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Subject Area : G6PD Deficiency in Children

THE SCREENING AND MORBIDITY PATTERN OF GLUCOSE-6-PHOSPHATE DEHYDROGENASE DEFICIENCY ANEMIA IN CHILDREN IN CHHATTISGARH

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ABSTRACT

Glucose-6-phosphatedehydrogenase (G6PD) deficiency is an X-linked genetic defect, affecting around 400 million people worldwide and is characterized by considerable biochemical and molecular heterogeneity. Deficiency of this enzyme is highly polymorphic in areas where malaria, undernutrition and lack of education are endemic. G6PD deficiency was reported in India more than 50 years ago. Our objective was to find out prevalence of G6PD anemia among the population of Kondagaon districts of Chhattisgarh with clinical and hematological profile of G6PD deficiency patients. According to studies, the prevalence of G6PD deficiency in India ranges between 0.8 and 6.3, with an overall average of around 1.9, with the highest prevalence observed in the tribal populations of certain states like Jharkhand, Chhattisgarh, and Gujarat.

INTRODUCTION

Glucose-6-phosphate dehydrogenase deficiency is a genetic disorder that affects red blood cells, which carry oxygen from the lungs to tissues throughout the body. In affected individuals, a defect in an enzyme called glucose-6-phosphate dehydrogenase causes red blood cells to break down prematurely. This destruction of red blood cells is called hemolysis.G6PD Deficiency was reported from India more than 50 years ago. The prevalence varies from 2.3 to 27.0 per cent with an overall prevalence of 7.7 percent in different tribal groups[1]. The highest prevalence of G6PD deficiency is usually found within tribal communities. The most common G6PD mutations found in India include "G6PD Orissa" and "G6PD Mediterranean"[2]. Chhattisgarh is formed from south eastern parts of Madhya Pradesh in the year 2000 and 32 % of population is tribal origin. Tribal Groups are prominently present in many parts of Chhattisgarh, such as Bastar, Narayanpur, Dantewada, Bijapur, Sukma, Surajpur, Balrampur, Kondagaon, Kanker, Surguja, Korea, Korba, and Jashpur.[3] The tribes of Bastar are known for their unique culture and heritage. Each tribe has its own dialects, costumes, eating habits, customs, and traditions.[4]

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Aims and Objectives: To observe G6PD deficiency in the selected district of Chhattisgarh.

MATERIALS & METHODS

According to previous study G6PD deficiency is prevalent in Chhattisgarh, particularly among tribal populations like the Gonds, where the frequency of this deficiency can range from 13% to 21% depending on the specific tribe[5]. Sample collectively from kondagaon district voluntarily attended the mobile camp and were screened for G6PD deficiency anemia.[3]The study was cleared by Institutional Ethical Committee of Shri Narayan Prasad Awasthi Government Ayurved College, Raipur Chhattisgarh.

INCLUSION & EXCLUSION CRITERIA

1. INCLUSION CRITERIA

- Age 4yr-16yr of both sexes.
- Tribal subjects will be selected irrespective of the socioeconomic status.
- Those who are willing to participate in the study.
- Written informed consent is documented.
- Those who have features of anemia.

2. EXCLUSION CRITERIA

Suffering from other co-morbid conditions like diabetes, CKD.

Suffering from any other systemic illness and infectious disease.

- Those who are not able to come for regular follow ups.
- Those who are not willing to participate in the study.
- Patient suffering from any infectious disorder.
- Those who are Falciparum positive.

STUDY DESIGN: - Non-Randomize, Open Single arm, observational, non- international survey study.

Sample size: Sample size of 100 patients.

Duration of Study: 6 month.

Follow up: 15 days.

No. Of Patient: Observe 100 patients.

The objective of our study was to find out prevalence of G6PD deficiency anemia. To know the clinical and hematological profile of patients suffering from G6PD deficiency anemia. The study was done in between August 2024 to January 2025.

Mobile Health Camp

For the screening, mobile camps were organized by Government Ayurved College and Hospital Raipur Chhattisgarh. A doctor, one laboratory technician and a data entry operator visited the places. A written consent in local language was obtained from the individuals who volunteered themselves for screening. In this study, written consent was obtained from the parents of children whose age was 4-16 years and assent form were signed by the children who were above 8 years.

Sampling

1. **HB Testing -**The laboratory technician collects 10 µl blood by finger prick and performs Hb test by Hb kit.
2. **G6PD Testing-** The technologist collects the 2ml blood sample in the EDTA tube for the G6PD enzyme in RBCs (Red blood cells). The sample is collected and kept in the pathology lab of Kondagaon and then the sample is brought to Raipur and tested. The method use for the testing of G6PD enzyme is Spectrophotometry method. Approximately 10-15 days after screening visit, a doctor and counsellor visit the site and distributes report cards. Institutional Ethical Committee of Shri Narayan Prasad Awasthi Government Ayurved College, Raipur Chhattisgarh.

RESULTS

100 (36were male children and 64 female children) were screened for G6PD deficiency anemia. During observation, data is collected from primary sources, and the results are presented objectively and logically, with no bias or interpretation. Observational data presented as an analytical study. Analytical studies can be observational or experimental. Observational studies are conducted without any intervention or experiment.

The data obtained after completion of observation has been presented through Chi Square test and Multiple Regression test. The observed data is displayed on the basis of following points– (Table 1. & Table 2.)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.116[a]	.013	-.007	1.25158	.013	.663	2	97[a]	.518

Table 1. Shows the Std. Deviation of objective parameters are, 0.73, 4.88, 7.82, 1.36, 1.02 and 1.24 , Age, Weight, Height, BMI, Hb and G6PD respectively.

Table 2.

This table 2. is a **Model Summary** from a linear regression analysis, likely output from SPSS or a similar statistical software.

Model

This refers to the regression model being reported. Since there's only one row, this table reports a single model.

R (.116)

This is the **multiple correlation coefficient**. It indicates the strength of the linear relationship between the observed and predicted values of the dependent variable.

- **.116** is a very weak correlation.

R Square (.013)

This is the **coefficient of determination**, showing the proportion of variance in the dependent variable explained by the independent variables.

- **.013** means only **1.3%** of the variance is explained, which is very low.

Adjusted R Square (-.007)

This adjusts the R Square for the number of predictors in the model.

- A **negative Adjusted R Square** implies that the model is performing **worse than a simple mean prediction**. This often happens when predictors do not improve the model fit.

Std. Error of the Estimate (1.25158)

This is the standard deviation of the regression's residuals. It tells you how much the observed values deviate from the predicted values, on average.

Change Statistics Section

This section shows whether adding predictors to the model significantly improves the fit.

R Square Change (.013)

The increase in R Square when the predictors are added to the model.

Table 1. Statistical data

	Age	Weight	Height	BMI	Hb	G6PD
Mean	14.30	41.30	142.85	20.20	10.7360	12.64
Std. Deviation	0.73	4.88	7.82	1.36	1.02	1.24

- Still **1.3%**—no improvement.

F Change (.663)

The **F-test statistic** for the change in R Square.

- Tests if the change is statistically significant.

df1 (2)

Degrees of freedom for the numerator. Corresponds to the number of predictors added.

df2 (97)

Degrees of freedom for the denominator. Related to sample size.

Sig. F Change (.518)

This is the **p-value** for the F-test.

- A value of **.518** means the change in R Square is **not statistically significant** (since it's much greater than .05), so the predictors **do not improve** the model meaningfully.

Final Result

This regression model is **not statistically significant** and has a **very weak explanatory power**. The predictors included do not explain much variance in the outcome variable.

a. Predictor: (Constant), Hb, BMI
b. Dependent Variable: G6PD

Regression Analysis Report

In this study, G6PD (Glucose-6-phosphate dehydrogenase) is taken as the dependent variable to examine its relationship with other factors using regression analysis. (FIG.1)

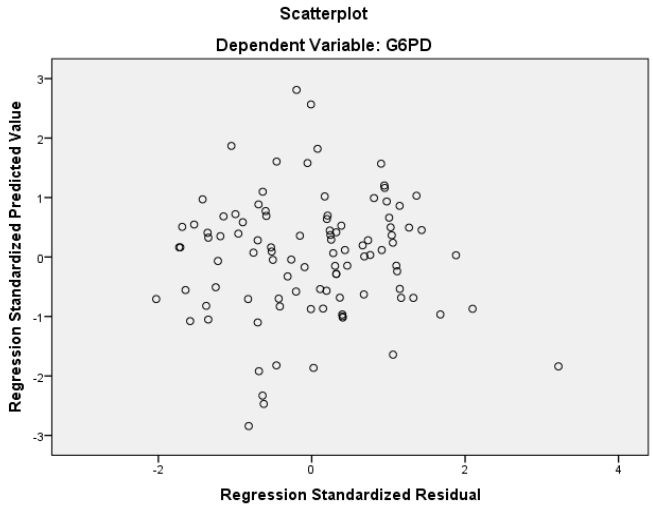

Figure 1. Regression analysis Scatterplot

The presented scatterplot is based on "Regression Standardized Residual" (x-axis) and "Regression Standardized Predicted Value" (y-axis), which helps visualize how well the regression model fits the data.

Key Observations

Distribution of Data Points

The scatterplot shows data points scattered randomly without any specific pattern. This randomness is a good indication that the regression model has adequately captured the relationship without bias or systematic error.

No Heteroscedasticity Detected

The spread of the residuals appears consistent across the predicted values, indicating there is likely no heteroscedasticity. This means the error terms are evenly distributed, which is a desirable property in regression models.

Model Reliability

The scatter of points suggests that the model used for predicting G6PD levels is likely appropriate and the results derived from it can be considered reliable.

Graph Type: Normal P–P Plot of Regression Standardized

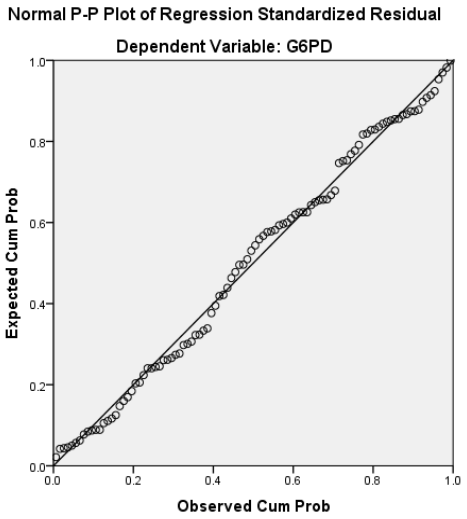

Figure 2. Normal p–p plot of regression standardized residuals

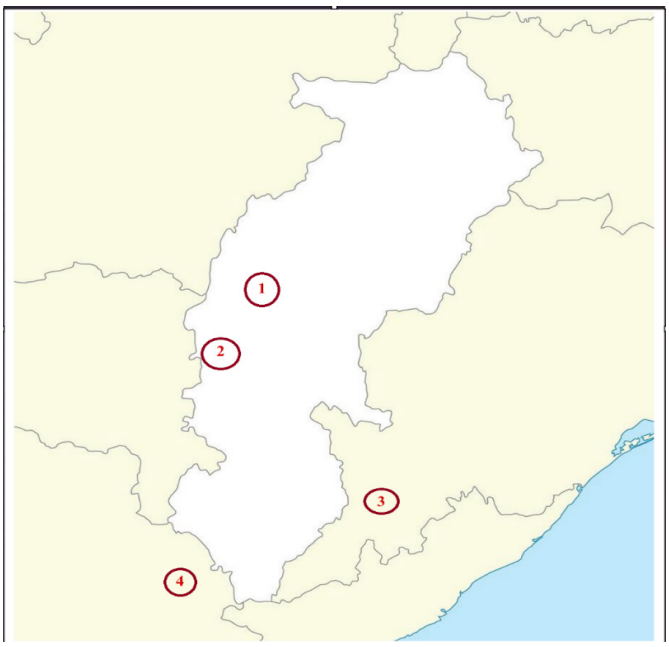

Figure 3. G6pd prevalence in Chhattisgarh and other state

Dependent Variable: G6PD

This plot is used to assess whether the residuals (errors) from a regression analysis follow a normal distribution-which is one

of the key assumptions of linear regression.

Graph Details

X-Axis (Observed Cum Prob):
Represents the cumulative probability of the actual standardized residuals from your dataset.
Y-Axis (Expected Cum Prob):
Shows the cumulative probability that would be expected if the residuals followed a perfect normal distribution.
Dots: Each dot represents a standardized residual.
Diagonal Line: This is the ideal line. If the residuals are normally distributed, all points would lie perfectly on this line.

Key Observations

Most of the points lie very close to the diagonal line, which is a good sign.

There are small deviations, but they are within acceptable limits.

RESULT

Both figures are shows

The scatterplot from the regression analysis indicates that the model is well-fitted and balanced. The results can be used confidently to understand the potential causes or associated factors of G6PD deficiency in the study population.

The Normal P–P Plot suggests that the residuals in the regression model for G6PD are approximately normally distributed. This supports the assumption of normality in linear regression and indicates that the model is statistically sound and reliable.

DISCUSSION

The states of Madhya Pradesh and Chhattisgarh make up Central India. According to reports, the prevalence of G6PD deficiency is 6.7% among Madhya Pradesh's Bhil tribe and 0.8% among the Sindhi population. Among the many Chhattisgarh tribes, the prevalence of G6PD deficiency varies from 6% to 19%.[6]

In the neighboring state of Chhattisgarh, the southeastern state of Odisha and the southern state of Andhra Pradesh are located. Research conducted in the eastern region indicates that the prevalence of G6PD deficiency has risen in Orissa (0% to 30.7%), Andhra Pradesh (from 0% to 12%)& Jharkhand (6.3%).[7] Since Bastar, Kondagaon, Gariaband, and Mahasamund are the districts of Chhattisgarh, which are adjacent to these states. The impact of G6PD deficiency can also be observed in these areas.(FIG. 3)

1. **Durg } 6.06%**
2. **Rajnandgaon-**
3. **Orissa – 8.6%**
4. **A.pradesh – 3.7%**

100 people were observed according to subjective and objective criteria which are as follows:

1. **Category** - There are peoples from General, OBC, ST and SC category in pharasagaon block. After observing 100 patients, General was found to be 2%, OBC was 24%, SC was 19%, ST was 55%.
2. **Gender**- After observing 100 patients, 64% were female and 36% were male. As per Census 2011 out of total population, 15.3% people live in Urban areas while 84.7% live in the Rural areas.
3. ***VAIVARNATA:*** On the basis of subjective parameter *Vaivarnata* (pallor), 100 patients were observed in different gradings. That is Grade-0 (Normal skin like– light brown, dark brown) were 96%. Grade-1 (Pallor of conjunctiva and mucous membrane) were 1%. Grade-2 (Pallor of conjunctiva, mucous membrane and skin) were3%.
4. **Hb%:** Hb kit (Quik check plus Hb meter) is used for testing the Hb gm%.It requires no specimen preparation. It has a wide hemoglobin measurement range of 5–25.6 g/dl. It's easy to clean and maintain. It can provide accurate results that are comparable to an automatic hematology analyze. After observing 100 patients, the mean value of Hb was found to be 10.73.
5. **G6PD ENZYME TEST :** To detect G6PD enzyme deficiency by Spectrophotometry method, the spectrophotometric assay is the standard for measuring G6PD activity in red blood cells. It provides a weighted average of the activity of both G6PD-deficient and G6PD-normal cells in a sample. This test provides the G6PD enzyme quantity in cells, after observing 100 patients, no G6PD positive patient was found. The mean value of G6PD was found to be 12.64% and the P value is 0.518, P value above the 0.05, it means not significant.

CONCLUSION

For the survey study, 100 kids were signed up. An objective parameter was chosen for the subjective judgment. After completing the survey with the selected sample size, we discovered that no patients in the Pharsagaon block of the Kondagaon district had a G6PD deficiency. The P value is more than 0.05, indicating that the result is non-significant, according to the statistical methods (Chi Square and Multiple Regression test) that were used to assess the observed data based on subjective and objective factors. In the future, more survey research on G6PD deficiency anemia in children from various districts, states, and parameters is required.

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