetic:** Genetic factors play a greater part in the aetiology of type I diabetes in children diagnosed under the age of 5 years.

**Viral:** Several viruses (e.g. Coxsackie B, rubella, mumps and cytomegalovirus) have been implicated in the aetiology of type 1 diabetes. Possible mechanism for their effect include molecular mimicry in which the immune response to the infection cross-reacts with islet antigens.
**Nutritional:** Breast-feeding seems to provide protection against the risk of developing type 1 diabetes.

**Chemical toxins:** Ingestion of the rodenticide Vacor is associated with development of type 1 diabetes.

**Stress:** Prior to the onset of type 1 diabetes, adults have been shown to experience severe life events than a control group. The cause of this effect is unclear but may relate to stress-induced impairment of resistance to infection in genetically susceptible individuals.

**1.7. Diagnosis of diabetes mellitus:**

The diagnosis of diabetes mellitus is easy to establish when a patient present with classic symptoms of hyperglycaemia (thirst, polyuria, weight loss), and has a fasting blood glucose concentration at or above 126 mg/dl (7.0 mmol/L) or a random value at or above 200 mg/dl (11.1 mmol/L), confirmed on another occasion.\(^{(38)}\)

In the old classification, both the National Diabetes Data Group (NDDG) in the United States\(^{(39)}\) and World Health Organization (WHO)\(^{(40)}\) established diagnostic criteria for normal glucose tolerance and diabetes based upon an oral glucose tolerance test (OGTT).

The new diagnostic criteria strongly suggest that the diagnosis of diabetes be made on the basis of fasting blood glucose
only. The OGTT should not be used for epidemiologic research, because it is an imprecise test with poor reproducibility. A provisional report from the WHO agrees with the new definitions, but suggests continued use of the OGTT for patients with blood glucose values in the uncertain range.

1.8. Complications of diabetes mellitus:

Type 1 diabetes mellitus is a serious condition associated with significant morbidity and mortality because of its both short- and long-term complications besides rare associated autoimmune diseases. The most frequent short-term complications include hypoglycemia, hyperglycemia and diabetic ketoacidosis. The most common long-term complications include retinopathy, nephropathy and cardiovascular disease.

1.9. Diabetes mellitus control:

1.9.1. Day to-day glucose variations:

The extent to which blood glucose concentrations vary at the same time each day is another useful measure of overall glycemic control. For patients who test their own blood glucose at the same times every day, this variability can be evaluated simply by scanning down columns of blood glucose measurements over several days.
The usual explanation for large daily fluctuations is an erratic lifestyle in terms of eating or exercise habits. For patients who do blood glucose monitoring, both the patient’s technique and the meter’s reliability should be checked periodically. It is then useful to compare an average of the 50 or so most recent blood glucose readings with the HbA1c value obtained at that visit. If the patients are interested in improving glycemic control by intensifying his or her diabetic regimen, then attention must be paid to the blood glucose patterns to detect problems of within-day and between-day variability. These fluctuations should be corrected before increasing the insulin regimen.

In type 2 diabetes, although similar general considerations apply to patients with type 2 diabetes, there is less variability in blood glucose concentrations in this disorder. As a result, the fasting blood glucose correlated fairly well with the HbAc1 value and can be used with the HbA1c to estimate glycemic control.\(^{(44,45)}\)

1.9.2. Glycated hemoglobin:

The most widely used clinical test is measurement of blood glycated haemoglobin also called HbA1c. Hemoglobin formed in new red blood cells enters the circulation without any glucose attached.
However, red cells are freely permeable to glucose. As a result, glucose becomes irreversibly attached to hemoglobin at a rate dependent upon the prevailing blood glucose. The higher the level of circulating glucose over the life of the red blood cells, the higher concentration of HbA1c. Thus the measurement of HbA1c related to the level of blood glucose over a period of time. It provides an effective tool for evaluating long-term management and degree of control of the diabetic patients. It reflects the mean blood glucose concentration over the previous six or eight weeks.\(^{(45)}\)

The Diabetic Control and Complications Trial (DCCT) demonstrated a strong correlation between the mean blood glucose concentration and the HbA1c values. Such that a HbA1c value of 7% represented a mean blood glucose value of about 150 mg/dl (8.3 mmol/L), and HbA1c value of 9% represented a mean blood glucose value of about 210 mg/dl (11.7 mmol/L). HbA1c be measured every three to six months in patients with type 1 diabetes.

**1.10. Attitude of patients towards diabetes:**

Diabetes is one chronic illness in which it is particularly important that the patient plays an active role in management. Patients attitudes may have considerable influence on the success of
management. Factors, which influence an individual’s attitude to diabetes are many and may not be obvious to a doctor who sees the disease primarily in physiological and pathological terms. Some of these factors include:

1.10.1. Psychological aspects:

When diabetes develops in a child it affects the lifestyle and interpersonal relationships of the entire family. Feelings of anxiety and guilt are common in parents. Similar feelings, coupled with denial and rejection are equally common in children, particularly during the rebellious teenage years.

In children with diabetes, these feelings find expression in non-adherence to instructions regarding nutritional and insulin therapy and in noncompliance with self-monitoring. Deliberate overdose with insulin, resulting in hypoglycemia or omission of insulin, often in association with excesses in nutritional intake and resulting in ketoacidosis may be pleas for psychological help or manipulative attempts to escape an environment perceived as undesirable or intolerable; occasionally, there may be manifestations
of suicidal intent. Frequent admissions to the hospital for ketoacidosis or hypoglycemia should arouse suspicion of an underlying emotional conflict.\(^{(46)}\)

Overprotection on the part of the parents is common and often is not in the best interest of the patient. Feelings of being different or being alone or both are common and may be justified in view of the restrictive schedules imposed by testing of urine and blood, administration of insulin, and nutritional limitations. Furthermore, concern about the likelihood of complications developing and the decreased life span of patients with type 1 diabetes fosters anxiety.\(^{(46)}\)

Many, but not all of these problems can be averted through continued empathic counselling based on correct information and attempts to build attitude of normality in the patient and a feeling of being a productive member of society. Recognizing the potential impact of these problems, peer discussion groups have been organized in many locales; feelings of isolation and frustration tend to be lessened by the sharing of common problems. When emotional problems are clearly responsible for poor compliance with the medical regimen, referral for psychological help is indicated.\(^{(46)}\)
1.10.2. Premorbid personality and experience of illness:

The development of chronic illness such as diabetes places a considerable stress on an individual and his family. Those who have learned to deal with stress in a mature way are more likely to cope with the responsibility of self-care and attempt to lead a normal life than those who have not, who may become over dependent on others or withdraw from normal life. There is some evidence that response to illness is a learned behaviour and that the individual responds to each illness in a similar way. This is helpful to the doctor as it may help him to predict a patient attitude to anew development in the disease -the onset of complications for example.\(^{(47)}\)

1.10.3. Views on the cause of illness:

Most people who develop an illness look for a cause. Particularly with a chronic illness, there may be a need to compensate for the feeling that it is unfair that they have been affected. Folk beliefs about the cause of particular illness are many and are rarely based on facts. Onset of diabetes is often attributed to a shock or eating too much sugar, others may see the disease as a punishment perhaps for some event in their past and they would not feel intervention was worth-while.\(^{(47)}\)
1.10.4. Perception of severity:

The doctor and the patient may hold completely different views about the severity of the illness. The doctor has the benefit of knowing the spectrum of the disease and how it compares with other conditions as a threat to the patient. The patient may have little or no experience of diabetes and is unlikely to know where his own disease falls within the range of severity. Patient not coping well if he believe his diabetes is not a serious condition.\(^{(47)}\)

1.10.5. Presence of physical symptoms:

For those patients who present with the classical acute symptoms of uncontrolled diabetes, relief from the constant thirst and polyuria is welcome and few patients will have negative attitude to their initial treatment. Others may present accidentally on routine examination in which case it is very difficult to motivate a symptomless individual to change his lifestyle e.g. diet may not be seen by the patient as a treatment in same way as insulin.\(^{(47)}\)

1.10.6. Impact on lifestyle:

To the doctor, it may seem straightforward that a patient who
develops diabetes should be managed with diet and insulin with some form of monitoring to check on progress. Failure to comply may be interpreted as a negative attitude to the disease and cause an angry response in the doctor. However, to the patient his condition is only one aspect of his life. The patient social life may be centered around events involving food and drink and he may not be prepared to draw attention to his condition by avoiding items not allowed in his diet or keeping to a regular medications. It may be helpful if the doctor initiates discussion of such point to encourage amore honest reaction from the patient and teach him ways of adapting his condition.\(^{(48)}\)

1.10.7. Attitude of family and friends:

Illness is an event which shared between family and friends and consultation with them usually preceded a visit to the doctor; it will certainly follow that visit. Studies on compliance in the last 26 years, shown that diabetic patients’ adherence to medical advice is of multifactorial nature.\(^{(49)}\)It is well worthwhile for the doctor to ask the patient about what he has been told by the others in an attempt to reduce the fear which may be induced by unpleasant discoveries
from other sources.

1.10.8. Attitude of caring professionals:

Chronic disease brings a patient into a long and potentially close relationship with the healthcare team. The success or failure of this relationship may play an important part in the development of the patient attitude to his condition. It is important the patient knows that the doctor is still interested or he may feel the doctor is not bothered and therefore it is not necessary for him to be, e.g. the doctor who ask for regular urine tests, but never looks at the results or emphasizes weight reduction, but never weight the patient. A caring and positive attitude from the doctor is essential to encourage the patient to continue with his treatment and to help him adapt to his new condition.\(^{(50)}\)

Care needs to be exercised when discharging patients from hospital care to the community care as patients may believe that their condition has been cured and that follow up is no longer necessary.\(^{(51)}\)

1.10.9. What should the doctor do?

Perhaps the most helpful way to think of this is for the doctor to imagine himself as the patient. To do this, he need to know details
of the patient background such as family, work, social life, level of education and previous experience of ill-health. At diagnosis he needs to find out what the patient already knows about diabetes and where his information come from. The doctor needs to remember that the other sources of information may be held in equal steem to his own and should be cautious about dismissing them without discussion. Trying to keep at it from the patient point of view each time the diabetes and its management is discussed may help the doctor to understand difficulties which have arisen. With practice it will become possible for the doctor to raise topics spontaneously and anticipate many of the problems which the patient is likely to encounter.\(^{(47)}\)

### 1.11. Treatment goals:

#### 1.11.1. General treatment objectives:

The health team has three basic objectives in the care of the person with diabetes.\(^{(52)}\)
- Maintain optimal nutrition: This first objective is a basic requirement for adequate growth and development and maintenance of desirable weight.
- Avoid hypoglycemia or hyperglycemia.
- Prevention of long term complications.

1.11.2. Specific treatment goals:

Persons with diabetes, their families, and health care teams must set treatment goals together. To do this requires open communication and appropriate patient self-management education. Treatment goals should be individualized, realistic, and achievable.\(^{(52)}\)

Diabetes control is assessed by SMBG on day-to-day bases and completed by glycated haemoglobin test which reflect the average plasma glucose concentration over the preceding 2-3 months.\(^{(53)}\)

1.11.3. Standard goals:

In setting individual patients glycemic targets shout take into account the results of prospective randomized clinical trials, most notably the Diabetes Control and Complications Trial (DCCT)\(^{(54)}\) and also the United Kingdom Prospective Diabetes Study (UKPDS),\(^{(55)}\) which confirm the same benefits of glycemic control in type 2 diabetes. In DCCT the average HbA1c is 7.2% in intensively treated
patients and 9.0% in conventionally treated groups. Where self monitoring of blood glucose (SMBG) targets in the same trial were 70-120 mg/dl (3.9 mmol/l – 6.7 mmol/l) before meals and at bedtime and < 180 mg/dl (10.0 mmol/l) when measured 1.5-2.0 hours post-prandialy.

1.12. Insulin injection therapy:\(^{(56)}\)

Insulin injection therapy has evolved progressively over the seven decades since it was first introduced into clinical practice in Toronto. The most commonly used insulins have concentration of a 100 IU/ml and are classified as rapid acting (onset 0.5 – 4 hours), intermediate acting (onset 2-4 hours) and long acting (onset 4-6 hours) depending on their duration of action.

A total daily dose of 0.5 – 1 U/kg/day is required. Two daily injections are now considered as standard therapy. Each injection consists of intermediate and short acting insulin, in proportions of 2:1. Two thirds of the total daily dose is given 30 min before breakfast and one third before the evening meal. The two insulins should always be drawn into the syringe in the same sequence (regular first), so that the residual insulin in the “dead space” is always the same type; thus greater stability of the patient can be assured once a therapeutic is
established. Single daily injections are now avoided because insulin regimens are now required to mimic physiological insulin secretions. In special circumstances, such as highly motivated older adolescent, or with particularly committed, capable parents, three or more injections can be used.\(^6\)

1.12.1. **Storage of insulin:**

Insulin has an effective shelf-life of at least 2 years if kept in a refrigerator at 4°C and can be kept at room temperature for up to 1 month. However, if kept in tropical climates, car interiors or freezer compartments insulin may degrade more rapidly.\(^{37}\)

1.12.2. **Self-insulin injections:**

Depending on the maturing and confidence of the individual patient, children as young as 5 years can be taught to administer their own injections of insulin. However, the age at which children start to give their own injections is very variable.\(^{37}\)

1.12.3. **Injection sites:**

Appropriate injection sites are upper and outer arms and buttocks, anterior and lateral thigh, and on either side and below the umbilicus. The use of different injection sites and rotation of these sites should be encouraged to avoid the development of lipohypertrophy. If
patients avoid injecting into these areas, lipohypertrophy will resolve, typically within 3 months.\(^{(37)}\)

1.12.4. Injection technique:

It is recommended that patients be taught to give the injection at a 45° angle to the surface of the skin. When using the very short (e.g. 5mm) needles the injection can be given vertically without pinching the skin unless the patient is very thin. Pen needles can be used up to three times before being changed.\(^{(37)}\)

1.13. Dietary management:

Actually, there are no special nutritional requirements for the diabetic child other than those for optimal growth and development. It requires an individualized approach and effective nutrition self-management education.\(^{(46)}\)

Children and adolescents must have a firm educational base provided, so that the individual and family can become increasingly independent in the self management of diabetes. The nutritional needs of the growing child and the behavioural issues that have an impact on adolescent diets must be regularly assessed. Caution must be exercised to avoid over aggressive dietary manipulation.\(^{(57)}\)
In all types of diabetes and especially in children, diet modifications are based on individuals' needs, while considering lifestyle, eating habits, food preferences, and level of physical activity. It may be more appropriate to base energy needs on a child’s usual food intake rather than on a theoretical estimate. This can be obtained through a careful diet or food intake record from the child’s care-giver based on a usual day’s intake before the onset of symptoms. The use of non-individualized meal plans based on calculated calories levels is not appropriate and can lead to non-compliance.\(^{(57)}\)

Baseline energy needs, can be estimated using 1,000 calories for the first year of age plus approximately 100 calories per year from one year until 10 to 12 years of age. This baseline value must be adjusted for growth spurts and variations in activity level to achieve and maintain normal growth. This calorie intake does not need to be calculated or altered unless the child is over or under weight.\(^{(58)}\) Height, weight and growth velocity should be plotted on standard growth grids several times a year to monitor the need for changes in calories levels.
Diabetics are allowed three main meals in addition to 3 snacks according to their caloric requirements. The total daily caloric intake may be divided to provide 20% at breakfast, 20% at lunch and 30% at dinner, leaving 10% for each of the mid-morning mid-afternoon and evening snacks. Carbohydrate should constitute 55%, fat 30% and proteins 15%. Refined sugars should be limited as much as possible for children (allowances can be made to those below 5 years of age) and high fiber content is also advisable.\(^{(59)}\)

1.14. Monitoring glycemic control:

1.14.1. Blood glucose testing

Self-monitoring of blood glucose (SMBG) can be used to manage diabetes effectively and safely. It can be used to aid in the adjustment of a therapeutic regimen in response to blood glucose values and to help individuals adjust their dietary intake, physical activity, and insulin doses to improve glycemic control on a day-to-day basis.\(^{(60)}\)

SMBG works by having patients perform a number of glucose tests each day or each week. The test most commonly involves pricking a finger with a lancet device to obtain a small blood sample, applying a drop of blood onto a reagent strip, and determining the glucose concentration by inserting the strip into a reflectance photometer for
an automated reading. Test results are then recorded in a logbook or stores in glucose meter’s electronic memory. People with diabetes can be taught to use their SMBG results to correct any deviations out of a desired target range by changing their carbohydrate intake, exercising, or using more or less insulin.

The frequency with which patients with diabetes should monitor their blood glucose level varies from person to person. A positive correlation between frequency of SMBG and glycemic control among patients with insulin-treated type 1 or type 2 diabetes has been demonstrated.\(^{60,61}\) However, laboratory measurement of glycated hemoglobin (HbA1c) provides the best available index of over all diabetes control.

1.14.2. Urine testing:

Urine glucose testing, frequently used in the past, has so many limitations that it should not used. It however, remains the only practical way to detect ketones. in the presence of a serious illness.\(^{60,61}\)

1.14.3. Self-management education:

For newly diagnosed patients, a staged approach to education should be used. Initial education focuses on the skills needed for survival,
which include: basic food/Meal plan guidelines, exercise guidelines, signs, symptoms, treatment and prevention of hypoglycemia, nutritional management during short-term illness, self-monitoring of blood glucose levels and plan for continuing care.

In depth information and additional topics are added after the patient has time to adjust to the diagnosis. The knowledge and skills needed to implement nutritional recommendations can not be acquired in one session; therefore, nutrition education must be an ongoing component of diabetes care. This is best accomplished through a coordinated team effort in which the dietitian must be an active participant.

1.15. Acute complications:

1.15.1. Hyperglycemia/diabetic ketoacidosis and acute illnesses:

Hyperglycemia can lead to diabetic ketoacidosis (DKA). It is characterized by elevated blood glucose levels (≥ 250mg/dl; “>13.9 mmol/L”) and the presence of ketones in the blood and urine. Symptoms include polyuria, polydipsia, hyperventilation, dehydration, the fruity odor of ketones, and fatigue. SMBG, testing for urine ketones, and medical intervention can all help prevent DKA. If left untreated, DKA can lead to coma and death. Treatment includes
supplemental insulin, fluid and electrolyte replacement, and medical monitoring.

Acute illnesses, such as flu, colds, vomiting, and diarrhoea if not managed appropriately, can lead to the development of DKA. Patients need to know the steps to take during symptoms of hyperglycemia or acute illness and they should be actively empowered so as to prevent DKA and its consequences.\(^{(64-67)}\)

Sick-day guidelines for persons with diabetes:\(^{(64)}\)

1- During acute illnesses, take usual doses of insulin. The need for insulin is continuous, or may even increase, during periods of illness, fever, dehydration, infection or the stress of illness can trigger the release of counter regulatory or “stress” hormones, causing hyperglycemia.

2- Monitoring of blood glucose levels and urine testing for ketones should be done at least four times daily (before each meal and at bed-time). Blood glucose reading exceeding 240 mg/dl and moderate to large urine ketones are danger signals indication that additional insulin is needed.

3- If regular foods are not tolerated, liquid or soft carbohydrate containing foods (such as regular soft drinks, soup, juices and ice
cream) should be eaten. At least 50 g of carbohydrate (3 to 4 carbohydrate choices). Should be consumed every 3 to 4 hours in small frequent feedings.

4- Ample amounts of liquid should be consumed every hour. If nausea or vomiting occurs, small sips – 1 or 2 tea spoon every 15 to 30 minutes, should be consumed. If vomiting continues, the health care team should be notified.

5- The health care team should be called if illness continues for more than one day.

1.15.2. Hypoglycemia:

The vital point of diabetic therapy is to try to maintain blood glucose levels as close to normal as possible, whilst avoiding frequent and disabling hypoglycaemia. Hypoglycemia is a common side effect of insulin therapy. Autonomic symptoms are shakiness, sweating, palpitations and hunger. Moderate and advanced hypoglycemic symptoms are related to neuroglycopenia and include headaches, confusion, lack of coordination, blurred vision, anger, seizures, and coma. Common causes of hypoglycemia include excess insulin, inadvertent or deliberate errors in insulin doses, improper timing of insulin in relation to food intake, intensive insulin
therapy, inadequate food intake, omitted, inadequate or delayed meals or snacks and increased or prolong duration of exercise or activity.

SMBG is essential for prevention and treatment. Changes in insulin injections, eating, exercise schedules, and travel routines warrant increased frequency of monitoring.(69) Guidelines of treatment of hypoglycemia includes:(70)

- Immediate treatment with carbohydrate is essential.
- If the blood glucose level falls below 70 mg/dl (3.9 mmol/L), treat with 15 g of carbohydrate, which is equivalent to:
  - 3 glucose tablets.
  - Fruit juice or regular soft drinks, ½ cup.
  - Sugar or honey, 1 tea spoon.
- Wait 15 minutes and retest if the blood glucose level remains <70 mg/dl (<3.9 mmol/L), treat with another 15gram of carbohydrate.
- Repeat testing and treatment until the blood glucose level returns to within normal range.
• Evaluate the time to the next meal or snack to determine the need for additional food. If it is more than an hour to next meal add additional 15 g of carbohydrate.

1.16. Exercise and its effect on blood glucose level:

Exercise is an integral component of growth and development. No form of exercise, including competitive sports of any kind, should be forbidden to the diabetic child, who should not be made to feel different or restricted. (46)

Although exercise does not absolutely result in better glycemic control in every child with diabetes, it is encourage to promote cardiovascular fitness and long-term weight control and to enhance social interaction and esteem through team play. Regular exercise improves gluoregulation by increasing uptake of glucose by muscles independent of insulin or through increasing insulin receptors. A major complication of exercise in diabetic patients is the presence of hypoglycemic reaction during or within hours of exercise. Immediate or delay hypoglycemia can occur in children whose glucose usually well controlled. Ideally, blood glucose monitoring should occur before and after exercise. Hypoglycemia can be avoided by taking complex carbohydrate in the form of a snack before exercise and/or by
decreasing the dose of insulin by approximately 10-20%. If hypoglycemia does not occur with exercise, adjustments in diet or insulin are not necessary.

1.17. The care of children with diabetes in the school:
Information should be supplied to the school or day care setting so that the school personnel are aware of the diagnosis of diabetes in the student and of the signs, symptoms and treatment of hypoglycemia. It is desirable that blood glucose testing be performed at the school or day care setting before lunch and when signs or symptoms of abnormal blood glucose levels are present.

1.18. Continuing care:
Continuing care is essential in the management of every patient with diabetes. At each visit the patient’s progress in achieving treatment goals should be evaluated by the health care team, and problems that have occurred should be reviewed. If goals are not being met, the management plan needs to be revised and/or the goals need to be reassessed.

1.18.1. Visit frequency:
Regular visits should be scheduled for all patients with diabetes. Patients should generally be seen at least quarterly until achievement of treatment goals. Thereafter, the frequency of visits may be decreased as long as patients continue to achieve all treatment goals. More frequent contact also may be required if patients are undergoing intensive therapy, not meeting glycemic or blood pressure goals, or have evidence of progression in microvascular or macrovascular complications.

1.18.2. Medical history: An interim history should be obtained at each visit.
1.18.3. Physical examinations:

The routine follow up examination should include: height (until maturity), weight, blood pressure, sexual maturation (in peripubertal patients), fundoscopy in patients at risk (referral if retinopathy detected), foot examination in patients at risk, if abnormalities are identified, more frequent follow-up may be required.(73)

Comprehensive dilated eye and visual examinations should be performed annually by an ophthalmologist or optometrist who is knowledgeable and experienced age 10 years and older who have had diabetes for 3-5 years, all patients diagnosed after age 30, and any patient with visual symptoms and/or abnormalities.(74)

1.18.4. Laboratory evaluation:

HbA1c: HbA1c determination should be performed routinely in all patients with diabetes, first to document the degree of glycemia control at initial assessment, then as part of continuing care.

A lipid profile: Should be performed on children older than 2 years after diagnosis of diabetes and when glucose control has been established. Tests resulting in borderline or abnormal values should be repeated for confirmation. If values fall within accepted risk levels, assessment should be repeated every 5 years. Tests resulting in abnormal values requiring institution of therapy should be repeated, following National Cholesterol Education Program recommendations for children and adolescents.(73,75)

Microalbuminuria: In the absence of previously demonstrated microalbuminuria, an annual test for the presence of microalbumin is necessary. Screening for microalbuminuria in individuals with type 1 diabetes should begin with puberty and after 5 year duration of the disease.(73,75)

1.18.5. Management plan:

The management plan should be reviewed at each regular visit to determine progress in meeting goals and to identify problems. This review should include the control of blood glucose levels, assessment of complications, control of blood pressure, control of dyslipidaemia, nutrition assessment,
frequency of hypoglycemia, adherence to all aspects of self-care, evaluation of the exercise regimen, follow up of referrals and psychosocial adjustment. In addition, knowledge of diabetes and self-management skills should be reassessed at least annually. Continuing education should be provided or encouraged.\(^{(73,75)}\)

**JUSTIFICATIONS:**

- Diabetes is a self-managed condition, therefore, it is fundamental for patients to acquire the relevant knowledge, skills, and attitudes needed for successful diabetes management.
- Knowledge, attitudes, and practices in diabetes mellitus can influence compliance, the level of glycemic control, and overall treatment outcomes.

**OBJECTIVES:**

1. To study the general characteristics and the diabetes-related knowledge (K), attitude (A) and practices (P) of the diabetic children attending different outpatient clinics in Khartoum State.
2. To investigate the effect of some socio-demographic and diabetes-related variables on attaining knowledge.
3. To assess the impact of knowledge, attitude of diabetic children and their families on the compliance with medical therapy.
4. To study the relation between the knowledge, attitude, and compliance score and glycaemic control.

**CHAPTER TWO**

**Methods and materials**
2.1 Study design:

This is a prospective cross-sectional study based on outpatient referred clinics.

2.2 Study area:

The study was conducted in Khartoum state in 5 main areas including:

1- Special diabetic centre in Khartoum: Japer Abueliz Diabetic Centre referred clinic.
2- Khartoum Children Emergency Teaching Hospital referred clinic.
3- Omdurman Children Emergency Teaching Hospital referred clinic.
4- Ahmed Gasim Teaching Hospital referred clinic.
5- Khartoum North Teaching Hospital referred clinic.

2.3 Study duration:

The data was collected within 6 months October 2002 to March 2003.

2.4 Study population:

All children previously diagnosed as having diabetes of any type were involved in the study.
2.4.1 Inclusion criteria:

All children aged 6 years to 18 years with diabetes looking after them in these referred clinics were eligible for this study.

2.4.2 Exclusion criteria:
- Newly discovered patients with diabetes less than 6 months.
- Patients age less than 6 years and above 18 years.
- Children/or their caregivers refused to give a consent.

2.5 Sample size and Sampling:

The statistical form used to calculate the sample size was

\[ N = \frac{Z^2 PQ}{d^2} \]

Where:

\( N = \) Sample size
\( P = \) Proportion of disease = 0.95/100,000\(^{(23)}\)
\( Q = 1-p=0.05. \)
\( d = \) Degree of accuracy.

At 90% level of confidence \( N = 58. \)
At 95% level of confidence \( N = 86. \)

A total of 100 patients aged 6 to 18 years attending any of the referred clinics and all those seen sequentially by the author were enrolled in this study.

2.6 Research tools and measurements:
2.6.1 Structured standardized questionnaire:

- **Patients** were contacted and informed about the purpose of the study, then consented and personally interviewed by the author with the help of a prestructured standardized questionnaire.

- **Diabetic children** were mainly involved as informants where their parents or care givers were involved in certain questions where their help was needed e.g. belief in alternative treatment/or dietary compliance.

- **Assistance and clarifications** were given
whenever subjects encountered difficulties with any aspects of the questions.

Questionnaire was divided into four sections:

The first part: contained information on personal data including socio-demographic characteristics and diabetes-related variables.

The second part: contained information about the subjects knowledge and level of care related to diabetes and its management. This includes:

- Assessing general knowledge of diabetes, causes/pathophysiology and consequences of having diabetes and its lifelong implications.
- Knowledge related to insulin injections, action of insulin, its organ of production and other practical details of insulin injections.
- Knowledge and practices related to monitoring; how to monitor and interpret blood sugar levels.
- Knowledge and self-care related to diabetic diet.
- Knowledge related to diabetic emergencies: symptoms of hypoglycemia, hyperglycemia and their management. It listed symptoms consistent with hyperglycemia and then hypoglycemia
and offered a series of choices as to what each scenario represented. Patients were also asked to select any number of proposed actions that they should take in the event of hypoglycemia, hyperglycemia and being unwell to eat or during minor illness.

- Effect of infection on blood glucose.
- Role of exercise on blood glucose control.
- Awareness of long term complications.

**The third part:** contained information about knowledge and attitude towards the treatment and doctor instructions related to insulin therapy and dietary adherence.

**The fourth part:** contained information about clinical and biochemical assessment where HbA1c was used as direct measure of control and patient weight and height were measured and used as indirect indicators of glycemic control.\(^{(45,76)}\)

**Reliability and Validity of the questionnaire:**

- Reliability is concerned with whether the questionnaire will produce the same results when administered repeatedly to an individual. Where validity is concerned with whether the
questionnaire is actually measuring what is purports to be measuring. This questionnaire is based on or preserving the skeleton of the Anglo-American questionnaire.\textsuperscript{(77,78)} which assesses knowledge in the different areas of diabetes regarding its causes/pathophysiology and other areas of diabetes management.

- A pilot study was done in 10% of patients and their data was excluded from the study, then the questionnaire was modified.
- Questions in this questionnaire were adjusted to cover an estimated level of knowledge i.e. all the components concerning knowledge were simple, basic questions about the condition, and they are adequately cover the area they are supposed to measure.

2.6.2. EDTA Tubes, disinfectants, disposable syringes and tourniquet:

These are the equipments used for blood sample collection. 3ml of a venous blood samples were collected into a labeled EDTA evacuated tubes and refrigerated until the end of the session when it was transported to a nearby special laboratory in Japer Abueliz Diabetic Centre for HbA1c assay.

2.6.3 Storage of the sample:
EDTA tubes were labeled with the child’s name, serial number and date of sampling. These samples of whole blood were stored in the refrigerator at a temperature between 2-8°C to be analyzed within 10 days of collection.

2.6.4 Laboratory investigations:

Blood samples were analyzed for HbA1c by an experienced laboratory technician using a technique known as liquid chromatography (cation exchange – temperature independent, Hemoglobin A1c, Biosystems, S.A, Spain). Within 10 days of receiving the sample. The normal laboratory range is (4.2 to 6.2). Good control is considered when a patient had HbA1c of less than or equal to 7.5%, fair if it is between 7.6 to 9.9% and poor if it is more than or equal to 10.0%.(27,28,31)

2.7 Statistical methods:

Data obtained from the questionnaire and laboratory results were entered in the computer using the statistical package of the social science (SPSS).(79) Descriptive and comparative statistics were performed. Chi-square test was used in assessing the effect of general characteristic on attaining the required knowledge.
**Scoring system:** generally score of one and zero were allotted for correct and uncorrected responses (apart from limited questions scored 2 for correct answers). The total of responses was computed to represent the overall knowledge and attitude score. A cut-off point of 60% was used, determined by the median of scores, below and above which the score was considered as low (poor knowledge) or high (good knowledge) respectively. Where only compliance with insulin and dietary medical therapies (from practice) were scored. The overall knowledge and attitude score of the diabetic children were generated and chi-square tests were used to test significance differences between categorical data. P. value of 0.05 or less was considered as indicative of statistical significance.

**2.8 Input of the author:**

- The author managed to interview all patients sequentially seen in the different out-patient clinics and filled the questionnaire.
- Collection of blood samples and charring in the analysis of HbA1c of the patients under the study.
- Entering the data in the computer using SPSS program and
performing some descriptive statistics apart from cross tabulations.

2.9 Ethical consideration:

- Approval consent of the study was taken from our local committee of pediatrics and child health University of Khartoum.
- Diabetic children and their parents were informed about the purpose of the study and then consented and interviewed.
- Informed consent was also taken from the different health authorities.
- Counseling and health education was given to the patients and their parents after completion of the questionnaire immediately.
- All ill patients were treated by the author or otherwise referred to a nearby emergency departments.