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Maturity of the patient registration system and factors associated with ICD-10 adoption in Côte d'Ivoire: a national analysis of the 2023 HHFA survey

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Research Article

Keywords: ICD-10, health information system, Côte d'Ivoire, HHFA, patient registration, CRVS

Posted Date: September 4th, 2026

DOI: https://doi.org/10.21203/rs.3.rs-10770057/v1

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Additional Declarations: No competing interests reported.

Abstract

Background

The health information system (HIS) supports the planning and monitoring of health interventions in low- and middle-income countries. Adoption of the International Classification of Diseases, tenth revision (ICD-10), is needed for comparable morbidity and mortality data. It also prepares the transition to ICD-11. In Côte d'Ivoire, no national study has assessed the state of the patient registration system or the factors associated with ICD-10 adoption.

Methods

This is a secondary analysis of data from the 2023 Harmonized Health Facility Assessment (HHFA), conducted in Côte d'Ivoire by the DIS/MSHP-CMU with support from the WHO. It is a cross-sectional assessment covering a nationally representative sample of 1113 health facilities. Weighted proportions were estimated for patient registration indicators and for reported ICD-10 adoption. A weighted multivariable logistic regression model was fitted to examine the determinants of reported ICD-10 adoption.

Results

The maturity of the registration system remained low (0.9/5; 95% CI 0.8 to 1.0). Register computerisation was marginal: 3.6% of facilities. Only 15.6% of the 1113 facilities reported using ICD-10 (95% CI 13.4 to 17.8). Among hospitals that recorded at least one death (n = 31), 12.9% performed cause-of-death coding (95% CI 0.0 to 25.8). The multivariable analysis identified two associated factors: the secondary level of care (aOR 4.76; 95% CI 2.87 to 7.88; $p < 0.001$) and the joint availability of a computer with an internet connection (aOR 2.43; 95% CI 1.50 to 3.93; $p < 0.001$). Management status did not explain the observed variation.

Conclusions

ICD-10 adoption remains limited (15.6%) and uneven across levels of care. It is concentrated in secondary and tertiary facilities. It is also concentrated in facilities with adequate computing infrastructure, independently of management status. These findings underline the need to strengthen training in clinical coding, particularly at the primary level. This training must be aligned with initiatives to strengthen CRVS.

Background

The health information system (HIS) is one of the six building blocks of health systems defined by the WHO [1]. It ensures the production of the data needed to plan, monitor and evaluate interventions. The performance of this system determines progress towards universal health coverage.

Assessing this performance requires a framework. The PRISM framework (*Performance of Routine Information System Management*) describes three dimensions [2–4]. These are the technical dimension (tools, standards, infrastructure), the behavioural dimension (skills, motivation, data-use culture) and the organisational dimension (governance, resources, leadership). Standardised facility assessments capture the technical and organisational dimensions well. They capture the behavioural dimension less well [2, 3]. The *Consolidated Framework for Implementation Research* (CFIR) complements PRISM for the analysis of implementation processes. It distinguishes determinants related to the innovation, to the outer and inner settings, to individuals and to the process [5]. The Discussion draws on both frameworks.

In low- and middle-income countries (LMICs), strengthening HIS has long been a priority [6]. Digitalisation now supports this effort. However, several obstacles persist. Data sources are fragmented. Paper support remains predominant. The uptake of classifications remains uneven [7, 8]. Digitalising primary tools (registers, electronic medical records, forms) can improve data quality and coding adoption [9, 10].

The registration system covers registers, compilation and transmission. Its quality is closely linked to the adoption of a standardised classification. In the logic of PRISM, weak registration limits the production of reliable coded data [2]. Coding, in turn, requires functioning registers. Few studies examine these two dimensions together in sub-Saharan Africa. This study addresses them from a single data source.

The second dimension concerns diagnostic coding. The tenth revision of the International Classification of Diseases (ICD-10) is the international standard for diagnoses and causes of death [11, 12]. Published in 1990, it was adopted progressively by WHO member states. It makes morbidity and mortality data comparable across countries. This comparability shapes epidemiological analysis and resource allocation.

In sub-Saharan Africa, its deployment remains partial. ICD-10 is officially adopted in most facilities there. Its use, however, remains uneven. Three main causes recur. These are the shortage of clinical coders, the absence of dedicated tools and incomplete medical documentation [13–15]. Coder training also varies widely from one country to another [16].

The eleventh revision (ICD-11), in force since 1 January 2022, is now the international reference [17, 18]. Its rollout raises particular challenges for LMICs. ICD-10 is not yet fully deployed there. The real level of ICD-10 adoption must therefore be known before planning this migration. In the WHO African Region, however, few multi-country assessments (HHFA, SARA) document this adoption [19, 20]. This gap limits regional comparison.

Côte d'Ivoire has 29.4 million inhabitants (2021 census) [21]. Strengthening the HIS is a priority axis of the National Health Development Plan (PNDS) 2021–2025 [22]. It is the subject of a dedicated plan, the Strategic Plan for the National HIS (PSSIS) 2021–2025 [23]. On the technical side, the national HIS has relied on the DHIS2 platform since 2015 [24]. The strengths and limits of DHIS2 have been described in several countries [25]. The national HIS, however, coexists with other sectoral tools. The World Bank thus notes that the health architecture remains fragmented [26]. This architecture requires targeted investment in support functions.

On the financing side, the 2014 Universal Health Coverage (CMU) law requires standardised coding for reimbursement [27, 28]. The incentive to adopt ICD-10 is therefore strong, particularly in the private sector. Civil registration and vital statistics (CRVS) reform points in the same direction. It requires systematic ICD-10 coding of causes of death, a condition for a functioning civil registration system [29, 30].

The few available Ivorian studies remain single-centre and limited to Abidjan. At Cocody University Hospital, 58% of staff did not know the definition of the medical record, 63% had received no dedicated training, and 52% linked this shortcoming to the quality of care [31]. At Anyama hospital, uptake of the electronic medical record remained uneven after four months [32]. These local studies give no national picture of the HIS or of ICD-10 adoption.

Three observations motivate this analysis. First, to date no national study has assessed the state of the patient registration system or the factors associated with ICD-10 adoption in Ivorian facilities. Both dimensions are nonetheless central to the PNDS 2021–2025 and to the National Digital Development Strategy [22, 33]. Second, the available studies are limited to single centres. This work targeted Abidjan referral facilities. Third, the Harmonized Health Facility Assessment (HHFA) conducted in 2023 covers a representative sample of 1113 facilities. It supports weighted analyses that can be extrapolated to the whole Ivorian health system [34]. Earlier work could not do this. Beyond the Ivorian case, these results inform the preparation for the ICD-11 transition in low- and middle-income countries. They feed the regional comparisons that the HHFA instrument makes possible [35].

Research question. What is the state of the patient registration system in Ivorian health facilities in 2023? Which factors are associated with reported ICD-10 adoption? To what extent do the level of care, management status, health region and available technical infrastructure explain the observed disparities?

Objectives. The study pursues three objectives: (1) to describe the patient registration system and summarise its maturity with a composite score (0 to 5); (2) to estimate the weighted prevalence of reported ICD-10 adoption; (3) to identify the factors associated with this adoption using weighted multivariable logistic regression.

Methods

Study design and data source

This is a secondary analysis of cross-sectional data from the Harmonized Health Facility Assessment (HHFA), a national survey conducted in 2023 in Côte d'Ivoire. It was carried out by the Directorate of Health Information (DIS) of the Ministry of Health, Public Hygiene and Universal Health Coverage (MSHP-CMU), with technical and financial support from the World Health Organization (WHO). The HHFA was developed by the WHO to succeed the Service Availability and Readiness Assessment (SARA). It is a standardised tool for assessing the availability, functionality and quality of services in health facilities [35, 36]. It includes a module dedicated to health information systems (HIS). This module documents patient data management practices and the use of disease classifications. Data collection ran from 10 August to 19 November 2023 (66 days) in three regional waves.

Population, sampling and data collection

The study population comprised all public and private health facilities in the country. Non-permanent advanced health posts and exclusively paramedical practices were excluded. The sampling frame listed 2645 facilities registered by the MSHP-CMU. Stratified simple random sampling by region selected the ESPCs (margin of error 15%, 95% confidence level [Z = 1.96], expected proportion p = 0.5). Hospitals, clinics, polyclinics, CHRs and CHUs were fully enumerated. The final sample comprised 1113 facilities across the 33 health regions. The distribution by level of care and management status is detailed in Supplementary Table S1.

Data collection mobilised 96 interviewers in 29 teams, supervised by 11 supervisors, after 15 days of training. Interviewers used tablets running CSPro. A control survey covered at least 10% of sites. Data were transferred daily to a secure server. Sampling weights allow national extrapolation. The sampling design was specified using the svydesign function (**survey** package), with the official weights, stratification by region and variance without an explicit primary sampling unit, following the recommendations of the DIS/MSHP-CMU (the survey producer) [34, 37].

Variables and operationalisation

Patient registration system

The availability and use of registers and individual patient records were documented separately for outpatient and inpatient care. For outpatient care, a composite maturity score (0 to 5) was built for all 1113 facilities. It is the sum of five binary indicators. These indicators cover the presence of a unique patient identifier, the use of individual patient records, the availability of a computerised register, the availability of a standardised form and the absence of a stock-out of that form. Its internal consistency was assessed with Cronbach's alpha, equivalent to KR-20 for binary items [38]. For inpatient care, the same dimensions were documented from the equivalent questions asked for that setting, among the 173 hospitals, clinics, polyclinics, CHRs and CHUs. This component is not merged into the national score: ESPCs do not offer inpatient services.

ICD-10 adoption (dependent variable)

The dependent variable is ICD-10 adoption. It relies on the direct survey question “Are ICD Codes used in the facility”. A facility is classified as an adopter if it reports using ICD codes. This measure is the most direct one, independent of context (billing, insurance or surveillance).

Implementation conditions

The availability of ICD-10 volumes, a register of the most frequent ICD-10 codes, staff trained in coding and a standardised coding guide could not be documented representatively. The corresponding sub-questions of the morbidity module have residual response counts (n = 10 to 46). These counts are insufficient for reliable weighted estimation. These dimensions are therefore not reported at the national level.

Explanatory factors

The independent variables are: the level of care; management status; the health region (33 categories); the presence of a trained HIS officer; and the technical infrastructure.

The level of care was defined in line with the strata of the HHFA sampling design. It comprises three categories: primary (primary care health facilities, ESPCs), secondary (general hospitals, regional hospitals and clinics) and tertiary (CHUs and polyclinics).

Management status is taken from the official survey variable, recoded by the data producer (managing authority). This variable distinguishes public, non-profit (NGO), faith-based and private for-profit facilities. The classification covers all 1113 facilities, with no imputation or exclusion.

The technical infrastructure has two components. The first is the availability of electricity. It was defined by the presence of an electricity source, its use beyond lighting alone, and its availability for most of the previous seven days. The second is the joint availability of a functional computer and an internet connection. It was treated as a single indicator, in line with the official HHFA convention.

Definition of the ICD-10 indicators

ICD-10 adoption covers all 1113 facilities. Cause-of-death coding is the only ICD-10 indicator defined in the official survey dictionary. It was estimated, as in the national report, among hospitals that recorded at least one death in the previous twelve months (n = 31). Notification of the number of deaths follows the same subpopulation.

Each operational definition was compared with the official HHFA indicator dictionary. The values obtained reproduce those published in the official report.

Missing data and sensitivity analysis

The proportion of missing values was computed for all key variables. The stratification, ICD-10 adoption and infrastructure variables are near-complete (0 to 4.5% missing). Questions on more detailed dimensions of the registration system and of mortality show high non-response rates (59 to 98%). These dimensions include computerised register support, coder training and death notification. These rates reflect the conditional logic of the HHFA questionnaire. Such questions are asked only of facilities that meet a prior eligibility condition. Missing values were recoded to 0 before the eligibility criterion was applied, in line with the official computation convention. Each indicator is thus estimated on the eligible subpopulation.

A sensitivity analysis excludes the two infrastructure variables. It checks that their inclusion does not modify the associations related to level of care. A more restrictive definition of adoption was also explored. Small counts and near-complete separation on some categories precluded a reliable estimate. These results are therefore not reported.

Statistical analysis

Analyses were performed with R 4.5.2 [39]. The **survey** and **srvyr** packages were used to account for the complex sampling design [37]. Weighted proportions were computed with 95% Wald confidence intervals, stratified by level of care. Differences between strata were tested with the Rao–Scott F test [40]. Effect size was measured with Cramér's V, interpreted following Cohen's conventions (indicative thresholds: $V < 0.10$ weak; 0.10 to 0.30 moderate; > 0.30 strong) [41].

A weighted multivariable logistic regression was fitted to identify the factors associated with reported ICD-10 adoption. All independent variables were entered simultaneously (forced entry). The health region served as an adjustment variable. This choice draws on the literature and the PRISM framework [2]. The final analysis covers all 1113 facilities across the three levels of care. Adjusted odds ratios (aOR) are reported with 95% CIs. Significance was set at 5%. Collinearity was checked with the variance inflation factor (VIF) [42]. Goodness of fit was assessed with a weighted Hosmer–Lemeshow test [43] and with the AUC (C-statistic) with a 95% CI [44].

Ethical considerations and patient involvement

The HHFA 2023 survey was approved by the National Ethics Committee for Life and Health Sciences (CNESVS) of Côte d'Ivoire on 13 April 2023 (Ref: 053 – 23/MSHPCMU/CNESVS-km; US HHS IRB00011917). This approval covers the present secondary analysis of the anonymised facility-level data. An authorisation request and a consent letter were obtained from the head of each surveyed facility. The data used in this analysis are anonymised. They contain no identifier that could be traced back to an individual patient or health worker.

Results

Sample characteristics

The analysed sample comprises 1113 health facilities distributed across the 33 Ivorian health regions. Under the HHFA level-of-care classification, the primary level (ESPCs) includes 940 facilities (84.5%). The secondary level includes 165 facilities (14.8%): 94 general hospitals, 22 regional hospitals and 49 clinics. The tertiary level includes 8 facilities (0.7%): 4 CHUs and 4 polyclinics. By management status, 895 facilities (80.4%) are public, 47 (4.2%) non-profit (NGO), 48 (4.3%) faith-based and 123 (11.1%) private for-profit. The detailed distribution by facility type and region is presented in Supplementary Table S1. The logistic regression covers all 1113 facilities (see Factors associated section).

Patient registration systems

Nationally, 8.1% of facilities have a unique patient identifier in outpatient care (95% CI 6.4 to 9.7). This proportion rises sharply with the level of care, from 6.3% at the primary level to 32.7% at the secondary level and 87.5% at the tertiary level ($p < 0.001$). Individual patient records are used in 38.6% of facilities (95% CI 35.9 to 41.3). A computerised outpatient register is available in 3.6% (95% CI 2.4 to 4.7). A standardised form is available in 21.2% of facilities (95% CI 18.8 to 23.6). The absence of a stock-out concerns only 19.3% of facilities (95% CI 17.0 to 21.6). All these indicators improve significantly with the level of care ($p < 0.001$) (Table 1).

The mean composite score is 0.9 (95% CI 0.8 to 1.0). It rises with the level of care: 0.8 at the primary level, 1.9 at the secondary level, 3.5 at the tertiary level (Fig. 1). Its internal consistency is good (Cronbach's alpha = 0.80; unchanged after weighting). As a result, the five components can be summed into a single indicator.

The same five dimensions, documented for inpatient care (hospitals, clinics, polyclinics, CHRs and CHUs), are shown in Table S2. Each proportion there exceeds that for outpatient care. Registration practices are therefore more formalised in hospitals.

ICD-10 adoption

ICD-10 adoption concerned 15.6% of facilities (95% CI 13.4 to 17.8) (Table 2). Among hospitals that recorded at least one death in the previous twelve months (n = 31), 12.9% used ICD-10 for cause-of-death coding (95% CI 0.0 to 25.8). In the same subpopulation, 16.1% notified the number of deaths to an external authority (95% CI 2.0 to 30.3). This 12.9% figure agrees with the 13% published in the 2023 HHFA report [34].

ICD-10 adoption rose sharply with the level of care. It increased from 13.4% at the primary level to 48.5% at the secondary level and 75.0% at the tertiary level ($p < 0.001$; Fig. 2). The tertiary-level estimate should nonetheless be interpreted with caution, given the small count (n = 8). Cause-of-death coding and notification are shown only indicatively at the tertiary level. The count there is too small (n = 3) for a reliable estimate (Table 2).

These estimates reflect reported ICD-10 use, not the quality of its implementation. The elements that would distinguish fully functional coding from nominal use could not be estimated representatively (see Methods). These elements include the availability of ICD-10 volumes, a register of the most frequent ICD-10 codes, trained staff and a standardised coding guide.

Factors associated with ICD-10 adoption

The factors associated with reported ICD-10 adoption were identified by weighted multivariable logistic regression. The analysis covers all 1113 facilities.

Compared with the primary level, secondary-level facilities had a higher probability of adopting ICD-10 (aOR 4.76; 95% CI 2.87 to 7.88; $p < 0.001$). This association was also significant at the tertiary level (aOR 18.23; 95% CI 2.22 to 149.90; $p = 0.007$). The width of the interval, however, calls for caution given the limited count ($n = 8$) (Table 3).

Management status was not associated with ICD-10 adoption (global Wald test: $p = 0.266$). Compared with public facilities (reference), the odds of adoption did not differ significantly for non-profit (aOR 0.47; 95% CI 0.17 to 1.31), faith-based (aOR 0.42; 95% CI 0.13 to 1.32) or private for-profit (aOR 1.02; 95% CI 0.51 to 2.03) facilities (Table 3).

The joint availability of a computer and an internet connection is associated with ICD-10 adoption (aOR 2.43; 95% CI 1.50 to 3.93; $p < 0.001$). By contrast, the availability of electricity is not significantly associated with adoption (aOR 1.01; 95% CI 0.63 to 1.62; $p = 0.974$). The presence of a trained HIS officer is not either (aOR 1.22; 95% CI 0.59 to 2.55; $p = 0.592$).

The global Wald test for the health region is significant ($p < 0.001$). ICD-10 adoption therefore varies strongly across regions, independent of the other factors in the model.

Model goodness of fit was then examined. The model showed good discrimination, with a weighted area under the ROC curve of 0.79 (95% CI 0.77 to 0.81), against 0.81 (95% CI 0.78 to 0.84) without weighting [44]. The weighted Hosmer–Lemeshow test was not significant ($\chi^2 = 11.2$; $df = 8$; $p = 0.19$), indicating good calibration [43]. Collinearity between predictors was low (maximum VIF = 2.4; maximum adjusted GVIF = 1.5) [42].

Finally, a sensitivity analysis excluding the infrastructure variables led to similar results. The associations observed for the level of care remained stable (secondary level: aOR 7.08; 95% CI 4.47 to 11.21; tertiary level: aOR 21.14; 95% CI 2.77 to 161.31). Management status remained unassociated with ICD-10 adoption (all categories $p > 0.3$). These results confirm that the main conclusions do not depend on the handling of the infrastructure variables.

Table 1
Patient registration system indicators in outpatient care: weighted proportions (Côte d'Ivoire, HHFA 2023)

Indicator	National (n = 1113)	Primary (n = 940)	Secondary (n = 165)	Tertiary (n = 8)	p
Unique patient identifier	8.1%	6.3%	32.7%	87.5%	< 0.001
Individual patient records used	38.6%	37.1%	60.0%	100.0%	< 0.001
Computerized outpatient register	3.6%	2.9%	13.3%	25.0%	< 0.001
Standardized form available	21.2%	19.6%	43.6%	75.0%	< 0.001
No form stock-out	19.3%	17.9%	38.8%	62.5%	< 0.001
Composite score (0–5)	0.9	0.8	1.9	3.5	—

Cronbach's alpha of the composite score: 0.80 (weighted alpha: 0.80). Rao–Scott F test for between-strata comparison. Level-of-care classification aligned with the HHFA sampling strata: Primary = ESPC (n = 940); Secondary = general hospital + regional hospital + clinic (n = 165); Tertiary = CHU + polyclinic (n = 8). A complementary component for inpatient care is presented in Table S2.

Table 2
ICD-10 adoption and cause-of-death coding: weighted proportions by level of care (Côte d'Ivoire, HHFA 2023)

Indicator	n (subpopulation)	National (%) [95% CI]	Primary (%)	Secondary (%)	Tertiary (%)
ICD-10 adoption	1113 (all facilities)	15.6 [13.4 to 17.8]	13.4 [11.1 to 15.6]	48.5 [40.9 to 56.1]	75.0 [44.8 to 105.2]
ICD-10 cause-of-death coding	31 (hospitals with ≥ 1 death)	12.9 [0.0 to 25.8]	—	10.7 [-1.8 to 23.2]	33.3 [-25.4 to 92.1]
Notification of number of deaths	31 (hospitals with ≥ 1 death)	16.1 [2.0 to 30.3]	—	14.3 [0.1 to 28.4]	33.3 [-25.4 to 92.1]

ICD-10 adoption = direct question "Are ICD Codes used", estimated across all facilities. Cause-of-death coding and notification are estimated among hospitals that recorded at least one death (n = 31), hence the "—" cells at the primary level. Negative CI bounds (Wald method) reflect instability with small counts (n = 3 at the tertiary level for mortality).

Table 3
Factors associated with ICD-10 adoption: weighted multivariable logistic regression (Côte d'Ivoire, HHFA 2023)

Variable	aOR	95% CI	p
Secondary level (vs primary)	4.76	2.87 to 7.88	< 0.001
Tertiary level (vs primary)	18.23	2.22 to 149.90	0.007
NGO / non-profit (vs public)	0.47	0.17 to 1.31	0.151
Faith-based (vs public)	0.42	0.13 to 1.32	0.138
Private for-profit (vs public)	1.02	0.51 to 2.03	0.964
Trained HIS officer	1.22	0.59 to 2.55	0.592
Electricity available	1.01	0.63 to 1.62	0.974
Computer and internet access	2.43	1.50 to 3.93	< 0.001
Health region	—	—	< 0.001

Model adjusted for the health region (33 categories), covering all 1113 facilities across the three levels of care. Weighted AUC = 0.79; weighted Hosmer–Lemeshow test p = 0.19 (see Results).

Discussion

Low maturity of the patient registration system

The outpatient patient registration system remains weakly formalised, with a mean score of 0.9 out of 5. The use of a computerised register remains rare (3.6%). The use of a unique patient identifier is also rare (8.1%). The formalisation of practices is more advanced in hospitals and rises with the level of care.

This observation finds a frame in PRISM [2, 3]. On the technical side, resources remain limited: registers are rarely computerised, and outpatient formalisation is weak.

The low maturity score is not specific to Côte d'Ivoire. Regional assessments reach the same conclusion [7, 10, 45].

ICD-10 adoption concentrated in higher-level facilities

Reported ICD-10 adoption remains limited. It concerns 15.6% of facilities. It rises sharply with the level of care (48.5% at the secondary level, 75.0% at the tertiary level). Cause-of-death coding remains rare (12.9% of hospitals that had deaths).

The national prevalence of 15.6% places Côte d'Ivoire among the countries at an early stage of ICD-10 adoption in sub-Saharan Africa. Comparisons must nonetheless be interpreted with caution. The

available estimates come from studies conducted in different contexts [15, 19, 20]. The rate of 88.2% reported in Nigeria concerns hospitals that had implemented ICD-10 [14]. The rate of 67% observed in Kenya reflects the reported use by 42 health workers in a single county [46]. These indicators therefore do not measure the same reality as the present national estimate.

Determinants of adoption: level of care and infrastructure

ICD-10 adoption is strongly associated with the level of care and with the joint availability of a computer and an internet connection. Secondary-level facilities adopt ICD-10 far more often than primary-level ones (aOR 4.76; 95% CI 2.87 to 7.88). The availability of a computer and an internet connection also makes a difference (aOR 2.43). By contrast, no significant association is observed with management status.

This strong association with the level of care may reflect a greater presence of physicians in hospitals [47]. ESPCs rely more on nursing staff. ICD-10 coding is generally performed by clinicians. Its adoption is probably facilitated where physician density is higher. The study data do not, however, allow this hypothesis to be tested directly. This result remains consistent with the diffusion of innovations theory. This theory stresses the importance of user skills in the adoption of new practices [48].

Management status is not associated with ICD-10 adoption. Public, non-profit, faith-based and private for-profit facilities do not differ. This result contrasts with observations reported in other LMICs, where the private sector often adopts standardised coding systems earlier [9]. In Côte d'Ivoire, adoption appears to depend more on the institutional capacity and equipment of facilities than on ownership or financing mechanisms.

Institutional and organisational factors appear to play a major role beyond the Ivorian context. In Somalia, an analysis of the 2022–2023 HHFA shows that facility type and region are the main factors associated with facility accreditation [49]. The presence of these same determinants in two different contexts reinforces the importance of their role.

By contrast, behavioural factors stand out little. The presence of a trained HIS officer is not associated with adoption. Individual competence therefore does not suffice without organisational and technical support. Finally, regional disparities are marked ($p < 0.001$). They add to the organisational factors of the PRISM framework.

Strengths and limitations

The study draws on the first nationally representative HHFA conducted in Côte d'Ivoire (n = 1113). Its weighted estimates are generalisable to the national health system. The instrument is standardised by the WHO. The results are therefore comparable with those of other countries. They reproduce the values of the official report [34]. The sensitivity analysis, finally, confirms that the main associations do not depend on the handling of the infrastructure variables.

Several limitations should be recalled. The cross-sectional nature of the data precludes any causal interpretation. The data are self-reported, without external audit. The indicators measure ICD-10 adoption, not its actual use or quality. As for the “HIS officer” variable, it does not capture the level of training in coding. This gap limits the interpretation of this result.

Other limitations relate to the size of some subgroups and to missing data. The counts at the tertiary level (n = 8) and in the subpopulation used for the analysis of causes of death (n = 31) are small. The corresponding estimates should therefore be interpreted with caution. Likewise, the non-profit (n = 47) and faith-based (n = 48) management categories have small counts. This widens their confidence intervals.

The infrastructure variables also have a high level of missing data. In line with the HHFA methodology, these values were recoded as absent from the facility. This assumption may lead to an underestimation of the actual availability of equipment. The sensitivity analyses, however, confirmed the stability of the main results. Finally, a stricter definition of ICD-10 adoption was explored. The available counts did not allow a reliable estimate. These results were therefore not retained.

Implications for policy and practice

The *Consolidated Framework for Implementation Research* (2022 version) [5] offers an implementation reading. ICD-10 remains a demanding innovation: it requires dedicated supports and training in coding. The outer setting sends contradictory signals. The CMU requires standardised coding for reimbursement [27, 28]. However, the absence of a national coding policy and the proliferation of sectoral tools [33] blur its reach. It is the inner setting that weighs most. The level of care and access to a connected computer prevail. Management status, electricity and a trained HIS officer do not intervene. The actors themselves remain out of view. Beyond the HIS officer, the HHFA captures neither the skills nor the attitudes of coders, which are nonetheless decisive for coding quality. Qualitative studies would therefore be useful. The implementation process, finally, escapes the instrument entirely.

Among these implications, the one concerning the registration of causes of death deserves particular attention.

ICD-10 adoption for cause-of-death coding remains low (12.9%). This estimate is consistent with the 13% reported in the 2023 HHFA [34]. This result is concerning for the Ivorian civil registration and vital statistics (CRVS) system.

CRVS reform is part of international efforts to strengthen civil registration. It aims to improve the production of mortality statistics [29]. ICD-10 coding is an essential component of this reform. Without a standardised classification, mortality data remain difficult to compare and to use for health planning and for monitoring the SDGs.

Cause-of-death coding is concentrated in a limited number of hospitals. It is almost absent in ESPCs. Yet these facilities are often the first to document deaths occurring in communities. This situation is a

substantial barrier to strengthening the CRVS system.

These weaknesses in death coding also bear on another future task: the migration to ICD-11.

The low level of ICD-10 adoption is a challenge for the transition to the new international classifications. Most facilities will have to take this step without having fully integrated ICD-10. This transition will require substantial investment in training and coding tools. Yet these prerequisites remain insufficient.

A phased approach appears more realistic. It could target, first, secondary and tertiary facilities, where ICD-10 adoption is already under way. This strategy would benefit from being aligned with efforts to strengthen CRVS [17, 29, 30]. ICD coding of causes of death could serve as a shared entry point for the HIS and civil registration.

Conclusions

This analysis of the 2023 HHFA data shows low ICD-10 adoption in Côte d'Ivoire. Only 15.6% of facilities use it. Adoption rises sharply with the level of care. Cause-of-death coding remains particularly limited (12.9% of hospitals that had deaths).

ICD-10 adoption is more frequent in secondary and tertiary facilities. It is strongly associated with the level of care (aOR 4.76 at the secondary level) and with the joint availability of a computer and an internet connection (aOR 2.43). By contrast, it is not associated with management status. These findings suggest that institutional and technical capacity is the main driver of ICD-10 adoption.

Strengthening clinical coding will probably require targeted investment. This investment should focus on digital infrastructure, coding tools and the training of health workers. This strategy must be aligned with efforts to strengthen CRVS and Universal Health Coverage.

Strengthening the Ivorian HIS towards ICD-11 [17, 18] calls for several measures. Coding training should be extended to ESPCs, where adoption is lowest. Coding should be embedded in medical and public health curricula. A national quality-assurance mechanism for diagnostic coding should be set up.

These measures will need to be accompanied by strengthening of the patient registration system. The low maturity observed still limits the production and use of data for decision-making.

Finally, better coordination with international efforts to strengthen CRVS [29, 30] could accelerate progress. ICD coding of causes of death is a natural entry point between the HIS and the civil registration system.

Future research

Qualitative studies are needed to explore the behavioural and organisational determinants of ICD coding adoption. These determinants are not captured by standardised surveys. Coding-quality audits based on clinical records will make it possible to measure actual quality beyond reported adoption. Prospective

follow-up of the ICD-11 transition will document the evolution of adoption and the effectiveness of strengthening strategies. A new HHFA wave after 2026 would be the ideal instrument.

Abbreviations

aOR: adjusted odds ratio AUC: area under the ROC curve (C-statistic) CFIR: Consolidated Framework for Implementation Research CHR: Centre Hospitalier Régional (Regional Hospital) CHU: Centre Hospitalier Universitaire (University Hospital) CI: confidence interval CMU: Couverture Maladie Universelle (Universal Health Coverage scheme) CNESVS: National Ethics Committee for Life and Health Sciences (Comité National d'Éthique des Sciences de la Vie et de la Santé) CRVS: Civil Registration and Vital Statistics CSPro: Census and Survey Processing System DHIS2: District Health Information System version 2 DIS: Directorate of Health Information EMR: Electronic Medical Record ESPC: Établissement Sanitaire de Premier Contact (Primary Care Health Facility) HG: Hôpital Général (General Hospital) HHFA: Harmonized Health Facility Assessment HIS: Health Information System ICD-10: International Classification of Diseases, tenth revision ICD-11: International Classification of Diseases, eleventh revision KR-20: Kuder-Richardson formula 20 (internal consistency for binary items) LMIC: Low- and Middle-Income Country MSHP-CMU: Ministry of Health, Public Hygiene and Universal Health Coverage PNDS: Plan National de Développement Sanitaire (National Health Development Plan) PRISM: Performance of Routine Information System Management PSSIS: Strategic Plan for the National Health Information System RGPH: General Population and Housing Census ROC: Receiver Operating Characteristic SARA: Service Availability and Readiness Assessment SDG: Sustainable Development Goals SNNCI: National Digital Development Strategy of Côte d'Ivoire VIF: Variance Inflation Factor WHO: World Health Organization

Declarations

Ethics approval and consent to participate.

The HHFA 2023 survey was approved by the National Ethics Committee for Life and Health Sciences (CNESVS) of Côte d'Ivoire on 13 April 2023 (Ref: 053 – 23/MSHPCMU/CNESVS-km; US HHS IRB00011917). This approval covers the present secondary analysis of the anonymised facility-level data. An authorisation request and a consent letter were obtained from the head of each surveyed facility.

Consent for publication.

Not applicable (facility-level study without identifiable individual data).

Patient and public involvement.

This analysis is based on data already collected at the facility level. It did not involve any direct patient or public participation in its design or conduct.

Competing interests.

The authors declare no competing interests.

Funding.

This research received no specific funding from public, commercial or not-for-profit bodies. The authors received no institutional funding dedicated to this analysis.

Author Contribution

DK designed the study, performed the statistical analyses, interpreted the results and drafted the first version of the manuscript. NEBA extracted the data and contributed to the design and refinement of the methodology, to the interpretation of results and to the critical review of the manuscript. KVW provided HHFA/WHO framing and contributed to the interpretation. AIBN provided expertise in hospital information systems and contributed to the interpretation of results. ASP provided institutional coordination within the Directorate of Health Information and critical review of the manuscript. All authors critically reviewed the manuscript, and read and approved its final version. DK (corresponding author) is the guarantor of the study.

Acknowledgement

The authors thank the Directorate of Health Information (DIS) and the Ministry of Health, Public Hygiene and Universal Health Coverage of Côte d’Ivoire for conducting the 2023 HHFA. They also thank the World Health Organization and the technical and financial partners that made the survey possible

Data Availability

The datasets analysed during the current study are not publicly available because they are the property of the Ministry of Health, Public Hygiene and Universal Health Coverage of Côte d'Ivoire, but are available from the Directorate of Health Information on reasonable request. The R analysis scripts produced for this study are available from the corresponding author on reasonable request.

References

1. World Health Organization. Everybody's business: Strengthening health systems to improve health outcomes: WHO's framework for action [Internet]. Geneva: World Health Organization. 2007. Available from: https://www.who.int/publications/i/item/everybody-s-business
2. Aqil A, Lippeveld T, Hozumi D. PRISM framework: A paradigm shift for designing, strengthening and evaluating routine health information systems. Health Policy Plann. 2009;24(3):217–28. 10.1093/heapol/czp010 . PubMed PMID: 19304786.
3. Kawakyu N, Coe M, Wagenaar BH, Sherr K, Gimbel S. Refining the performance of routine information system management (PRISM) framework for data use at the local level: An integrative review. PLoS ONE. 2023;18(6):e0287635. 10.1371/journal.pone.0287635.
4. MEASURE Evaluation. PRISM: Performance of routine information system management series [Internet]. Chapel Hill: University of North Carolina. 2018. Available from: https://www.measureevaluation.org/prism.html
5. Damschroder LJ, Reardon CM, Opra Widerquist MA, Lowery J. The updated Consolidated Framework for Implementation Research based on user feedback. Implement Sci. 2022;17:75. 10.1186/s13012-022-01245-0 . PubMed Central PMCID: PMC9617234.
6. editorsLippeveld T, Sauerborn R, Bodart C. Design and implementation of health information systems [Internet]. Geneva: World Health Organization; 2000. Available from: https://iris.who.int/handle/10665/42289
7. Harerimana A, Wicking K, Biedermann N, Yates K, Pillay JD, Mchunu G. Adoption of electronic health records by nurses in Africa: A scoping review. Digit Health. 2025;11:20552076251357401. doi:10.1177/20552076251357401 PubMed Central PMCID: PMC12437165.
8. Karamagi HC, Muneene D, Droti B, Jepchumba V, Okeibunor JC, Nabyonga J, et al. eHealth or e-Chaos: The use of digital health interventions for health systems strengthening in sub-saharan Africa over the last 10 years: A scoping review. J Global Health. 2022;12:04090. 10.7189/jogh.12.04090.
9. Luna D, Almerares A, Mayan JC, González Bernaldo de Quirós F, Otero C. Health informatics in developing countries: Going beyond pilot practices to sustainable implementations. Healthc Inf Res. 2014;20(1):3–10. 10.4258/hir.2014.20.1.3.
10. Byrne E, Sæbø JI. Routine use of DHIS2 data: A scoping review. BMC Health Serv Res. 2022;22:1234. 10.1186/s12913-022-08598-8 . PubMed Central PMCID: PMC9535952.
11. World Health Organization. International statistical classification of diseases and related health problems, 10th revision [Internet]. Geneva: World Health Organization. 2010. Available from: https://www.who.int/standards/classifications/classification-of-diseases
12. Jette N, Quan H, Hemmelgarn B, et al. The development, evolution, and modifications of ICD-10: Challenges to the international comparability of morbidity data. Med Care. 2010;48(12):1105–10. 10.1097/MLR.0b013e3181ef9d3e.
13. Biruk E, Habtamu T, Taye G, Ayele W, Tassew B, Nega A et al. Improving the quality of clinical coding through mapping of national classification of diseases (NCoD) and international classification of

disease (ICD-10). Ethiopian Journal of Health Development [Internet]. 2021;35(SI-1):59–65. Available from: https://www.ejhd.org/index.php/ejhd/article/view/4610

14. Adeleke IT, Ajayi OO, Jimoh AB, Adebisi AA, Omokanye SA, Jegede MK. Current clinical coding practices and implementation of ICD-10 in Africa: A survey of Nigerian hospitals. Am J Health Res. 2015;3(1–1):1–9. 10.11648/j.ajhr.s.2015030101.16.
15. Olagundoye O, van Boven K, Daramola O, Njoku K, Omosun A. Improving the accuracy of ICD-10 coding of morbidity/mortality data through the introduction of an electronic diagnostic terminology tool at the general hospitals in Lagos, Nigeria. BMJ Open Qual. 2021;10(1):e000938. 10.1136/bmjoq-2020-000938 . PubMed PMID: 33674344.
16. Otero Varela L, Doktorchik C, Wiebe N, Southern DA, Knudsen S, Mathur P, et al. International classification of diseases clinical coding training: An international survey. Health Inform Manage J. 2024;53(2):101–10. 10.1177/18333583221106509.
17. World Health Organization. ICD-11 reference guide [Internet]. Geneva: World Health Organization. 2024. Available from: https://icdcdn.who.int/icd11referenceguide/en-2024-01/html/index.html
18. World Health Organization. ICD-11 implementation or transition guide [Internet]. Geneva: World Health Organization. 2019. Available from: https://icd.who.int/en/docs/ICD-11%20Implementation%20or%20Transition%20Guide_v105.pdf
19. World Health Organization. SCORE for health data technical package: Global report on health data systems and capacity, 2020 [Internet]. Geneva: World Health Organization. 2021. Available from: https://www.who.int/publications/i/item/9789240018709
20. O'Neill K, Takane M, Sheffel A, Abou-Zahr C, Boerma T. Monitoring service delivery for universal health coverage: The service availability and readiness assessment. Bull World Health Organ. 2013;91(12):923–31. 10.2471/BLT.12.116798 . PubMed PMID: 24347731.
21. Institut National de la Statistique de Côte d'Ivoire. Résultats globaux définitifs du recensement général de la population et de l'habitat (RGPH) 2021 [Internet]. Abidjan: Institut National de la Statistique. 2022. Available from: https://www.ins.ci/RGPH2021/RESULTATS%20DEFINITIFSRP21.pdf
22. Ministère de la Santé et de l'Hygiène Publique de Côte d'Ivoire. Plan national de développement sanitaire (PNDS) 2021–2025 [Internet]. Abidjan: Ministère de la Santé et de l'Hygiène Publique. 2021. Available from: https://dppsci.com/download/plan-national-de-developpement-sanitaire-_pnds-2021-2025-vf/
23. de la Ministère. Santé et de l'Hygiène Publique, Direction de l'Informatique et de l'Information Sanitaire. Plan stratégique du système national d'information sanitaire (PSSIS) 2021–2025. Abidjan: Ministère de la Santé et de l'Hygiène Publique; 2022.
24. Gnassou L, Barry A, Chauffour J. La puissance du DHIS2: Une contribution à une meilleure gestion des données grâce à un renforcement des compétences des parties prenantes en côte d'ivoire. Chapel Hill, NC: MEASURE Evaluation, USAID; 2020.

25. Dehnavieh R, Haghdoost A, Khosravi A, Hoseinabadi F, Rahimi H, Poursheikhali A, et al. The District Health Information System (DHIS2): A literature review and meta-synthesis of its strengths and operational challenges based on the experiences of 11 countries. Health Inform Manage J. 2019;48(2):62–75. 10.1177/1833358318777713.
26. World Bank. Health systems assessment for Côte d'Ivoire: Accelerating reforms toward universal health coverage [Internet]. World Bank Group. 2020. Available from: https://documents.worldbank.org/en/publication/documents-reports/documentdetail/186071589777801915/health-systems-assessment-for-cote-d-ivoire
27. République de Côte d'Ivoire. Loi n° 2014 – 131 du 24 mars 2014 instituant la couverture maladie universelle. Journal Officiel de la République de Côte d'Ivoire; 2014.
28. Seri BNUV. Analyse critique de la mise en œuvre de la couverture maladie universelle (CMU) en côte d'ivoire. Revue de Droit Comparé du Travail et de la Sécurité Sociale. 2023;(1):172–5. 10.4000/rdctss.5484
29. Phillips DE, AbouZahr C, Lopez AD, Mikkelsen L, de Savigny D, Lozano R, et al. Are well functioning civil registration and vital statistics systems associated with better health outcomes? Lancet. 2015;386(10001):1386–94. 10.1016/S0140-6736(15)60172-6.
30. World Health Organization. Civil registration and vital statistics [Internet]. Fact sheet. 2024. Available from: https://www.who.int/news-room/fact-sheets/detail/civil-registration-and-vital-statistics
31. Bationo YÉ, Thomas HA, Yaokreh JB, Ouattara O. La gestion des archives médicales en Côte d'Ivoire: Une étude transversale au centre hospitalier universitaire de Cocody (Abidjan). Health Res Afr. 2025;3(10). 10.5281/hra.v3i10.7035.
32. Allade NEB, Ahoussou EM, Yohou KS, Konan DJP, Nigue L, Diallo M. Appropriation du dossier patient informatisé par les prestataires de soins à l'hôpital général d'Anyama, Côte d'Ivoire: Évaluation de la mise en œuvre. J Epidemiol Popul Health. 2026;74(S1):203293. 10.1016/j.jeph.2026.203293.
33. République de Côte d'Ivoire, Ministère de l'Économie Numérique, des Télécommunications et de l'Innovation. Stratégie nationale de développement du numérique en côte d'ivoire (SNNCI) 2021–2025 [Version 1.4] [Internet]. Abidjan: MENUTI. 2022. Available from: https://telecom.gouv.ci/new/uploads/publications/171137227746.pdf
34. de la Ministère. Santé, de l'Hygiène Publique et de la Couverture Maladie Universelle (MSHP-CMU), Direction de l'Information Sanitaire. Évaluation harmonisée des établissements sanitaires (HHFA) en Côte d'Ivoire: Enquête 2023, synthèse du rapport [Internet]. Abidjan: MSHP-CMU; 2024. Available from: https://www.afro.who.int/sites/default/files/2025-08/Analyse%20Sante%20Locale-%20synthese%20rapport%20HHFA_FINAL%20%28002%29.pdf
35. World Health Organization. Harmonized health facility assessment (HHFA): Comprehensive guide [Internet]. Geneva: World Health Organization. 2023. Available from: https://www.who.int/publications/i/item/9789240060302
36. World Health Organization. Service availability and readiness assessment (SARA): Reference manual [Internet]. Version 2.2. Geneva: WHO. 2015. Available from:

https://www.who.int/publications/i/item/WHO-HIS-HSI-2014.5-Rev.1

37. Lumley T. Complex surveys: A guide to analysis using R. Hoboken, NJ: Wiley; 2010. 10.1002/9780470580066.
38. Bland JM, Altman DG. Cronbach's alpha. BMJ. 1997;314(7080):572. 10.1136/bmj.314.7080.572.
39. R Core Team. R: A language and environment for statistical computing [Internet], Vienna. Austria: R Foundation for Statistical Computing; 2025. Available from: https://www.R-project.org/
40. Rao JNK, Scott AJ. The analysis of categorical data from complex surveys: Chi-squared tests for goodness of fit and independence in two-way tables. J Am Stat Assoc. 1981;76(374):221–30. 10.1080/01621459.1981.10477633.
41. Cohen J. Statistical power analysis for the behavioral sciences. 2nd ed. Hillsdale, NJ: Lawrence Erlbaum Associates; 1988.
42. O'Brien RM. A caution regarding rules of thumb for variance inflation factors. Qual Quantity. 2007;41(5):673–90. 10.1007/s11135-006-9018-6.
43. Archer KJ, Lemeshow S. Goodness-of-fit test for a logistic regression model fitted using survey sample data. Stata J. 2006;6(1):97–105. 10.1177/1536867X0600600106.
44. Robin X, Turck N, Hainard A, Tiberti N, Lisacek F, Sanchez JC, et al. pROC: An open-source package for R and S + to analyze and compare ROC curves. BMC Bioinformatics. 2011;12:77. 10.1186/1471-2105-12-77.
45. Mutale W, Chintu N, Amoroso C, et al. Improving health information systems for decision making across five sub-saharan african countries: Implementation strategies from the african health initiative. BMC Health Serv Res. 2013;13(Suppl 2):S9. 10.1186/1472-6963-13-S2-S9.
46. Maina DM, Rucha KK, Otieno GO, Khisa A, Rithaa GK. Health professionals' factors influencing utilization of disease classification systems in public hospitals in Kiambu County, Kenya. Sci Res J. 2021;9(1):9–16. 10.31364/SCIRJ/v9.i01.2021.P0121835.
47. Ahmat A, Okoroafor SC, Kazanga Chiumia I, Asamani JA, Millogo JJS, Abdou Illou MM, et al. The health workforce status in the WHO African region: Findings of a cross-sectional study. BMJ Global Health. 2022;7(Suppl 1):e008317. 10.1136/bmjgh-2021-008317.
48. Dearing JW, Cox JG. Diffusion of innovations theory, principles, and practice. Health Aff. 2018;37(2):183–90. 10.1377/hlthaff.2017.1104.
49. Osman NH, Abdi AM, Jimale AM, Adam AA, Abdi IM, Moallim AA, et al. Healthcare facility accreditation status and associated factors in Somalia: Evidence from the 2022–2023 harmonized health facility assessment. BMC Health Serv Res. 2026;26:581. 10.1186/s12913-026-14377-6.

Figures

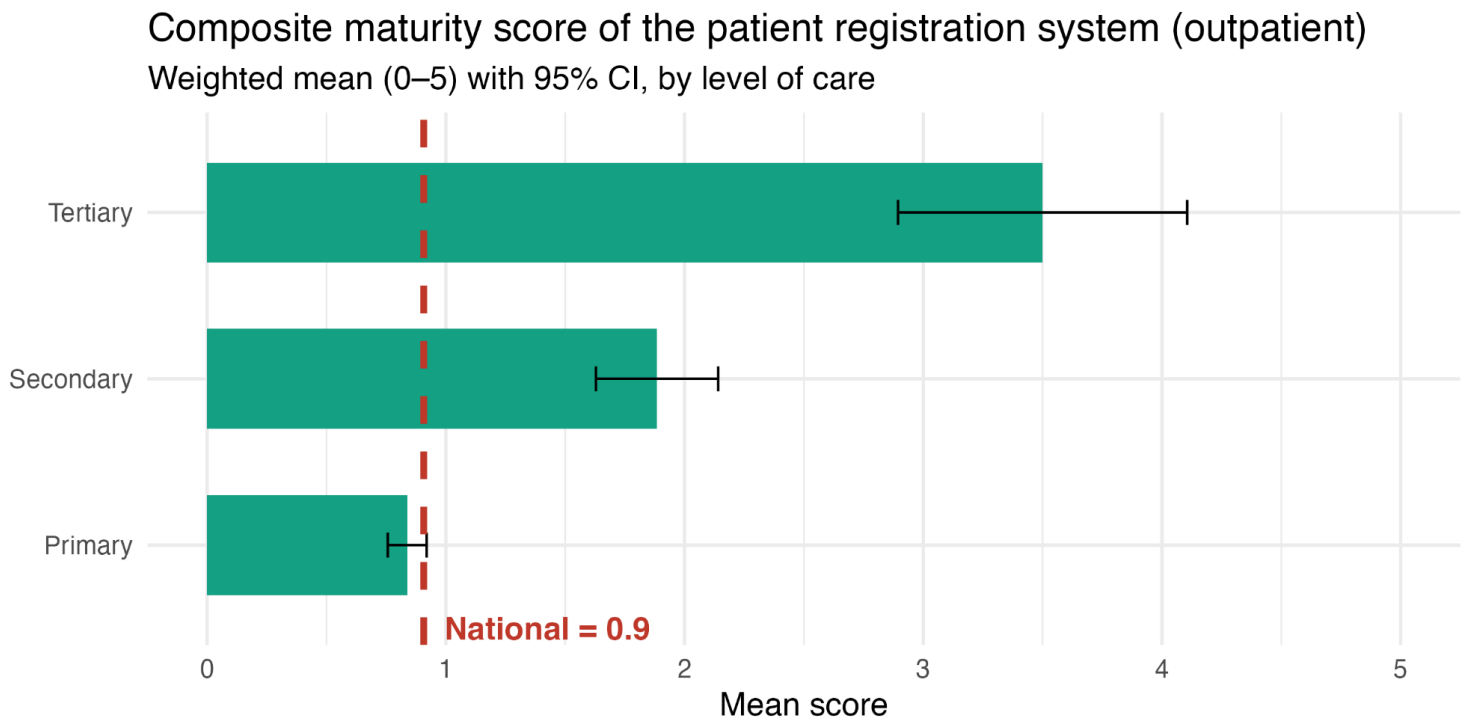


Figure 1

Composite score of the registration system (outpatient) by level of care. Weighted mean (0–5) with 95% CI. The dashed line represents the national mean.

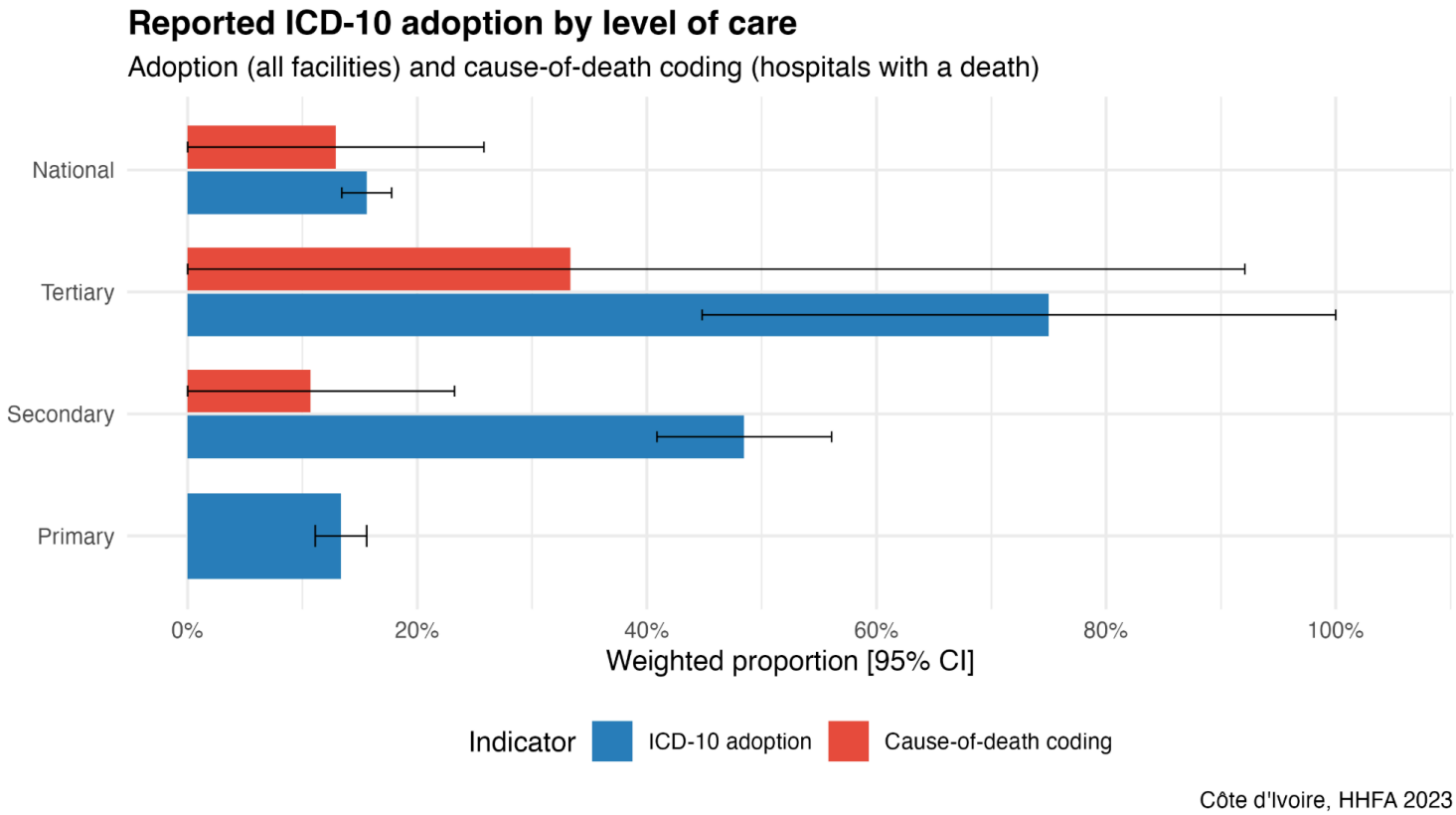


Figure 2

Reported ICD-10 adoption by level of care (weighted proportion). Overall adoption across all facilities (n = 1113) and cause-of-death coding among hospitals that recorded at least one death in the previous 12 months (n = 31). Côte d’Ivoire, HHFA 2023.

Supplementary Files

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- Supplementarytables.docx