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Mapping ICD-10 to ICCC-3 for Childhood Cancer Classification Using Cancer Incidence in Five Continents (CI5) Data

Jiaxing Liu
Heilongjiang University of Chinese Medicine
Xinghua Sun
Second Affiliated Hospital of Heilongjiang University of Chinese Medicine
Manli Sun
The Second Hospital of Heilongjiang Province
Huan Yang
21118298@zju.edu.cn

The Second Hospital of Heilongjiang Province

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Abstract

Background Global childhood and adolescent cancer burden estimation is limited by inconsistent diagnostic classification systems. ICCC-3 is the benchmark for pediatric cancer research, but large registries mainly use ICD-10, which cannot be directly matched to ICCC-3. A unified mapping framework is required to accurately quantify disease burden and enable cross-database data comparison.

Methods We used pediatric cancer incidence data from the US registries in CI5 Volume XII, which provides dual coding in ICD-10 and ICCC-3. We developed a three-tier ICD-10 to ICCC-3 mapping strategy: (1) direct mapping to main diagnostic groups; (2) subgroup mapping for lymphoid and hematopoietic neoplasms; and (3) manual mapping for the other subgroups.

Results We identified 77,236 pediatric cancer cases coded in ICD-10 and 77,152 cases coded in ICCC-3. Near-perfect concordance (CR ≈ 1.00) was observed for retinoblastoma, brain and CNS tumors, renal tumors, and hepatic tumors. Over-mapping was noted for epithelial neoplasms/melanomas (CR = 1.24), bone tumors (CR = 1.11), and leukemias (CR = 1.07), while under-mapping occurred for neuroblastomas (CR = 0.67), germ cell tumors (CR = 0.72), soft tissue sarcomas (CR = 0.87), lymphomas (CR = 0.88), and unspecified malignant neoplasms (CR = 0.47). For lymphoid and hematopoietic neoplasms, an ICD-O-3–mediated crosswalk enabled subgroup mapping with enhanced specificity. However, for most other subgroups, precise one-to-one mapping was not feasible, with the exception of hepatoblastoma (C22.2).

Conclusion This study provides the first systematic mapping of ICD-10–coded pediatric cancer cases to ICCC-3 categories. The mapping demonstrated reliable correspondence for lymphoid and hematopoietic neoplasms subgroups. Concordance for certain solid tumors remained suboptimal due to limitations of ICD-10 in capturing morphological details.

Introduction

Childhood cancer is a rare but significant public health concern, accounting for a small proportion of all cancer cases but posing substantial challenges due to its distinct epidemiological and biological features that distinguish them from adult cancers [1]. Therefore, the International Classification of Childhood Cancer (ICCC) was developed to provide a standardized framework for pediatric malignancy classification, based on International Classification of Diseases for Oncology (ICD-O) codes, to ensure consistency in international epidemiological studies and accurate classification of childhood cancer burden [2]. The International Incidence of Childhood Cancer (IICC) project, coordinated by the International Agency for Research on Cancer (IARC), has established ICCC as the global standard for reporting pediatric cancer incidence, making it the most authoritative population-based investigation of childhood cancer incidence worldwide [3–5]. Ward ZJ et al. used a simulation model based on the ICCC-3 classification to estimate incidence and a global 5-year net survival rate for childhood cancer in 2019 [6, 7]. However, to date, no globally accessible public estimate database for childhood cancer utilizes ICCC classification. This limitation hampers the comparability of childhood cancer estimates across regions, weakens the policy utility of global burden data, and may lead to misclassification of pediatric

cancers in international health assessments. Two authoritative global disease databases, the Global Cancer Observatory (GLOBOCAN) and Global Burden of Disease (GBD), could provide estimates of the global childhood cancer burden but rely on the ICD-10 [8–10]. To overcome this limitation, a reliable mapping framework is needed to align ICD-10 based cancer codes with the ICCC-3 classification for childhood. While the Surveillance, Epidemiology, and End Results (SEER) Program and the International Association of Cancer Registries (IACR) provide forward mapping conversion rules (e.g., from ICCC-3 and ICD-O to ICD-10), the inverse mapping from ICD-10 back to ICCC-3 remains unavailable [11, 12]. Notably, no published studies have systematically compared the classification discrepancies between ICD-10 and ICCC-3 or proposed a reliable method for reverse mapping. This gap highlights a critical unmet need in cancer registry data interoperability, particularly for retrospective or cross-database analyses.

The latest edition of the CI5, Volume XII, was released online in October 2023, provides detailed data coded using ICD-10, ICD-O-3, and ICCC-3, making it a perfect resource for evaluating the concordance between ICD-10 and ICCC-3 classifications [13]. Such an evaluation is crucial for enhancing the accuracy of childhood cancer burden assessments.

Therefore, this study conducts a systematic evaluation of the concordance between ICD-10 and ICCC-3 classifications using data from CI5 Volume XII among individuals aged 0–19 years, aimed to develop a comprehensive and reproducible mapping framework to convert ICD-10 codes into ICCC-3 categories for consistent childhood cancer classification across global datasets.

Method

Study Design and Data Source

CI5 Volume XII (maintained by IARC and IACR) provided high-quality, population-based cancer incidence data from 460 registries across 65 countries, covering diagnoses made between 2013 and 2017, ranging from 0–4 years up to 85 + years, reporting age- and sex-specific case counts, age-standardized incidence rates [13]. The detailed database comprises 297 cancer categories, each defined by a combination of ICD-10 site codes and ICD-O-3 morphology codes. In some registries, these are further mapped to ICCC-3 for pediatric cancers, categorizing tumors into 12 main groups and 47 subgroups. United States (U.S.) national registry data (registry code: 384000099) from CI5 Volume XII was downloaded for analysis due to its high data quality, comprehensive and high population coverage, and detailed dual coding with both ICD-10 and ICCC-3 [14]. CI5 provides age-specific case counts in 5-year age intervals. We selected and aggregated data for the following age groups: 0–4, 5–9, 10–14, and 15–19 years, corresponding to the full pediatric age range of 0–19 years. For each cancer type, we summed the number of cases across these four age groups to obtain total case counts for children and adolescents. Importantly, CI5 does not provide individual-level data, and therefore, we could not determine both the ICD-10 and ICCC-3 codes for the same patient which precluded the calculation of

individual-level concordance metrics such as Cohen's kappa. Instead, only group-level aggregate counts were available separately under each classification system.

ICD-10 to ICCC-3 Mapping Strategy

We developed a three-tier mapping strategy to align ICD-10-coded pediatric cancer cases with ICCC-3 categories as shown in Fig. 1: (1) direct mapping to main diagnostic groups based on anatomical and clinical correspondence; (2) ICD-O-3 mediated mapping for hematopoietic and lymphoid subgroups; and (3) mapping of remaining cases to appropriate subgroups where possible.

General mapping

ICD-10 codes were mapped to ICCC-3 main diagnostic groups primarily informed by existing definitions in the ICD-10 system and clinical understanding of pediatric cancer types [15]. For example, tumors of the brain and CNS (ICD-10, C70-C72) were aligned with ICCC-3 Group III (CNS and miscellaneous intracranial and intraspinal neoplasms). Unmapped or ambiguously mapped ICD-10 codes were mapped to main group "XI Other Malignant Epithelial Neoplasms And Malignant Melanoma" but counted toward total cases.

Lymphoid and hematopoietic neoplasms subgroups mapping

For a more granular mapping within ICCC-3 Groups I (leukemias, myeloproliferative and myelodysplastic diseases) and II (lymphomas and reticuloendothelial neoplasms), we employed a bridge mapping strategy using ICD-O-3 as an intermediary. First, we obtained the ICCC-3 and ICD-O-3 correspondence table from the SEER website ICCC Recode ICD-O-3/WHO 2008 [16], which provides detailed subgroup classifications for pediatric cancers based on ICD-O-3 morphology (M-codes) and topography. Importantly, we relied on the updated 2008 version of the ICCC-3 classification rather than the original 2005 version. This decision was based on key consideration that since our study utilized U.S. data from 2013–2017, it was more likely that the later classification—aligned with the WHO Classification of Tumours of Haematopoietic and Lymphoid Tissues (2008)—was in use during this period. Next, we extracted the ICD-O-3 to ICD-10 conversion table for lymphoid and hematopoietic diseases from CI5 Volume XII, Chap. 3, covering ICD-O-3 codes M9590-M9992 [13]. By merging these two datasets using ICD-O-3 codes as the key, we constructed a consolidated crosswalk table that facilitates mapping between ICD-10 topography codes and ICCC-3 diagnostic categories.

Other subgroups mapping: For ICD-10 codes not covered by the above procedures, we applied a manual mapping approach. Where possible, we used diagnostic descriptors within ICD-10 to assign cases to the most likely ICCC-3 subgroup. For example, C22.2 (hepatoblastoma) was mapped to ICCC-3 Group VIIa1 (hepatoblastoma). Although mapping these codes posed challenges due to limited detail in ICD-10, this process ensured completeness and minimized loss of rare tumor types from the final datasets.

Consistency Assessment from ICD-10 to ICCC-3

To evaluate the alignment between the ICD-10 and ICCC-3 classification systems, we calculated a consistency ratio defined as: Consistency Ratio (CR) = Number of cases classified under ICD-10/Number of cases classified under ICCC-3. CR > 1 indicates that the number of cases classified under ICD-10 exceeds that classified under ICCC-3, whereas CR < 1 indicates under-mapping relative to ICCC-3. This ratio was computed for only the main diagnostic groups (I-XII) defined in ICCC-3.

Results

For the 0–19 age group in the U.S. registry, we identified 77,236 total cancer cases coded using ICD-10 (site code 001:“All sites”, including C00-C96, D09.0, D41.4, and D45-D47) and 77,152 total cancer cases coded using ICCC-3. Figure 2 provides a schematic representation of the mapping algorithm used to convert ICD-10 topography codes to corresponding ICCC-3 diagnostic groups (I-XII). A total of 23 cancer categories (all 12 major cancer groupings and 11 selected subtypes) were compared between the ICD-10 and ICCC-3 classification systems using data from CI5 Volume XII. The remaining 36 subtypes could not be mapped due to lack of correspondence or ambiguous classification.

General mapping

The consistency ratio (CR) varied substantially across 12 main cancer groups. High concordance (CR ≈ 1.00) was observed for pediatric cancers such as retinoblastoma (CR = 1.00), CNS and miscellaneous intracranial and intraspinal neoplasms (CR = 1.03), renal tumors (CR = 1.03) and hepatic tumors (CR = 1.04) (Fig. 3). While systematic over-mapping was observed for XI epithelial neoplasms/melanomas (CR = 1.24), VII bone tumors (CR = 1.11) and I leukemias (CR = 1.07), contrasted with under-mapping of IV neuroblastomas (CR = 0.67), X germ cell tumors (CR = 0.72), IX soft tissue sarcomas (CR = 0.87), II lymphomas (CR = 0.88) and XII unspecified neoplasms (CR = 0.47).

Lymphoid and hematopoietic neoplasms subgroups mapping

As described in Method section, using ICD-O-3 morphology codes as the primary linkage key, we developed a comprehensive crosswalk table between ICD-10 topography codes and ICCC-3 diagnostic groups (Table 1). This table serves as a critical tool for translating ICD-10-coded clinical data into ICCC-3 lymphoid and hematopoietic neoplasms subgroups, facilitating pediatric cancer research with enhanced specificity.

Table 1
ICD-O-3-mediated mapping between ICD-10 and ICCC-3 in lymphoid and hematopoietic malignancies

ICCC-3(2008)	ICD-O-3 (first version)	Full ICD-O-3 title	ICD-10 (2010)
Ia1 Precursor cell leukemias	9811/3	B lymphoblastic leukemia/lymphoma, NOS	C91.0
	9812/3	B lymphoblastic leukemia/lymphoma with t(9;22)(q34;q11.2); BCR-ABL1	C91.0
	9813/3	B lymphoblastic leukemia/lymphoma with t(v;11q23); MLL rearranged	C91.0
	9814/3	B lymphoblastic leukemia/lymphoma with t(12;22)(p13;q22); TEL-AML1 (ETV6-RUNX1)	C91.0
	9815/3	B lymphoblastic leukemia/lymphoma with hyperdiploidy	C91.0
	9816/3	B lymphoblastic leukemia/lymphoma with hypodiploidy (Hypodiploid ALL)	C91.0
	9817/3	B lymphoblastic leukemia/lymphoma with t(5;14)(q31;q32); IL3-IGH	C91.0
	9818/3	B lymphoblastic leukemia/lymphoma with t(1;19)(q23;p13.3); E2A-PBX1 (TCF3-PBX1)	C91.0
	9835/3	Precursor cell lymphoblastic leukemia, NOS	C91.0
	9836/3	Precursor B-cell lymphoblastic leukemia	C91.0
	9837/3	T lymphoblastic leukemia/lymphoma	C91.0
Ia2 Mature B-cell leukemias	9823/3	B-cell chronic lymphocytic leukemia/small lymphocytic lymphoma	C91.1
	9826/3	Burkitt cell leukemia	C91.8
	9832/3	Prolymphocytic leukemia, NOS	C91.3
	9833/3	Prolymphocytic leukemia, B-cell type	C91.3
	9940/3	Hairy cell leukemia (C42.1)	C91.4
Ia3 Mature T-cell and NK cell leukemias	9827/3	Adult T-cell leukemia/lymphoma (HTLV-1 positive)	C91.5
	9831/3	T-cell large granular lymphocytic leukemia	C91.7

ICCC-3(2008)	ICD-O-3 (first version)	Full ICD-O-3 title	ICD-10 (2010)
	9834/3	Prolymphocytic leukemia, T-cell type	C91.6
	9948/3	Aggressive NK-cell leukemia	C94.7
Ia4 Lymphoid leukemia, NOS	9820/3	Lymphoid leukemia, NOS	C91.9
Ib Acute myeloid leukemias	9840/3	Acute myeloid leukemia, M6 type	C94.0
	9861/3	Acute myeloid leukemia, NOS	C92.0
	9865/3	Acute myeloid leukemia with t(6;9)(p23;q34); DEK-NUP214	C92.0
	9866/3	Acute promyelocytic leukemia, t(15;17)(q22;q11-12)	C92.4
	9867/3	Acute myelomonocytic leukemia	C92.5
	9869/3	Acute myeloid leukemia with inv(3)(q21;q26.2) or t(3;3)(q21;q26.2); RPN1-EVI1	C92.0
	9870/3	Acute basophilic leukemia	C94.7
	9871/3	Acute myeloid leukemia with abnormal marrow eosinophils	C92.5
	9872/3	Acute myeloid leukemia, minimal differentiation	C92.0
	9873/3	Acute myeloid leukemia without maturation	C92.0
	9874/3	Acute myeloid leukemia with maturation	C92.0
	9891/3	Acute monocytic leukemia	C93.0
	9895/3	Acute myeloid leukemia with myelodysplasia-related changes	C92.8
	9896/3	Acute myeloid leukemia, t(8;21)(q22;q22)	C92.0
	9897/3	Acute myeloid leukemia, 11q23 abnormalities	C92.6
	9898/3	Myeloid leukemia associated with Down Syndrome	C92.7
	9910/3	Acute megakaryoblastic leukemia	C94.2
	9911/3	Acute myeloid leukemia (megakaryoblastic) with t(1;22)	C94.2

ICCC-3(2008)	ICD-O-3 (first version)	Full ICD-O-3 title	ICD-10 (2010)
		(p13;q13); RBM15-MKL1	
	9920/3	Therapy-related myeloid neoplasm	C94.6
	9931/3	Acute panmyelosis with myelofibrosis (C42.1)	C94.4
Ic Chronic myeloproliferative diseases	9863/3	Chronic myeloid leukemia, NOS	C92.1
	9875/3	Chronic myelogenous leukemia, BCR/ABL positive	C92.1
	9876/3	Atypical chronic myeloid leukemia, BCR/ABL negative	C92.2
	9950/3	Polycythemia vera	D45
	9960/3	Myeloproliferative neoplasm, NOS	D47
	9961/3	Primary myelofibrosis	D47.4
	9962/3	Essential thrombocythemia	D47.3
	9963/3	Chronic neutrophilic leukemia	D47.1
	9964/3	Chronic eosinophilic leukemia, NOS	D47.5
Id Myelodysplastic syndrome and other myeloproliferative diseases	9945/3	Chronic myelomonocytic leukemia, NOS	C93.1
	9946/3	Juvenile myelomonocytic leukemia	C93.3
	9975/3	Myeloproliferative neoplasm, unclassifiable	D47.1
	9980/3	Refractory anemia	D46.4
	9982/3	Refractory anemia with sideroblasts	D46.1
	9983/3	Refractory anemia with excess blasts	D46.2
	9984/3	Refractory anemia with excess blasts in transformation	C92.0
	9985/3	Refractory cytopenia with multilineage dysplasia	D46.5
	9986/3	Myelodysplastic syndrome with 5q deletion (5q- syndrome)	D46.6
	9987/3	Therapy-related myelodysplastic syndrome, NOS	D46.7
	9989/3	Myelodysplastic syndrome, NOS	D46.9

ICCC-3(2008)	ICD-O-3 (first version)	Full ICD-O-3 title	ICD-10 (2010)
	9991/3	Refractory neutropenia	D46.7
	9992/3	Refractory thrombocytopenia	D46.7
Ie Unspecified and other specified leukemias	9800/3	Leukemia, NOS	C95.9
	9801/3	Acute leukemia, NOS	C95.0
	9805/3	Acute biphenotypic leukemia	C95.0
	9806/3	Mixed phenotype acute leukemia with t(9;22)(q34;q11.2); BCR-ABL1	C95.0
	9807/3	Mixed phenotype acute leukemia with t(v;11q23); MLL rearranged	C95.0
	9808/3	Mixed phenotype acute leukemia, B/myeloid, NOS	C95.0
	9809/3	Mixed phenotype acute leukemia, T/myeloid, NOS	C95.0
	9860/3	Myeloid leukemia, NOS	C92.9
	9965/3	Myeloid and lymphoid neoplasms with PDGFRA rearrangement	D47.5
	9966/3	Myeloid neoplasms with PDGFRB rearrangement	C92.7
	9967/3	Myeloid and lymphoid neoplasms with FGFR1 abnormalities	C96.7
	9930/3	Myeloid sarcoma	C92.3
	9971/3	Myeloproliferative neoplasm, unclassifiable	Not found in CI5 XII
IIa Hodgkin lymphomas	9650/3	Hodgkin lymphoma, NOS	C81.9
	9651/3	Hodgkin lymphoma, lymphocyte-rich	C81.4
	9652/3	Hodgkin lymphoma, mixed cellularity, NOS	C81.2
	9653/3	Hodgkin lymphoma, lymphocyte depletion, NOS	C81.3
	9654/3	Hodgkin lymphoma, lymphocyte depletion, diffuse fibrosis	C81.3
	9655/3	Hodgkin lymphoma, lymphocyte depletion, reticular	C81.3

ICCC-3(2008)	ICD-O-3 (first version)	Full ICD-O-3 title	ICD-10 (2010)
	9659/3	Hodgkin lymphoma, nodular lymphocyte predominance	C81.0
	9661/3	Hodgkin granuloma	C81.9
	9662/3	Hodgkin sarcoma	C81.3
	9663/3	Hodgkin lymphoma, nodular sclerosis, NOS	C81.1
	9664/3	Hodgkin lymphoma, nodular sclerosis, cellular phase	C81.1
	9665/3	Hodgkin lymphoma, nodular sclerosis, grade 1	C81.1
	9667/3	Hodgkin lymphoma, nodular sclerosis, grade 2	C81.1
IIb1 Precursor cell lymphomas	9727/3	Precursor cell lymphoblastic lymphoma, NOS	C83.5
	9728/3	Precursor B-cell lymphoblastic lymphoma	C83.5
	9729/3	Precursor T-cell lymphoblastic lymphoma	C83.5
	9811/3	B lymphoblastic leukemia/lymphoma, NOS	C91.0
	9812/3	B lymphoblastic leukemia/lymphoma with t(9;22)(q34;q11.2); BCR-ABL1	C91.0
	9813/3	B lymphoblastic leukemia/lymphoma with t(v;11q23); MLL rearranged	C91.0
	9814/3	B lymphoblastic leukemia/lymphoma with t(12;22)(p13;q22); TEL-AML1 (ETV6-RUNX1)	C91.0
	9815/3	B lymphoblastic leukemia/lymphoma with hyperdiploidy	C91.0
	9816/3	B lymphoblastic leukemia/lymphoma with hypodiploidy (Hypodiploid ALL)	C91.0
	9817/3	B lymphoblastic leukemia/lymphoma with t(5;14)(q31;q32); IL3-IGH	C91.0
	9818/3	B lymphoblastic leukemia/lymphoma with t(1;19)(q23;p13.3); E2A-PBX1 (TCF3-PBX1)	C91.0

ICCC-3(2008)	ICD-O-3 (first version)	Full ICD-O-3 title	ICD-10 (2010)
	9837/3	T lymphoblastic leukemia/lymphoma	C91.0
IIb2 Mature B-cell lymphomas (except Burkitt lymphoma)	9597/3	Primary cutaneous follicle centre lymphoma	C82.6
	9670/3	Malignant lymphoma, small B lymphocytic, NOS	C83.0
	9671/3	Malignant lymphoma, lymphoplasmacytic	C83.0
	9673/3	Mantle cell lymphoma	C83.1
	9675/3	Malignant lymphoma, mixed small and large cell, diffuse	C85.9
	9678/3	Primary effusion lymphoma	C83.8
	9679/3	Mediastinal large B-cell lymphoma (C38.3)	C85.2
	9680/3	Malignant lymphoma, large B-cell, diffuse, NOS	C83.3
	9684/3	Malignant lymphoma, large B-cell, diffuse, immunoblastic, NOS	C83.3
	9688/3	T-cell/histiocyte-rich large B-cell lymphoma	C83.3
	9689/3	Splenic marginal zone B-cell lymphoma (C42.2)	C83.0
	9690/3	Follicular lymphoma, NOS	C82.9
	9691/3	Follicular lymphoma, grade 2	C82.1
	9695/3	Follicular lymphoma, grade 1	C82.0
	9698/3	Follicular lymphoma, grade 3	C82.2
	9699/3	Marginal zone B-cell lymphoma, NOS	C83.0
	9712/3	Intravascular large B-cell lymphoma (C49.9)	C84.8
	9731/3	Plasmacytoma, NOS	C90.3
	9732/3	Multiple myeloma (C42.1)	C90.0
	9733/3	Plasma cell leukemia (C42.1)	C90.1
	9734/3	Plasmacytoma, extramedullary	C90.2

ICCC-3(2008)	ICD-O-3 (first version)	Full ICD-O-3 title	ICD-10 (2010)
	9735/3	Plasmablastic lymphoma	C83.3
	9737/3	ALK positive large B-cell lymphoma	C83.3
	9738/3	Large B-cell lymphoma arising in HHV8-associated multicentric Castleman disease	C83.3
	9761/3	Waldenstrom macroglobulinemia (C42.0)	C88.0
	9762/3	Heavy chain disease, NOS	C88.2
	9764/3	Immunoproliferative small intestinal disease (C17._)	C88.3
	9765/3	Immunoproliferative disease, NOS	Not found in CI5 XII
	9766/3	Angiocentric immunoproliferative lesion	C83.8
	9970/3	Myeloproliferative disease, NOS	Not found in CI5 XII
	9823/3	B-cell chronic lymphocytic leukemia/small lymphocytic lymphoma	C91.1
IIb3 Mature T-cell and NK-cell lymphomas	9700/3	Mycosis fungoides (C44._)	C88.4
	9701/3	Sezary syndrome	C84.0
	9702/3	Mature T-cell lymphoma, NOS	C84.1
	9705/3	Angioimmunoblastic T-cell lymphoma	C84.4
	9708/3	Subcutaneous panniculitis-like T-cell lymphoma	C86.5
	9709/3	Cutaneous T-cell lymphoma, NOS (C44._)	C86.3
	9714/3	Anaplastic large cell lymphoma, T-cell and Null cell type	C83.8
	9716/3	Hepatosplenic T-cell lymphoma	C84.6
	9717/3	Intestinal T-cell lymphoma	C86.1
	9718/3	Primary cutaneous CD30 + T-cell lymphoproliferative disorder (C44._)	C86.2

ICCC-3(2008)	ICD-O-3 (first version)	Full ICD-O-3 title	ICD-10 (2010)
	9719/3	NK/T-cell lymphoma, nasal and nasal-type	C86.6
	9724/3	Systemic EBV positive T-cell lymphoproliferative disease of childhood	C86.0
	9725/3	Hydroa vacciniforme-like lymphoma	C84.5
	9726/3	Primary cutaneous gamma-delta T-cell lymphoma	C84.5
	9767/3	Erdheim-Chester disease	Not found in CI5 XII
	9768/3	Juvenile xanthogranuloma	Not found in CI5 XII
	9827/3	Adult T-cell leukemia/lymphoma (HTLV-1 positive)	C91.5
IIb4 Non-Hodgkin lymphomas, NOS	9591/3	Malignant lymphoma, non-Hodgkin, NOS	C85.9
	9760/3	Immunoproliferative disease, NOS	C88.9
IIc Burkitt lymphoma	9687/3	Burkitt lymphoma, NOS	C83.7
IId Miscellaneous lymphoreticular neoplasms	9740/3	Mast cell sarcoma	C96.2
	9741/3	Malignant mastocytosis	C96.2
	9742/3	Mast cell leukemia (C42.1)	C94.3
	9750/3	Malignant histiocytosis	C96.8
	9751/3	Langerhans cell histiocytosis, NOS	C96.6
	9752/3	Langerhans cell histiocytosis, unifocal	Not found in CI5 XII
	9753/3	Langerhans cell histiocytosis, multifocal	Not found in CI5 XII
	9754/3	Langerhans cell histiocytosis, disseminated	Not found in CI5 XII
	9755/3	Histiocytic sarcoma	C96.8
	9756/3	Langerhans cell sarcoma	C96.4
	9757/3	Interdigitating dendritic cell sarcoma	C96.4
	9758/3	Follicular dendritic cell sarcoma	C96.4

ICCC-3(2008)	ICD-O-3 (first version)	Full ICD-O-3 title	ICD-10 (2010)
	9759/3	Fibroblastic reticular cell tumor	C96.4
IIe Unspecified lymphomas	9590/3	Malignant lymphoma, NOS	C85.9
	9596/3	Composite Hodgkin and non-Hodgkin lymphoma	C85.1

Other subgroups mapping

For the mapping of other subgroups, we identified only one definitive one-to-one correspondence: C22.2 (hepatoblastoma) was successfully mapped to ICCC-3 Group VIIa1 (hepatoblastoma). For the remaining subgroups, precise mapping proved challenging as either: (1) no corresponding ICCC-3 subgroup could be clearly identified, or (2) unambiguous mapping to a single subgroup was not clinically or pathologically feasible.

Discussion

To our knowledge, this is the first systematic attempt to map ICD-10 codes onto ICCC-3 categories, as no previous studies have systematically explored this approach. Mapping between ICD-10 and ICCC-3 is widely considered nearly impossible because ICD-10 lacks histological information and was not specifically designed for cancer classification, whereas ICCC-3 relies on ICD-O-3 morphology and topography codes [17, 18]. These two systems are inherently different in structure and intent, so the mapping can easily feel like “apples to oranges”.

Why, then, did we still undertake this effort? The primary motivations are: (1) the gold-standard status of ICCC-3 for pediatric cancer classification versus the predominant use of ICD-10 in major global cancer burden estimates (e.g., GLOBOCAN, GBD). Notably, while GLOBOCAN incidence data derives from CI5 (which collects ICD-O-3 data), it ultimately adopts ICD-10 to align with national vital statistics standards [19]. Cancer registry data with ICD-O-3 serve primarily for calibration rather than direct estimation; (2) CI5's ICD-O-3 conversion tables enable partial reverse mapping; (3) it allows resource-limited regions to analyze childhood cancer subtypes; (4) it paves the way for establishing a global ICCC-3-based surveillance system; and (5) it enables comparative analyses between ICD-10-based adult cancer studies and ICCC-3 pediatric research.

The CI5 Volume XII database represents an exceptional resource for investigating the ICD-10 to ICCC-3 mapping due to its unique inclusion of all three coding systems (ICD-10, ICD-O-3, and ICCC-3) for each registered case. For this study, we utilized high-quality U.S. national registry data, which offers particularly robust coverage and data integrity for more reliable classification analysis [14].

Our mapping results highlight the practical challenges we encountered. When mapping to the 12 ICCC-3 main groups, we were often aware that a given ICD-10 code could correspond to multiple ICCC-3 groups. For example, lung cancers (C34) in children are frequently metastatic tumors such as sarcomas (group IX) [20], but ICD-10 allocates them to epithelial neoplasms/melanomas (group XI) based solely on anatomical location. Similarly, teratomas occurring in various anatomical sites are categorized into different ICD-10 codes according to location [21], while in ICCC-3 they all belong to germ cell tumors (group X), leading to an overestimation of group XI and group III, and underestimation of group X. Moreover, the over-mapping of bone malignancies in ICD-10 (C40-C41) versus ICCC-3 Group VIII primarily reflects the fundamental classification difference where ICD-10's anatomical coding captures both primary bone tumors and bone-involved metastases (common in pediatric neuroblastoma, lymphomas), while ICCC-3's histologic criteria correctly exclude non-osteogenic tumors from Group VIII [22, 23]. Group II (lymphomas) was under-mapping mainly because lymphomas arising in the gastrointestinal tract, CNS, bone, and other sites being assigned to groups XI, III, VIII, or other categories. In addition, certain borderline entities between lymphoma and leukemia, as well as lymphomas with unknown primary sites, may be coded under groups I or XII in ICCC-3 [24], further contributing to case loss.

However, some tumors exhibit relatively “clean” correspondence between ICD-10 and ICCC-3, which can be explained from several aspects: (1) High tumor specificity: Retinoblastoma (ICD-10: C69.2) occurs almost exclusively in children and has a single histological type, making its mapping to ICCC-3 Group I (retinoblastoma) nearly unambiguous [25]. Hepatoblastoma (ICD-10: C22.2) is the predominant liver cancer in children, whereas adult-type liver cancers are rare in this age group, resulting in accurate mapping to ICCC-3 Group VII (hepatic tumors) [26]. In the kidney (ICD-10: C64), Wilms tumor is the most common pediatric malignancy, with very few other malignant types, making its mapping to ICCC-3 Group VI (renal tumors) relatively straightforward [27]. Although brain and CNS tumors (ICD-10: C70-72) encompass multiple anatomical sites, pediatric brain tumors are relatively concentrated in types (e.g., astrocytomas, medulloblastomas), and ICCC-3 Group III (brain and CNS tumors) covers the majority of pediatric cases, resulting in high mapping consistency [28].

For lymphoid and hematopoietic neoplasms subgroups mapping, we employed a deterministic mapping approach using ICD-O-3 morphology codes as the bridging standard between ICD-10 and ICCC-3 classifications, which revealed distinct mapping patterns: complete concordance was achieved for Groups I-II (leukemias/lymphomas) due to ICD-10's detailed hematologic coding (e.g., C91.0-C91.9 for acute lymphoblastic leukemia subtypes) and CI5 conversion tables maintaining morphology-specific linkages. As mentioned, borderline entities between lymphoma and leukemia are prone to misclassification in ICD-10. For example, acute lymphoblastic leukemia with mass formation may be coded as C91 (leukemia, group I) in ICD-10, whereas ICCC-3, based on morphology codes, may classify it into group II (lymphomas). This issue is particularly prominent in children, where certain T-cell lymphomas/leukemias represent a disease continuum that ICD-10 cannot distinguish. By establishing one-to-one correspondence at the subgroup level, we effectively resolved this issue, resulting in more accurate mapping between groups I and II.

Among solid tumors, only hepatoblastoma (ICD-10 C22.2 → ICCC-3 VIIa1) could be reliably mapped at the subgroup level due to its unique site-histology correspondence. The remaining subgroups (III–XII) could not be accurately mapped, primarily because ICD-10 lacks sufficient histologic granularity. The precise deterministic mapping of lymphoid/hematopoietic neoplasms (ICCC-3 groups I-II) holds critical significance for pediatric oncology, as these groups comprise approximately 50% of childhood cancers [5] and their detailed ICD-10 coding enables accurate epidemiological surveillance, molecular subtype identification, and protocol-specific outcome analyses, while avoiding the misclassification biases inherent in solid tumor mapping - this granular coding framework directly supports global treatment initiatives and registry interoperability by maintaining morphology-specific linkages through ICD-O-3 bridging standards, though its success highlights the contrasting limitations in solid tumor subgroup classification where ICD-10's anatomical focus precludes equivalent precision without supplemental histologic data.

Limitation

Our study has several important limitations, primarily stemming from methodological constraints in cancer classification. First, while CI5 data allowed us to map ICD-10 codes to ICCC-3, the lack of individual-level, cross-classified data prevented the use of rigorous agreement metrics such as Cohen's kappa [29, 30]. Instead, we relied on a simplified consistency ratio (ICD-10 to ICCC-3 case counts), which may introduce measurement bias by either overestimating or underestimating true concordance. Future studies should incorporate standardized agreement statistics and linked individual-level data to improve classification accuracy. Second, the mapping of lymphoma and hematological malignancy subgroups was developed specifically for ICD-10 (2010 version), ICD-O-3 first edition, and ICCC-3 (WHO 2008 version). Changes in ICD-10, ICD-O, and ICCC-3 over time, through addition, modification, or removal of codes, may introduce inconsistencies in longitudinal applications of the mapping. Therefore, this should be interpreted with caution when applied to other coding versions. Third, variations in diagnostic criteria, and data quality control across countries or data sources may affect the generalizability of the mapping strategy. Fourth, intrinsic differences between ICD-10 and ICCC-3, particularly the absence of histological detail in ICD-10, mean that certain tumor types, especially rare or mixed histologies, are prone to misclassification during mapping. Fifth, rare pediatric malignancies with small case counts are more sensitive to single misclassification events, potentially amplifying proportional errors. Sixth, the mapping strategy has not yet been externally validated on independent datasets or in other registry settings, which may limit its reproducibility and robustness. Seventh, discrepancies between clinical diagnosis and registry coding, including delayed updates or diagnostic revisions, may further reduce classification accuracy. Finally, temporal changes in diagnostic technology and practices over the data collection period could affect the comparability of mapped classifications across time.

Conclusions

This study is the first to systematically map ICD-10–coded pediatric cancer cases (ages 0–19) from the U.S. registry in Cancer Incidence in Five Continents, Volume XII (CI5 XII, 2013–2017) to ICCC-3

diagnostic categories. We developed a three-tier mapping strategy, including direct mapping, ICD-O-3–mediated crosswalks for lymphoid and hematopoietic neoplasms, and manual mapping for other subgroups. Our results indicate that for highly specific cancer types—such as retinoblastoma, CNS tumors, renal tumors, and hepatic tumors—ICD-10 codes can be reliably converted to ICCC-3 categories with high concordance, and one-to-one correspondence for lymphoid and hematopoietic neoplasms subgroups appears robust and credible.

However, for other solid tumors, the consistency between ICD-10 and ICCC-3 remains lower, reflecting the inherent limitations of ICD-10, which lacks detailed morphological information necessary for ICCC-3 classification. Additionally, mapping was performed at the population level, precluding individual-level validation or the use of statistical methods that rely on individual-level data. This limitation may partially reduce the reliability of the results. The mapping strategy is primarily applicable to ICD-10 (2010 version), ICD-O-3 first edition, and ICCC-3 (WHO 2008 version); caution is warranted when applying it to other versions. Furthermore, certain ambiguous cases still require expert judgment, introducing potential subjectivity.

Despite these limitations, this mapping framework provides a practical tool for standardizing pediatric cancer data across different coding systems. It facilitates cross-database comparisons among GBD, GLOBOCAN, and ICCC-3 datasets, enhances the utility of ICD-10–coded data in epidemiological research, and lays a foundation for future efforts to improve classification accuracy and support global surveillance of childhood cancers.

Abbreviations

ICD-10 International Classification of Diseases, 10th Revision

ICCC-3 International Classification of Childhood Cancer, Third Edition

ICD-O-3 International Classification of Diseases for Oncology, Third Edition

CI5 Cancer Incidence in Five Continents

GLOBOCAN Global Cancer Observatory

GBD Global Burden of Disease

WHO World Health Organization

IICC International Incidence of Childhood Cancer

IARC International Agency for Research on Cancer

IACR International Association of Cancer Registries

SEER Surveillance, Epidemiology, and End Results

CNS Central Nervous System

CR Consistency Ratio

Declarations

Ethics approval and consent to participate

All data used in this study were publicly available and aggregated, and thus, no ethical approval or patient consent was required.

Consent for publication

Not applicable.

Availability of data and materials

The print edition of CI5 Volume XII (IARC Scientific Publication No. 169) can be downloaded from the IARC Publications website: https://publications.iarc.who.int.

The processed data generated in this study are available within the article and its supplementary materials. Additional information can be obtained from the corresponding author upon reasonable request.

Competing interests

The authors declare no competing interests.

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Authors' contributions

JXL, XHS and HY conduct the study. HY drafted the manuscript. MLS revised the manuscript. All authors read and approved the final manuscript.

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Patient and Public Involvement statement

Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research

Clinical Trial Number

Not applicable.

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Figures

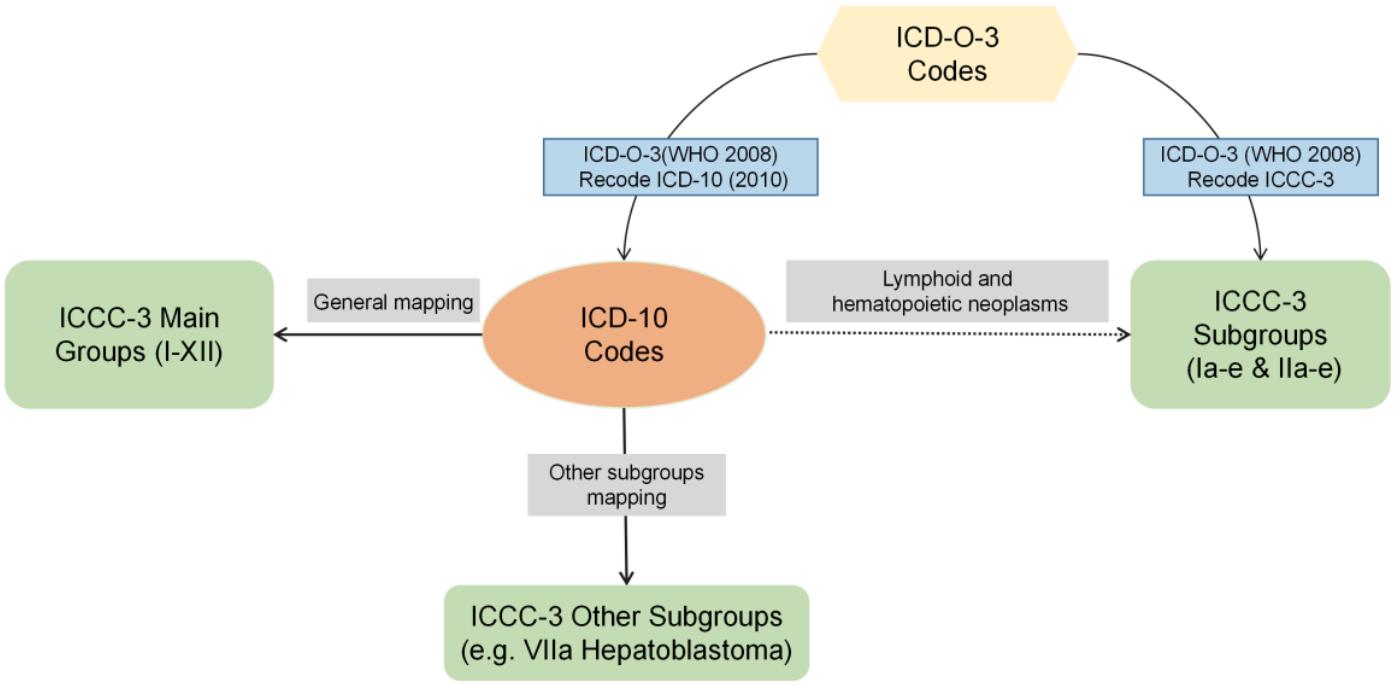


Figure 1

Mapping strategy from ICD-10 to ICCC-3 for pediatric cancers.

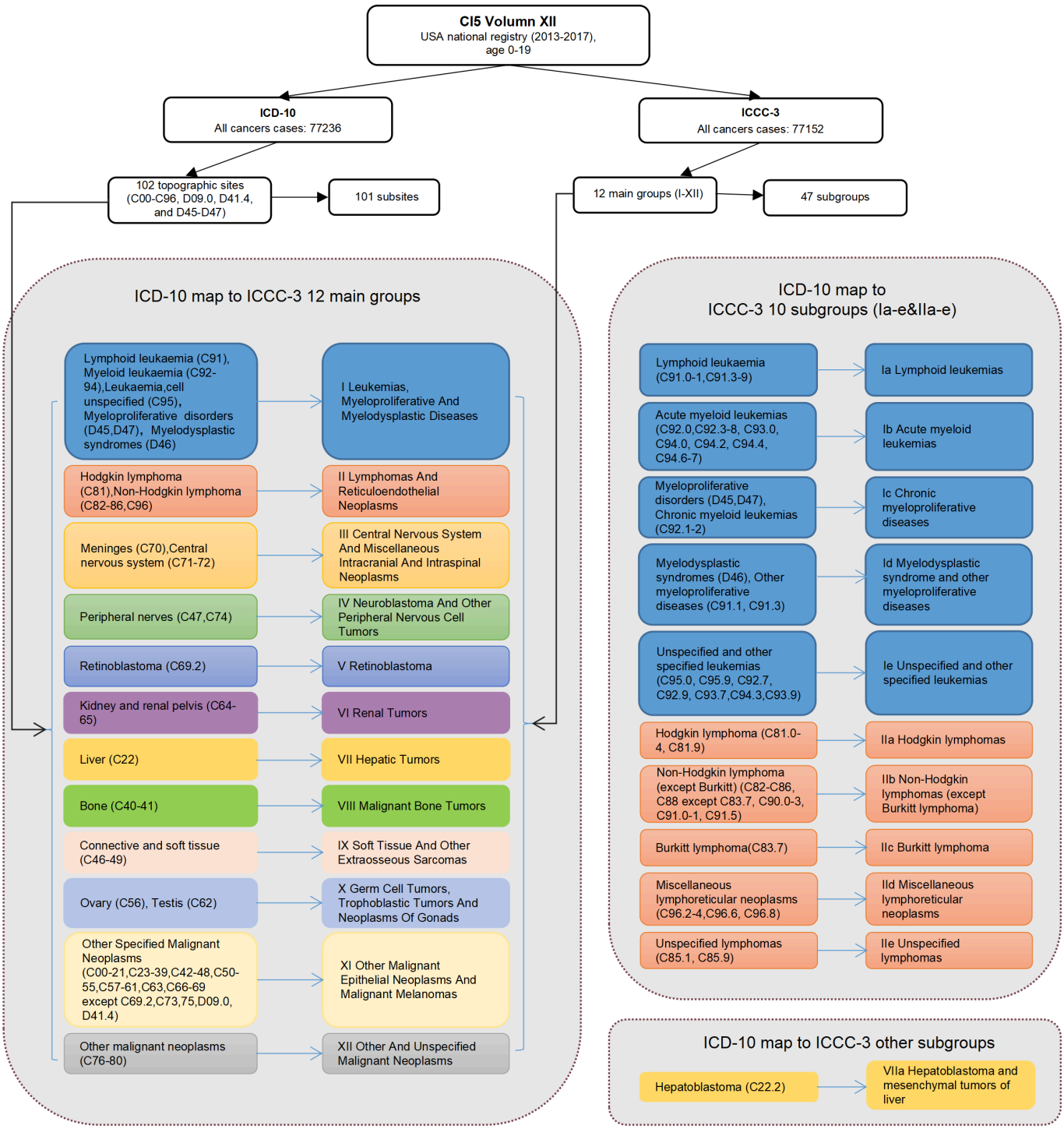


Figure 2

Mapping from ICD-10 to ICCC-3 for childhood and adolescent cancers using CI5 XII U.S. 2013-2017 national registry data.

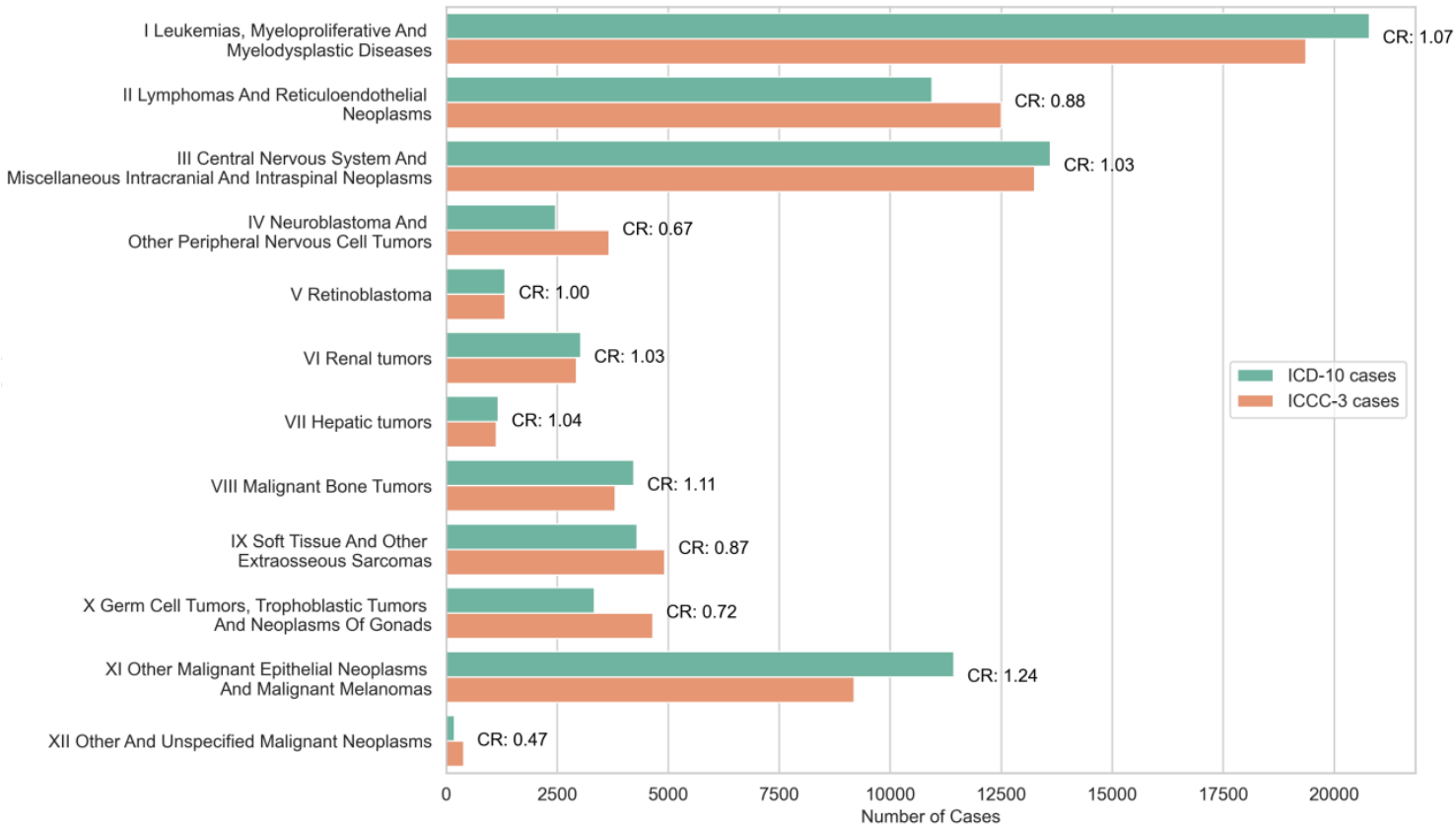


Figure 3

General mapping results from ICD-10 to ICCC-3.