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Comparison of Hematocrit Values Using the Microhematocrit Method and the Automatic Hematology Analyzer

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ABSTRACT

Background & Objective: Hematocrit is the percentage of erythrocyte volume in blood that is important for assessing health status, especially in relation to oxygen transport capacity. Hematocrit tests can be performed manually (microhematocrit) or automatically (hematology analyzer). Differences in the working principles of the two methods can cause variations in results. This study aims to determine the difference in hematocrit values using the microhematocrit method and the automatic hematology analyzer. **Method:** This study is analytical in nature with a quantitative approach, using 30 venous blood samples from outpatients at Kraton Pekalongan Regional General Hospital. The examination was performed using the microhematocrit method and the automatic hematology analyzer. The data were analyzed using normality tests and *Paired Sample T-Tests* using SPSS. **Result:** The average hematocrit value using the manual microhematocrit method was 33.33%, while the average value using the automatic hematology analyzer was 32.41%. The statistical test results showed a significant value of 0.075 (P> 0.05), indicating that there was no significant difference between the two methods. **Conclusion:** There was no significant difference between the hematocrit values obtained by the microhematocrit method and the automatic hematology analyzer. Both methods can be used interchangeably depending on the availability of equipment and clinical needs.

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Introduction

A hematocrit test is a special blood test performed in a laboratory that is useful for diagnosing diseases such as dengue fever (DBD), anemia, polycythemia, and severe diarrhea (Maharani 2017). Hematocrit can be measured using two methods, namely manual and automatic. The manual method consists of two methods, namely microhematocrit and macrohematocrit (Chairani et al. 2022). One of the commonly used manual methods is the microhematocrit method, which has long been used in laboratory tests and is still considered relevant today. In this procedure, a blood sample is placed in a microhematocrit capillary tube, then centrifuged using a centrifuge. After centrifugation is complete, the percentage of red blood cell volume is determined by comparing the height of the red blood cell column to the total height of the blood column. The microhematocrit method is known as the gold standard in hematocrit analysis due to its ease of implementation and relatively low cost. However, the accuracy of the results can be affected by the sampling technique and conditions during the centrifugation process (Hasanah and Hidayat 2024).

Hematocrit testing is a complete blood test, and generally, complete blood tests already use automatic devices or hematology analyzers (Nirwani, Hartati, and Faruq 2018). A hematology analyzer is a digital-based automatic device that can produce data quickly and can be used for various test parameters, such as complete blood count, which includes hemoglobin, erythrocytes, erythrocyte index, leukocytes, thrombocytes, and hematocrit (Arini et al. 2023). One of the advantages of using a hematology analyzer is its efficiency in terms of time and sample volume. In addition, the results have undergone the laboratory's internal quality control process, ensuring their accuracy and consistency. (Subur Wibowo and Isnaini Isnaini 2024). However, there are disadvantages to automatic hematocrit testing using a hematology analyzer. As in cell count testing, the results for leukocytes or platelets may be low because some cells are not counted due to their abnormal shape (Hastuti 2018).

Hematology analyzers work based on the principle of flow cytometry, a method that allows the measurement of the number and characteristics of normal-sized blood cells. In this process, reagents are flowed through a narrow channel through which thousands of blood cells pass sequentially. The device then automatically and accurately counts and analyzes these cells. This technology enables high efficiency in complete blood tests and supports the speed and accuracy of diagnosis in clinical laboratories (Kesuma, Syumarliyanty, and Hartono 2021). Each stage in the laboratory testing process, from pre-analytical, analytical, to post-analytical, can affect the accuracy of the test results. The pre-analytical stage is the most vulnerable to errors, especially those related to sample collection and handling procedures using EDTA anticoagulants. Meanwhile, errors in the analytical stage can occur due to centrifugation duration and speed that do not meet standards, as well as inaccuracies in reading the test result scale (Nugrahani, Ariyadi, and Nuroini 2018). Based on research conducted by Nuraeni 2020, which compared hematocrit values in venous blood using the automatic method and capillary blood using the microhematocrit method using normal blood samples or samples from individuals with no history of disease, the results showed no significant difference with a p-value of 0.383 $\alpha > 0.05$ (Nuraeni 2020). In contrast, research conducted by Hidayah (2018) on the difference in capillary blood hematocrit values using a hematology analyzer and manual microhematocrit showed that the microhematocrit method produced higher results

than the automatic hematology analyzer, meaning that there was a difference (Hidayah 2018).

Based on the above description, the researcher was interested in conducting research on the comparison of hematocrit values using the microhematocrit method and the automatic hematology analyzer with venous blood samples.

Objective

The objective of this study was to determine the difference in hematocrit values using the microhematocrit method and the automatic hematology analyzer.

Method

The type of research used was analytical with a quantitative approach. The population in this study were outpatients who underwent routine blood tests at the Kraton Regional General Hospital in Pekalongan City, totaling 30 patients. Sampling was conducted randomly with the following criteria:

1. Inclusion Criteria
   a. Patients without diagnoses such as anemia, dengue fever, or other conditions requiring hematocrit testing.
   b. Patients eligible for routine hematology testing.
   c. Blood samples were not contaminated and did not clot.
2. Exclusion Criteria
   a. Patients with conditions that could affect hematocrit testing, such as fever.
   b. Patients undergoing therapy that could affect hematocrit testing, such as blood transfusions.
   c. Blood samples that are contaminated and contain clots.

This study was conducted in March 2025 at the Pekalongan Health Analyst Academy Laboratory. Sample testing was performed using manual and automated methods. The data in this study were derived from primary and secondary sources. Primary data were obtained from the results of outpatient examinations who underwent routine blood tests at the Kraton General Hospital in Pekalongan City. Secondary data were obtained from research journals, literature reviews of several books, and relevant internet sources as supporting research materials. The data obtained were then processed and tested in SPSS using a data normality test. If both data sets were normally distributed, the difference test used the Independent T-Test parametric test, and if one or both data sets were not normally distributed, the difference test used the non-parametric Willcoxon test.

Results

A study comparing hematocrit values using the microhematocrit method and automatic hematology analyzer on 30 samples from outpatients at Kraton Pekalongan Regional General Hospital, conducted at the Hematology Laboratory of the Pekalongan Academy of Health Analysts on March 19-20, 2025, obtained the following results.

TABLE 1. Manual and Automatic Hematocrit Values

No	Manual	Automatic
1	26	27,2
2	24	22,0
3	26	26,0
4	28	28,4

5	32	31,4
6	41	37,7
7	41	41,7
8	31	30,4
9	30	27,8
10	38	37,3
11	42	38,4
12	38	34,4
13	25	22,7
14	38	38,7
15	34	31,8
16	23	19,7
17	32	30,2
18	29	39,1
19	36	33,1
20	32	27,2
21	35	37,3
22	37	37,4
23	41	39,8
24	31	29,5
25	39	38,7
26	33	33,2
27	34	34,8
28	33	31,9
29	37	34,9
30	34	29,7
Mean	**33,33%**	**32,41%**

Based on the hematocrit values obtained using manual and automatic methods, the average result for the manual method was 33.33% and for the automatic method was 32.41%.

TABLE 2. Normality Test Results

	Shapiro-Wilk		
	Statistic	**Df**	**Sig**
Manual	.965	30	**.**408
Automatic	.962	30	**.**356

Based on the normality test results, it is known that the data is normally distributed, with a sig value greater than 0.05, namely 0.408 for manual hematocrit and 0.356 for automatic hematocrit, which means there is no difference.

TABLE 3. Paired Sample T-Test Results

Df	**Sig 2-tailed**
29	,075

Based on the results of the Paired Sample T-Test, a value of sig = 0.075 a>0.05 was obtained, indicating that there is no difference between the hematocrit values obtained using the manual method and the automatic hematology analyzer.

Discussion

Hematocrit testing plays an important role in clinical and medical laboratory settings, particularly as an indicator of oxygen-carrying capacity in the blood and for evaluating the erythrocyte status of patients. This test is widely used in diagnosing various medical conditions such as anemia, polycythemia, dehydration, and dengue

hemorrhagic fever (DHF), where hematocrit values often serve as an early indicator of plasma leakage or a decrease in red blood cells (Maharani 2017). In practice, there are two common approaches to hematocrit testing: the manual method using a microhematocrit, and the automatic method using a hematology analyzer. These two methods have different working principles, so it is very important to evaluate their suitability and compare them, especially in terms of accuracy of results, time efficiency, and suitability for use in health facilities with different resources.

Based on hematocrit examinations using manual and automatic methods on 30 samples from outpatients at the Kraton Regional General Hospital in Pekalongan City, the average hematocrit value was 33.33% for the microhematocrit method and 32.41% for the automatic method. Although the average value of the microhematocrit method was slightly higher, the difference was not significant. Based on the results of a statistical test using a paired sample t-test -test, a significant value of 0.075 ($\alpha > 0.05$) was obtained, meaning that there was no significant difference between the two methods in the context of hematocrit testing of venous blood samples.

The microhematocrit method is a manual method that has been widely used for a long time and is known for its simplicity and low cost. In this method, blood is placed in a microhematocrit capillary tube and then centrifuged for 3-5 minutes at a speed of 10,000-16,000 rpm. The final result is the separation of blood into three main layers: plasma, buffy coat, and erythrocytes, which are counted by comparing the height of the erythrocyte column to the total blood volume in the tube (Hasanah & Hidayat, 2024). Although this method is considered the gold standard, the results are still prone to errors arising from technical factors such as errors in blood filling volume, suboptimal centrifugation, or subjective reading of results.

In contrast, the automatic hematology analyzer method uses a more sophisticated working principle, usually based on flow cytometry or electrical impedance to automatically detect and measure blood cells. This system works by reading signals from thousands of blood cells passing through a narrow channel where optical and electrical detection is performed quickly and systematically (Kesuma, Syumarliyanty, and Hartono 2021). The advantages of this method lie in its speed and ease of use, small sample volume, and ability to examine various blood parameters simultaneously. However, the use of this method requires special reagents and proper instrument calibration to ensure accurate and consistent results (Arini et al. 2023). No significant differences in results between the two methods were also found in several previous studies conducted by Maria Nuraeni on the comparison of automatic venous blood hematocrit values and capillary blood microhematocrit method with 39 samples, all of which showed no differences. These results support the findings in this study and show that both methods can still be used interchangeably depending on the needs and availability of facilities in the laboratory (Nuraeni 2020). This is in contrast to the study conducted by Hidayah 2018, where the microhematocrit method produced higher hematocrit values than the automatic method. This may be due to the use of capillary blood samples in the study, which may be more affected by in vivo factors such as local hemoconcentration at the fingertips (Hidayah 2018).

Factors that can affect hematocrit test results can be divided into two major groups, namely in vivo and in vitro factors. In vivo factors include individual physiological and biological conditions such as age, gender, hydration status, blood viscosity, and even a person's place of residence. For example, individuals living at

high altitudes tend to have higher hematocrit values due to adaptation to lower oxygen levels (Yumaroh 2020). In addition, men generally have higher hematocrit levels than women due to the influence of androgen hormones that stimulate erythrocyte production. The patient's hydration status also plays an important role; a person who is dehydrated may show higher hematocrit values due to increased blood concentration resulting from plasma loss.

In vitro factors or technical factors also contribute significantly to the final hematocrit test results. Errors in blood collection techniques, such as using a tourniquet for too long, can cause local hemoconcentration, resulting in hematocrit values that are higher than the actual condition. Conversely, drawing blood from an arm with an IV line can lower hematocrit values due to hemodilution. In addition, sample quality factors such as homogeneity with anticoagulants, temperature and storage time, as well as centrifugation speed and time can also affect the validity of the results (Yumaroh 2020).

One of the main advantages of the microhematocrit method is its simplicity and cost efficiency. The equipment used is relatively inexpensive and does not require additional chemicals or reagents. Therefore, this method is highly suitable for use in small laboratories or remote areas with limited resources. On the other hand, automated methods are superior in terms of speed and convenience, especially in large hospitals with high testing volumes, as they can integrate hematocrit results with other hematological parameters simultaneously and digitally.

In the context of modern clinical laboratories, the use of automated methods is increasingly becoming the preferred choice because it can reduce inter-operator variability and improve work efficiency. However, it is important to note that test results from automated methods need to be validated periodically with manual methods as quality control, given that automated devices remain susceptible to calibration errors or internal component damage (Kesuma, Syumarliyanty, and Hartono 2021). From a practical standpoint, the results of this study show that both the microhematocrit and automated methods can be used in venous blood hematocrit testing with relatively the same level of confidence. This provides laboratories with the flexibility to choose the method that best suits their operational conditions, equipment availability, and the clinical urgency of the test. In emergency situations or in facilities with limited resources, the microhematocrit method remains a viable and reliable option. However, for diagnostic purposes that require high speed and comprehensive examination, the automatic method will provide significant advantages.

Considering the research results and other supporting factors, it is recommended that the choice of hematocrit method be tailored to the context of each laboratory. Small laboratories or those in remote areas can rely on the microhematocrit method, while large hospital laboratories or reference laboratories should use the automated method while continuing to prioritize result validation and regular internal quality control.

Conclusion

Based on the research conducted, it can be concluded that there is no difference between manual hematocrit testing (microhematocrit) and automatic testing (hematology analyzer) in 30 samples of outpatients at Kraton Regional General Hospital in Pekalongan City.

It is recommended that future researchers conduct studies with larger samples and consider factors such as age, gender, and the clinical condition of patients.

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