

Towards appropriate training for Moroccan laboratory professionals: Identifying QMS needs

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ABSTRACT

Background: Professional development plays a key role in improving laboratory quality management by enhancing staff skills and knowledge to implement and maintain the quality management system (QMS). This research aims to identify and prioritize continuing training needs for Moroccan laboratory professionals in QMS and to formulate recommendations for suitable training programs.

Methods: The present research is a cross-sectional, quantitative study conducted among a larger group of laboratory professionals from September 2021 to May 2023. The data collection tool was a self-administered questionnaire. Statistical data analysis was performed by IBM SPSS version 22.0 software calculating Chi-square.

Results: A total of 478 people participated in the study. Participants' training needs on various topics related to quality in medical laboratories ranged from 68.20% to 84.52%, covering several subjects such as quality tools (82.01%), continuous improvement (83.68%), ISO 9001 (83.26%), and ISO 15189 (79.71%).

Conclusions: The results indicate a favorable trend toward continuing training in QMS. These suggestions should be considered when formulating future training programs to foster strong commitment and continuous improvement of skills, thereby improving the quality of healthcare provision and guaranteeing patient safety.

Keywords: continuing education, continuing professional development, ISO 15189, ISO 9001, medical laboratory, Morocco, quality management system

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INTRODUCTION

Medical laboratory professionals (MLPs) play a central role in healthcare systems, carrying out complex analyses in various disciplines such as hematology, chemistry, virology, molecular biology, and microbiology [1]. Their responsibilities include examining blood, urine, fluids, and tissues to ensure correct diagnosis and appropriate treatment of patients, as well as improving medical practice as a whole [2,3]. MLPs must also ensure effective quality management to guarantee the precision, reliability,

and accuracy of results, essential to the effectiveness of clinical judgments and the well-being of patients [4,5].

A Quality Management System (QMS) integrates multiple facets, including quality assurance, following laboratory protocols, and compliance with international standards [6]. To successfully implement these standards and integrate quality measures into professional practices, there is universal consensus on ongoing QMS training, which plays a decisive role in improving the quality of results and care within healthcare establish-

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ments [7–10]. Appropriate QMS training enables professionals to master and implement the standards and procedures they need to maintain a high level of quality in their day-to-day practice [11,12]. In addition, QMS training plays an important role in strengthening the quality culture within teams [13], promoting the development and preservation of professionals' knowledge and skills [14,15]. This results in improved accuracy and reliability of results, a crucial factor in clinical laboratories where accurate diagnoses and effective interventions rely heavily on these parameters [5].

Consequently, enhancing QMS skills and knowledge is becoming essential to meet growing accreditation requirements and ensure optimal performance of health-care services.

A recent research has shown that inaccuracies in laboratory results can lead to misinterpretation and inappropriate treatment, exerting a considerable influence on patients' overall health [16]. The consequences of inadequate management extend beyond individual patient treatment to encompass broader public health implications, as inaccuracies can lead to insufficient medical interventions, increased healthcare expenditure, and challenges related to managing public health emergencies such as epidemics, as highlighted by Parija and colleagues [17].

On the other hand, current training programs are not always adapted to the rapid changes in laboratory standards and technologies, creating a gap between the skills needed and those held by professionals [18]. Consequently, a meticulously structured continuing education program is essential to enable laboratory professionals to keep abreast of the latest advances and preserve the integrity of diagnostic protocols, thereby promoting improved patient outcomes and public health well-being [19].

Despite the importance of quality management in medical laboratories (ML), the specific QMS continuing education requirements for ML in Morocco are not sufficiently documented. This gap may compromise the quality of diagnosis and care. Given this, our study aims to identify and prioritize these needs to develop continuing education programs tailored to local conditions and aligned with international standards. By addressing existing challenges, these programs will strengthen the ability of laboratory professionals to meet high-quality standards.

METHODS

For this cross-sectional study, we followed the guidelines set out in the STROBE Declaration, a global initiative to improve the accuracy and quality of reporting on observational studies. This methodology ensures a complete and transparent presentation of the methods used, the

results obtained, and their subsequent interpretation, in line with established best practices for this category of research [20].

Study population

The research aimed to involve MLPs from all twelve distinct regions of Morocco, including professionals employed in both the public and private sectors.

Sampling technique

Our survey focused on 1,520 laboratory technicians in the public sector in Morocco, as well as 322 biologists in the public sector and 359 biologists in the private sector [21]. However, the exact number of laboratory technicians in the private sector has still not been disclosed. The sample size was determined by applying a simple random sampling technique that was modified to incorporate an estimated infinite population.

The formula used to calculate the sample size is as follows: $n = Z^2 \times p \times (1-p) / e^2$ where n is the sample size; Z is the Z-score, which represents the desired level of confidence (1.96 for a 95% confidence level); p is the estimated proportion of the population with the characteristic under study (often assumed to be 0.5); and e is the tolerated margin of error (e.g. 5%).

Using these parameters, the required sample size was calculated to include 384 participants. We chose to include a sample of 478 participants, which exceeds the minimum sample size to mitigate the effects of possible non-response or incomplete data, thus improving the precision of statistical estimates.

Data collection

This study uses a combination of online and paper-based survey methods to reinforce the participation of MLPs in the twelve regions of Morocco. Data obtained from the online survey were exported to Microsoft Excel, while information collected on paper was entered manually into the same application. The survey instrument designed was distributed over a period running from September 2021 to May 2023. The survey questionnaire and its content were developed based on a review of existing literature [22–26], as well as quality standards, such as ISO 18159, ISO 9001 [27,28].

The first part of the questionnaire was devoted to gathering general information about the survey participants, including aspects such as age, gender, and years of experience. Then, the second part was devoted to the continuing training needs expressed about the 12 topics of medical laboratory QMS.

Validity

The questionnaire was pre-tested with five professionals, three technicians, and two biologists to improve

quality and clarify certain issues. The overall Cronbach's alpha coefficient was 0.973, indicating exceptional internal consistency.

Scoring and statistical processing of data

Significance scores provided by participants were categorized into three levels: high significance (score > 3.75), moderate significance (score ≥2.5 and ≤3.75), and low significance (score <2.5). Prioritization of topics and training areas in the QMS was based on the proportions of participants who assigned a high significance score, with topics ranked as priority 1 for a score of ≥ 80%, priority 2 for a score between 70 and 79%, priority 3 for a score between 60 and 69%, and priority 4 for a score ≤59% [29,30].

Statistical analysis was performed using IBM SPSS version 22.0. Descriptive data were summarized by calculating means, frequencies, and percentage frequencies according to variable type. Chi-square was used to examine factors influencing continuing education needs. A *p*-value threshold of less than 0.05 was set for statistical significance. It should be noted that six incomplete records were excluded from the database to ensure the integrity of the analyses.

RESULTS

Socio-demographic characteristics

Table 1 illustrates the socio-demographic characteristics of the sample studied, comprising 478 people. It shows that 55.44% of participants were women, and the under-30 age group was predominant (45.61% %). In terms of professional category, a large majority (86.19%) were laboratory technicians, while a smaller percentage were biologists (10.88%) and other professional categories (2.92%). The majority of respondents work in the public (47.49%) and private (42.26%) sectors.

Table 1. Participant characteristics (n=478)

Socio-demographic characteristics		n (%)
Age	Under 30	218 (45.61%)
	30-40 years old	138 (28.87%)
	40-50 years old	52 (10.88%)
	50-60 years old	52 (10.88%)
	Over 60	18 (3.77%)
Gender	Male	213 (44.57%)
	Female	265 (55.44%)
Profession	Biologist	52 (10.88%)
	Laboratory technician	412 (86.19%)
	Other	14 (2.92%)
Sector of activity	University Hospital	49 (10.25%)
	Public	227 (47.49%)
	Private	202 (42.26%)
Experience	Less than one year	57 (11.92%)
	1 to 3 years	100 (20.92%)
	3 to 10 years	146 (30.54%)
	More than 10 years	175 (36.61%)

Laboratory professionals' preferences for continuing education in QMS

In the present study, it was found that, on average, 81.60% of participants expressed a need for ongoing quality management system (QMS) training covering the 12 topics assessed (Table 2), with a 95% confidence interval (CI) of [77.80%, 85.00%]. Table 2 reveals a strong demand for training on various aspects of QMS for ML, with mean scores ranging from 3.84 to 4.34 and standard deviations from 1.20 to 1.39. The majority of participants reported a high need for training in risk management (84.52%) and ISO 9001 standards (83.26%), while quality tools (82.01%) also attracted significant interest. On the other hand, subjects such as the management of the purchasing process (68.20%) and human resources management (74.48%) were perceived as having a lower priority (Table 2).

Table 2. Ranking of QMS training needs according to predetermined topics (n=478)

Quality management system training items	Mean ± SD	Continuing training needs (n, %)			Estimate (95% CI)
		Low	Medium	High	
Risk management	4.34 ± 1.20	45 (9.41%)	29 (6.07%)	404 (84.52%)	0.845 (0.810-0.876)
Continuous improvement approach	4.19 ± 1.22	48 (10.04%)	30 (6.28%)	400 (83.68%)	0.837 (0.801-0.869)
ISO 9001 requirements	4.19 ± 1.25	54 (11.3%)	26 (5.44%)	398 (83.26%)	0.833 (0.796-0.865)
Standard requirements on equipment management	4.21 ± 1.24	51 (10.67%)	33 (6.90%)	394 (82.43%)	0.824 (0.787-0.857)
Quality tools	4.19 ± 1.24	52 (10.88%)	34 (7.11%)	392 (82.01%)	0.820 (0.783-0.853)
Metrology in medical analysis laboratories	4.20 ± 1.24	52 (11.04%)	31 (6.58%)	388 (81.17%)	0.824 (0.786-0.857)
Laboratory Information System Management	4.14 ± 1.29	58 (12.13%)	32 (6.69%)	388 (81.17%)	0.812 (0.774-0.846)
ISO 15189 requirements	4.11 ± 1.29	62 (12.97%)	35 (7.32%)	381 (79.71%)	0.797 (0.758-0.832)
Auditing in ML	4.10 ± 1.28	59 (12.34%)	46 (9.62%)	373 (78.03%)	0.780 (0.740-0.817)
Standard requirements on document management	4.08 ± 1.28	64 (13.42%)	49 (10.27%)	364 (76.31%)	0.763 (0.722-0.801)
Standard requirements on human resources management	4.03 ± 1.33	69 (14.44%)	53 (11.09%)	356 (74.48%)	0.745 (0.703-0.783)
Standard requirements on purchasing process management	3.84 ± 1.39	88 (18.41%)	64 (13.39%)	326 (68.20%)	0.682 (0.638-0.724)
Score Average					
Average of 12 ML QMS subjects	4.13 ± 1.12	44 (9.20%)	44 (9.20%)	390 (81.60%)	0.816 (0.778-0.850)

Prioritization of MLPs QMS Training Needs

Of the 12 topics assessed, seven were ranked as top priority, with a proportion of participants indicating significant needs over 80% (Table 3). Four topics were identified as second priority, with percentages ranging from 74.48% to 79.71%, including ISO 15189 requirements (79.71%), medical laboratory auditing (78.03%), document management requirements (76.31%) and human resources management (74.48%). Only one topic, which concerns the requirements of purchasing process management standards (68.20%), was ranked as the third priority, with a percentage between 61.00% and 69.00% (Table 3).

Determinants associated with the prioritization of continuing education needs among MLPs

Statistical analysis of continuing education needs in the various socio-demographic categories studied indicates that participants attach predominant importance to these needs. Regardless of the specific sub-group analyzed, a substantial majority articulate a pronounced need for continuing education, with over 80.00% of respondents across all age groups, genders, sectors of activity, and experience. The results underline a collective agreement regarding the need for continuing education, demonstrating a consistent trend across different socio-demographic variables. For example, young professionals under 30 (82.11%) and those aged 50-60 (88.46%) show an exceptionally strong need. Women (83.77%) are slightly more inclined to pursue continuing education than their male counterparts (78.87%). Overall, this penchant for strong demand for continuing education is remarkably consistent across all the subgroups analyzed,

Table 3. Priority needs for QMS training as ranked by participants (n=478)

Priority	Rank	QMS training items
Priority 1 (≥80%)	1	Risk management
	2	Continuous improvement approach
	3	ISO 9001 requirements
	4	Requirements of equipment management standards
	5	Quality tools
	6	Medical laboratory metrology
	7	Laboratory Information System Management
Priority 2 (71%-79%)	8	Requirements of ISO 15189
	9	Medical laboratory auditing
	10	Requirements of standards on document management
	11	Requirements of human resources management standards
Priority 3 (61%-69%)	12	Requirements of purchasing process management standards

with no statistically significant differences observed according to chi-square tests (p -values >0.05), indicating that the perception of the importance of continuing education needs remains consistent across the different socio-demographic groups studied (Table 4).

DISCUSSION

Continuing education is essential for maintaining the skills of healthcare professionals, particularly in laboratories. This research represents an innovative effort to define the continuing education needs of medical laboratory professionals (MLPs) in Morocco about the quality management system (QMS).

Table 4: Socio-demographics and their influence on the overall importance of continuing training needs

Socio-demographic characteristics		Overall importance of continuing training needs (12 items combined)			Chi-square (p-value)
		Low	Medium	High	
Age	Under 30	17 (7.8%)	22 (10.09%)	179 (82.11%)	0.307
	30-40 years old	16 (11.59%)	11 (7.97%)	111 (80.43%)	
	40-50 years old	7 (13.46%)	3 (5.77%)	42 (80.77%)	
	50-60 years old	1 (1.92%)	5 (9.61%)	46 (88.46%)	
	Over 60	3 (16.67%)	3 (16.67%)	12 (66.67%)	
Gender	Male	26 (12.21%)	19 (8.92%)	168 (78.87%)	0.126
	Female	18 (6.79%)	25 (9.43%)	222 (83.77%)	
Categories	Technicians	37 (8.98%)	40 (9.71%)	335 (81.31%)	0.627
	Biologists	6 (11.54%)	2 (3.85%)	44 (84.62%)	
	Other	1 (7.14%)	2 (14.29%)	11 (78.57%)	
Area of activity	Public	22 (9.69%)	23 (10.13%)	182 (80.18%)	0.598
	Private	20 (9.9%)	18 (8.91%)	164 (81.19%)	
	University Hospital	2 (4.08%)	3 (6.12%)	44 (89.8%)	
	Less than one year	1 (1.75%)	6 (10.53%)	50 (87.72%)	
Experience	1 to 3 years	10 (10%)	11 (11%)	79 (79%)	0.530
	3 to 10 years	14 (9.59%)	12 (8.22%)	120 (82.19%)	
	More than 10 years	19 (10.86%)	15 (8.57%)	141 (80.57%)	

The survey covered a total of 478 Moroccan MLPs, revealing a slight feminine predominance (55.44%). These results diverge from a study carried out in Ethiopia by Gebregzabher et al. (2023) who identified a preponderance of male respondents within their sample. Our results indicate that the participants of the current study work in the private (42.26%) and public (47.49%) sectors. In contrast, the same research by Gebregzabher et al. (2023) states that a large majority of the subjects in their study belonged to the public sector [2]. These discrepancies and correspondences underline the importance of socio-demographic characteristics and regional context in the formulation of continuing education and human resource management strategies in the ML sector.

In our study, the overall estimator was 0.816 (95% CI: 0.778-0.850), confirming the perceived importance of such training and underlining the need to strengthen skills in these areas to ensure effective management in line with international standards. These results corroborate those of Kasvosve et al. (2014) who assign a mean score of 79.00% to the importance of QMS, ranging from 74.00% to 84.00% [30]. Essuman et al. (2023) also corroborate this high demand for training, with an average reported priority of 80.59% (± 9.024) [29].

In addition, our study shows that participants rank seven topics as Class 1 priorities. These results reveal a collective recognition of the importance of continuing education in improving the reliability of results and quality of care. This awareness is essential to direct future initiatives towards improving professional practices and optimizing ML services. Similarly, Gebregzabher et al (2023) stress the importance of targeting continuing professional development programs in critical areas to ensure adequate training [2].

Our survey of QMS-related continuing education needs for laboratories reveals both similarities and discrepancies to the studies conducted by Kasvosve et al. (2014) in Botswana and Essuman et al. (2023) in Ghana. Indeed, equipment management is designated as a top-level priority in our research, in line with the findings of Essuman et al. (2023). Furthermore, laboratory accreditations (ISO 15189) are listed as type 2 priorities in all three studies. These similarities suggest that certain aspects of quality management are universally recognized as essential to laboratory efficiency, irrespective of geographical variations. However, our study highlighted discrepancies, particularly with regard to document management, which we classified as a second-level priority, whereas Essuman et al. (2023) consider them a first-order priority, and Kasvosve et al. (2014) deem them less essential [30]. Another disagreement concerns procurement process management, which our research assessed as a class 3 priority, whereas Essuman et

al. (2023) ranked it as priority 2 [29]. These findings underline the fact that priorities for QMS training depend on the contextual framework, underscoring the need for training tailored to regional specificities.

Furthermore, our results show a strong and homogeneous consensus on the importance of continuing training among all the socio-demographic sub-groups studied. The absence of any significant difference between these groups, confirmed by Chi-square tests, suggests that the need for continuing training is perceived as essential, irrespective of age, gender, professional category, or level of experience. This finding could be interpreted as an indicator of widespread recognition of the importance of continuous skills improvement in a constantly evolving professional environment. The slight difference observed between women and men, although not significant, could suggest a greater sensitivity on the part of women to professional development opportunities, potentially linked to social or cultural factors. Similarly, the high demand from young professionals could reflect their desire to acquire skills quickly to advance their careers, while the strong interest among older professionals could indicate a need to remain competitive with younger, more skilled colleagues. In the Moroccan context, QMS is not systematically included in the continuing training of laboratory professionals. A parallel international phenomenon is evident, particularly in Cambodia [31,32], Singapore [13], and India [1,33], where the availability of formal, mandatory quality management training is lacking, despite its recognized importance. These challenges indicate that quality management training problems are not exclusive to Morocco, but are widespread throughout the world. Consequently, the results of this study, although focused on Morocco, apply to other countries facing similar gaps in continuous QMS training.

In addition, it should be emphasized that the use of surveys to identify training needs is an essential opportunity to adapt and adjust programs to the realities on the ground. In the context of this study, the results reveal a need to integrate specific QMS modules into ongoing training programs for laboratory professionals. By adopting such an approach, based on identified needs, it would be possible to enhance Moroccan professionals' quality management skills and ensure greater compliance with international standards. This would improve laboratory performance and align their practices with global quality standards. These results underline the importance of designing continuing training programs that meet a wide range of needs.

Nevertheless, there are some limitations to this work, notably the over-representation of laboratory technicians, while other groups such as secretaries and chief technicians are under-represented. This disparity may

compromise the generalizability of the results. A further limitation is the paucity of literature allowing in-depth comparison of our results. In addition, the needs assessment could have benefited from a more holistic approach incorporating the viewpoints of decision-makers and medical laboratory managers to elucidate more effectively the key challenges of the field.

CONCLUSIONS

The results of this study provide valuable information on the continuing training needs of medical laboratory practitioners in Morocco, particularly about QMS. The results indicate that, on average, 81.60% of participants expressed an increased need for continuing education on the twelve topics assessed. In addition, the study highlights an increased demand for training in QMS areas, with particular attention paid to risk management, the continuous improvement process and ISO 9001 and ISO 15189 standards. The results of this study are fundamental for policy-makers, trainers and researchers, as they provide a coherent basis for improving continuing education programs, enhancing the skills of professionals and, ultimately, improving the quality of patient care. Hence the need for in-depth research into the development of systematic evaluation methods to improve continuing professional development (CPD) activities, taking into account preferences for training formats, perceptions, and barriers related to CPD. It is also recommended to study the factors that hinder the transition from voluntary to mandatory CPD, and to pay particular attention to evaluating the effectiveness of CPD programs, especially in terms of quality management, in order to maintain and improve quality standards in medical laboratories.

ABBREVIATIONS

CPD – Continuing professional development
 ISO – International Organization for Standardization
 ML – Medical laboratories
 MLPs – Medical laboratory professionals
 QMS – Quality management system
 SD – Standard deviation

AUTHORS' CONTRIBUTION

ME - conceptualization, data collection and processing, drafting of original version,
 HG - conceptualization, data processing and drafting of original version
 HO- methodology and proofreading of manuscript
 KEM- methodology and proofreading of manuscript
 MA- data processing and manuscript revision
 YEA- English translation of work and revision of manuscript

AEO- manuscript revision and statistical processing

AK- manuscript revision and English translation of work

ACK- manuscript revision and statistical processing

EB- conceptualization, validation and supervision

CONFLICT OF INTEREST

None to declare.

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