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Abstract

We discuss the bioecological model of Urie Bronfrenbreener and its application to diabetes care and psychosocial wellbeing of children with diabetes in Sub-Saharan Africa. Using empirical evidence, this paper demonstrates that the bioecological model provides an important framework for understanding diabetes care needs and intervention strategies required to enhance the well-being of children living with diabetes. The paper also discusses clinical and research implications. The advantage of applying the bioecological model in drawing up intervention strategies for those living with diabetes is that it targets large-scale public health interventions unlike medical intervention that focus on a single individual.

Keywords: Bioecological Model, PPCT, Children, Adolescents, Diabetes-care, Psychosocial-wellbeing

Introduction

Health care providers, psychologists, parents and significant others like teachers, require comprehensive knowledge of social and biological factors that contribute to personal development and health care of children and adolescents with diabetes mellitus. Diabetes mellitus is a metabolic disorder of multiple etiologies that is characterized by chronic hyperglycemia with disturbances of carbohydrate, fat and protein metabolism resulting from defects in insulin secretion, insulin action or both.[1, 2]

One framework that can help improve knowledge on environmental and biological factors that contribute to the development, health care and psychosocial wellbeing of children living with chronic illness such as diabetes mellitus is the bioecological model of Urie Bronfenbrenner[49]. The bioecological model can help researchers and health care practitioners to understand a phenomenon within a larger context, in this case a framework for understanding the factors that produce and maintain health and health-related issues in diabetes. The bioecological model allows the identification of strategic points of interventions and to understand how social problems are produced and sustained within and across the various ecological systems. Research evidence indicates that the most efficient preventive and intervention strategies for childhood problems consider the context in which a child lives, the interactions a child has with other people, influence of institutions and policies in the immediate and wider environment[51]. These ecologies are considered to influence a developing child[3]. As a result, it is useful to understanding how the bioecological model can be utilized to understand the needs of children with diabetes.

The aim of this paper is to discuss the application of the bioecological model to diabetes care and psychosocial wellbeing in children and adolescents with diabetes in Sub Saharan Africa. We review the ecological model based on the interrelations among the process-person-context time (PPCT) model concept of the bioecological theory[4]. Then the paper discusses how the bioecological model can be applied to understand diabetes care and psychosocial issues that affect children with diabetes within the Sub-Saharan African context. Finally, clinical and research implications are discussed.

The Bioecological Model

The bioecological theory of development posits that human development is a transactional process, influenced by an individual's interactions with various aspects and spheres of the environment[5]. The bioecological theory has four major components: process, person, context and time also known as the Process-Person-Context-Time (PPCT) model.[6]

Process

The proximal or near processes involve all sorts of transactions between the child and the immediate surrounding that are responsible for the development of the child's competences and general wellbeing.[3] Proximal processes are near contexts to a child involving a reciprocal interaction between a child and the environment. It is a bidirectional relationship between the child and the environment. To be effective (contribute to child's competences and wellbeing), the transaction between the child and the environment must occur in a fairly regular basis over an extended period of time in a reciprocal manner. The transactions must be enduring and participating in such interactive processes over time generates the ability, motivation, and

knowledge necessary for development. Therefore, proximal processes are an important engine of development.[53] These proximal processes drive development and are often seen as either protective or preventive systems for example parental warmth, affection and discipline strategies. Other than proximal processes, distal process are at work in the life of a child with diabetes. Distal processes involve a unidirectional transaction between the child and environment incorporating persons, objects and factors away from the center of the child. To have an effect on the child, distal process should have an enduring interaction with the child. Examples of distal may include the family's ability to support the child financially or emotionally. The form, power, content and direction of the proximal process affecting development vary systematically as a joint function of the characteristics of the developing person and environment.[4]

Person

The person component of the model centers on the biological and genetic aspects of a child including personal characteristics that a child brings with into any social situation.[7] The characteristic that a child brings in any situation can be divided in to three types: demand, resource and force characteristics.[4] Demand characteristics relate to "personal stimulus", those that act as an immediate stimulus to another person such as age, gender, skin color, coping skills, reasoning and physical appearance. These types of characteristics may influence initial interactions because of the expectations formed immediately. Therefore, to some extent the degree and nature of interactions involving family members, caregivers or peers is partially determined by the characteristics of the child itself. Resource characteristics relate to mental and emotional resources such as past experiences, skills and intelligence and also to social and material access.[3] Force characteristics are those that have to do with differences of temperament,

motivation, persistence among others.[4] Two children may have equal resource characteristics, but their developmental trajectories will be quite different if one is motivated to succeed and persists in tasks.[4]

Context

The context is the best known component of the bioecological model and perhaps the most important of all four components in conceptualizing and designing intervention studies in child development.[3] The context contains four distinct systems: micro, meso, exo and macro systems and each has either a direct or indirect influence on the child's development. The four systems within the framework of diabetes are depicted in the PPCT framework in table 1.

[insert table here}

The first system (i.e., the microsystem) is any environment such as home, school, or peer group in which a person spends a good deal of time.[4] The second system is the mesosystem. The mesoystem focuses on the connections between two or more systems within the microsystem. At this level, the model proposes that socialization is influenced by those who interact with the child, such as schools, peers and neighborhood. The systems here are believed to interact; for example, the home environment of the child can influence what happens at the playground with other kids. The exoystem is the third layer and looks at the context within a developing child's environment that the child does not directly encounter but impacts on the development. A decision to adjust work schedule for a parent can, for example, indirectly affect the parent-child interaction or attachment time. Finally, the fourth layer of the context is called the macrosystem.

The macrosystem is a context encompassing any group (culture, subculture, or other extended social structures) whose members share values or belief systems, resources, hazards, life styles, opportunity structures, life course options and patterns of social interchange.[8] An example of the macrosystem is an economic crisis in a country which may shape the development of a child.

Time

The final element of the process-person-context-time model is time. The time element of the model also known as chronosystem includes components such as chronological age, duration and nature of periodicity.[3] Time-related events such as parent's debilitating illness, divorce or change of residence can have a more profound impact on a younger child compared to older ones.

Application of the bioecological model on diabetes care and psychosocial issues

"Nothing is as practical as a good theory" – Lewin Kurt, 1951, *p*169.[9] As with any robust theoretical model, Bronfenbrenner's ecological model of development is parsimonious and applicable to areas such as pediatric diabetes. The basic premise of the Process-Person-Context, and Time model of Bronfenbrenner's thinking is that health, behavior and their determinants are interrelated.

Process

Pediatric diabetes takes place in a progressive and complex reciprocal interaction between an active, evolving child with diabetes and the people, objects and symbols in its immediate environment. Proximal process are useful in clinical practice as tools to understand required

adjustments to diabetes care and in understanding as well as adjusting psychosocial wellbeing of children with diabetes. For instance, parental warmth and emotional availability are related to improved diabetes care and diabetes related quality of life (QoL).[50] The form, power, content and direction of proximal processes will affect diabetes care and psychological wellbeing based on the functions of the characteristics of the child.[4] For example, if the child has low self-efficacy and the people surrounding the child are not supportive of diabetes care, the child may have sub-optimal glycemic control especially in the absence of critical objects such as automatic insulin pumps. An A1C goal of < 7.5% (58mmol/mol) is recommended across all pediatric age-groups.[10] However, the increase use of basal-bolus regimens, insulin pumps, frequent blood glucose monitoring, goal setting, and improved patient education in youth from infancy through adolescence have been associated with more children reaching the blood glucose targets set by the American Diabetes Association in developed countries.[10-12] In developing countries both proximal and distal process make it difficult for children to reach the target of < 7.5% (58mmol/mol).

From a diabetes care and psychosocial wellbeing inquiry perspective, examples of proximal processes, either protective or preventative, can be phrased in questions such as: Does the child get lessons about appropriate diabetes self-care activities? Does the child receive social support useful for diabetes management? Does the child get protection from physical and psychological harm such as discrimination from other children? Does the child get nutrition suitable for diabetes management? It is also important to note that children with diabetes are affected by distal processes including the family's own ability to support a child with diabetes as well as interact with other environments, of which the child is part of (e.g., access to health centers or

pharmacies for medical essentials, resources to enable integration with different people of health status).

Person

The self of a child with diabetes is very important in determining levels of diabetes care and psychological wellbeing. Biological and genetic predisposition of the child have long been associated with diabetes mellitus,[13-14] diabetes care [15] and psychological wellbeing.[16] For the former, there are alleles or genetic variants associated with type 1 diabetes mellitus (T1DM) which either provide susceptibility or protection from acquiring the disease.[17] Further, evidence for hereditary influence can be deduced from twin studies. The concordance for T1DM is approximately 50% for monozygotic twins and the risk to a first degree relative is approximately 5%.[18]

Children with diabetes have personal characteristics which may affect diabetes care and their psychological wellbeing, such as their age, gender, weight and ethnicity. Firstly, insulin dose percentiles (ID-Perc) have been found to significantly differ during various periods of childhood and are influenced by gender, body weight, and insulin injection regimes.[19] For instance, the 50th ID-Perc (P50) varied among 0.67 insulin required (IU)/kg (age 3 years), 0.93 IU/kg (13 years), and 0.70 IU/kg (23 years) increasing from early childhood to adolescence and decreasing toward adulthood. The highest P50 ID was found at 12 years in females (0.94 IU/kg) and at 14 years in males (0.92 IU/kg). In multivariate regression analysis, insulin dose was significantly ($P < 0.001$) associated with age, gender, and insulin delivery regime.[19] Moreover, one other study found that children with diabetes were shorter (128.3 ± 24.3 cm vs. 133.6 ± 24.7 cm) and lighter (29.2 kg ± 15.3 vs. 31.3 ± 15.4 kg).[20] Height (−1.1 ± 1.2 vs. −0.2 ± 0.8) and weight (−1.2 ± 1.3

vs. −0.7 ± 1.3) were significantly lower in diabetic children compared to health controls ($P < 0.05$).[20]

Other studies indicate that the age of onset in South Africa and Ethiopia was later than elsewhere in the world[21-22] and the peak age of onset of T1DM in Sub-Saharan Africa was a decade later than in the West.[21, 23-24] Ethnic differences in the peak age of onset have also been reported in some African countries. For instance, in South Africa it has been reported that the peak age of onset was about 13 years in the white South Africans (similar to Europeans) but about 23 years in the black South Africans.[21] These ethnic difference may be due to socioeconomic status and lifestyle difference between white and black people. There is also evidence that young people compared to adults have more challenges with diabetes self-care.[25]

Diabetes psychosocial issues tend to affect girls more than boys. A longitudinal study including 910 T1DM and 241 type 2 mellitus (T2DM) young people found that health related quality of life (HRQL) for girls remained stable or decreased over time whereas boys' HRQL increased.[26] Moreover, girls tend to report more depression symptoms compared to boys.[27-28] Girls also tend to face more gender specific discrimination and stigma related to diabetes than boys. For instance, girls with diabetes tend to be more perceived as reproductively unfit in romantic relationships than boys with diabetes and also tend to have more worries concerning finding a romantic partner or possibilities of giving birth.[29] These studies suggest that the impacts of diabetes on HRQL differ by sex and should be consider in clinical management.

Other personal characteristics useful for diabetes self-care are self-efficacy[30], motivation[31] and personality traits.[32] Self-efficacy and motivation are useful in taking charge of one's own diabetes management. Personality can also be a barrier or facilitator of support from others. Extroverts compared to introverts tend to have a wider social support network that may be useful for diabetes care[52].

Physical maturity is one of the biggest challenges in diabetes management. Majority of T1DM is diagnosed in individuals younger than 18 years of age and this group require unique aspects of care and management, such as adjusting insulin intake during this period of insulin sensitivity related to physical growth and sexual maturation, ability to provide self-care and neurological vulnerability to hypoglycemia and hyperglycemia as well as possible adverse neurocognitive effects of diabetes ketoacidosis.[10,33-34] In addition, some children with diabetes especially in developing counties are presenting with comorbid conditions such as Malaria [35], HIV and AIDS [36] and may also be undernourished due to high poverty levels, all of which complicate diabetes care and contribute to psychosocial problems.

Given the implications of the person in diabetes, considering personal characteristics of a child with diabetes in treatment choices, care and other interventions is crucial. Therefore, clinicians should carefully consider predispositions of children with diabetes such as age and sex when deciding on a treatment plan. Psychological predispositions such as self-efficacy should be considered to optimize diabetes self-care and adherence to treatment.

Context

The environment or context in which a child with diabetes develops has implications for diabetes care and psychosocial wellbeing. The microsystem contains environments such as home, school, or peer groups that have direct and indirect effect on diabetes care and psychosocial wellbeing. The home environment, especially family support and good home structure, is useful for diabetes care, in particular glucose monitoring. There is also a link between QoL and metabolic control since poor metabolic control burdens the family.[37] Diabetes can cause enormous pressure on how the family functions which either can strengthen or break family ties, depending on the characteristics of a family.[29] During adolescence there is increasing independence and adolescents often challenge parents' supervision of their diabetes care. This may lead to conflicts within a family. T1DM is demanding and affects everyday lives of not only patients with diabetes but also their families and significant others. This may in turn exert stress on the family which is already burdened by diabetes management cost. Diabetes specific family conflict is related to poorer adherence and glycemic control.[10] Advice given by parents or family members (e.g., "Shouldn't you check your blood glucose? I think you are low!") can be perceived as offensive or intrusive behaviors into diabetes management, especially in adolescents who want to be or become independent.[29] On the other hand, constant respectful and unconditional support to patients' diabetes management may improve diabetes treatment outcomes. In some cases, poor glycemic control is because of lack of caregiver involvement and poor or inconsistent family management and punitive or negative parenting. This is where health care providers should encourage developmentally appropriate family involvement in diabetes management tasks for children and adolescents, recognizing that premature transfer of diabetes care to the child can result in nonadherence and deterioration in glycemic control.[10] In low-income homes, apportioning resources to household food stuffs can be a source of conflict, given that patients

with diabetes are supposed to take certain diets that have low saturated fat composition and are rich in vegetables, part of a healthy diet, which may not be liked by other family members. This underscores the importance of family and friends in diabetes management.

Peers are useful in diabetes care. Literature suggests that friends' support for blood glucose testing is related to patients' disease adaptation and QoL.[38] Peers can be supportive in diabetes care and can also thwart adaptation to the disease. Because adolescents with diabetes sometimes face discrimination from peers, they may want to hide the condition from others.[29] Some adolescents want to feel normal like their peers which in turn makes them abandon their medical kits that often attract interest from their healthy peers for fear of discrimination or unwanted attention.

Adolescents spend much of their time at school. Therefore, the school is an important agent for diabetes care and psychosocial wellbeing for children with diabetes. Despite the underscored importance of schools, children with diabetes in the school and day care setting still face discrimination from teachers and the school system. Some schools may refuse admissions of children with diabetes and children in classrooms may not be provided with the assistance necessary to monitor glucose and may be prohibited from eating needed snacks.[10] Sometimes the school may not know how to handle a child with a hypoglycemia or hyperglycemia episode. Therefore, each school should be acquainted with general guidelines for the care of the child with diabetes in the school and day care setting developed by various organizations such as the American Diabetes Association and national diabetes associations.[10] Broadly the guidelines

include i. Diabetes medical management plan, ii. Responsibilities of various care providers and iii. Expectations of the student in diabetes care[10].

The mesosystem from the diabetes perspective entails linkages and process that influence diabetes care and psychosocial wellbeing in two or more settings containing the child with diabetes. This linkage of more settings can be exemplified by the recommendation from the American Diabetes Association that the parent/guardian should provide the school or day care with materials and equipment necessary for diabetes care tasks, provide supplies to treat hypoglycemia, and provide information about the students, meal/ snack schedule and emergency phone number for parent or guardian among others.[10]

Diabetes-related stress in a family may contribute to poor glycemic control. Given the developmental age of children, some may think it is their fault due to their diabetes and may engage in self-destructive behavior like skipping injecting insulin, hospital appointment or even very drastic measures such as suicide. This is when the relationship between community health workers, diabetes peer educator and families of the child with diabetes should be strengthened. This also includes encouraging the parent/guardian to be accompanying the child for hospital appointments in order to enable the heath care provider assess psychosocial issues in a family that may affect diabetes care. The connection between other larger structures such as a church or community support groups can also be expected to have distal processes at work because they help the child and family copy with diabetes related stress and get the necessary support for the child. Counseling services available to the family in times of need can influence the functioning of the mesosystem.[3]

The exosystem contains linkages and processes that indirectly influence processes within the immediate setting in which the developing child lives. For example, a parent's work schedule can influence the parent's involvement in diabetes care. In cases where a parent does not accompany a child for a hospital appointment, a common practice observed in Zambia[16], the parent will have limited interaction with the health care provider and for young children, they may perceive this as if they are unwanted by parents. In addition, parental work stress or frustrations from everyday house hold chores may in turn cause the parent to behave more irritable which may make children think that it's their fault the parent is going through that anger and stress and may be the cause for some drastic measures children with diabetes sometimes go through such as stopping taking medicine or suicide attempts to gain attention from parents. Some policies on how many appointments a child should attend at the hospital to receive certain service, e.g. free insulin or syringes can all be considered as exosystem influences on the child.

The macrosystem contains societal blueprint and influences other systems mentioned above. Cultural beliefs and propensities are some of those in the system that have influence on diabetes care and psychosocial wellbeing. For instance, there are beliefs that girls with diabetes cannot give birth, and in developing countries, a good number of patients with diabetes consult traditional healers who claim to be able to cure diabetes.[29] National health policies influence diabetes care. Diabetes and obesity, for example, have social etiological roots in the structure and lack of regulations on the food industry, the tobacco industry and the cultural tradition of sedentary life style. Santé diabètes, a Non-Governmental Organization working in the area of diabetes in Africa, points out that in recent years, there has been an overweight problem in Africa

especially with the sharp increase in the consumption of food that contains more saturated fat and an increasing number of people with a sedentary lifestyle, as a result of rising income and urbanization in Africa.[39] Urban life style in Africa is characterized by changes in dietary habits involving an increase in consumption of refined sugars and saturated fat and a reduction in fiber intake.[40] These changes will probably further increase the risk of obesity and death. Obesity in turn is particularly associated with an increased risk of developing T2DM. Moreover, Sub-Saharan African consumers are increasingly aspiring for fast food choices and most African countries like Zambia, South Africa, and Nigeria are among the top fast food establishment destinations.[41] Consequently, urbanization and its consequences on diabetes may increase the risk of stress and depression which may compromise diabetes care. The development of stress and depression associated with urbanization may also led to the development of diabetes. The circle is a vicious one which may also lead to other psychosocial problems such as increase in treatment cost, discrimination, and poor QoL among others.

Other macrosystem influences on diabetes include health care policies or guidelines such as the standards for diabetes medical care by the America Diabetes Association which spell out how diabetes care should be done.[10] Although in some countries, non-communicable diseases (NCDs) policies and departments are in existence, their capacity to provide adequate medical care for persons with diabetes mellitus and also the prevention of T2DM is way below expected standards. For instance, in Zambia and Mozambique, referral pathways are poorly used and sometimes non-existent.[42] The Diabetes Foundation and International Insulin Foundation (IIF) found that three main problems were related to referrals in Zambia:

1. Lack of information given to users about their diagnosis in general and specifically about the reason for the referral;
2. Many of the patients referred were not given a letter which should have facilitated their entry into the hospital system;
3. Lack of linkage from the hospital, back to the urban health centers for follow-up.

A survey by IIF showed that healthcare workers where often (no figures reported) unfamiliar with the management of uncommon diseases such as diabetes. Diabetes was often mistaken for cerebral malaria; 21 out of 199 patients in Tanzania who were diagnosed as having cerebral malaria actually had diabetes mellitus.[42] To make matters worse, there is lack of qualified human resources, essential medical drugs and poor access to health facilities especially among rural clients. When medical drugs are available, they are expensive due to taxes and procurement procedure[43]. Budget allocations to health especially diabetes are crucial determinants of the nature of care patients will receive. In 2009, the World Health Organization reported that the 7.02 million cases of diabetes recorded by the WHO in African countries resulted in a total economic loss of US$ 25.51 billion, a figure which has since increased.[44] Political will and increased budget allocation to non-communicable disease like diabetes remain a challenge in most developing countries. Some countries like Zambia subsidize the cost of medicine to make them accessible to patients. In addition, education policies that encourage physical education can contribute to reducing traditional sedentary life style in children.

Time

A good example of how the chronosystem affects diabetes care and psychosocial wellbeing is by examining the "honeymoon" period. The honeymoon period is the time in people with T1DM shortly following diabetes diagnosis when the pancreas is still able to produce a significant amount of insulin to reduce insulin need and aid blood glucose control. Children with T1DM have often shown adjustment problems at the onset of diagnosis and after the "honeymoon" period has finished.[45-46] Children find it difficult to adjust especially injecting themselves multiple insulin doses and adjusting their diet. This period is when most adolescents experience stress related to diabetes care.[29]

Duration of diabetes from diagnosis play a role on a child's psychological wellbeing. Developmental stage and physiological differences related to sexual maturity are crucial in deciding and implementing an optimal diabetes regimen plan.[10] In adolescents, non-adherence problems can be a result of the increase in counter-regulatory hormones (e.g., growth hormones, cortisol, epinephrine and glucagon) responsible for insulin resistance, a situation also known as "dawn phenomenon." [47] Dawn phenomenon is the night-to-morning elevation of blood glucose before and after breakfast in subjects with both T1DM and T2DM. In people without diabetes mellitus, blood glucose and plasma insulin concentrations remain remarkably flat and constant overnight, with a modest transient increase in insulin secretion just before dawn to restrain hepatic glucose production and prevent hyperglycemia.[48] People without diabetes mellitus do not show symptoms of the dawn phenomenon.

Another issue worth discussing that occurs during the course of a person's development is the types of diabetes in relation to someone's age. The onset of T1DM can occur at any age, but is

generally before the age of 40 while T2DM often has its onset after the age of 50 but can also develop before the age of 50.[2] However, due to demographic changes, people young than 18 years old are now increasingly being diagnosed with T2DM. The time component of Bronfenbrenner's model refers not only to chronological age and duration but also to the nature of periodicity. As alluded to earlier, in developing countries changes in demographic characteristics and rise of the middle class entails there will be a sharp increase in the consumption of food that contains more saturated fat and an increasing number of people with a sedentary lifestyle.

Clinical and research implications

To begin with clinicians and researcher should take into consideration the processes (proximal and distal), personal characteristics of the child with diabetes, micro-, meso-, exo- and macrosystems with which a child with diabetes lives in and the chronosystem and how these influence diabetes care and psychosocial wellbeing. Clinicians and researchers should also know that two or more children may have equal resource characteristics and context, but their developmental trajectories will be quite different if one is motivated to succeed and persist in tasks despite having diabetes. The child's wellbeing is linked to his or her resources characteristics, whether physical, mental or emotional and the environment in which it exists. Therefore, assessment of the child's, psychological wellbeing and environment are crucial in optimizing diabetes care and psychosocial wellbeing of the child with diabetes. To understand the lives of young people with diabetes, clinicians and researchers need to identify areas of strength and vulnerability in the child's ecology; understand the multi-directional interactions between nature and nurture and also that there is differential susceptibility to the influence of

nature and nurture in children with diabetes; conduct evaluation studies to demonstrate efficacy of interventions targeting the ecology of a child with diabetes so that clinicians do not reinvent the wheel doing interventions that do not work; initiate and/or improve relationships between different stakeholders important for diabetes care such as the family, community, school, diabetes international bodies and pharmaceutical companies in order to improve the wellbeing of children. Then there is need to sensitize and educate communities on diabetes and how to help children with diabetes so that positive outcomes for children are realized at school and community level.

Conclusion

Deriving from empirical evidence, this paper has illustrated how the bioecological model can be used to understand diabetes care and psychosocial wellbeing of children. The paper shows that the proposition of the ecological thinking is that diabetes, behavior and its determinants are interrelated. Future studies should investigate how the bioecological model can be applied in everyday pediatric diabetes. This also means that ecological interventions that foster behavioral and contextual change through targeting environmental factors that are most likely to influence diabetes care and psychosocial wellbeing are possible. Unlike medical interventions delivered by a health care provider at the individual levels, the proposed interventions are larger scale and emphasize the complexity of behavior and the environment (person x environment interaction) rather than a person's behavior only.

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Table 1: The PPCT framework explaining bio-ecological factors affecting diabetes care and psychosocial functioning in children with diabetes mellitus.

PPCT Component	Diabetes Care and Psychosocial Functioning Issues
Process	Transactions between child with diabetes and immediate environment; e.g., low self-efficacy coupled with lack of family support affects glycaemic control
Person	Biological and genetic predispositions: alleles associated with T1DM, age, gender weight and race are associated with diabetes care. Self-efficacy, motivation, personality traits affect influence diabetes management. Comorbid HIV and Malaria complicate care
Context	
Microsystem	Home, school, peers role in diabetes care and buffering psychosocial problems
Mesosystem	Interaction and effect of interaction on diabetes care and psychosocial wellbeing between parents and school, community health workers and child/family, church and counselling centre for psychological support
Exosystem	Parents schedule, work stress/frustrations and how they affect diabetes care and child relationship
Macrosystem	Diabetes policies, budget to health-diabetes, food drugs regulations, and cultural practices influence of diabetes care
Time	Honey moon period, the Dawn Phenomenon' adolescent period and counter regulatory hormones, transition times e.g. urbanization and sedentary times.