To the Graduate Council:

I am submitting herewith a dissertation written by James A. Grubb entitled "The Relationship Between Blood Glucose Level and Reading Comprehension in Diabetic Children." I have examined the final copy of this disseratation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Education, with a major in Curriculum and Instruction.

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We have read this dissertation
and recommend its acceptance:

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Vice Chancellor
and Dean of the Graduate School

THE RELATIONSHIP BETWEEN BLOOD GLUCOSE LEVEL AND READING COMPREHENSION IN DIABETIC CHILDREN

A Dissertation

Presented for the

Doctor of Education

Degree

The University of Tennessee, Knoxville

James A. Grubb

December 1990

DEDICATION

This dissertation is dedicated to the memory of my best friend, Sergeant Eddie Cameron. His kind example showed me the meaning of courage, faith and strength.

ACKNOWLEDGMENTS

This researcher wishes to thank several people for their help in the completion of this dissertation. First, I wish to thank Dr. Phyllis Huff, the director of my committee and dissertation, who gave hours of professional advice. Thanks also goes to Dr. William Poppen, Dr. Estill Alexander and Dr. Lester Knight who were members of my committee. Each of these scholars contributed in unique and valuable ways to this work.

The author also wishes to thank Dr. Anne Meek for her continued support. Her confidence in me helped me through many rough hours and motivated me to strive for perfection.

The author wishes to express gratitude to his friends for their moral support and encouragement during this work. Particularly, Larry Anderson helped type and revise this work into its present form.

Lastly, the research wishes to express deep appreciation to his mother, Mildred Grubb. Her financial and moral support made this work possible.

ABSTRACT

The purpose of this study was to determine if blood glucose level affected reading comprehension test scores in diabetic children. This finding could possibly prevent a diabetic child from being labeled as "learning disabled."

A total of nineteen fourth, fifth, and sixth grade children participated in the study. Of this nineteen, ten were girls and nine were boys. The children were attending a day camp sponsored by the American Diabetes Association.

The study was conducted during two summers. Twelve subjects participated in summer one (1986) and seven participated in summer two (1987). The same procedures were followed during both summers with no subjects repeating the study.

The subjects completed the Gates-MacGinitie Reading Comprehension Test immediately before their pre-lunch blood glucose test. This was done on three different days during the camp with the subjects taking a different form of the same test each day.

The blood glucose check was supervised by a registered nurse but tests were done by the subjects themselves suing Glucostix and the Glucometer II system for blood glucose monitoring. Reading test scores and blood glucose levels were recorded and compared by the researcher. A scatter diagram and correlation coefficient were used to determine if a relationship existed. No control group

existed since diabetic subjects were not compared with nondiabetic subjects.

Data for the study were analyzed by computer. The slope of the scatter diagram showed a negative relationship existed between blood glucose level and reading comprehension test scores in diabetic children. The correlation coefficient was determined to be -.47 also suggesting a negative relationship.

Based upon the findings of this study, a negative relationship existed between abnormal blood glucose levels and reading comprehension test scores in fourth, fifth, and sixth grade diabetic children.

TABLE OF CONTENTS

CHAPTER		PAGE
I.	INTRODUCTION	1
	Statement of the Problem	2
	Purpose of the Study	3
	Question	3
	Need	4
	Assumptions	4
	Delimitations and Limitations	4
	Definition of Terms	5
	Procedures	6
	Organization of the Study	7
II.	REVIEW OF RELATED LITERATURE	8
	Diabetes and Cognitive Functioning	8
	Summary	11
III.	METHODS AND PROCEDURES	12
	Sample Selection and Description	12
	Instruments	13
	Procedures	15
	Statistical Treatment	16
	Summary	17
IV.	ANALYSIS OF DATA	18
	Introduction	18
	Findings	18
	Summary	22
V.	SUMMARY, FINDINGS, CONCLUSIONS, DISCUSSION AND RECOMMENDATIONS	23
	Summary	23
	Findings	24
	Conclusion	25
	Discussion and Recommendations	25
BIBLIOGRAPHY		28
VITA		34

CHAPTER I

INTRODUCTION

An average day in school for a diabetic child may consist of varying fluctuations in his or her blood glucose level. A child who becomes very sleep mid-morning, is unable to concentrate in the class before lunch, or complains of a headache after gym may have undetected hypoglycemia (low blood sugar). A child who needs extra trips to the bathroom or water fountain may be experiencing the signs of hyperglycemia (high blood sugar). These symptoms indicate that diabetes may be going out of control and should be reported by the teacher or nurse to the parents (Siminerio & Betschart, 1986).

Glucose provides the major source of energy to the brain and central nervous system. Different blood glucose levels do affect some types of cognitive functioning (Holmes, Hayford, Gonzalez, & Weydert, 1983). A study by Gath, Smith, and Baum reported that 28.5% of the diabetic children they examined were at least two years behind chronological age in reading (Gath, Smith, & Baum, 1980). The presence of substantial reading and memory problems in children has implications for diabetes education. Traditional approaches to instruction and management may require modification to

minimize or simplify reading requirements (Holmes & Richman, 1985). This raises at least one important question for educators: Does blood glucose level influence a diabetic child's ability to comprehend what he or she reads?

This study was an attempt to analyze the effects of blood glucose level on reading comprehension ability in diabetic children.

STATEMENT OF THE PROBLEM

In most diseases the presence of physical symptoms represents a signal to the patient to take corrective action such as taking medication or seeking help. The symptoms themselves are reliable indicators of physiological state. Other disorders such as diabetes are often characterized by only vague sensations that may differ from person to person (Pennebaker, Cox, Frederick, Wunsch, Evans, & Pohl, 1981).

The control of diabetes is currently imprecise and this results in fluctuating levels of blood glucose. The disease can frustrate a child by depriving him of his normal activity, or it can set him apart from other children producing timid withdrawal or overt aggression (Gath, Smith, & Baum, 1980).

However, it is more difficult to interpret the exact relationship between cognitive deficits and glucose

concentrations. Holmes et al. (1983) found performance deficits during hypoglycemia with slowed math recall and visual reaction time. She and her colleagues also found slowed visual reaction time at hyperglycemia suggesting that cognitive impairments may occur during both low and high glucose levels (Holmes et al., 1983). This slowed visual reaction time could also affect the reading comprehension ability of these diabetic children. However, reading comprehension has not been addressed in these studies.

PURPOSE OF THE STUDY

The primary purpose of this study was to determine if blood glucose level in diabetic children affects their reading comprehension. This finding could possibly prevent a diabetic child from being labeled as "learning disabled."

QUESTION

The question investigated by this researcher specifically addresses reading comprehension ability as it relates to blood glucose level in the diabetic child. Do hypoglycemia and hyperglycemia affect the manner in which a diabetic child comprehends what he or she reads?

NEED

An in-depth search of the literature relating to blood glucose level and cognitive functioning revealed a limited body of knowledge. The previous studies have suggested a need for further research. Also the fact that a study of this topic has not been done before creates a definite need.

ASSUMPTIONS

This study is based on a number of assumptions. These include the following:

1. The validity and reliability of the reading comprehension tests are accurate and all forms are comparable.
2. The blood glucose test results are correct.
3. The subjects responded in an honest manner.
4. All testing conditions were similar.

DELIMITATIONS AND LIMITATIONS

There are a number of delimitations and limitations to this study. These include the following:

1. The researcher made no attempt to control the blood glucose levels of the subjects.

2. The subjects of the study included only pupils in grades four, five, and six.

3. The subjects participated on a voluntary basis.

4. The subjects took the reading comprehension test in an "outdoor camp" setting.

DEFINITION OF TERMS

For the purpose of this study, the following operational definitions were accepted:

1. GLUCOSE--sugar

2. HYPERGLYCEMIA--a high level of sugar in the blood (above 120 mg/dl).

3. HYPOGLYCEMIA--a low level of sugar in the blood (below 60 mg/dl).

4. INSULIN--a hormone produced in the beta cells of the pancreas; it lowers blood sugar.

5. INSULIN-DEPENDENT DIABETES--a condition in which the pancreas stops making insulin. Individuals with this condition must take daily injections of insulin to survive. Also called Type I or juvenile diabetes.

6. MG/DL--milligrams of glucose per deciliter (100 milliliters) of blood. A standard way of measuring blood glucose levels.

7. NORMAL BLOOD GLUCOSE LEVEL--between 70 mg/dl and 120 mg/dl (Siminerio & Betschart, 1986).

8. READING COMPREHENSION--understanding what is read (Harris & Hodges, 1981). Specifically for this study the score on the Gates-MacGinitie Reading Comprehension Test.

PROCEDURES

The sample for this study consisted of diabetic fourth, fifth, and sixth graders participating in a day camp for diabetic children. The camp was sponsored by the American Diabetes Association. Subjects participated strictly on a voluntary basis. Guidelines for working with human subjects were followed.

The subjects completed the Gates-MacGinitie Reading Comprehension Test (at their grade level) immediately before their pre-lunch blood glucose test. This was done on three different days during the camp with the subjects taking a different form of the same test each day. It is standard procedure to test blood-sugar level before each meal. This allows the subject to determine if he or she needs an extra helping of food, or perhaps a bit less insulin if blood sugar is low (Siminerio & Betschart, 1986). The blood glucose check was supervised by a registered nurse but tests were

done by the subjects themselves using Glucostix and the Glucometer II system of blood glucose monitoring.

Reading test scores and blood glucose levels were recorded and compared by the researcher. A scatter diagram and correlation coefficient were used to determine if a correlation existed. All subjects participating were in the experimental group. No control group existed since diabetic subjects were not compared with nondiabetic subjects.

ORGANIZATION OF THE STUDY

This study will be presented in five major sections or chapters. Chapter I consists of the introduction, statement of the problem, purpose of the study, question, need, assumptions, delimitations and limitations, definition of terms, procedures, and a statement of the organization of the study.

Chapter II is a review of the related literature dealing with diabetes and cognitive functioning.

Chapter III is an explanation of the methods and procedures followed in collecting data for the study.

Chapter IV includes presentation and analysis of the data.

Chapter V presents a summary, provides conclusions, and presents recommendations from the study.

CHAPTER II

REVIEW OF RELATED LITERATURE

This chapter presents a review of literature related to children with diabetes and cognitive functioning. A complete computer search of ERIC, MEDLINE, and PSYCHINFO revealed limited information relating to this topic. Following is a discussion of this material.

DIABETES AND COGNITIVE FUNCTIONING

The cognitive abilities of children with diabetes, as measured by standardized intelligence tests, have been examined in several research studies. Some studies in the 1930s, as reported by McGavin, Schultz, Peden, and Bowen (1940), suggest children with diabetes were above average in intellectual ability. Flender and Lifshitz (1976) found that maximum performance in fine motor coordination and memory performance in juvenile diabetic patients was attained with blood glucose levels between 150 mg/dl and 300 mg/dl. However, their brief abstract does not provide sufficient detail of tasks and methods of inducing hyperglycemia for comprehensive analysis.

In Gath, Smith, and Baum's (1980) study of 70 children with diabetes, they concluded that the prevalence of psychiatric disorder was no greater than in their comparison group, but that the children with diabetes were delayed in reading skills. Children whose diabetic control was assessed clinically as poor during the period of study were more likely to be poor readers. Delamater et al. (1984) suggests that attentional and fine motor skills are important to school work and are affected by fluctuations in glucose level.

Hagan et al. (1985) did a study that includes responses of children with diabetes to a specific memory task. In this study the trend was for the 30 children with diabetes to perform less well on each of the measures than their siblings and less well than comparison children matched on age and sex.

Holmes et al. (1983) found that different blood glucose levels do affect some types of cognitive functioning. The study consisted of twelve diabetic subjects recruited from the student population of the University of Iowa. Attention to and performance on a reaction time task, requiring a rapid motor response to the onset of a visual stimulus, was slowed at both high and low blood glucose levels compared with normal levels. They also found evidence that rate of remembering information may be impaired at low glucose levels

when performance was timed, as speed of recalling rote math facts was slowed. Accuracy did not suffer, but rate of work was slowed.

Holmes et al. (1984) reported that in learning situations, some verbal time tests may place diabetic individuals at a slight disadvantage, depending on their blood glucose levels. Twelve male diabetic subjects between 18 and 35 years of age were recruited for this study. The subjects completed the Verbal Associative Fluency Test and the Stroop Word Task. Regardless of the underlying cognitive mechanisms involved, it was apparent that overt measures of verbal fluency and naming skills showed a slowing in response to glucose alterations. High glucose concentrations did not produce the striking acute cognitive effects that low concentrations did, although subtle performance deviations may occur according to Holmes.

Holmes and Richman (1985) did a study to better understand the relationship among disease variables, intellectual skills, and academic achievement in children with diabetes. Forty-four insulin-dependent diabetic children between the ages of 6 and 16 years were evaluated at a university department of pediatrics. Children were given an I.Q. test and three other tests that measured visual-motor skill, isolated memory for words, and memory for digits.

In this study evidence suggested that diabetic children experience reading difficulty based on their memory impairments for the component parts of reading (i.e., letter name, sound/symbol associations, etc.). They suggest that traditional approaches to instruction and management may require modification to minimize or simplify reading requirements.

Ponte (1987) reported that parents of children with diabetes said their children had more difficulty in school. Her study consisted of thirty families who had a child with a diagnosed seizure disorder, thirty who had a child diagnosed as having insulin-dependent diabetes, and thirty-three families with healthy children who were used as a comparison group. The families were interviewed and evaluated. The parents of diabetic children also said that they had more behavioral problems than children in the comparison group.

SUMMARY

This chapter presented a review of literature related to children with diabetes and cognitive functioning. The next chapter will discuss the methods and procedures used by the research to see if a relationship exists between blood glucose level and reading comprehension in diabetic children.

CHAPTER III

METHODS AND PROCEDURES

This chapter describes the methods and procedures followed to accomplish this study, the purpose of which was to determine if a relationship existed between blood glucose level and reading comprehension in diabetic children. Several procedures for conducting the study were identified and followed. In this chapter are descriptions of the selection of the sample and the selection of the instruments. An explanation of the procedures employed to collect and analyze the data are also included.

SAMPLE SELECTION AND DESCRIPTION

The subjects who participated in this study were fourth, fifth, and sixth grade diabetic children who attended a one week summer day camp sponsored by the American Diabetes Association. Subjects participated on a voluntary basis. Letters explaining the study both to the parents and to the students accompanied the initial registration forms for the camp (see Appendix). The letters adhered to the guidelines for working with human subjects.

Permission slips were attached to each letter and only subjects returning the letters were chosen for the study. The study was conducted for two summers with twelve participants during the summer of 1986 and seven during the summer of 1987. Ten of the subjects were girls and nine were boys. It is estimated that only one in every 600 children develops diabetes (Siminerio & Betschart, 1986). Therefore it is difficult to obtain a large sample of diabetic children. The same procedures were followed during both summers with no subjects repeating the study.

INSTRUMENTS

The Gates-MacGinite Reading Comprehension Test was chosen as the main instrument by the researcher. The Gates Silent Reading Test and the Gates Primary Reading Tests, two of the first widely used tests in reading, were published in 1926. In the years that followed, Professor Gates repeatedly revised and improved the tests and introduced new tests and new concepts in testing. In 1960 Walter H. MacGinite began working with Professor Gates, and in 1965 they published a completely revised series, the Gates-MacGinitie Reading Tests (MacGinitie, Kamans, Kawalski, MacGinitie, & MacKay, 1978).

The validity of a test has to do with what the test measures. To the extent that the test measures what the test

user wants measured and nothing else, the test is valid. The Gates-MacGinitie Reading Tests measure important knowledge and skills that are common to most school reading curricula and validity has been established (MacGinitie et al., 1978).

The reliability of a test is a matter of how accurately the test measures whatever it does measure. A truly reliable test should always produce the same results. All levels of the Gates-MacGinitie Reading Tests have established reliability. The Kuder-Richardson Formula 20 reliability coefficients were computed from the standardization sample for each level of the test. The published reliability of all forms of the tests used by the researcher is 90 (MacGinitie et al., 1978).

However, no reading test can measure reading achievement with perfect accuracy: human behavior is too variable. All scores must be considered to be somewhat tentative, and should be understood in the light of whatever else you know about the individual student or the group.

Only the comprehension part of the test was used. The Comprehension Test measures the student's ability to read complete prose passages with understanding. It contains 16 different passages of varying lengths and a total of 43 questions about these passages. The passages include selections from various literary works and subject-matter fields. Some of the question about these passages require an

understanding of information that is explicitly stated in the passage; others require an understanding of information that is only implicit in the passage.

The Gates-MacGinitie Reading Test was selected because three parallel forms of the same test were available. Since students were required to take the same test on three different days, a different form of the test was needed each day to eliminate familiarity.

PROCEDURES

Students completed the reading test in a picnic shelter which was removed from other camp activities. This helped to eliminate distractions and interruptions from the other campers. The timed test was given at 9:30 a.m. and lasted for 25 minutes with the researcher monitoring the students. Immediately after completing the test, students checked their blood glucose level using the Glucometer II Blood Glucose Meter with Glucostix Reagent Strips. It was standard camp procedure for students to check their blood-sugar at this time because of their high activity level. The researcher recorded the blood glucose level with the form of the test taken at that time.

Following is an explanation of the Glucometer II system of checking blood glucose level:

1. Lift the instrument lid and press the on/mode/off button.
2. Clean the puncture site by washing your hands in warm water and drying thoroughly. This not only cleans the finger to be punctured, but helps stimulate the blood flow.
3. Remove a fresh Glucostix Reagent Strip from the bottle and replace the bottle cap, tightly. Prepare a facial tissue for the blotting procedure.
4. Prepare a finger puncture device, such as Glucolet, and prick your finger. Form a large drop of blood on the end of your finger. Avoid squeezing excessively.
5. Press the start test button and at the sound of the beep (50 second display), quickly apply a large drop of blood to the Glucostix test pads. Completely cover both yellow test pads with blood.
6. At 20 seconds (long beep) immediately blot the test pads using the tissue.
7. After you have blotted the reagent strip, open the test door and insert the reagent strip into the strip guide with the reacted test pads facing the test window and the end of the strip positioned behind the strip guide tab. Immediately close the test door.
8. Just as the countdown reaches 1, five short "beeps" sound followed by a display of three bars. A digital readout of the test result is then displayed.
9. Open the test door and throw away the used reagent strip. (Miles Laboratories, 1986)

STATISTICAL TREATMENT

The reading comprehension tests were manually scored by the researcher. A raw score was recorded and compared with the blood glucose level of the subject at the time of the test. A scatter diagram and correlation coefficient were used to determine if a relationship existed between reading

comprehension test scores and blood glucose level in diabetic children.

SUMMARY

This chapter presented the methods and procedures used to collect the data to determine if a relationship exists between blood glucose level and reading comprehension in diabetic children. The next chapter will present the data collected with an analysis of this data.

CHAPTER IV

ANALYSIS OF DATA

INTRODUCTION

The data collected for this study were used to determine if a relationship existed between blood glucose level and reading comprehension in diabetic children. A scatter diagram and a correlation coefficient were used to determine any existing relationship.

The data were gathered during two different time periods. The results for subjects A-L were gathered during the summer of 1986 and the results for subjects M-S were gathered during the summer of 1987. Three forms of the reading comprehension test were taken by each subject. The data appear in Table 1.

FINDINGS

All data for this study were analyzed by computer. The mean of the reading comprehension scores was 21. The scores of 19, 21, and 25 occurred five times each making the data multimodel. The test scores ranged from 5 (lowest) to 35 (highest) establishing a range of 30. The glucose level mean

TABLE 1

Reading Achievement Scores and Glucose Levels for Diabetic Children (N=19)

	Reading Test Scores			Glucose Level		
Subject	Form1	Form2	Form3	Test1	Test2	Test3
A	28	21	24	92	173	104
B	23	19	24	81	130	248
C	23	23	20	238	183	285
D	26	26	21	220	322	224
E	23	20	21	126	319	224
F	12	18	15	313	353	311
G	25	19	23	155	158	41
H	30	35	28	147	85	281
I	22	27	21	47	45	54
J	29	25	28	155	87	88
K	23	32	21	168	158	258
L	9	11	15	400	400	243
M	19	28	25	370	200	397
N	19	26	25	287	329	200
O	32	24	23	108	307	328
P	17	19	25	234	300	90
Q	5	15	14	196	73	74
R	20	13	9	266	324	400
S	7	15	13	301	263	319

was 212. The mode was 400 with a range determined to be 359.

Scatter diagrams or scattergrams provide a picture of the relationship between two variables. In a scatter diagram each point represents paired measurements on two variables for an individual. In this study the X axis represents the reading comprehension test score and the Y axis represents glucose level.

The slope indicates the general direction of the relationship. For a negative slope, the direction of the points is from the upper left to the lower right (Hinkle, Wiersman, & Jurs, 1988). The slope of the scatter diagram obtained for this study is that of a negative correlation between blood glucose level and reading comprehension test scores (see Figure 1).

The correlation coefficient is an index that describes the extent to which two sets of data are related. A correlation coefficient of +.10 or -.10 indicates there is little relationship between the variables. A coefficient of +.90 or -.90 indicates a strong relationship (Hinkle, Wiersma, & Jurs, 1988).

The correlation coefficient for this study was determined by computer based upon the following formula:

$$r = \frac{(\Sigma xy) - n\overline{xy}}{(n - 1)SxSy}$$

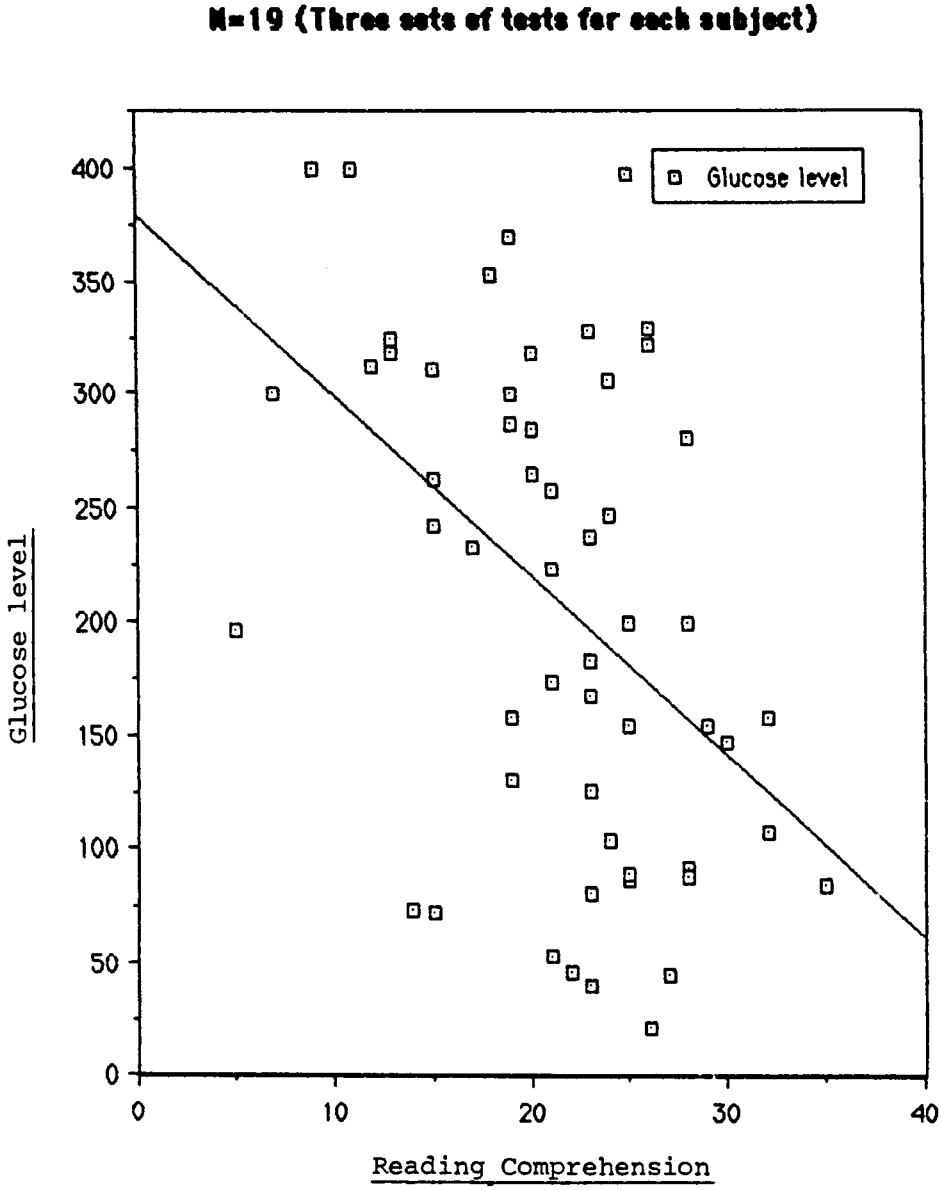


Figure 1. Comparison of glucose level and reading comprehension.

r = correlation coefficient

x = reading score

y = blood glucose level

Sx = standard deviation of x

Sy = standard deviation of y

$\{$ = sum of

$\bar{x}$ = sample mean of x

$\bar{y}$ = sample mean of y

n = number of subjects

(Ferguson, 1981)

The correlation coefficient was determined to be -.47. The results of this study are near the mid-point suggesting a possible relationship between blood glucose level and reading comprehension test scores of fourth, fifth, and sixth grade diabetic children.

SUMMARY

The preceding chapter presented the data gathered by the researcher and an analysis of this data. A discussion of the findings and implications for further research will be presented in the next chapter.

CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS, DISCUSSION AND RECOMMENDATIONS

SUMMARY

Purpose

The purpose of this study was to determine if blood glucose level affected reading comprehension test scores in diabetic children. This finding could possibly prevent a diabetic child from being labeled as "learning disabled."

Participants

A total of nineteen fourth, fifth, and sixth grade children participated in the study. Of this nineteen, ten were girls and nine were boys. The children were tested while they were attending a day camp sponsored by the American Diabetes Association.

Procedures

The study was conducted during two summers. Twelve subjects participated in summer one (1986) and seven participated in summer two (1987). No subjects repeated the study.

The subjects completed the Gates-MacGinitie Reading Comprehension Test immediately before their pre-lunch blood glucose test. This was done on three different days during the camp with the subjects taking a different form of the reading test each day.

The blood glucose check was supervised by a registered nurse but tests were done by the subjects themselves using Glucostix and the Glucometer II system for blood glucose monitoring. Reading test scores and blood glucose levels were recorded and compared by the researcher. A scatter diagram and correlation coefficient were used to determine if a correlation existed. No control group existed since diabetic subjects were not compared with nondiabetic subjects.

FINDINGS

Data for the study were analyzed by computer. The slope of the scatter diagram was that of a negative relationship between blood glucose level and reading comprehension test scores in diabetic children. The correlation coefficient was determined to be -.47.

CONCLUSION

Based upon the findings of this study, a negative relationship existed between abnormal blood glucose levels and reading comprehension test scores in fourth, fifth, and sixth grade diabetic children.

DISCUSSION AND RECOMMENDATIONS

A limitation of the study, as noted in Chapter I was that the testing was completed in the outdoor setting of a camp which could have been a distractor to some of the subjects. Testing was done with the subjects separated from the other children and most subjects appeared eager to complete the tests in order to rejoin the large group. A different testing situation such as a school or home setting may have produced different results.

Most subjects reported relatively high blood glucose levels after the tests. Had more low blood glucose levels been obtained the findings might have been changed. The high glucose levels proved to have a negative relationship when compared to the reading test scores. It was impossible for the researcher to alter the blood glucose level of the subjects.

Classroom teachers should be aware of the blood glucose level of their diabetic students before any testing situation, particularly in reading. Children should check their blood glucose level before testing. A diabetic child with an abnormal blood sugar may need more time on a timed test. High or low blood glucose levels may alter the mood or the attitude of the child thus affecting how well he or she scores on a test.

Because of the limited resources available related to diabetic children and cognitive functioning, and the findings of this study the researcher suggests that more intensive study be done in this area. The medical and educational aspects of this study need to be combined in order to present a clearer picture. Follow-up studies need to be done to see if blood glucose fluctuations in "normal" children affect their reading comprehension ability. Also this study might be replicated with children with hypoglycemia and other blood disorders.

The researcher also recommends that a survey be conducted to determine the number of diabetic children who presently attend special education classes in the public schools. Teachers who work daily with diabetic children need a clear understanding of diabetes and how it can affect cognitive functioning. It is hoped that this understanding

could possibly prevent a diabetic child from erroneously being labeled as "learning disabled."

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APPENDIX

Dear Parents:

The purpose of this study is to determine the effects of blood glucose levels upon reading comprehension abilities in diabetic children. The test will take approximately thirty minutes and will be given before the pre-lunch blood glucose check for three days during the Knoxville Day Camp for Diabetic Children. Reading test scores and blood glucose levels will be recorded and compared.

This study will help to determine if a relationship exists between reading comprehension test scores and blood glucose levels. There are no known risks to this testing procedure. Benefits include an increased awareness of educators about diabetes and hopefully will attribute reading comprehension problems to blood glucose levels and not to learning disabilities in diabetic children.

Your child's identity will be kept confidential. Only the investigator will have access to test scores and blood glucose levels that are recorded. These will be stored in a locked filing cabinet in his home. Upon the completion of testing, all results will be encoded without individual identities, and the original forms with the child's name on them will be destroyed. Any reference to individual performance will be disguised to protect your child's identity.

If you have any questions about the research either now or later, please contact James A. Grubb. Your child's participation in this study is voluntary, and you or your child may refuse to participate. You may withdraw your child at any time during the testing without penalty.

****

I have read and understood the explanation of this study and agree for my child to participate.

_____ _____

Child's Name Date

_____

Parent's Signature

Dear Student:

Hi! My name is Mr. Grubb and I am doing a study to see if your blood sugar level affects the way that you understand what you read. I will be doing this study at the Knoxville Day Camp for Diabetic Children. If you agree to help me you will take a 30 minute reading test right before you check your blood sugar and eat lunch. I will then compare how you do on the test with your blood sugar level. This will be done on three days during the camp.

This study will help teachers understand more about diabetes and how your blood sugar affects the way you read. There will be no risks involved for you in taking the test. One good thing that could happen is that teachers will see that your blood sugar level does affect how you understand what you read and not think that you have a learning problem.

Only I will know the results of your tests and I will keep them locked in a cabinet at my house. Any uses of your results will be disguised to keep others from finding out your identity.

If you have any questions about this study please contact Mr. James A. Grubb. Your participation is voluntary, and you may decide not to participate at all. Also you may withdraw at any time during the testing without any penalty.

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I have read and understood the explanation of this study and agree to participate.

_____ _____

Name Date

_____

Signature

VITA

James A. Grubb was born in Strawberry Plains, Tennessee, on February 27, 1954. He grew up in Mascot, Tennessee, where he attended Mascot Elementary School. He graduated from Carter High School in 1972.

In June 1974, he graduated from Walters State Community College, Morristown, Tennessee, with an A.S. degree. He graduated from the University of Tennessee, Knoxville, in 1976 with a B.A. degree. In June 1978, Mr. Grubb received his M.S. degree in education from the University of Tennessee.

Mr. Grubb taught third and fourth grades at East Knox County Elementary School from 1979 until 1986. While working on his doctorate degree he was a graduate teaching assistant at the University of Tennessee at Knoxville. From 1986 to 1988 he supervised field experience students in elementary schools and taught a seminar on methods of instruction. Since fall of 1988 he has been teaching fourth and fifth grades at Adrian Burnett Elementary School in Knoxville, Tennessee.

Mr. Grubb is a member of Phi Delta Kappa and resides in Knoxville, Tennessee.