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Original article

Management and perceptions of anemia and iron deficiency prior to cardiac surgery

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ABSTRACT

Introduction. Anaemia and iron deficiency (ID) are common in patients with cardiovascular disease and are associated with increased morbidity and mortality in cardiac surgery. However, no data are available on how this issue is addressed in Ibero-America. We therefore sought, under the auspices of the Inter-American Society of Cardiology, to explore the knowledge, attitudes, and practices of Latin American physicians involved in the perioperative care of patients undergoing cardiac surgery. **Materials and methods.** We conducted a cross-sectional study using an anonymous electronic survey distributed between January and August, 2025, through snowball sampling. Physicians engaged in clinical practice involving the care of patients prior to cardiac surgery were eligible for inclusion. **Results.** A total of 881 physicians from 23 countries responded. Although 83.7% reported routinely screening for anaemia, only 43.7% indicated that they assessed iron deficiency. Institutional protocols addressing this topic were reported by 18.2% of respondents. Marked heterogeneity was observed in therapeutic management: only 11.8% reported administering intravenous iron when anaemia or ID was diagnosed. While 46.9% of participants stated that they had routine access to intravenous iron, only 26.6% of these reported prescribing this intervention for patients in the preoperative cardiac surgery setting within the 6 months preceding the survey. Furthermore, 54.8% of respondents had not received specific training and felt only moderately prepared to manage these conditions. **Conclusions.** Our findings suggest substantial gaps between the available evidence and clinical practice in the preoperative management of anaemia and iron deficiency, underscoring the need for institutional protocols and enhanced specialised medical education.

Keywords: Anemia; Iron Deficiencies; Cardiac Surgical Procedures; Perioperative Care; Surveys And Questionnaires (Source: MeSH-NLM).

RESUMEN

Manejo y percepciones sobre la anemia y deficiencia de hierro previo a cirugía cardíaca

Introducción. La anemia y la deficiencia de hierro (DH) son condiciones frecuentes en pacientes con enfermedades cardiovasculares y se asocian a mayor morbimortalidad en cirugía cardíaca. Sin embargo, no existen datos sobre cómo es abordada esta problemática en Iberoamérica. Debido a ello, desde la Sociedad Interamericana de Cardiología nos propusimos explorar conocimientos, actitudes y conductas de médicos latinoamericanos involucrados en el perioperatorio de cirugía cardíaca. **Materiales y métodos.** Se realizó un estudio transversal mediante una encuesta electrónica anónima distribuida entre enero y agosto de 2025, utilizando un muestreo tipo «bola de nieve». Se incluyeron médicos con actividad asistencial que involucre la atención de pacientes previa a cirugía cardíaca. **Resultados.** Respondieron la encuesta 881 médicos de 23 países. Si bien el 83,7% manifestó que tamizaba la presencia de anemia de forma rutinaria, solo el 43,7% expresó evaluar la DH. Un 18,2% manifestó contar con protocolos institucionales sobre este tópico. El manejo terapéutico mostró notables diferencias: solo el 11,8% indicó administrar hierro endovenoso (EV) ante el diagnóstico de anemia o DH. El 46,9% de los participantes expresó tener acceso rutinario a hierro EV; sin embargo, solo el 26,6% de ellos refirió haber indicado esta intervención a pacientes en el preoperatorio de cirugía cardíaca en los 6 meses previos a responder la encuesta. Además, el 54,8% de los encuestados no había recibido formación específica y se sentía solo moderadamente preparado para manejar estas condiciones. **Conclusión.** Nuestros datos sugieren que existen brechas significativas entre la evidencia disponible y la práctica clínica en el manejo preoperatorio de anemia y DH, destacando la necesidad de protocolos institucionales y mayor educación médica especializada.

Palabras clave: Anemia; Deficiencia de Hierro; Cirugía Cardíaca; Cuidado Perioperatorio; Encuestas y Cuestionarios (Fuente: DeCS-BIREME)

Introduction

Iron deficiency (ID) affects approximately 2 billion people worldwide. It is estimated that around 1.2 billion individuals have anaemia associated with this deficiency, which has been recognised by the Global Burden of Disease Study as one of the five leading causes of years lived with disability [1]. Although the global burden of ID is well documented, there are limited epidemiological data on its prevalence among cardiovascular patients and in the context of cardiac surgery in Latin America.

From a pathophysiological perspective, ID is characterised by a reduction in total body iron stores, associated with depleted reserves and/or decreased circulating iron [2, 3]. The most common causes include inadequate dietary intake, chronic blood loss, malabsorption, and chronic inflammatory states [2].

Individuals living with cardiovascular diseases, such as significant atherosclerosis, heart failure, or other chronic conditions (including renal insufficiency), exhibit low-grade but persistent inflammation. Chronic inflammatory states are associated with increased hepcidin levels, one of the main hormones regulating iron metabolism, which promotes degradation of ferroportin, resulting in reduced intestinal iron absorption and mobilisation [2, 3]. Consequently, individuals with cardiovascular diseases have a higher prevalence of anaemia and ID compared with the general population.

ID is a major determinant in the development of anaemia, which has been consistently associated with poorer clinical and surgical outcomes [4, 5]. Given the magnitude of this problem, the World Health Organization developed the Patient Blood Management (PBM) programme to address this condition in a comprehensive and systematic manner [6].

In recent decades, there has been an increasing number of studies demonstrating the benefits of intravenous iron therapy in patients with heart failure or prior to cardiac surgery [7-11]. Although iron administration in patients with heart failure has become widely adopted, the same has not occurred for the treatment of anaemia and ID prior to cardiac surgery. Owing to this gap between evidence and clinical practice, the Inter-American Society of Cardiology (SIAC in Spanish) sought to conduct a survey among cardiologists, cardiovascular surgeons, internists, intensivists, and anaesthetists to explore their perspectives and practices in the management of patients with anaemia and ID in the perioperative setting of cardiac surgery.

Materials and methods

Study design

This study was designed and reported in accordance with the Consensus-Based Checklist for Reporting of Survey Studies (CROSS), proposed by the Enhancing the Quality and Transparency of Health Research (EQUATOR) Network [12, 13]. The questionnaire was developed by two investigators with experience in the design of medical surveys, based on the available literature and the study objectives. Its content was reviewed by the SIAC working group to ensure clinical relevance and clarity; no formal pilot testing was undertaken, as the questionnaire was directed at specialist physicians and comprised structured, easily interpretable questions. Once the final version was established, a descriptive cross-sectional study based on an electronic survey was conducted.

Study population

Physicians engaged in clinical practice related to the cardiovascular field were included, without restrictions regarding country of residence, specialty, or workplace setting. Only participants who did not complete all variables required for the analysis were excluded.

Data collection process

The survey was implemented through the SurveyMonkey® platform, which incorporates automated mechanisms to reduce the likelihood of duplicate responses. These include the automatic recording of IP addresses by the platform. However, the investigators had no access to IP addresses or any other identifying data; therefore, responses remained anonymous to the research team.

The survey was disseminated through the email distribution list of SIAC members, as well as via the institutional website and official SIAC social media channels (X, Facebook, and Instagram), using a non-probabilistic snowball sampling approach.

Variables

The questionnaire comprised 30 items organised into sections designed to collect demographic, academic, occupational, and clinical practice-related information, with the aim of assessing knowledge, attitudes, and practices regarding anaemia and ID in the context of cardiac surgery.

Variables were predominantly categorical and were obtained through closed-ended multiple-choice questions. In the questionnaire, the term "routine administration of intravenous iron" referred to the usual prescription of intravenous iron in clinical practice when anaemia and/or ID were identified during preoperative assessment.

Procedures

The survey was self-administered and available in two languages: Spanish and Portuguese. It was disseminated and remained open for responses between January and August, 2025. Upon completion of the data collection period, the corresponding

author downloaded the responses from the SurveyMonkey® platform, after which data analysis was performed.

Statistical analysis

Continuous variables are presented as mean and standard deviation or as median and interquartile range (IQR), according to their distribution. Normality was assessed by graphical inspection (histograms and normal probability plots) and the Shapiro-Wilk test. Categorical variables are presented as absolute frequencies and percentages. Comparisons between proportions were performed using the chi-squared test or Fisher's exact test, as appropriate according to expected cell frequencies. Comparisons between continuous variables with normal distribution were conducted using Student's t test for independent samples; when the distribution was non-normal, the Mann-Whitney U test was applied.

Given that the proportion of missing data was below 1% for all variables analysed, no data imputation was performed.

All analyses were conducted using Stata® version 18.0 (StataCorp, College Station, TX, USA). A two-sided p-value <0.05 was considered statistically significant.

Ethical aspects

The survey included a preamble outlining the study objectives, the voluntary nature of participation, and the anonymity of responses. Participants were also informed that data would be handled confidentially and in accordance with national and international data protection regulations. The preamble explicitly stated that completion of the survey implied provision of informed consent to participate.

To minimise response bias, written consent was not required due to the anonymous nature of the survey and the absence of identifiable data collection. The study protocol was approved by the Executive Committee of the SIAC.

Results

A total of 881 physicians participated in the survey, of whom 38.5% were women. The median age was 40.0 years (IQR: 33-51). Among respondents, 62.5% were practising clinical cardiologists, 4.1% reported working in cardiovascular rehabilitation, 15.0% were specialists in internal medicine, 6.7% were anaesthetists, 4.0% were critical care specialists, and 7.7% were cardiovascular surgeons. Participants resided in 23 countries across the Americas and Spain **(Figure 1)**. Regarding workplace setting, 27.8% worked in public hospitals, 38.6% in private centres, and 33.5% in mixed institutions; additionally, 85.0% reported working in an academic institution.

With respect to professional training, 27.4% reported being in training (fellows or residents) **(Table 1)**. Among specialists, 12.5% had less than 5 years of experience, 28.6% between 5 and 15 years, and 31.6% more than 15 years of practice in their specialty. Overall, 25.3% of participants indicated that cardiac surgery was not performed at their workplace; among those where it was performed (n = 658),

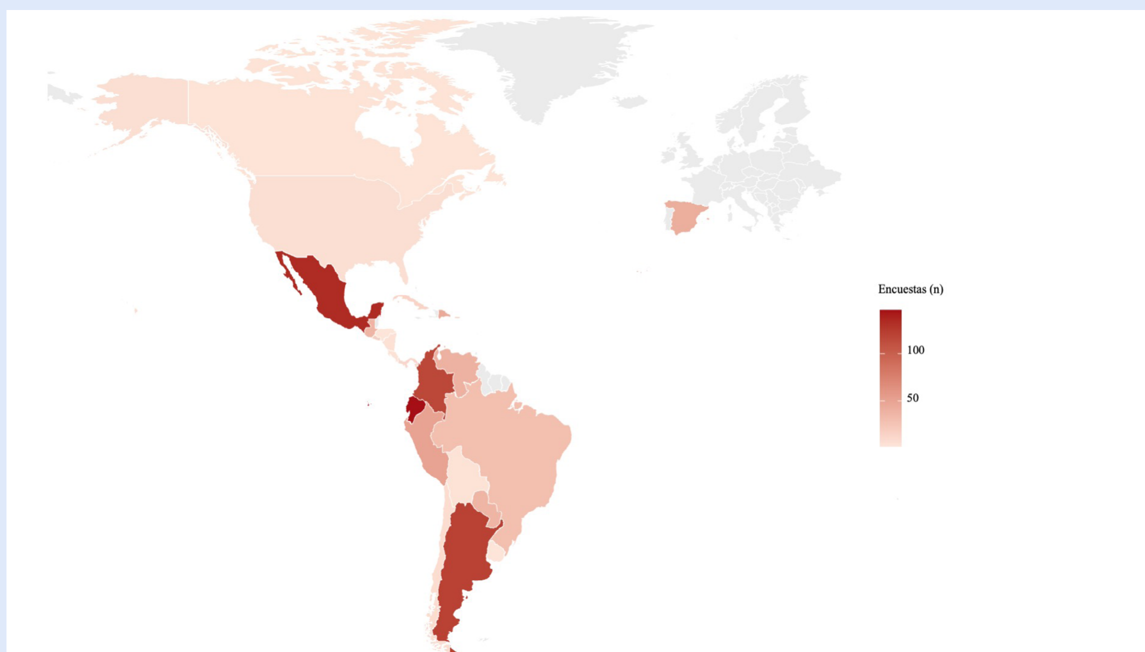

Figure 1. Geographical distribution of survey participants according to country of residence.

the median annual number of procedures was 100 (IQR: 40-200). Moreover, 31.7% reported that cardiac surgeries at their institution were performed exclusively with cardiopulmonary bypass, whereas the remainder combined techniques with and without cardiopulmonary bypass.

Regarding preoperative assessments, 83.7% of respondents reported routinely assessing for anaemia, 11.8% did so occasionally, and 4.5% did not or were unsure. For ID, 43.7% reported routine assessment, 30.7% occasional assessment, and 25.6% did not or were unsure **(Figure 2)**. Concerning haemoglobin thresholds used to define preoperative anaemia, 35.8% reported using a value <13 g/dL in men; 43.5% used 12 g/dL in women; and 3.6% reported using 13 g/dL in women as well. In addition, 18.2% indicated having an institutional protocol for the preoperative assessment of anaemia and 13.7% reported having one specifically for ID.

Overall, 74.7% of participants stated that they would postpone a scheduled surgery in the presence of low haemoglobin levels, 8.1% reported that no haemoglobin value would prompt postponement, and 17.2% were unsure. Among those who would consider postponing surgery, the median haemoglobin threshold was 9 g/dL (IQR: 8-10). Table 2 summarises the main management approaches reported by respondents in the presence of anaemia and/or ID in the preoperative setting of cardiac surgery.

Globally, 11.8% of participants reported routinely administering intravenous iron to patients in whom anaemia and/or ID had been identified during preoperative assessment. Specialists in internal medicine and cardiologists reported prescribing this treatment more frequently than other respondents **(Table 3)**. Regarding institutional access to intravenous iron, 46.9% reported routine availability, 34.3% occasional availability, and 18.8% reported no access. Furthermore, 38.7% of participants reported having administered intravenous iron for the treatment of patients with heart failure in the preceding 6 months. In contrast, only 4.1% reported having administered intravenous iron in candidates for cardiac surgery, and 13.7% in both settings. Among those with routine access to intravenous iron, only 26.6% had used it in the preoperative context.

Finally, participants rated on a scale from 1 to 10 how prepared they felt to assess anaemia and ID, yielding mean scores of 6.4 (standard deviation [SD]: 2.5) and 6.2 (SD: 2.7), respectively **(Figure 3)**. Overall, 54.8% reported never having received specific training in this area and 24.3% were unsure. Nevertheless, participants considered the topic highly relevant to their clinical practice, assigning a mean score of 9.1 (SD: 1.8).

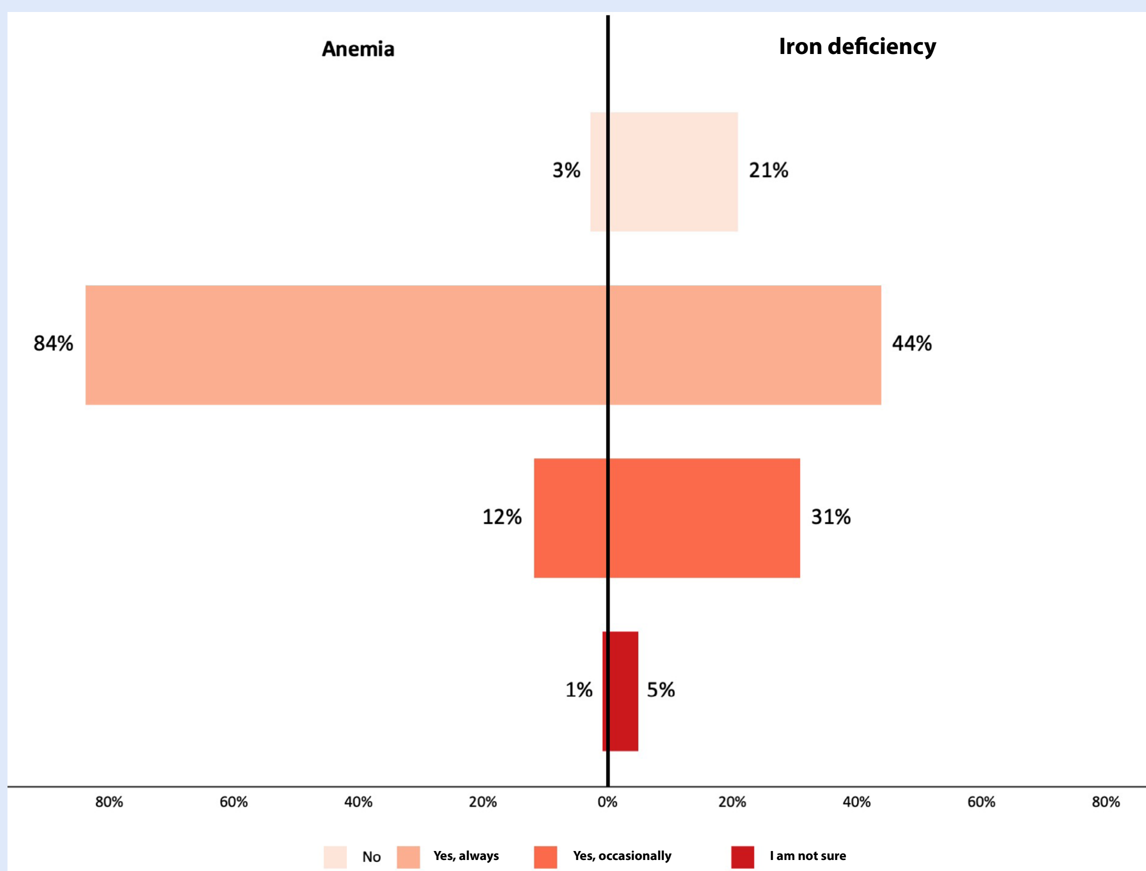

Figure 2. Comparison of preoperative assessment of anaemia and iron deficiency among participants.

Table 1. Proportion of physicians in training versus specialists, according to participants' specialty.

	Resident/Fellow (n = 241)	Specialist (n = 640)
Cardiology	25.7%	74.3%
Internal Medicine	46.2%	53.8%
Anaesthesiology	17.0%	83.0%
Critical Care Medicine	8.6%	91.4%
Cardiovascular Surgery	23.5%	76.5%

Discussion

The main findings of our study were as follows: i) a high proportion of physicians involved in the care of patients with cardiovascular disease reported systematically assessing anaemia prior to cardiac surgery, whereas a considerably smaller proportion reported assessing ID; ii) a low proportion of participants reported routinely administering intravenous iron as part of preoperative management; iii) fewer than half of respondents reported having routine access to intravenous iron; and iv) even among those with access to intravenous iron, only around one in four had used it in the preoperative setting in the six months preceding the survey.

Despite substantial evidence demonstrating that anaemia and ID are independent risk factors that increase morbidity, mortality, and resource utilisation in both cardiac and non-cardiac surgery [10, 14-19], and that multiple studies have shown clinical benefits of preoperative treatment, including reductions in transfusion requirements and improvements in postoperative recovery [11, 20-25], our findings suggest a significant gap between evidence and clinical practice in Latin America. Accordingly, the low proportion of participants reporting the availability of institutional protocols for the evaluation and management of perioperative anaemia warrants particular attention. The absence of formal protocols may reflect organisational and implementation barriers at the institutional level, which could contribute to the variability in clinical practices observed and limit the systematic adoption of PBM strategies.

In the context of our region, these findings may be influenced by structural factors inherent to health systems in Latin America. The availability of intravenous iron may be constrained by access barriers, budgetary limitations, differences in coverage between public and private systems, as well as logistical challenges related to its procurement and administration. In this setting, the limited availability of therapeutic resources may also indirectly influence clinical decision-making and the degree of priority that healthcare professionals assign to the evaluation and management of anaemia and ID in the preoperative period.

The findings of our survey are consistent with previous observations in other settings. Manzini *et al.* conducted a survey among 788 physicians in Europe involved in the care of patients undergoing surgery and found that 24% were unaware of the association between perioperative anaemia and adverse outcomes, and that more than 60% did not treat this condition even when it was identified [26]. Similarly, another survey conducted among anaesthetists in Romania reported that, although 97% of participants stated that PBM had a favourable impact on surgical outcomes, only 33% worked in centres with protocols to implement appropriate PBM strategies [27]. Moreover, only 39% of participants had received formal training in PBM, consistent with our findings [27]. Comparable results have been reported in other contexts. Wilson *et al.* observed that, in colorectal oncological surgery, fewer than half of physicians had standardised policies for the management of anaemia, while only 13.3% of anaesthetists routinely requested iron studies as part of the preoperative assessment [28]. Likewise, Bennett *et al.* conducted a survey among hepatobiliary surgeons and

Table 2. Management approaches following the diagnosis of anaemia and iron deficiency prior to cardiac surgery.

	Anemia		Iron deficiency	
	Always	Occasionally	Always	Occasionally
Referral to haematology	21.7%	14.9%	22.3%	16.8%
Request specific investigations*	33.3%	32.0%	28.8%	29.8%
Transfusion to achieve haematocrit >30%	18.3%	24.7%	3.2%	7.7%
Intraoperative transfusions	17.0%	37.3%	4.4%	12.4%
Administer oral iron	11.0%	24.5%	9.8%	19.8%
Administer intravenous iron	8.9%	28.1%	8.6%	22.0%

*Evaluation to identify the cause of anaemia or iron deficiency.

Table 3. Likelihood of administering intravenous iron in the presence of anaemia or iron deficiency, according to participants' specialty.

	Anaemia			
	Always	**Frequently**	**Occasionally**	**Never**
Cardiologists	10.4%	31.4%	44.2%	14.0%
Internal Medicine	11.4%	33.3%	45.6%	9.9%
Anaesthesiology	0.0%	13.6%	45.8%	40.7%
Critical Care	0.0%	17.1%	60.0%	22.9%
Cardiovascular Surgery	4.4%	7.4%	48.5%	39.7%
		Iron deficiency		
Cardiologists	9.7%	23.8%	45.4%	21.1%
Internal Medicine	9.1%	31.1%	44.7%	15.2%
Anaesthesiology	1.7%	6.8%	33.9%	57.6%
Critical Care	5.7%	20.0%	48.6%	25.7%
Cardiovascular Surgery	6.1%	3.0%	40.9%	50.0%

anaesthetists, and found that 45% of surgeons reported "not providing any specific treatment" for this condition, whereas 38% of anaesthetists stated that anaemia was "the responsibility of another specialty"[29]. Although, in our study, most participants recognised the importance of anaemia as a prognostic factor in cardiac surgery, only one in four participants with access to intravenous iron formulations had administered it within the previous six months.

To the best of the authors' knowledge, there are no previous surveys that have evaluated the opinions and

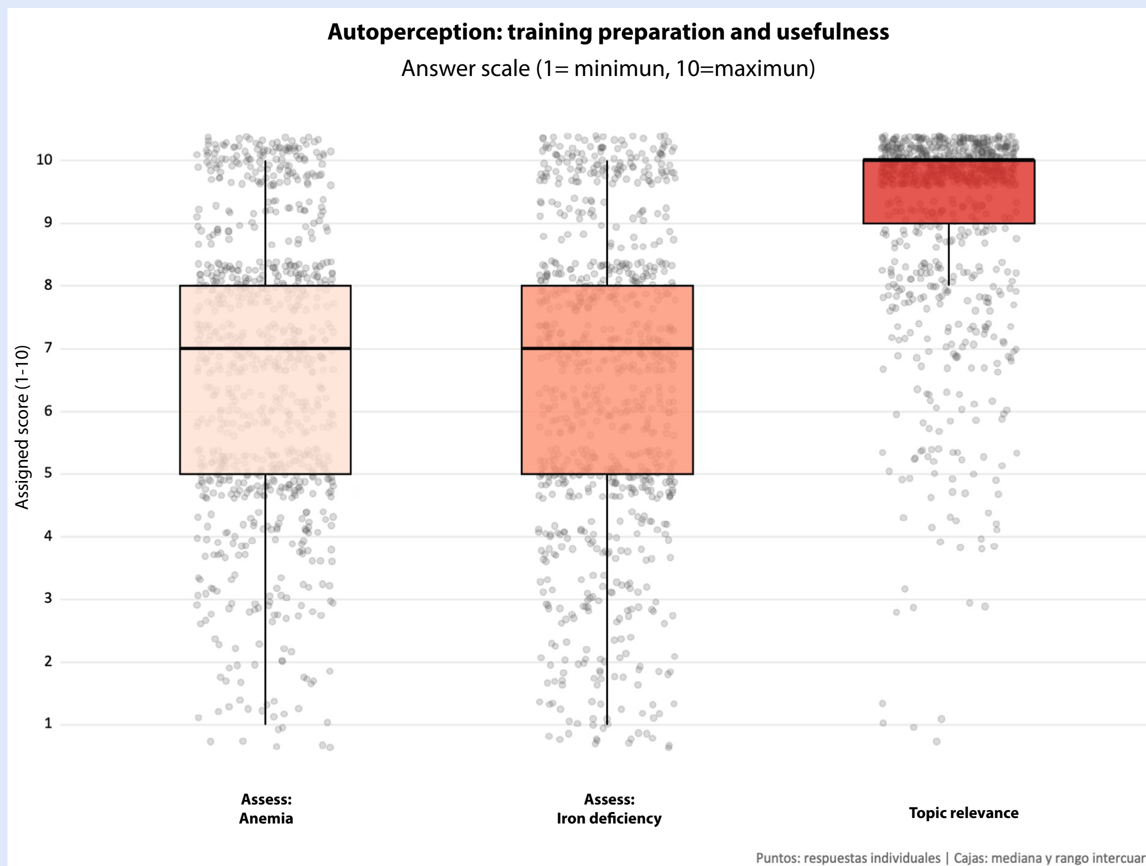

Figure 3. Perceived preparedness to assess iron deficiency and anaemia in the perioperative setting of cardiac surgery and their clinical relevance.

practices of cardiologists and related specialties regarding the preoperative management of anaemia and ID in cardiac surgery, either globally or in Latin America [28-30]. The fact that more than half of respondents reported not having received formal education on the assessment and management of anaemia or ID, and that professionals reported feeling only moderately prepared, underscores the importance of addressing this issue through medical education, both at undergraduate and postgraduate levels, and of implementing clinical support tools, such as electronic alerts and standardised clinical pathways [31, 32].

This study has several limitations that should be considered when interpreting its findings. First, due to the non-probabilistic sampling method and the broad geographical distribution of participants, it was not possible to estimate a theoretical sample size or calculate a response rate, which precludes assessment of the representativeness of the sample. Second, as this was a self-administered survey, responses reflect participants' perceptions or self-reported practices, and it is not possible to objectively verify whether these behaviours align with actual clinical practice. Therefore, reporting bias may be present, and the evaluation and treatment of anaemia and ID in routine practice may be even less frequent than reported. Although the total number of participants was high and responses were obtained from professionals across 23 countries, some regions may be underrepresented, which may limit the generalisability of the findings. Furthermore, the sample consisted predominantly of specialist physicians, particularly clinical cardiologists, which restricts the applicability of the results to other medical disciplines involved in the perioperative care of cardiac surgery patients. In addition, the questionnaire was not subjected to formal psychometric validation or a structured pilot test, which precluded formal assessment of the reliability and stability of responses. Finally, as with all survey-based studies, inherent biases cannot be excluded, including selection bias (due to greater participation of individuals with a particular interest in the topic) and recall bias when reporting usual clinical practices.

As strengths, our study included a substantial number of professionals from diverse specialties and countries, which enhances the representativeness and robustness of the findings. Moreover, to the best of the authors' knowledge, this is the first study to systematically explore perceptions and practices regarding the evaluation and management of anaemia and ID in the preoperative period of cardiac surgery, integrating the perspectives of multiple disciplines involved in perioperative care.

In conclusion, our findings suggest that significant gaps exist between the recognised clinical relevance of anaemia and ID in cardiac surgery and their management in routine clinical practice. Although the assessment of anaemia is common, routine screening for ID is less widespread, and substantial variation persists in the diagnostic criteria employed.

Moreover, the use of intravenous iron remains limited, constrained by both access barriers and underutilisation, even in institutions where this therapy is available. More than half of participants have not received formal training in this area and report feeling insufficiently prepared.

Taken together, these findings highlight the urgent need to develop institutional protocols, standardise diagnostic and therapeutic criteria, and promote continuing education programmes aimed at improving the quality of preoperative management of anaemia and ID.

Author contributions

SGZ: conceptualisation, methodology, investigation, formal analysis, writing-original draft. AB: conceptualisation, methodology, review and editing. **AA:** methodology, visualisation, writing-original draft. **JP, MCD:** methodology, investigation, data curation, formal analysis, visualisation, writing-original draft. **RMR:** investigation, data curation, visualisation. **RV, GA:** investigation, writing-original draft. **JC, DXC, FCT, RMRo:** investigation. **MISL, MAQ, JEGM:** investigation, data curation. **MN, RCMC, VEUS:** investigation, formal analysis, review and editing. **RLS:** investigation, review and editing. **CER, GB, AGM:** investigation, visualisation, review and editing. All authors approved the final version of the manuscript.

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