

Survey of Correlation Between Serum Transferrin Saturation and Platelet Indices in High School Female Students in the Northwest Iran

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Abstract

Background: Platelet indices (PIs), including platelet count (PC), mean platelet volume (MPV), platelet distribution width (PDW), and platelet larger cell ratio (P-LCR) are used to predict clinical outcomes in patients with various medical conditions. The current study aimed at evaluating the correlation between serum iron saturation (IS) and PIs among the female students living in the Northwest of Iran.

Methods: The current cross sectional study included 254 high school female (HSF) students aged 15 to 18 years in Hamadan, Iran, from September to January 2016. After completion of a questionnaire, the hematological parameters were determined using standard methods. HSF afflicted with infections and acute hemorrhage, and the ones with malignancies and inflammatory diseases were excluded. The correlation between the serum levels of IS and PIs in the female residents of Northwest of Iran was evaluated using the Pearson correlation test.

Results: The reference range of PIs in healthy HSF in the Northwest of Iran was as follows: PC 241 ± 53 109/L, MPV 9.67 ± 0.88 fL, PDW $11.904\% \pm 1.68\%$, and P-LCR 22.908 ± 6.69 fL. Decreased IS and MPV resulted in increased PC in the current study population. An inverse correlation was observed between PC and IS ($P < 0.05$). There was no correlation between MPV, PDW, P-LCR, and IS ($P > 0.05$), but a linear correlation was observed between PDW and MPV ($P < 0.001$) as well as PDW and P-LCR ($P < 0.001$).

Conclusions: The current study data indicated IS as one of the most important factors affecting PC. PIs can serve as a clue to the severity of iron deficiency in HSF. It is recommended to conduct complementary studies to identify prognostic and diagnostic utilities of PIs in clinical practices.

Keywords: Serum Iron Status, Platelet Indices, High School Females

1. Background

Iron deficiency (ID), a major deficiency in micronutrients, affects over 2 billion individuals worldwide, and iron deficiency anemia (IDA) is the leading cause of anemia (1-3). A variety of changes in iron metabolism and platelets are reported in IDA. Platelets with an average diameter of $2.5 \mu\text{m}$ and a discoid shape participate in critical reactions central to hemostasis and thrombosis (4). With respect to metabolism, enzymatic activity, and function, larger platelets are considered more active than the smaller ones (5). Thus, platelet size or volume is an indirect measure of platelet activation (6).

Hematology cell counters measuring platelet count (PC), as well as other platelet indices (PIs) such as mean platelet volume (MPV), platelet distribution width (PDW), and platelet larger cell ratio (P-LCR) are common in many laboratories at no additional cost. Previous studies showed the persistent correlation between increased MPV with various disorders such as coronary artery disease, cerebral

and myocardial infarction, as well as diabetes mellitus (6). Altogether, PIs could be a biomarker to contribute to the early detection of disease, screening for malignant tumors, prognosis, and response to treatment (7, 8). Abnormalities in these parameters may be a pointer to a subclinical condition, which lead to early diagnosis by further investigation.

In most clinical laboratories, PIs are not evaluated since the clinical importance and local reference values are often ignored in laboratories. Based on the current research in literature, there was no report on the relationship between the serum levels of IS and PIs in high school females (HSF), as one of the groups vulnerable to IDA. If all PIs are simultaneously measured, a good tool is provided to measure the severity of disease, as well as an understanding of the likely etiology that leads to changing platelet indices. The current study aimed at establishing the reference range of PIs and survey of correlation between the serum levels of IS and PIs in the HSF living in Northwest of Iran.

2. Methods

2.1. Subjects and Sampling

The HSF students living in Hamadan, Iran, aged 15 to 18 years ($n = 254$) were evaluated from September to January 2016. The participants were selected by the multistage sampling method. At first, 16 high schools were randomly selected as clusters. HSF were chosen using the stratified random sampling method for each unit in the 2nd phase. The ethics committee of Hamadan University of Medical Sciences approved the research protocol. After the completion of the questionnaires, blood sampling was carried out by the qualified personnel. To assess hematological parameters, 5 mL of venous blood was taken from each subject. The blood samples were collected in ethylenediaminetetraacetic acid (EDTA) anticoagulated tubes and the period between sampling and data analysis was less than 3 hours. HSF with acute hemorrhage, infections, cancer, and chronic inflammatory diseases (e.g., rheumatoid arthritis) were excluded from the study. All subjects signed the informed consent letters.

2.2. Measurement of Hematological Parameters

Hematological parameters including PC, MPV, PDW, and P-LCR were assayed by cell counter (Sysmex KX-21N Hematology Analyzer, Japan). The normal ranges of PC, MPV, PDW, and P-LCR in the laboratory were 150 to $410 \times 10^9/L$, 8.5 to 12.4 fL, 9.4% to 18.1% , and 14.3 to 44 fL, respectively. The blood samples were collected in tubes without anticoagulant agent to measure iron saturation (IS) parameters such as serum iron, total iron-binding capacity (TIBC), and transferrin saturation, which were analyzed by a Hitachi-912 instrument (Japan) after 4 hours.

2.2.1 Definition of Anemia

Anemia diagnosis can only be based on hemoglobin (Hb) and/or hematocrit (HCT) (9). The severity of anemia was categorized as follows: mild (100 to 120 g/L), moderate (70 to 100 g/L), and severe (< 70 g/L). The following formula was used to detect IDA:

$$(\text{serum iron} / \text{TIBC}) \times 100 < 16.$$

2.3. Statistical Analysis

IP and PIs were collected, analyzed, and reported as mean \pm standard deviation (SD). The relationship between the serum levels of IP and PIs was assessed using the Pearson correlation. All data were analyzed with SPSS statistical package (SPSS; 16, Inc., USA). Data were expressed as mean \pm SD with $P < 0.05$ as the significance level.

2.4. Ethical Approval

The study protocol was approved by the ethics committee of Hamadan University of Medical Sciences.

2.5. Sample Size Calculation

According to the previous study (10), $\alpha = 0.05$, and $\beta = 0.1$, the minimum sample size of 254 was required in the current study.

$$n = \left[\frac{(z_{\alpha} + z_{\beta})}{0.5 \ln \left(\frac{1+r}{1-r} \right)} \right]^2 + 3 \quad (1)$$

3. Results

All the participants were HSF students with the mean age of 16.8 ± 0.2 years. The hematological and IP in females studying in Hamadan high schools are presented in Table 1. In the current research, anemia and IDA were assessed on the basis of different criteria (6). The Pearson correlation results in HSF are shown in Table 2.

3.1. Platelet Counts

An inverse correlation was observed between PC, MPV, PDW, P-LCR, and IS through the Pearson correlation (Table 2).

3.2. Mean Platelet Volume

Although a linear correlation was observed between MPV with both hematocrit and PDW, as well as between the mean platelet volume and PC, only the correlation between MPV and PDW was confirmed by the logistic regression test ($P < 0.001$). No relationship was found between MPV and IS ($P > 0.05$) (Table 2).

3.3. Platelet Distribution Width

A linear relationship was found between PDW and both MPV and MCHC, in addition to an inverse correlation between PDW and MPV. The logistic regression test confirmed the inverse relationship only between PDW and MPV ($P < 0.001$). No correlation was found between PDW and IS ($P > 0.05$), but a linear correlation was found between PDW and MPV ($P < 0.001$) (Table 2).

3.4. Platelet Larger Cell Ratio

No correlation was found between P-LCR and IS ($P > 0.05$). A linear correlation was observed between MPV and P-LCR ($P < 0.001$), as well as between PDW and P-LCR ($P < 0.001$) (Table 2).

Table 1. Hematological Profile and Iron-related Parameters in the Study Participants

Variable	Minimum	Maximum	Mean	Std. Deviation	Number
Hb, g/L	97	171	136	10	254
HCT, %	30.0	46.7	40.9	2.2	254
MCV, fL	68.9	97.0	86.4	4.5	254
MCH, pg	20.9	34.3	28.8	2.2	254
MCHC, %	27.9	38.3	33.3	1.6	254
Iron, $\mu\text{g/dL}$	3.0	271.0	79.0	39.8	254
TIBC, $\mu\text{g/dL}$	132.0	585.0	365.1	55.8	254
IS, %	1.0	76.0	22.2	11.3	254
PDW, %	8.6	18.8	11.9	1.7	251
MPV, fL	7.5	12.7	9.7	0.9	251
P-LCR, fL	8.3	47.2	22.9	6.7	251
PC, $10^9/\text{L}$	150	420.0	241.0	52.7	254

Abbreviations: APC, Platelet Count; Hb, Hemoglobin; HCT, Hematocrit; MCH, Mean Cell Hemoglobin; MCV, Mean Cell Volume; MCHC, Mean Cell Hemoglobin Concentration; MPV, Mean Platelet Volume; PDW, Platelet Distribution Width; P-LCR, Platelet Large Cell Ratio; RBC, Red Blood Cells; RDW, Red Cell Distribution Width; Iron, Iron Serum; TIBC, Total Iron Binding Capacity.

Table 2. The results of the Pearson Correlation Test in the Study Participants

Variables	IS	PDW	MPV	P-LCR	PC
IS					
The Pearson correlation	1	-0.022	-0.045	-0.042	-0.198 ^a
P value		0.734	0.480	0.503	0.002
PDW					
The Pearson correlation	-	1	0.938 ^a	0.959 ^a	-0.500 ^a
P value	-	-	< 0.001	< 0.001	< 0.001
MPV					
The Pearson correlation	-	-	1	0.992 ^a	-0.461 ^a
P value	-	-	-	< 0.001	< 0.001
P-LCR					
The Pearson correlation	-	-	-	1	-0.478 ^a
P value	-	-	-	-	< 0.001
PC					
The Pearson correlation	-	-	-	-	1
P value	-	-	-	-	-

^aCorrelation is significant at 0.05 level.

4. Discussion

The current study mainly aimed at determining the correlation between serum levels of IS and PIs in Hamadan HSF. There is a recent increase in researches on MPV, PDW, and P-LCR levels as soon as their immense values were re-

vealed in the prediction and prognosis of several medical conditions (10). The current study for the 1st time specified the normal value of PIs in healthy HSF in Hamadan. Increased PC was observed with decreased values of serum iron, IS, and MPV in the current study. An inverse correlation was found between PC and IS. Moreover, there was no

correlation between IP parameters (such as serum iron and TIBC) and PIs parameters (such as MPV, P-LCR, and PDW); future studies are required to confirm this correlation.

In the current study, the reference range of PIs in healthy HSF in the Northwest of Iran was as follows: PC 241 ± 53 109/L, MPV 9.67 ± 0.88 fL, PDW $11.904\% \pm 1.68\%$, and P-LCR 22.908 ± 6.69 fL. These values enable clinicians to apply such indices in research on various diseases. In the current study, consistent with previous reports (11), IS was the most important factor affecting platelet counts.

The mean MPV of the current study was 9.67 ± 0.88 fL, which was higher than that of recorded in the study by Demirin et al. (8.9 ± 1.4 fL) (12). In the stable situations, it is shown that MPV, the most accurate indicator of platelet size, has an inverse relationship with PC (13). A higher MPV value in the current study may be related to the lower PC, compared with the Caucasian value. Based on MPV, a straightforward and accurate marker of platelet function, it can be assumed that the current study platelets were more functionally active than those of Caucasian population, which yet remains to be proven.

Previous studies indicated no correlation between transferrin saturation with percentage of TCD4 lymphocytes and TCD4/TCD8 ratio in the 2 group of students with and without iron deficiency (14).

Presently, there are studies with respect to the utility of PIs to prognoses and diagnose various diseases. The performance of PIs in diagnosis of various diseases was reported. Some researchers showed that PIs may be useful adjunctive inflammatory markers of malignant tumors (15), which could predict the patients with acute myocardial infarction (16) and be used to predict placental abruption (17). Nevertheless, contradictory results are sometimes observed on the clinical studies of PIs in other diseases (18, 19).

The current study had limitations of small sample size; further large scale studies should be conducted to assess the relationship between the serum levels of IS and PIs in HSF. However, investigation of PC and PIs can serve as a clue to the severity of ID.

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Footnotes

Conflict of Interests: Authors declared no conflict of interest.

Authors' Contribution Hassan Rafieemehr, Mohammad Rafiee, and Marzieh Mahmoodi contributed in the study designed, data analysis, preparing the manuscript, approving the final version, and supervising the study.

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