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Comparison The Reference Ranges of Medical Laboratory Solution Manufacturers with Local Reference Ranges in Zliten City: A survey study

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مقارنة النطاقات المرجعية للشركات المصنعة لمحاليل المختبرات الطبية مع النطاقات المرجعية المحلية في مدينة زليتن: دراسة استقصائية

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Abstract:

Most of medical laboratories in Libya rely entirely on the default normal ranges provided by international manufacturers, without verifying their suitability to the physiological and environmental characteristics of the local community. This field survey aimed to assess the application and use of commercial reference values within medical laboratories in the Zliten region, identify the diagnostic packages most affected by local variations, and determine the level of awareness and support among medical staff for establishing independent national reference values. The study employed a descriptive-analytical approach. A scientific questionnaire and a field survey were designed, involving a purposive sample of 65 technicians working in medical laboratories (both public and private) in Zliten. The data underwent descriptive and inferential analysis using the Statistical Package for the Social Sciences (SPSS), specifically cross-reference analysis and Fisher's Exact Test to match the expected frequency distribution in the sample. The statistical results showed a 100% consensus among laboratories regarding their adherence to and full compliance with the technical manuals of international importing companies such as Roche, Abbott, and Mindray. Inferential analysis revealed a very strong correlation ($p < 0.001$) between the workplace and the sensitivity to detecting physiological deviations; private sector practitioners demonstrated a higher awareness of detecting these variations compared to the public sector, which is subject to intense operational pressure. The complete blood count (CBC) was the most frequently performed test for detecting deviations, at 61.5%, and 84.6% of participants attributed these

variations to the prevailing dietary patterns and lifestyle habits in the region. Finally, the proposal to establish local reference values received overwhelming support, at 92.3%. The study concludes that reliance on international company standards creates a potential diagnostic gap that does not accurately reflect the true biological reality of Libyan citizens. The study strongly recommends, in general and specifically to decision-makers in the Zliten health sector, the urgent adoption and implementation of a national project aimed at developing and establishing independent local reference standards that ensure diagnostic accuracy and protect patient safety.

Keywords: Reference standards, medical laboratories, Zliten, Fisher's exact test, complete blood count (CBC).

الملخص

تعتمد معظم المختبرات الطبية في ليبيا اعتمادًا كليًا على النطاقات الطبيعية الافتراضية التي توفرها الشركات المصنعة العالمية، دون التحقق من ملاءمتها للخصائص الفسيولوجية والبيئية للمجتمع المحلي. هدفت هذه الدراسة الميدانية إلى تقييم تطبيق واستخدام القيم المرجعية التجارية في المختبرات الطبية بمنطقة زليتن، وتحديد حزم التشخيص الأكثر تأثرًا بالاختلافات المحلية، وتحديد مستوى الوعي والدعم بين الكوادر الطبية لوضع قيم مرجعية وطنية مستقلة. استخدمت الدراسة منهجًا وصفيًا تحليليًا. صُمم استبيان علمي ومسح ميداني، شمل عينة مقصودة من 65 فنيًا يعملون في مختبرات طبية (حكومية وخاصة) في زليتن. خضعت البيانات لتحليل وصفي واستدلالي باستخدام الحزمة الإحصائية للعلوم الاجتماعية (SPSS)، وتحديدًا تحليل الإحالة المرجعية واختبار فيشر الدقيق لمطابقة التوزيع التكراري المتوقع في العينة. أظهرت النتائج الإحصائية إجماعًا تامًا بين المختبرات بشأن التزامها الكامل بالأدلة الفنية لشركات الاستيراد الدولية مثل روش، وأبوت، وميندراي. وكشف التحليل الاستدلالي عن وجود ارتباط قوي جدًا ($p < 0.001$) بين بيئة العمل وحساسية الكشف عن الانحرافات الفسيولوجية؛ إذ أظهر العاملون في القطاع الخاص وعيًا أكبر بأهمية الكشف عن هذه الاختلافات مقارنةً بالقطاع العام، الذي يتعرض لضغوط تشغيلية شديدة. وكان تعداد الدم الكامل (CBC) الاختبار الأكثر شيوعًا للكشف عن الانحرافات، بنسبة 61.5%، وعزا 84.6% من المشاركين هذه الاختلافات إلى أنماط التغذية السائدة وعادات نمط الحياة في المنطقة. وأخيرًا، حظي اقتراح وضع قيم مرجعية محلية بتأييد ساحق، بنسبة 92.3%. وتخلص الدراسة إلى أن الاعتماد على معايير الشركات الدولية يخلق فجوة تشخيصية محتملة لا تعكس بدقة الواقع البيولوجي الحقيقي للمواطنين الليبيين. توصي الدراسة بشدة، بشكل عام وخاصة لصناع القرار في قطاع الصحة بمدينة زليتن، بالتبني والتنفيذ العاجل لمشروع وطني يهدف إلى تطوير وإنشاء معايير مرجعية محلية مستقلة تضمن دقة التشخيص وتحمي سلامة المرضى.

الكلمات المفتاحية: المعايير المرجعية، المختبرات الطبية، زليتن، اختبار فيشر الدقيق، تعداد الدم الكامل.

Introduction

Medical laboratories and laboratory analyses are of clinical importance in the modern healthcare system, as they are relied upon for more than 70% of medical decisions related to diagnosis, monitoring treatment plans, and disease prediction. In this context, the value of a laboratory result does not derive from its numerical value alone, but rather from its degree of deviation from or conformity to what are known as reference intervals/ranges.(Adekoya et al., 2025) A reference interval is scientifically defined as the numerical range encompassing the results of 95% of apparently healthy individuals within a specific and homogeneous statistical population.(Doyle & Bunch, 2023) Therefore, the accuracy of a medical diagnosis is closely and conditionally linked to the suitability of these reference intervals for the population targeted

by the medical care.(Ma et al., 2024) The vast majority of medical laboratories in developing countries, including Libya, rely almost entirely on the reference intervals provided by global manufacturers of medical devices and reagents (such as Roche, Abbott, and Siemens), which are listed in the accompanying kit inserts.(Plebani, 2025) However, these reference values are derived and determined by manufacturers based on samples taken from specific communities, often European or North American, that differ substantially in their genetic makeup, physiological structure, and lifestyle from other communities.(Ren et al., 2023) International organizations concerned with laboratory standards, such as the Clinical and Laboratory Standards Institute (CLSI) and the International Federation of Clinical Chemistry and Laboratory Medicine (IFCC), recommend that each local laboratory verify or transfer these values to suit the local community it serves.(Turgeon, 2022) However, the lack of practical implementation of these recommendations leads to the phenomenon of transient misdiagnosis, where locally healthy individuals are classified as patients (false positive) or vice versa (false negative), resulting in significant psychological and economic burdens on the patient and the community, and a drain on healthcare resources.(Pellejero-Sagastizábal et al., 2025) The discrepancy between manufactured reference values and actual population levels stems from a complex interplay of several laboratory factors, including:(Pellejero-Sagastizábal et al., 2025)

- **Genetic and ethnic factors:** Genetic variation directly influences blood hemoglobin levels, enzymes, and certain biomarkers.(Pellejero-Sagastizábal et al., 2025)
- **Dietary and daily patterns:** Dietary habits, sodium and fat intake, and water quality vary from one community to another, impacting biochemical analyses such as kidney function, lipid profile, and cardiac enzymes.(Pellejero-Sagastizábal et al., 2025)
- **Climatic and geographical factors**: Sun exposure, temperature, and humidity play a crucial role in vitamin (especially vitamin D) and hormone levels, serving as a physiological mechanism for environmental adaptation.(Pellejero-Sagastizábal et al., 2025)

Zliten is a vital city in northwestern Libya, characterized by its unique demographics, dietary habits, and environmental and geographical conditions (such as proximity to the coastline, groundwater characteristics, and local agricultural and industrial activities).(Mourad & Husayn, 2025) These environmental characteristics and the lifestyle of the population in Zliten may lead to clear physiological variations in some vital signs and medical analyses compared to the communities on which manufacturers based their standard studies. Examining the laboratory reality in Zliten and comparing its reference values exemplifies the national need to reassess diagnostic standards.

Vital indicators in the human body are affected by (fixed vital factors, variable environmental factors, and pre-analytical factors

- Genetic and racial diversity (Genetic Polymorphism:

Genes control production rates of transport proteins, levels of liver enzymes (such as Cytochrome P450 enzymes), and blood cell density. For example, studies confirm that individuals of African descent have a different physiological balance in the number of white blood cells (Benign Ethnic Neutropenia) compared to Caucasians, without any medical condition, and the attempt to apply Western companies' standards to them leads to them being wrongly diagnosed with "leukopenia".

- Environmental, geographical, and nutritional variables Environmental & Dietary Matrix:
- Nature of water and nutrition: Local dietary habits play a direct role; Communities whose diet depends on certain proportions of sodium, or the quality of groundwater rich in certain minerals (as is the case in some wells in the central region of Libya, may have different levels of salts and kidney functions Creatinine, Urea.
- Exposure to sunlight and vitamin D: Despite the sunny climate of Zliten, numerous regional studies in North Africa and the Middle East have shown a widespread incidence of "low vitamin D" as a result of social habits, type of clothing, and spending long periods of time indoors, which makes the default normal value of manufacturers (>30 ng/mL) inconsistent with the actual physiological and environmental reality of the majority of healthy residents in the region.
- Pre-analytical factors:

Blood collection mechanisms, transport conditions, hours of fasting, and the nature of physical activities typical in the local community differ from the standard trial populations of large companies, affecting indicators such as cholesterol, triglycerides, fasting blood glucose and cardiac enzymes.

Zliten region gains exceptional research importance because it is a growing health and educational center in the Libyan state (represented by its specialized medical centers and academic institutions). Conducting this comparative study in this geographical area achieves strategic goals that go beyond mere academic work:

- Clinical Impact: Protecting patients from unnecessary treatments resulting from false positive diagnoses, and preventing the overlooking of true medical conditions false negatives.
- Economic Impact: rationalizing health spending; Reducing the confirmatory tests that doctors request when there is doubt about the results saves huge budgets for hospitals and citizens.
- Applied scientific research: Providing a clear scientific methodology that can be circulated in the future to the rest of Libyan cities to create a "National Register of Libyan Reference Values."

Problem of the study

The problem addressed in this research emerged from repeated field observations by laboratory specialists and physicians in the Zliten region. These observations indicate a persistent deviation in the results of seemingly healthy individuals from the normal ranges specified by manufacturers in certain vital analyses (such as complete blood count, thyroid function tests, and vitamin D levels). Therefore, this research seeks to answer the fundamental question: Are there statistically significant differences between the reference values issued by manufacturers and the actual normal physiological values of the Zliten region population.

Objectives of the study

1. To investigate and evaluate the current use of reference values in Zliten region laboratories (public and private) through a field survey.
2. To monitor and identify the medical analyses most prone to deviation from manufacturers' reference values, based on practitioners' experience.

3. To provide a preliminary database to encourage health authorities to adopt a national project for developing local reference values specific to the Libyan population (Local Reference Intervals) to ensure the safety and quality of medical diagnoses

Methodology

- **Study population**: The study population targeted the staff working in diagnostic medical laboratories and then medical analyses, and the geographical diversity of the city of Zliten.
- **Study Sample:** Due to the specialized nature of the study population, a purposive sample was selected to represent actual practitioners in the field. The final sample size for statistical analysis was (65) participants, distributed across the following operational environments:
- **The public sector**: This represents the critical mass of the sample with (55) participants, or 84.6%.
- **The private sector**: This represents (10) participants, or 15.4%.
- **Data Collection:** The questionnaire was used as the primary tool for collecting primary data from the sample. The tool was designed based on a review of academic literature and international standards for laboratory medicine.
- **Duration of the study:** The sample was collected from June 7th to June 9th , 2026

Statistical Methods

The data were processed and quantitatively analyzed using the Statistical Package for the Social Sciences (SPSS v25). The following statistical tests and methods were applied based on the nature of the variables:

- **Descriptive Statistics:** Frequencies and Percentages: To describe the distribution of the sample and summarize their responses on the questionnaire axes.
- **Cumulative Percentages:** To identify upward patterns in the descriptive distribution of variables.
- **Inferential Statistics:** Cross-Tabulation: To study the nature of the network relationship and the distribution of responses between independent and dependent variables.
- **Fisher's Exact Test:** This inferential test was adopted as a strict alternative to the traditional Pearson chi-squared test. This methodological decision was made due to the nature of the 2x2 cross-sectional tables in the study, which showed that one cell (representing 25.0% of the cells) had an expected frequency of less than 5 (where the minimum expected value was 2.00). Since this discrepancy precluded the use of the traditional chi-squared test scientifically, Fisher's exact test was employed to ensure true and statistically unbiased significance levels at a significance level of $\alpha \leq 0.05$.

Hypotheses

Based on the preceding data and field laboratory observations, this research formulates two main hypotheses that will be statistically tested:

- Null Hypothesis ($H_0): There are no statistically significant differences at a significance level ($\alpha \leq 0.05$) between the reference values adopted by medical device manufacturers and the actual normal ranges for the population of the Zliten region.
- Alternative Hypothesis (H_1): There are statistically significant differences at a significance level ($\alpha \leq 0.05$) between the manufacturers' reference values and the actual normal ranges for the population of the Zliten region in certain vital analyses, necessitating the modification or formulation of local reference ranges.

Acknowledgment

It is my pleasure to extend my deepest gratitude and appreciation to all the medical and technical staff, engineers, and workers in the diagnostic medical laboratories in Zliten region, both public and private.

I would like to express my sincere thanks and profound gratitude to them all for their warm welcome, open-mindedness, and prompt and responsible response in completing the field study forms within a short period. Their tangible practical experience and insightful observations, drawn from daily practice, have been instrumental in enriching this research and strengthening its scientific rigor.

This work would not have been possible without their invaluable assistance. I have benefited greatly from their knowledge and guidance, which illuminated the practical aspects of this research and helped connect the theoretical framework with the clinical realities of medical laboratories. In conclusion, I ask Allah Almighty to bless their efforts and to always grant them success in serving humanity and raising the level of healthcare in our society, wishing them further progress, success and excellence in their professional and scientific careers.

Results

Table (1): Frequencies and percentages of distribution of sample members by medical laboratory sector

Laboratory Sector					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Government	55	84.6	84.6	84.6
	Private	10	15.4	15.4	100.0
	Total	65	100.0	100.0	

Table (1) shows the descriptive distribution of members of the study sample of medical analysis engineers and practitioners in the Zliten region according to work sector. It is clear that the vast majority of participants belong to the government sector, with a frequency of 55 participants and a percentage of 84.6%.

Table (2): Frequencies and Percentages of Sample Distribution According to Average Daily Sample Count in the Laboratory.

Samples per Day					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 50	5	7.7	7.7	7.7
	from 50 to 150	5	7.7	7.7	15.4
	More than 150	55	84.6	84.6	100.0
	Total	65	100.0	100.0	

Table (2) shows the descriptive distribution of the study sample according to the average daily workload (number of samples) in the targeted medical laboratories in the Zliten region. The results showed that the vast majority of the sample, 84.6% (n = 55), work in laboratories with a high daily workload exceeding 150 samples.

Table (3): Frequencies and percentages of the type of medical reagents used in laboratories.

Reagents used in your laboratory					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Roche,, Abbott , Mindray	65	100.0	100.0	100.0

The statistical outputs shown in the table above showed a state of absolute consensus at a rate of 100.0% among all members of the study sample (N=65) on the absolute and complete reliance in the operation of medical laboratories on reagents and solutions produced by the major global monopoly companies in the field of medical diagnostics, represented by the companies (Roche, Abbott, and Mindray).

Table (4): Frequencies and Percentages of the Mechanism for Adopting and Entering Reference Values in Medical Laboratories.

Normal Ranges					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Same reference company	65	100.0	100.0	100.0

Table (4) shows the responses of the sample members regarding how to handle and enter reference values into the laboratory system. The results were conclusive, with a 100% consensus (n = 65) in favor of the option of full adherence to the reference values provided by the manufacturers of medical devices and reagents.

Table (5): Frequencies and Percentages of Observed Outliers in Apparently Healthy Individuals.

Observe test results falling					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	sometimes	13	20.0	20.0	20.0
	Never	52	80.0	80.0	100.0
	Total	65	100.0	100.0	

Table (5) shows the descriptive distribution of the sample's opinions regarding the extent to which they observed laboratory results outside the normal range specified by manufacturers for apparently healthy individuals (routine screening cases). The results indicate that 80.0% (n = 52) of participants reported never observing such deviations (answer: Never), while 20.0% (n = 13) of laboratory engineers reported frequently observing outliers (answer: Sometimes). Although the majority tended toward not observing,

Table (6): Frequencies and Percentages of Medical Tests Most Frequently Deviated from Manufacturers' Ranges.

Which test show the most different?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	CBC	40	61.5	61.5	61.5
	TSH	10	15.4	15.4	76.9
	Vitamin D	15	23.1	23.1	100.0
	Total	65	100.0	100.0	

Table (6) shows the opinions of the sample members regarding the medical tests most prone to deviation from the normal ranges approved by manufacturers in the Zliten region. The results showed that the complete blood count (CBC) was the most frequently deviated medical test,

with a rate of 61.5% and a frequency of 40 participants. This was followed by the vitamin D test at 23.1% (n = 15), and then the thyroid-stimulating hormone (TSH) test at 15.4% (n = 10).

Table (7): Frequencies and Percentages of Sample Members' Opinions on the Necessity of Establishing Local Reference Ranges.

Local Reference Range					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	60	92.3	92.3	92.3
	No	5	7.7	7.7	100.0
	Total	65	100.0	100.0	

Table (7) shows the descriptive distribution of the sample members' opinions on the scientific and practical need to establish reference ranges specific to the residents of the Zliten region or Libyan society in general (Local Reference Range). The results showed almost absolute and overwhelming support from practitioners; 92.3% (n = 60) of the total participants stated the utmost necessity of establishing local reference ranges to avoid diagnostic errors, while the percentage of those who opposed this approach did not exceed 7.7% (n = 5) only.

Table (8): Frequencies and Percentages of Sample Members' Opinions on the Main Reasons Behind the Variation in Reference Values.

what are the primary causes behind the differences between the manufacturers' ranges?					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Food Style	55	84.6	84.6	84.6
	Environment	10	15.4	15.4	100.0
	Total	65	100.0	100.0	

Table (8) shows the descriptive distribution of the sample members' opinions on the variables and underlying factors behind the variation in normal ranges between manufacturers and residents of the Zliten region. The results showed that the vast majority of participants, at 84.6% (n = 55), attribute this variation to local dietary patterns and consumption habits. In contrast, 15.4% (n = 10) of laboratory engineers believe that environmental and climatic

factors, such as water quality and weather, are the primary influence. This result underscores the biophysical specificity associated with the lifestyle in the region, which must be considered when formulating any local diagnostic criteria.

Table (9): Chi-squared test and exact matching to measure statistical significance.

Statistical Test	Value	Degrees of Freedom (df)	Asymptotic Significance (2-sided)	Exact Significance (2-sided)
Pearson Chi-Square	47.273[a]	1	.000	—
Fisher's Exact Test	—	—	—	.000
Number of Valid Cases (N)	65	—	—	

The statistical data extracted from the table indicate a strong, statistically significant network correlation. The Pearson chi-squared value was 47.273 at df = 1, with an approximate significance level below the assumed range ($p < 0.001$). Methodologically, a single cell at the bottom of the table has an expected frequency of less than 5 (representing 25.0% of the total cells in the cross-sectional table, with a minimum expected value of 2.00). This scientifically precludes relying on the traditional Pearson chi-squared value for 2x2 cross-sectional tables due to its inaccuracy. Based on this methodological limitation, the more rigorous alternative statistical criterion, Fisher's Exact Test, was employed. The result obtained from Fisher's Exact Test definitively confirmed this substantial correlation. The exact significance level (2-sided) reached 0.000, which is a highly significant level approaching absolute zero ($p < 0.001$). Based on this inferential result, the null hypothesis (H_0) is rejected and the alternative hypothesis (H_1) is accepted, statistically confirming that the observed distribution of responses and field observations in the study sample is not due to chance or randomness, but rather is causally and structurally related to the nature of the intersecting variables in the study environment.

Discussion

The study showed a 100% consensus among participating laboratories on strict adherence to the reference ranges issued by major global manufacturers such as Roche, Abbott, and Mindray, without any prior local physiological modification or review. The seriousness of this finding lies in the complete absence of local verification protocols (Verification/Studies) recommended by international organizations such as the Clinical and Laboratory Standards Institute (CLSI).(Almuthaybiri et al., 2025) The formulation of these virtual reference ranges by global companies is largely based on reference samples taken from Western or Asian populations whose physiological, environmental, and genetic characteristics differ from those of North African populations, and specifically Libyan populations. This makes the application of these values a matter of technical accountability and a potential source of hypothetical diagnostic error. Advanced inferential analysis using Fisher's Exact Test revealed a very high and profound statistically significant correlation ($p < 0.001$) between the workplace and the extent to which deviations in results were detected in apparently healthy individuals. Opinions

were sharply divided; 100% of private sector practitioners confirmed that they sometimes observed this discrepancy, while 94.5% of public sector practitioners reported never observing it consistently (the answer was "never"). This sharp clinical disparity is attributed to the nature of operations and patient flow in each sector. The public sector is under immense operational pressure, handling over 150 samples daily (84.6%), and most tests are focused on routine general screening or administrative procedures, which may prevent staff from tracking the finer details of result margins. In contrast, the private sector deals with a patient segment requiring more rigorous clinical monitoring and medical conditions that necessitate precise matching between clinical symptoms and laboratory findings. This has given private sector practitioners greater technical sensitivity and keen observation of the mismatch between the default parameters of companies and the physiological reality of citizens in Zliten. The study's findings precisely identified the diagnostic packages most affected by the absence of local reference values. The complete blood count (CBC) analysis ranked first as the most frequently performed test for deviation, at 61.5%. This is justified from a hematological perspective; Cellular indicators (such as red blood cell count, hemoglobin levels, and packed cell volume (PCV)) are among the most sensitive indicators, highly influenced by the genetic, ethnic, and climatic makeup of communities. Comparing them to standardized measurements from imported devices often leads to the misclassification of normal physiological conditions as pathological (or vice versa). Vitamin D testing came in second at 23.1%, followed by thyroid-stimulating hormone (TSH) at 15.4%. These indicators aligned with the opinion of the overwhelming majority of the sample (84.6%), who attributed this variation to the dietary patterns and daily consumption habits of the Zliten region's population. Dietary inputs, actual sun exposure levels, and lifestyles play a crucial role in shaping the body's biochemistry and the balance of hormones and vitamins, which explains the inadequacy of standardized ranges designed for communities with vastly different dietary and lifestyle patterns. This discussion culminated in the study's most significant finding: 92.3% of practicing medical professionals supported the scientific necessity of this approach. The study's ultimate goal is to establish local reference values specific to the region's population or Libyan society in general. This finding demonstrates that technicians' 100% adherence to the companies' default values is a software and technical obligation imposed by the operating systems of imported devices, not a scientific conviction in the suitability of these values. This overwhelming support (92.3%) lends this study significant practical legitimacy and presents it to decision-makers in the Zliten health sector as an urgent scientific document. It calls for the sponsorship of a national project to collect samples from healthy local individuals, develop local physiological records and normal ranges to ensure accurate diagnoses, protect patients from misdiagnoses, and raise the standards of laboratory medicine in the city.

Conclusion

This study concluded its investigation by reaching key conclusions regarding the reality of reference interval assessment within medical laboratories (both public and private) in the Zliten region. The study demonstrated a 100% consensus among the targeted medical personnel on complete adherence to and full compliance with the technical publications and default reference intervals issued by major international companies supplying solutions and reagents, such as Roche, Abbott, and Mindray. This reliance is accompanied by a complete absence of

any local verification studies or institutional efforts to adapt these physiological ranges to align with the biological characteristics of the local population. The impact of operational specialization on field monitoring: Inferential analysis (using Fisher's exact fit test) revealed a strong and significant correlation ($p < 0.001$) between the work sector and the sensitivity to monitoring variations in results. Private sector practitioners demonstrated a higher level of awareness in monitoring physiological deviations in seemingly healthy individuals due to the meticulous clinical monitoring of patients, in contrast to the public sector, which is governed by high operational intensity (exceeding 150 samples daily) and focuses primarily on screening and routine general examinations. The tests most affected by local variations were identified by the study sample as the complete blood count (CBC), at 61.5%, followed by vitamin D (23.1%) and thyroid-stimulating hormone (TSH) (15.4%). Participants (84.6%) attributed these deviations to the dietary patterns and daily lifestyle habits specific to the Zliten region, which directly impact the body's biochemistry and hormonal and cellular balance compared to the standards set by companies for Western or Asian societies. This collective demand for change is evident. The study culminated in an overwhelming and overwhelming endorsement of 92.3% by laboratory experts and engineers demanding the urgent scientific and clinical necessity of establishing local reference values specific to Libyan society, thus giving the recommendations of this research strong practical legitimacy.

Recommendation

1. The Libyan Ministry of Health and relevant academic and research institutions are urged to adopt a comprehensive national protocol for collecting reference samples from apparently healthy individuals within the community to establish a local physiological database, prioritizing the standards of the complete blood count (CBC).
2. Major medical laboratories, particularly those in teaching hospitals and public diagnostic centers, are required to implement the recommendations of international organizations (such as CLSI and IFCC) by conducting periodic verification studies of the data sheets accompanying company reagents before officially adopting their normal ranges in patient reports.
3. Joint workshops and scientific seminars are to be organized for clinicians and medical laboratory engineers to deepen understanding of physiological and environmental variations and their impact on interpreting laboratory results, thus avoiding hypothetical diagnostic errors resulting from the misinterpretation of imported normal ranges.
4. Future medical research should be supported to focus on measuring and analyzing the impact of prevailing local dietary and lifestyle patterns in the Zliten region on hormone and vitamin levels (such as vitamin D and TSH) to provide accurate and locally adapted diagnostic safety margins.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that they have no conflict of interest.

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