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COMPARATIVE STUDY OF MANUAL VS AUTOMATED HEMATOLOGY ANALYSERS IN COMPLETE BLOOD COUNT REPORTING.

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1. INTRODUCTION

The Complete Blood Count (CBC) remains among the most frequently ordered laboratory investigations in clinical medicine, and the transition from manual microscopy-based methods to fully automated hematology analyzers has been one of the defining shifts in modern laboratory practice. The thesis under review compares manual hematological techniques — cyanmethemoglobin hemoglobin estimation and Neubauer hemocytometer counts for red cells, white cells, and platelets — against the automated Sysmex XN-350 analyzer, using 70 paired EDTA blood samples. This review paper evaluates the study's literature grounding, methodological detail, internal data consistency, statistical treatment, and the coherence of its conclusions.

2. Summary of the Study

2.1 Rationale and Objectives

The introduction is well constructed, tracing the historical shift from manual hematology to automation, describing the analytical principles of modern analyzers (electrical impedance, optical scattering, flow cytometry), and correctly noting that manual peripheral smear examination retains an important complementary role for detecting morphological abnormalities that automated counters cannot reliably classify. The three stated objectives — estimating Hb, RBC, WBC, and platelet counts by both methods, comparing the results, and evaluating the reliability of each approach — are clear, focused, and appropriately scoped to

the study design actually carried out.

2.2 Methodology Overview

The materials and methods chapter is unusually thorough for a thesis of this kind, providing full reagent compositions (Drabkin's, Hayem's, Turk's, and Rees–Ecker fluids), step-by-step procedures, counting-chamber conventions, and the exact calculation formulas used for each manual parameter. This level of procedural detail is a genuine strength, as it would allow another laboratory to replicate the manual methods exactly. Automated analysis was performed on the Sysmex XN-350, a five-part differential analyzer using DC impedance with hydrodynamic focusing, sodium lauryl sulfate hemoglobinometry, and fluorescence flow cytometry. The stated statistical plan was a paired Student's t-test to assess agreement between methods and Pearson's correlation coefficient to assess the relationship between them, with significance set at $p < 0.05$.

2.3 Key Findings as Reported

Seventy participants were enrolled, most (40%) aged 36–55 years, with a male-to-female ratio of roughly 56:44. The results chapter presents four comparison tables (Hb, RBC, WBC, platelet count) across three age bands, each with an automated-method column and a manual-method column, followed by narrative interpretation. The abstract summarizes the overall conclusion as: manual methods consistently produced slightly higher values than the automated analyzer across all four parameters, with the automated method judged reliable for routine screening and manual/peripheral smear examination retained as an important confirmatory tool.

3. Critical Analysis

3.1 Literature Review Quality

The review of literature is a genuine strength of this thesis relative to comparable student work. Each of the eleven studies discussed (Astrand et al., 2024; Winther-Larsen et al., 2025; Zhao et al., 2024; Lewis & Pozdnyakova, 2023; Goti et al., 2024; Rizk, 2024; Kim et al., 2025; De Iuliis & Ranieri, 2025; Othmani et al., 2025; Barnes, 2005; Alphonsa et al., 2025) is summarized with distinct methodological detail and a specific, non-generic finding, rather than a repeated template. The recurring theme — that automated analyzers are reliable for quantitative CBC parameters but cannot fully replace manual peripheral smear examination for morphological abnormalities — is consistently and accurately drawn from the cited sources, and the discussion chapter later ties each of these studies back to the present findings in a genuinely comparative way rather than a simple restatement.

3.2 A Significant Internal Data Inconsistency

The most serious issue in this thesis is a systematic inconsistency between the numerical values presented in the result tables' column headers and the narrative interpretation text that follows each table. For hemoglobin, red blood cell count, and white blood cell count, the table headers list "Automated" values that are numerically higher than the "Manual" values in every age group and overall — yet the interpretation paragraphs immediately below each of these three tables attribute the higher figures to the manual method and the lower figures to the automated method, effectively reversing the two labels. Only the platelet count table is internally consistent, with the interpretation text correctly matching the table's column headers (manual higher than automated). Table 1 below summarizes this discrepancy.

Table 1. Comparison between table header values and the accompanying interpretation text for each parameter's overall mean.

Parameter	Table Header Values (Automated vs Manual)	Table Interpretation Text	Consistent?
Hemoglobin (overall)	Automated 15.43 > Manual 14.46	States automated = 14.46, manual = 15.43	No — labels swapped
RBC (overall)	Automated 4.42 > Manual 4.07	States manual = 4.42, automated = 4.07	No — labels swapped
WBC (overall)	Automated 7346 > Manual 6757	States automated = 6757, manual = 7346	No — labels swapped
Platelet (overall)	Manual 244,714 > Automated 171,429	States manual = 244,714, automated = 171,429	Yes — labels match

This is not a trivial typographical slip: it directly affects the thesis's central empirical claim. The abstract and conclusion both assert that "manual methods consistently yielded slightly higher values for all hematological parameters," a claim that is only actually supported by the raw table headers for platelet count. For hemoglobin, RBC, and WBC, the table headers as printed indicate the opposite pattern — that the automated analyzer produced the higher values — and it is only the (apparently mislabeled) interpretation text that aligns with the abstract's overall narrative. Whichever set of numbers is correct, the thesis in its current form contains a direct internal contradiction between its own tables and its own narrative for three of the four parameters studied, and this should be resolved by returning to the raw laboratory data before the thesis is considered final.

3.3 Missing Inferential Statistics

The methodology chapter explicitly commits to a paired Student's t-test and Pearson's correlation coefficient to formally evaluate agreement between the manual and automated

methods, with a stated significance threshold of $p < 0.05$. However, the results chapter reports only descriptive means for each parameter and age group; no t-statistics, p-values, correlation coefficients, or confidence intervals appear anywhere in Chapter 4. As a result, the study's repeated claim that the two methods show "good agreement" or produce "comparable results" is, as presented, a qualitative impression drawn from inspecting mean differences rather than a statistically supported conclusion. Given that a paired t-test and Pearson correlation were both explicitly planned, their absence from the results is a substantial gap that should be corrected; a Bland–Altman analysis, which is the standard approach for comparing two measurement methods and is commonly used in this exact type of hematology-analyzer comparison literature, would also have been a valuable and relatively simple addition.

3.4 Sample Size, Population, and Design Considerations

A sample of 70 paired specimens is reasonable for a preliminary method-comparison study but is modest relative to the number of comparisons being drawn (four parameters across three age bands, i.e., twelve age-stratified cells per table). The three age bands themselves (15–20, 21–35, 36–55 years) are not clearly justified on physiological or clinical grounds, and no rationale is given for excluding participants over 55, a demographic in which hematological parameters and analyzer performance can behave differently. The study population is also not described in terms of whether samples included any known-abnormal specimens (e.g., anemia, leukocytosis, thrombocytopenia); given that the literature review itself repeatedly emphasizes that manual-automated discrepancies are most pronounced in abnormal samples, the omission of any abnormal-versus-normal breakdown limits how much the present dataset can speak to the clinical scenarios the introduction itself identifies as most important.

3.5 Reference List Quality

The reference list contains a duplication similar to that seen in other theses from this program: the Bain, Bates, Laffan, and Lewis (2017) textbook "Dacie and Lewis Practical Haematology" is listed three times in full, verbatim. In addition, several references appear in the bibliography (Ike et al., 2010; Lantis et al., 2003; Novis et al., 2006; Pierre, 2002; Rock et al., 1984; Zandecki et al., 2007) without any corresponding in-text citation anywhere in the introduction, literature review, or discussion chapters. These are minor editorial issues relative to the data-consistency problem above, but they should be cleaned up before submission.

3.6 Discussion Chapter Quality

Independent of the labeling issue above, the discussion chapter itself is well organized and does more comparative work than is typical for a thesis at this level. Rather than listing prior studies sequentially, the author explicitly connects each cited study's specific finding to the present results — for example, linking Goti et al.'s (2024) observation that RBC indices alone under-characterize morphological anemia subtypes to the present study's own reliance on quantitative parameters, and linking Rizk's (2024) findings on scatterplot misclassification of overlapping leukocyte populations to the present study's WBC comparison. This kind of study-by-study integration, rather than a generic restatement that a cited paper 'supports the present findings,' is a genuine strength and distinguishes this discussion chapter from more superficial literature summaries. The chapter's final paragraph also appropriately frames manual and automated methods as complementary rather than competitive, which is a reasonable and well-supported synthesis position given the literature reviewed, even though — as noted above — the specific numerical support offered for this position within the present dataset is currently compromised by the table/text inconsistency.

4. Strengths of the Study

- Exceptionally detailed and reproducible methodology, including full reagent compositions, step-by-step manual procedures, and exact calculation formulas for each parameter.
- A genuinely comparative, non-formulaic literature review that draws specific, differentiated findings from each cited study rather than a repeated template.
- A sensible, clearly stated study design directly comparing paired manual and automated results on the same 70 specimens, allowing direct method comparison.
- A discussion chapter that engages substantively with prior literature on automated-versus-manual and automated-versus-smear comparisons, correctly identifying the consistent theme that automation should complement rather than replace manual morphological review.

5. Weaknesses and Limitations

- A systematic inconsistency between the automated/manual value labels in the result table headers and the accompanying interpretation text for three of four measured parameters (Hb, RBC, WBC), which directly undermines the central quantitative claim of the abstract and conclusion.

- The paired t-test and Pearson correlation coefficient specified in the methodology are never reported in the results chapter, leaving the claimed 'agreement' between methods without formal statistical support.
- No Bland–Altman or other bias/limits-of-agreement analysis, despite this being the standard approach for this type of method-comparison study.
- Modest, single-center sample (n = 70) with no reported inclusion of abnormal hematological specimens, despite the literature review's own emphasis that discrepancies are most relevant in abnormal samples.
- Unexplained age-band boundaries and no participants over 55 years included.
- A triplicated reference and several references not cited anywhere in the text.

6. Significance and Practical Implications

Notwithstanding the data-labeling issue, the underlying exercise is clinically relevant: laboratories in resource-limited settings frequently rely on manual methods either exclusively or as a backup to automated analyzers, and empirical local comparisons of this kind help establish confidence in automated results while clarifying when manual confirmation is warranted. The thesis's literature synthesis reinforces a well-supported and clinically important message — that automated analyzers are reliable for routine quantitative screening but peripheral smear examination remains essential whenever morphological abnormality is suspected — and this conclusion stands independently of the numerical labeling issue identified above, since it is drawn primarily from the cited literature rather than from the present study's own contested figures.

7. Recommendations for Revision

Before this thesis is finalized, the underlying laboratory data should be re-checked against the printed tables to determine which set of automated/manual labels is correct for hemoglobin, RBC, and WBC, and the abstract, results, and discussion should be made internally consistent with whichever labeling is verified as accurate. The results chapter should also be expanded to report the paired t-test statistics, p-values, and Pearson correlation coefficients that the methodology chapter promises, ideally supplemented with a Bland–Altman plot showing the mean bias and 95% limits of agreement between the two methods for each parameter. Reporting whether any specimens contained known hematological abnormalities, and if so analyzing them separately from normal specimens, would also let the study speak more directly to the clinical scenarios its own introduction identifies as most important. Finally, the

duplicated reference entry should be removed and the bibliography checked against the in-text citations.

8. CONCLUSION

This thesis addresses a clinically relevant and well-motivated question with an unusually detailed and reproducible manual-methods protocol and a genuinely comparative literature review. Its central weakness is a data-reporting inconsistency in which the result tables and their accompanying interpretation text assign the higher mean values to opposite methods for three of the four parameters studied (hemoglobin, RBC, and WBC), directly affecting the validity of the thesis's headline claim that manual methods consistently exceed automated ones. Compounding this, the planned inferential statistics (paired t-test, Pearson correlation) are never actually reported, leaving the claimed agreement between methods without quantitative support. Neither issue requires new data collection to resolve — both can be corrected by returning to the original laboratory records and completing the statistical analysis already specified in the methodology — after which this would be a solid, clinically useful piece of comparative laboratory research.