THE STATISTICAL ANALYSIS THROUGH THE NEWTON`S DIVIDED DIFFERENCE INTERPOLATION IN DIABETIC PATIENTS

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ABSTRACT: In the modern society, Diabetes is a serious, chronic disease. Diabetes is a condition in which the pancreas does not produce enough insulin. In this research paper, the aim of this study is to find the suitable polynomial equation of the diabetic patients with the variable (x) for the unequal doses of insulin.

KEYWORD: Insulin doses in units as x variable, glucose level in mg/dl for fasting as $f\ (x)$, Newton`s divided difference formula for two variable function in Interpolation.

INTRODUCTION: In this research paper, we may be interested to observe the polynomial equation between the doses of insulin with the tendency of glucose level, Here we construct the polynomial equation using the Newton`s divided difference interpolation formula. Every day we are seeing that the patients of diabetes have become the biggest problem in the country. This is a life – threatening disease. Diabetes is a condition in which the pancreas does not produce enough insulin. There are two main type of diabetes; type–1 and type–2, the latter being the most common. Although they are both types of diabetes, type–1 and type–2 are very different conditions. There are also other types of diabetes that affect a minority of people: gestational diabetes, maturity – onset diabetes of the young and rarer from that is related to infections, medication and pancreas disease. Many people get more complications because the disease is often diagnosed after irreversible complications, such as retinopathy, kidney damage, heart disease or slow healing wounds, have developed. A study by the country`s top research organization estimated that diabetes in India increased by 10%, likely to more than double from the current 70 million in the next decade. Some points to reduce the risk of diabetes.

1) Keep your blood sugar at 100 mg/dl and glycerated blood level (HbAIC) below 5.7%.
2) Keep your blood pressure below 130/90 mm/hg, using medicine if needed.
3) Get cholesterol tested once a year, if high take medicines to lower it.
4) Walking, swimming or play for at least one hour a day seven days a week.
5) Keep a healthy weight below 90 cm for men and 80 cm for women.

If you need require insulin to control your diabetes, you will be prescribed one or more of the five main types. The difference between each type is the length you injected. You may find that one type of insulin always suits you, or you may need to change or use different combinations from time to time. Rapid - acting insulin, short – acting insulin, intermediate – acting insulin, long – acting insulin, peak less long – acting insulin. The amount of insulin you need one day and the type or combination of insulin use it known as insulin. Which diet is best for you depend on what type of diabetes you have and how your routine is . When you diagnosed with type I diabetes or when you start insulin with type II diabetes, the regimen that is prescribed to you is unlikely to be a permanent regimen for you.

Interpolation is a technique, in which a tool for finding the estimating values of the dependent variable corresponding to a value of the independent variable. A number of interpolation formula for equal interval such as Newton`s forward interpolation formula, Newton`s Backward interpolation formula, Newton`s central differences interpolation, Stirling formula, Bessel`s formula and for unequal interval such as Newton`s divided differences interpolation formula, Lagrange`s interpolation formula.

When the values of arguments are given at unequal or unevenly spaced interval, then the various differences will also be affected by the changes in the value of argument and in that case the definition of differences for equal interval will not hold good.

DATA COLLECTION: We have gone through with the patients (n=15) to observe the effect of insulin doses to control the glucose level. We tested insulin doses with 10, 13, 15, 18 and 17 doses in units over 15 patients each. The effected glucose level on an average was observed as given below.

(Insulin Doses) x	10	13	15	18	17
(Glucose Level) $f(x)$	400	372	358	330	329

RESEARCH METHODOLOGY: The following Research Methodology is adopted for the proposed research paper.

- Identification of the Research Problem of diabetic patients.
- Theoretical framework and study of related literature of diabetic patients.
- Mathematical formulation of the research problem to analyzing the solution of Newton`s methods.
- Tabulated divided differences form for the Research Problem.
- Analysis and numerical solution of the mathematical model.
- Interpretation and statistical analysis or results.
- Conclusion.

MATHEMATICAL FORMULATION OF THE RESEARCH PROBLEM:

- $f(x_0, x_1) = \frac{f(x_1) - f(x_0)}{(x_1 - x_0)}$
- For General Form.

$$f(x_0, x_1, x_2, x_3, \ldots\ldots, x_n) = \frac{f(x_1, x_2, x_3, \ldots\ldots, x_n) - f(x_0, x_1, x_2, \ldots\ldots, x_{n-1})}{(x_n - x_0)}$$

- The divided differences may be put in tabular form as follows :

x_i	$f(x_i)$	$f(x_i, x_j)$	$f(x_i, x_j, x_k)$	$f(x_i, x_j, x_k, x_l)$
x_0	$f(x_0)$			
		$f(x_0, x_1) = \frac{f(x_1) - f(x_0)}{(x_1 - x_0)}$		
x_1	$f(x_1)$		$f(x_0, x_1, x_2) = \frac{f(x_1, x_2) - f(x_0, x_1)}{(x_2 - x_0)}$	
		$f(x_1, x_2) = \frac{f(x_2) - f(x_1)}{(x_2 - x_1)}$		$f(x_0, x_1, x_2, x_3) = \frac{f(x_1, x_2, x_3) - f(x_0, x_1, x_2)}{(x_3 - x_0)}$
x_2	$f(x_2)$		$f(x_1, x_2, x_3) = \frac{f(x_2, x_3) - f(x_1, x_2)}{(x_3 - x_4)}$	
		$f(x_2, x_3) = \frac{f(x_3) - f(x_2)}{(x_3 - x_2)}$		$f(x_1, x_2, x_3, x_4) = \frac{f(x_2, x_3, x_4) - f(x_1, x_2, x_3)}{(x_4 - x_1)}$
x_3	$f(x_3)$		$f(x_2, x_3, x_4) = \frac{f(x_3, x_4) - f(x_2, x_3)}{(x_4 - x_2)}$	
		$f(x_3, x_4) = \frac{f(x_4) - f(x_3)}{(x_4 - x_3)}$		
x_4	$f(x_4)$			

Newton`s Divided Difference Interpolation Formula :

$$f(x) = f(x_0) + (x - x_0)f(x_0, x_1) + (x - x_0)(x - x_1)f(x_0, x_1, x_2) + (x - x_0)(x - x_1)(x - x_2)f(x_0, x_1, x_2, x_3) + \ldots\ldots\ldots\ldots\ldots\ldots + (x - x_{n-1})f(x_0, x_1, x_2, x_3, \ldots\ldots, x_n)$$

CALCULATION: The data collected through 5 patients sample as given below in terms of insulin doses (x_i) corresponding to glucose level $f(x_i)$ as dependent variable.

Units x_i	**mg/dl** $f(x_i)$	$f(x_0,x_1)$	$f(x_0,x_1,x_2)$	$f(x_0,x_1,x_2,x_3)$	$f(x_0,x_1,x_2,x_3,x_4)$
10	400				
		-9.33			
13	372		0.466		
		-7.00		-0.1165	
15	358		-0.466		0.334
		-9.33		1.4077	
18	330		5.165		
		1.00			
17	329				

$$f(x) = f(10) + (x-10)f(x_0,x_1) + (x-10)(x-13)f(x_0,x_1,x_2) + (x-10)(x-13)(x-15)f(x_0,x_1,x_2,x_3) + (x-10)(x-13)(x-15)(x-18)f(x_0,x_1,x_2,x_3,x_4)$$

Where, $f(10) = 400$

$(x-10)f(x_0,x_1) = (x-10)(-9.33)$

$= -9.33x + 93.3$

$(x-10)(x-13)f(x_0,x_1,x_2) = (x^2 - 23x + 130)(0.466)$

$= 0.466x^2 - 10.718x + 60.58$

$(x-10)(x-13)(x-15)f(x_0,x_1,x_2,x_3) = (x^3 - 38x^2 + 475x - 1950)(-0.1165)$

$= -0.1165x^3 + 4.427x^2 - 55.3375x + 227.175$

$(x-10)(x-13)(x-15)(x-18)f(x_0,x_1,x_2,x_3,x_4) = (x^4 - 56x^3 + 1159x^2 - 10500x + 35100)(0.334)$

$= 0.334x^4 - 18.704x^3 + 387.106x^2 -$

$3507x + 11723.4$

Thus, The Polynomial that can represent the given numerical data is

$f(x) = 0.334x^4 - 18.8205x^3 + 391.999x^2 - 3582.385x + 12504.455$

CONCLUSION: This shows a polynomial equation of numerical data on a dependent variable with unequal interval. The degree of the required polynomial equation is one, less than the number of pairs of observation. And Newton`s divided difference interpolation formula is used for finding the estimated values in Numerical Analysis.

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REFERENCES

1. **A. R. Vasishtha, Hemlata Vasishtha:** Numercal Analysis & Programming in C, Krishna Prakashan.
2. **A. Quarterani, R. Sacco, F. Saleri. 2000**. Numerical Mathematics, Springe – Verlage, New York.
3. **Chwaiger J. (1994):** "On a Characterization of polynomials by divided differences" Aequationes Math", 48, 317–323.
4. **De Boor C (2003):** "A divided difference expansion of a divided difference". "J Approx. Theory", 122, 10–12.
5. **Dokken T & Lyche T (1979):** "A divided difference formula for the error in Hermite interpolation," "BIT", 19, 540–541.
6. **Flotter M (2003):** "Error formulas for divided differences expansions and numerical differentiations", "J. Approx. Theory", 122, 1- 9.
7. **Fred T (1979):** "Recurrence Relations for computing with modified divided difference", "Mathematics of Computation". Vol. 33, No. 148, 1265–1271.
8. **J. I. Maeztu. 1982,** SIAM Journal on Numerical Analysis, 19 (5): 1032.
9. **Lee E.T.Y. (1989):** "A Remark on Divided Differences", "American Mathematical Monthaly". Vol. 96, No. 7, 618 – 622.
10. **Manish Goyal and N.P. Bali,** Engineering Mathematics, sixth edition.
11. **Park, Young Kou. 1994**, Kyung Book Mathematical Journal, 34 (2): 207.
12. **Reaven GM:** Insulin Secretion and insulin action in non–insulin dependent diabetes mellitus, which defect is primary? Diabetes care 7 (Suppt.): 17-24, 1984.
13. **Rosemary Walker & Jill Rodgers,** Diabetes, A Practical guide to managing your health Science.
14. **R. B. Srivastava and Purushottam Kumar Srivastava,** Journal of Experimental Sciences 2012, 3(1):01-04.
15. **Robert R. Sokal, Biometry:** The principles and practices of statistics in Biology Research.
16. **R. Krees. 1998,** Numerical Analysis, Spriger – Verlage, New York.
17. **Reaven GM: Olefsky JM:** Relationship between hetrogenity of insulin responses and insulin resistance in normal subjects and patients with chemical diabetes. Dia-bectologia 13: 201– 206, 1977.
18. **Wang X & Wang H (2003):** "Some results on numerical divided difference formula".
19. **Wang X & Yang S (2004):** "On dividing differences of the remainder of polynomial interpolation".