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The WHO global landscape of cancer clinical trials

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Clinical trials are essential to advancing cancer control, yet access and participation remain unequal globally. The World Health Organization (WHO) established the International Clinical Trials Registry Platform (ICTRP) to enable a complete view of interventional clinical research for all those involved in healthcare decision-making and to identify actionable goals to equitable participation at the global level. A review of 89,069 global cancer clinical trials registered in the WHO ICTRP between 1999 and December 2022 revealed a cancer clinical trial landscape dominated by high-income countries and focused on pharmacological interventions, with multinational collaboration limited to only 3% of recruiting trials. Several of the deadliest cancers, including liver, stomach, pancreas and cervical cancer, were consistently missing from the top most-studied cancer types, particularly in Africa and Southeast Asia. In this Review, we summarize the key findings of the WHO global landscape review and discuss strategies to act on these data, which provide critical empirical evidence to inform policy, practice and investment decisions.

Cancer clinical trials are critical for improving global cancer control by identifying effective preventative, diagnostic and therapeutic strategies. As a result of well-conducted translational and clinical research, cancer mortality has progressively decreased in countries with robust health systems[1,2]. Nevertheless, the global burden of cancer is still high and is projected to grow sharply in the coming years, with an estimated 35 million new cases in 2050, a 77% increase from the 20 million cases recorded in 2022 (ref. 3). Low-resource settings will be disproportionately affected by this surge in cancer cases and will account for 70% of global cancer deaths[3]. These trends underscore the critical importance of strengthening cancer research ecosystems and promoting implementation research in all income settings as a key component of the global cancer control strategy.

Although clinical trials are one of the most impactful game changers in oncology by enabling evidence-based interventions, they have become increasingly complex and expensive, resulting in a progressive loss of efficiency and quality. Over the past two decades, cancer clinical trials have shifted from predominantly publicly funded, high-impact studies designed to answer questions relevant to patients to predominantly industry-funded trials, more likely to use putative surrogate end points and identify modest clinical benefits[4–7]. In parallel, capacity development has stalled in many regions and countries, exacerbating global inequalities and limiting the generalizability of research findings to diverse populations[8,9]. To fully unlock the transformative potential of cancer clinical trials at scale, while ensuring affordability, sustainability and inclusivity, a range of technical, operational, regulatory and economic challenges need to be overcome at the regional, national and global levels. Addressing these challenges demands multisectoral collaboration, the coordination of efforts across multiple stakeholders and international actors, and data to inform these actions.

The WHO has a key role in driving this process as part of its mandate to harness the power of science and research as a critical enabler of the Triple Billion targets of the 13th WHO General Programme of Work 2019–2023 and the health-related Sustainable Development Goals[10]. Research stands as a cornerstone in advancing progress toward WHO targets for prevention and control of noncommunicable diseases[11]. More specifically, research is highlighted as a strategic

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BOX 1

WHO analytical approach

Study design and data source. We conducted a cross-sectional analysis of trials registered in the ICTRP, a publicly accessible database for clinical trials hosted by the WHO[15,36]. At the time of analysis, the ICTRP consolidated and integrated data from 17 international primary registries (national and regional) and five partner registries. The ICTRP includes the information considered most critical for the global community to increase transparency in clinical research[15].

Eligibility criteria. Cancer clinical trials registered from 1 January 1999 to 31 December 2022 were evaluated for eligibility. Records were eligible when the study type was interventional and the condition field mapped to 'malignant neoplasm' in the harmonized list of disease categories.

Variables. The following variables were extracted: study phase, planned sample size, age and sex eligibility, intervention category (behavioral, biological, combination product, device, diagnostic test, dietary supplement, drug, genetic, other or unknown, procedure and radiation as registered in the ICTRP), tumor site, recruitment status, year of registration, country of recruitment and sponsors. The ICTRP defines a 'primary sponsor' as the individual, organization, group or other legal entity that takes on the responsibility for initiating, managing and registering the trial and/or financing a study, and this entity may or may not be the main funder.

Country classification. Country names were standardized according to United Nations official nomenclature, stratified by World Bank (July 2022) income groups in HIC, UMIC, LMIC and LIC countries[37] and allocated to one of six WHO regions: Africa, Americas, Eastern Mediterranean, Europe, Southeast Asia and Western Pacific.

Objectives. The primary objective was to characterize the global distribution of oncology trials by geography, national income level and disease burden. Secondary objectives included detailed description of trial phase, sample size, age eligibility, intervention type, sponsor category and temporal trends.

Statistical analysis. Descriptive statistics summarized all variables overall and stratified by World Bank income group and WHO region. Group differences were tested with the χ^2 test (two sided, α=0.05). Research intensity was normalized to disease burden using trials per prevalence unit and trials per mortality unit, calculated as the number of registered trials divided by the corresponding GLOBOCAN 2022 prevalence or mortality rate per 100,000 population[38]. Associations between cancer incidence and trial volume across regions were assessed with Pearson's correlation coefficient (after verifying approximate normality), whereas the relationship between income level and trial volume was examined with Spearman's rank correlation. All analyses and visualizations were performed in R (version 4.3.1) and Microsoft Power View.

priority in the Cancer Resolution WHA70.12 (adopted by the 70th World Health Assembly in 2017), which underscores the need to promote research to improve cancer prevention and control, including research on health outcomes, quality of life and cost-effectiveness[12].

Delivering on the mandate provided by WHA70.12 and aligning with the broader noncommunicable disease agenda[13], the WHO is developing strategies to assist countries and regions to strengthen their capacity to produce locally relevant evidence on cancer control through quality clinical trials; to promote quality, patient-centered research across the cancer continuum; to identify trends, gaps and future priorities in cancer research and innovation; and to enhance implementation research. This is complemented by the synergistic activity of the WHO specialized International Agency for Research on Cancer, which focuses on the causes of human cancer, the mechanisms of carcinogenesis and cancer epidemiology. Moreover, to enhance generation of timely, reliable and actionable scientific evidence across medical disciplines and diseases, the WHO Science Division is developing best-practice guidance to assist countries to strengthen clinical trials ecosystems, address key scientific and ethical considerations in clinical trial design and implementation and enhance inclusion of underserved subpopulations in clinical trials[14].

To provide a consolidated evidence base for strategic policy formulation, we performed a global landscape review of registered cancer clinical trials, thereby addressing the current gap in comprehensive data on global oncology research activity. Our analytical framework uses data from the WHO ICTRP[15], the world's most extensive database of clinical trials that collates data from international registries to identify key trends, gaps and regional disparities in the global cancer trial portfolio (Box 1). This Review consolidates the principal findings of our analysis, providing WHO and relevant stakeholders with a robust empirical foundation for policy and strategic action aimed at advancing well-designed, patient-centered, context-appropriate and equitable oncology research. The WHO makes the underlying data reviewed here freely available as an interactive visualization at the Global Observatory for Health R&D (WHO landscape of clinical trials on cancer).

Global oncology trials at a glance

By 31 December 2022, the ICTRP contained 112,899 oncology-focused entries. A total of 89,069 interventional cancer trials (79% of total cancer trials) were selected for inclusion after removal of duplicates and exclusion of observational studies. Trial recruitment status showed that 43% of interventional trials were completed, 26% were actively recruiting and 31% were suspended, not yet recruiting or of unknown status (Table 1). The temporal trends showed that annual registrations increased at a mean rate of 7.3% between 2005 and 2021, yielding a 207% absolute rise over that interval, followed by a decline in 2022, plausibly attributable to delayed data uploads and pandemic-related disruption (Fig. 1a). These findings are a clear testament to the global commitment to reduce the burden of cancer through evidence-based science. The expanding research pipeline has translated into substantive progress, accelerating the development of preventative and therapeutic strategies, including targeted agents, immunotherapies and precision radiotherapy techniques that are reshaping clinical practice and improving patient outcomes. Yet the true impact of this effort will depend on translating quantitative growth into methodologically robust studies that are inclusive and clinically relevant.

Our analysis showed that the numerical growth of cancer trials has not been uniform across development phases. The cancer trial portfolio remains skewed toward exploratory designs, with a high proportion of phase 2 trials (39% of all registrations) and trials of small sample size (63% enrolling <100 participants) that consistently increased over time (Fig. 1b). By contrast, phase 3 studies account for only 13% of entries, a proportion that has stayed essentially static over

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Table 1 | Characteristics of interventional cancer clinical trials registered in the ICTRP from 1999 to 2022

Characteristics	Total (%)	Completed (%)	Recruiting (%)	Other[a] (%)
N (%)	89,069 (100)	38,034 (43)	23,174 (26)	27,861 (31)
Sex				
Both	67,894 (76)	28,636 (75)	18,057 (78)	21,201 (76)
Female	12,215 (14)	5,707 (15)	2,852 (12)	3,656 (13)
Male	5,641 (6)	2,545 (7)	1,349 (6)	1,747 (6)
Unknown	3,319 (4)	1,146 (3)	916 (4)	1,257 (5)
Phase				
0	1,641 (2)	173 (0)	888 (4)	580 (2)
1	11,321 (13)	6,178 (16)	2,707 (12)	2,436 (9)
2	34,766 (39)	15,472 (41)	8,276 (36)	11,018 (40)
3	11,653 (13)	4,274 (11)	2,806 (12)	4,573 (16)
4	2,881 (3)	958 (3)	913 (4)	1,010 (4)
Unknown or not applicable	26,807 (30)	10,979 (29)	7,584 (33)	8,244 (30)
Planned sample size				
1–100	56,241 (63)	27,682 (73)	14,898 (64)	13,661 (49)
101–1,000	25,195 (28)	8,426 (22)	7,536 (33)	9,233 (33)
1,001–10,000	2,092 (2)	757 (2)	550 (2)	785 (3)
10,001–100,000	218 (0)	91 (0)	71 (0)	56 (0)
100,001–500,000	21 (0)	10 (0)	7 (0)	4 (0)
>500,000	5 (0)	1 (0)	2 (0)	2 (0)
Unknown or not applicable	5,297 (6)	1,067 (3)	110 (0)	4,120 (15)
Primary sponsor				
Academic, medical or research institution	57,389 (64)	24,583 (65)	16,844 (73)	15,962 (57)
Pharmaceutical or biotechnology company	11,286 (13)	4,977 (13)	1,755 (8)	4,554 (16)
Individual, other or unknown	15,759 (18)	6,286 (17)	3,854 (17)	5,619 (20)
Private sector, philanthropic foundation, trust, NGO or corporate donor	4,202 (5)	2,030 (5)	639 (3)	1,533 (6)
Public sector institution	433 (0)	158 (0)	82 (0)	193 (1)
Intervention(s)				
Behavioral	2,490 (3)	1,499 (4)	588 (3)	403 (1)
Biological	5,494 (6)	2,907 (8)	1,327 (6)	1,260 (5)
Combination product	297 (0)	60 (0)	155 (1)	82 (0)
Device	2,354 (3)	1,161 (3)	675 (3)	518 (2)
Diagnostic test	559 (1)	130 (0)	280 (1)	149 (1)
Dietary supplement	620 (1)	382 (1)	122 (1)	116 (0)
Drug	54,279 (61)	22,640 (60)	11,839 (51)	19,800 (71)
Genetic	210 (0)	90 (0)	79 (0)	41 (0)
Other/unknown	10,265 (12)	3,977 (10)	3,804 (16)	2,484 (9)
Procedure	10,015 (11)	4,291 (11)	3,371 (15)	2,353 (8)
Radiation	2,486 (3)	897 (2)	934 (4)	655 (2)
WHO region				
Africa	978 (1)	443 (1)	127 (0)	408 (1)
Americas	34,914 (33)	19,199 (44)	6,496 (25)	9,219 (26)
Eastern Mediterranean	2,288 (2)	1,193 (3)	665 (3)	430 (1)
Europe	28,495 (27)	9,946 (23)	5,509 (21)	13,040 (36)
Southeast Asia	3,775 (4)	1,316 (3)	799 (3)	1,660 (5)

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Table 1 (continued) | Characteristics of interventional cancer clinical trials registered in the ICTRP from 1999 to 2022

Characteristics	Total (%)	Completed (%)	Recruiting (%)	Other[a] (%)
Western Pacific	31,218 (30)	10,747 (24)	11,906 (46)	8,565 (24)
Unknown	3,848 (4)	1,056 (2)	161 (1)	2,631 (7)
Income group				
LIC	173 (0)	53 (0)	21 (0)	99 (0)
LMIC	5,929 (6)	2,390 (6)	1,379 (6)	2,160 (7)
UMIC	19,152 (20)	4,379 (11)	8,387 (35)	6,386 (20)
HIC	67,805 (70)	32,853 (81)	14,285 (59)	20,667 (65)
Unknown	3,848 (4)	1,056 (3)	161 (1)	2,631 (8)
Country diversity				
Single country, overall	75,597 (85)	33,030 (87)	21,309 (92)	21,258 (76)
Single-country UMIC, LMIC, LIC	17,659 (20)	4,113 (11)	8,752 (38)	4,794 (17)
Multiple countries, overall	13,472 (15)	5,004 (13)	1,865 (18)	6,603 (24)
HIC with UMIC, LMIC and/or LIC	5,400 (6)	1,910 (5)	746 (3)	2,744 (10)

[a]Includes suspended (terminated or withdrawn), not recruiting, (for example, pending recruitment), unknown (status could not be determined) and not applicable. NGO, nongovernmental organization.

time (Table 1 and Fig. 1b), underscoring a persistent bottleneck in converting mid-stage findings into the large, confirmatory investigations required for regulatory approval and routine clinical adoption. We also observed a progressive increase in the number of trials without Food and Drug Administration-defined phases (or phase not available), highlighting the need to enhance comprehensive reporting in trial registrations.

In sum, these observations suggest a central concern: a rising quantity of trials is not, in itself, synonymous with higher-quality or practice-changing evidence. A definitive assessment of trial quality would require detailed evaluation of study design, particularly the choice and validity of primary end points, along with assessment of clinical value; that level of methodological granularity, however, lies beyond the scope of the present landscape Review.

Our analysis has also identified persistent underrepresentation of both pediatric and geriatric cohorts. We observed that only 3.3% of trials enroll participants <14 years, despite the distinct biology and therapeutic needs of childhood malignancies. Although half of all protocols had no upper age cutoff, just 28% explicitly targeted adults ≥60 years, suggesting limited emphasis on geriatric oncology. Previous findings demonstrated that, despite two-thirds of patients with cancer being over 65 years old, only about 25% of cancer trial participants are in this age group[16,17]. Improving age-reporting practices is essential to better assess and monitor the inclusion of underrepresented populations such as older adults and pediatric patients in cancer clinical trials. Lastly, eligibility was undefined in 17.0% of registrations, underscoring continuing deficiencies in mandatory data fields.

The primary sponsor was predominantly noncommercial in nature, with academic and research institutions accounting for 54% of sponsorships, followed by healthcare institutions (15%), government organizations (4%) and nonprofit organizations (5%) (Table 1). Industry sponsorship was discerned in 19% of the clinical trials examined in this study. However, these findings need to be interpreted with caution as, within the ICTRP, the 'sponsor' denotes the entity responsible for registering the trial and not necessarily funding it. Recent analyses indicate that industry-funded oncology studies have risen over time[4], suggesting that sponsorship records, when defined as in the ICTRP, may underestimate commercial support. Accurately characterizing funding sources will therefore require supplementary data beyond registry sponsorship fields, which was not undertaken in this study.

Collectively, these findings define a global oncology trial ecosystem characterized by substantial numerical growth over the past two decades, a predominance of phase 2 studies, underrepresentation of both pediatric and older populations, incomplete phase disclosure and limited information on trial funders. In addition, several key themes emerged and are discussed below.

The cancer clinical trial landscape remains dominated by high-income countries

The distribution of oncology clinical trials is markedly uneven across the globe, with seven of every ten oncology trials in the ICTRP hosted in high-income countries (HICs); the imbalance was greater for completed studies versus recruiting ones (81% versus 59% of trials in HICs) (Table 1). Upper–middle-income countries (UMICs) accounted for 20% of the overall portfolio but 35% of actively enrolling trials, representing a significant redistribution across income groups ($\chi^2 < 0.001$). Standardized residuals confirmed that UMICs were markedly overrepresented among active studies (standardized residual = 52.5) and pinpoint the Western Pacific as the main driver of this shift (standardized residual = 38.8 for recruiting studies). Conversely, the Americas exhibited a relative surplus of completed trials (Fig. 2). Regionally, three WHO regions concentrated almost all cancer clinical trial activity: the Americas (33%), the Western Pacific (30%) and Europe (27%) together hosted almost 90% of all trials, while the Eastern Mediterranean, Southeast Asia and Africa collectively accounted for <7% of trials (Table 1). At the national level and considering all trials, the USA alone accounted for nearly one-third of all studies, followed by China (19%), Japan (13%), Germany (9%), France (9%), the UK (8%) and Italy (8%). At the opposite extreme, 63 sovereign states, predominantly small-island or very-low-income nations, had no oncology trial listed and a further 50 countries registered fewer than ten trials. A similar trend was evident among trials currently recruiting, with China (21%), the USA (16%), Japan (8%), Germany (4%) and France (4%) comprising more than half of active studies, whereas many countries in Africa, Southeast Asia and Latin America recorded few or no trials. Temporal analyses further corroborated these patterns. Trial registrations have accelerated most steeply in the Western Pacific, whereas increases in the Eastern Mediterranean, Africa and Southeast Asia have been very modest. Unsurprisingly, within income groups, expansion was most pronounced for HICs and UMICs; lower–middle-income country (LMIC) and low-income country (LIC) output remains essentially flat (Fig. 1c).

The persistent geographic and income-related imbalances in oncology research reported here jeopardize both the equity of access to innovation and the generalizability of trial-derived evidence[8,9,18].

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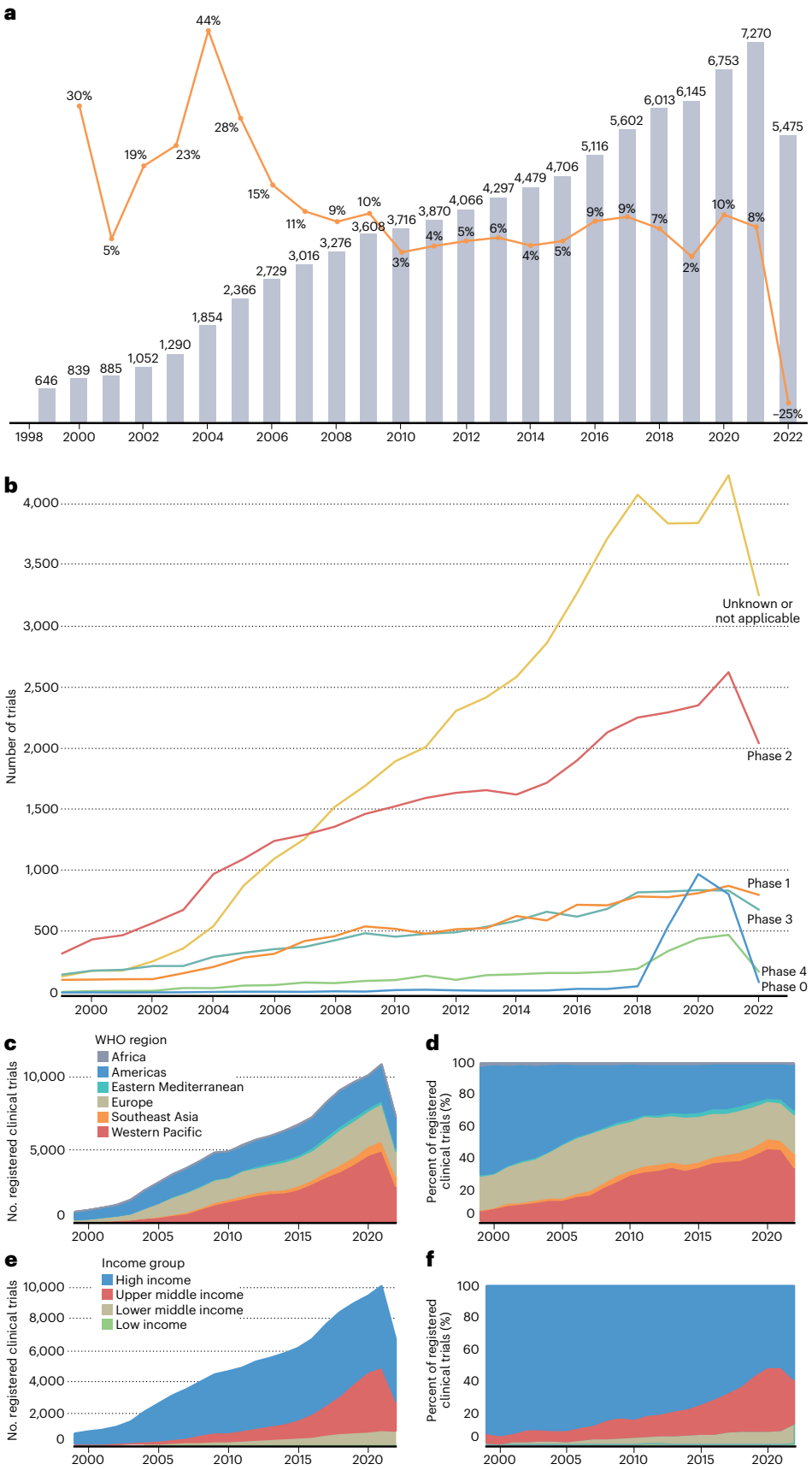

Fig. 1 | Global temporal trends for cancer clinical trials registered between 1999 and 2022. a, Annual number of registered cancer clinical trials between 1999 and 2022 (bars) and percentage yearly increase (orange dots). **b**, Global temporal trends for cancer clinical trials by trial phase. **c**–**f**, Total annual number of registered clinical trials and percentage distribution (**c**,**d**), respectively, between 1999 and 2022 by WHO geographic region and by World Bank economic development category (**e**,**f**, respectively).

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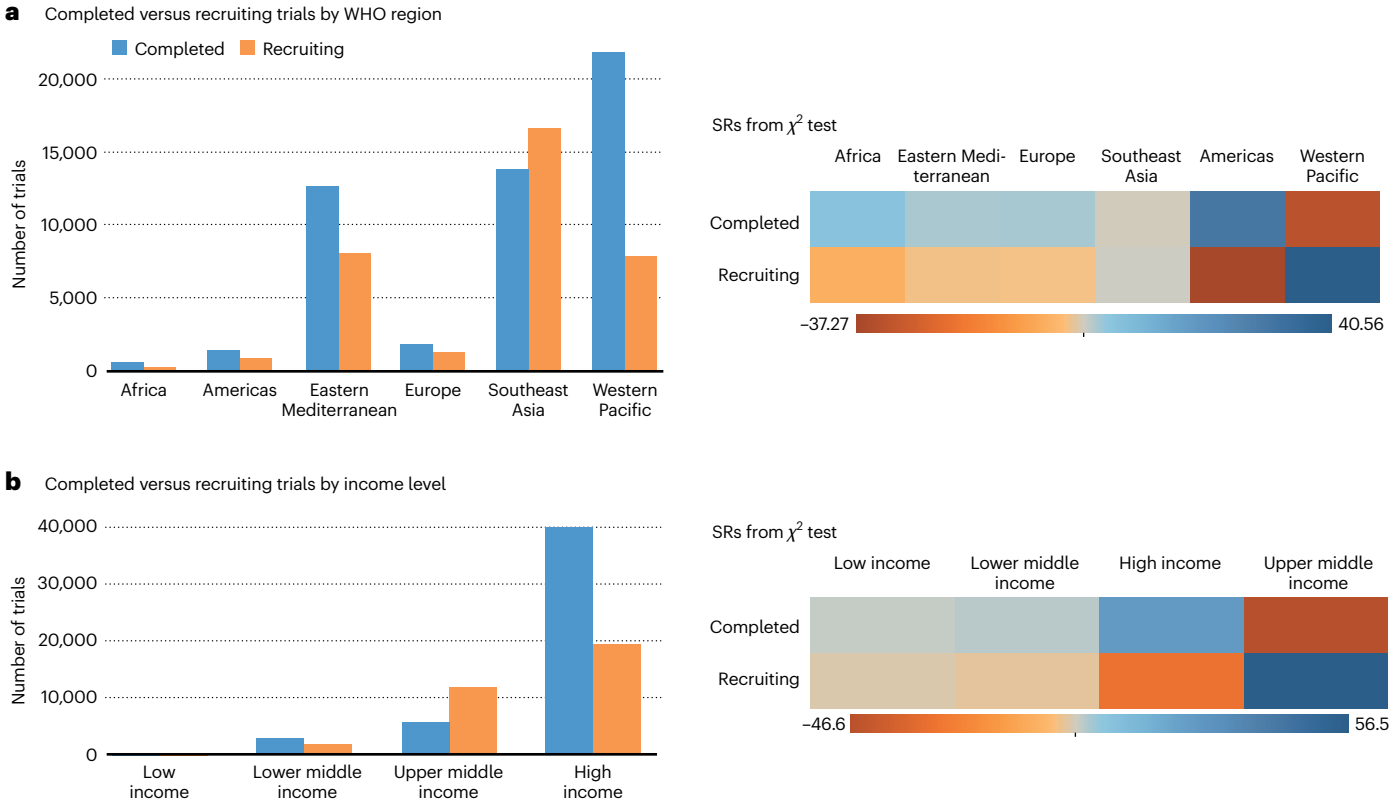

Fig. 2 | Distribution of completed versus recruiting trials by income group and WHO region. a,**b**, Heatmaps display standardized residuals (SRs) from the χ^2 test, for both 'completed' and 'recruiting' trials, indicating how much each region (**a**) or income group (**b**) deviates from the expected distribution. Larger positive (blue) or negative (red) values are represented by more intense colors and indicate which group contributes most to the differences. The largest SR was observed in the Western Pacific region for recruiting trials (38.82), indicating a substantial overrepresentation of recruiting trials versus completed ones in this region. The Americas showed the opposite trend, with more completed trials but fewer recruiting trials (**a**). Regarding income groups, the largest SR was observed in HICs (19.19) in the completed trial category and from UMICs in the recruiting trials (52.53) (**b**), suggesting an expanding clinical trial landscape in UMICs.

The concentration of studies in high-income settings risks producing findings that do not translate to lower-resource contexts, where patient demographics, tumor subtypes and healthcare infrastructures differ substantially. Meanwhile, trial activity in LMICs and LICs has stagnated, perpetuating 'trial deserts' that further exacerbates disparities in access to novel therapeutics and hinder locally relevant innovation. On the other hand, although UMICs have expanded their share of global trials substantially, this growth often remains confined to urban, tertiary centers, leaving rural and marginalized populations excluded[19–21]. These global disparities reflect uneven distributions of economic resources, healthcare infrastructure and research capacity across regions. Mitigating them requires coordinated, multi-stakeholder collaboration and strategic resource allocation to strengthen workforce capacity, regulatory frameworks, ethical review processes and data infrastructure. Equally critical is prioritizing trials adapted to local health system constraints, thereby enhancing feasibility and clinical applicability and promoting implementation research to identify cost-effective, context-specific interventions[22]. Finally, the establishment of regional consortia can facilitate knowledge exchange among experts, harmonize oversight and reduce trial costs.

Imbalance between clinical trial volumes and cancer burden

A critical measure of oncology trial equity is the extent to which research effort aligns with cancer burden. Using burden-normalized indicators, we found nearly 345 clinical trials per unit of cancer mortality in HICs and 4.2 in LICs, reflecting an approximately 80-fold disparity in research allocation relative to disease burden. This imbalance was also observed across geographic regions: Africa and the Eastern Mediterranean had the lowest proportional investment in clinical trials per disease burden, despite having considerable cancer-related mortality (Fig. 3). The alignment between clinical research activity and the epidemiological burden of cancer was assessed using cancer incidence, mortality and metrics of trials per case and trials per death for the 13 most prevalent cancer types. Globally and considering all trials, the most frequently studied tumors were breast cancer, followed by lung cancer, lymphomas, colorectal cancer, leukemia and prostate cancer. Misalignment has been observed between the global prevalence and mortality patterns of various cancers and the trial ratios. Lymphomas, leukemia, breast cancer and melanoma had the highest number of clinical trials per death, with over 1,500 trials allocated per death unit in some cases, despite lower fatality rates. By contrast, stomach cancer, urinary tract cancers, lung cancer and cervix and bladder cancer had substantially fewer trials per death, often below 600. Lung cancer, despite being among the most lethal tumor types, showed a disproportionately low research-to-death ratio (Fig. 3).

Imbalances were even more pronounced for clinical trials actively recruiting (Fig. 4). HICs hosted 14,285 ongoing trials, equivalent to 7.05 trials per 100,000 prevalent cases and 60.02 trials per 100,000 deaths, whereas LICs hosted only 21 active trials (0.15 per 100,000 cases, 0.43 per 100,000 deaths), yielding a >100-fold differential in real-time research effort relative to disease burden. UMICs appeared at an intermediate position, with 11.24 trials per 100,000 cases and 52.42 trials per 100,000 deaths. Regional patterns showed similar trends. The Western Pacific was associated with 13.88 trials per 100,000 cases and 66.14 trials per 100,000 deaths, highlighting a disproportionately high research focus.

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Category	All trials	Cases per 100k	Deaths per 100k	All trials per prevalence unit	All trials per mortality unit
Income group					
HIC	82,288	2,027	238	40.6	345.75
UMIC	25,631	746	160	34.37	160.19
LMIC	7,578	259	70	29.26	108.26
LIC	206	136	49	1.51	4.2
WHO region					
Europe	34,715	1,584	237	21.92	146.48
Americas	39,675	1,249	141	31.77	281.38
Western Pacific	41,286	858	180	48.12	229.37
Southeast Asia	5,316	263	73	20.21	72.82
Eastern Mediterranean	2,575	237	61	10.86	42.21
Africa	1,056	164	49	6.44	21.55
Tumor type					
Lymphoma + myeloma	9,888	29	5	341	1,977.60
Leukemia	7,628	17	4	448.7	1,907
Breast	14,236	99	9	143.8	1,581.80
Melanoma + skin	3,006	96	2	31.3	1,503
Prostate	6,650	63	5	105.6	1,330
Colon + rectum	9,617	67	12	143.5	801.4
Endocrine glands	729	25	1	29.2	729
Corpus uteri	655	18	1	36.4	655
Cervix uteri	2,314	19	4	121.8	578.5
Bladder	1,638	22	3	74.5	546
Lung	11,214	33	23	339.8	487.6
Urinary tract	738	15	2	49.2	369
Stomach	3,257	23	10	141.6	325.7

Fig. 3 | All cancer trials versus cancer burden for regions, income groups and tumor types. This figure displays the distribution of all cancer clinical trials to cancer burden (both incidence and mortality) across World Bank income groups, WHO regions and for the 13 most prevalent tumor types. 'All trials per prevalence unit' represents the number of trials per 100,000 prevalent cases, while 'all trials per mortality unit' indicates the number of trials per 100,000 cancer deaths. Higher values indicate greater research intensity per burden unit. These ratios provide a direct measure of research activity relative to population-level disease burden and highlight inequities in clinical trial allocation. Higher ratios reflect greater research investment per unit of burden. Shading reflects the range of values from high (red) to low (blue) for ease of comparison (100k, 100,000 individuals).

The Americas and Europe followed, with 46.07 and 23.24 trials per mortality unit, respectively. Meanwhile, Africa and the Eastern Mediterranean regions showed the lowest engagement, with less than three trials per 100,000 deaths and under one trial per 100,000 cases in Africa. These values reflect severe underrepresentation in clinical research of vast areas of the world despite evident disease burden. Our findings also suggest that, although UMICs have expanded their research portfolios, this effort remains insufficient to match epidemiological need. This observation is corroborated by a Spearman correlation ($\rho = 1.00, P < 0.001$) indicating that national income level strongly predicts trial density, whereas geographic region alone shows only a moderate, nonsignificant association ($\rho = 0.49, P = 0.33$).

Underrepresentation of several high-burden cancers was evident also for trials actively recruiting. Globally, liver, stomach and pancreatic cancers were among the top six causes of cancer death but did not appear among the most frequently studied cancers (Fig. 5). Regional analyses magnified these discrepancies: in the Western Pacific, four of the region's six most lethal cancers (liver, stomach, esophageal and pancreatic) were all absent from the top six by trial representation. Southeast Asia exhibited similar misalignment, with cervical, liver, esophageal and mouth or oropharyngeal cancers critically underrepresented. In Europe, both pancreatic and stomach cancer ranked among the top six causes of death but did not receive corresponding research focus. These patterns were echoed in the Eastern Mediterranean, Americas and Africa, where liver and pancreatic cancers were recurrently neglected. Cervical cancer, a major contributor to mortality in Africa and Southeast Asia, was not among the most-studied cancers.

These findings suggest that the number of registered trials might not translate into commensurate investigation of the cancers accounting for the highest lethality, particularly in lower-resource settings. Contributing factors likely include market-driven funding mechanisms that favor indications with higher commercial return, general inadequate regulatory and operational infrastructure in LMICs and a persistent disconnect between global research agendas and local epidemiology. To redress this misalignment, stakeholders must prioritize reallocation of resources toward high-mortality, understudied cancers. Aligning research investment with disease burden and recognizing that scientific feasibility (for example, availability of candidate agents) and market incentives both influence trial distribution could help the global oncology trial portfolio yield more equitable, context-appropriate and practice-relevant evidence.

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Category	Recruiting trials	Cases per 100k	Deaths per 100k	Recruiting trials per prevalence unit	Recruiting trials per mortality unit
Income group					
HIC	14,285	2,027	238	7.05	60.02
UMIC	8,387	746	160	11.24	52.42
LMIC	1,379	259	70	5.32	19.7
LIC	21	136	49	0.15	0.43
WHO region					
Europe	5,509	1,584	237	3.48	23.24
Americas	6,496	1,249	141	5.2	46.07
Western Pacific	11,906	858	180	13.88	66.14
Southeast Asia	799	263	73	3.04	10.95
Eastern Mediterranean	665	237	61	2.81	10.9
Africa	127	164	49	0.77	2.59

Fig. 4 | Recruiting cancer trials versus cancer burden for regions and income groups. This figure presents the number of recruiting cancer clinical trials alongside burden-adjusted metrics across World Bank income groups and WHO regions. 'Recruiting trials per prevalence unit' refers to the number of trials per 100,000 prevalent cancer cases, while 'recruiting trials per mortality unit' refers to the number of trials per 100,000 cancer deaths. These ratios provide a direct measure of research activity relative to population-level disease burden and highlight inequities in clinical trial allocation. Higher ratios reflect greater research investment per unit of burden. Shading reflects the range of values from high (red) to low (blue) for ease of comparison.

A snapshot of phase 3 trials

A total of 8,217 large phase 3 clinical trials with at least 100 participants were further analyzed. Four cancer types (breast cancer; tracheal, bronchus and lung cancers; lymphomas; and colorectal cancer) accounted for 53% of all trials. Most trials were conducted in the USA, but China led in the number of recruiting trials, with 729 active studies, followed by the USA, Japan, Germany and India, each with over 100 currently recruiting clinical trials. Most of these clinical trials were sponsored by academic or public institutions in all regions except the Americas, where pharmaceutical or biotechnology companies acted as the sponsor for most of the trials. These large phase 3 trials are likely to have the greatest public health impact; most are concentrated in a few countries and on a few cancer types, mirroring the issues seen with trials at all stages.

Domestic research initiatives predominate

The proportion of cancer clinical trials involving multinational collaboration was calculated to infer the global collaborations and knowledge sharing in cancer clinical trials across different countries and regions, particularly between HICs and other income groups. Single-country trials constituted 85% of the total, with 75,597 trials conducted primarily within individual countries. Multinational trials represented only 15% of the total (13,472 trials); specifically, 9% were conducted in the context of HIC–HIC collaboration and 6% were between HIC and other income groups (UMIC, LMIC and LIC). Looking at the recruiting trials, this percentage dropped to 3% (746 trials) (Table 1).

The observation that a substantial majority of cancer clinical trials are conducted within individual countries implies a predominant focus on domestic research initiatives. This may be influenced by various factors such as funding availability, regulatory differences and logistical challenges associated with coordinating international studies[23]. The relatively limited proportion of trials engaging in multicountry collaboration, especially between HICs and LICs or LMICs, suggests persistent barriers to extensive global cooperation in cancer research. Identifying and addressing these challenges is essential for promoting more inclusive and equitable global collaboration in cancer clinical trials. On the other hand, our findings also indicate that most clinical trials in LICs and LMICs are delivered in the context of north–south partnership. Global collaboration between HICs and limited-resource settings presents potential drawbacks, particularly when the influence is disproportionately skewed toward HIC-driven research initiatives. This imbalance can result in a mismatch between the research priorities of LICs and LMICs and the agendas set by HICs, by which specific health needs in southern regions are deprioritized or overlooked. In addition to causing inefficiencies and waste of resources, the imposition of research priorities that may not resonate with local communities gives rise to ethical concerns regarding the potential colonialist exploitation of underserved populations. There is also a risk that the sustainability of interventions may be overlooked, and the benefits of research may not translate effectively to LMIC populations due to issues related to affordability, accessibility and local adaptation. To mitigate these challenges, efforts should promote equitable partnerships that involve local stakeholders in the research process, prioritize capacity building and ensure that the research agenda aligns with the local health needs and priorities. Collaboration should aim for mutual benefit and the advancement of global health while respecting the unique challenges and strengths of each participating country.

Imbalance toward pharmacological interventions

Consistent with previous findings, we observed a substantial disproportion in the number of clinical trials focused on drugs compared to radiotherapy and surgical procedures, which are integral components of cancer management[24,25]. Most trials were drug related (54,279; 61%), while other categories were less represented, including procedures (10,015; 11%), biological interventions (5,494; 6%), behavioral interventions (2,490; 3%), devices (2,354; 3%), radiotherapy (2,486; 3%) and diagnostic tests (559; 1%) (Table 1). This discrepancy may reflect historical biases and a prevailing emphasis on drug-centric approaches, often driven by industry, in cancer research[26]. While drug trials are undoubtedly crucial for developing new therapeutic options, an overemphasis on pharmaceutical interventions hampers a holistic understanding of and progress in cancer treatment and management. Addressing these imbalances is critical for promoting a more comprehensive and patient-centered approach to cancer research.

The low number of diagnostic studies reflected in the data is exacerbated by the fact that diagnostic tests are not required to be registered in a clinical trial registry, as they do not meet the criteria stated in the International Standards for Clinical Trial Registries, which specifies that, for the purposes of registration, an interventional clinical trial

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	Cancer type	Clinical trial rate	Cancer type	Mortality rate
Globally	Breast cancer	12.55%	Tracheal, bronchus and lung cancer	18.70%
	Tracheal, bronchus and lung cancer	9.71%	Colon and rectal cancers	9.30%
	Lymphomas, multiple myeloma	9.53%	Liver cancer	7.80%
	Colon and rectal cancers	8.18%	Breast cancer	6.80%
	Leukemia	7.26%	Stomach cancer	6.80%
	Prostate cancer	60.5%	Pancreatic cancer	4.80%
Western Pacific	Breast cancer	9.77%	Tracheal, bronchus and lung cancer	26.10%
	Tracheal, bronchus and lung cancer	13.99%	Liver cancer	11.70%
	Lymphomas, multiple myeloma	8.43%	Colon and rectum cancers	10%
	Leukemia	5.60%	Stomach cancer	9.60%
	Prostate cancer	3.78%	Esophageal cancer	6%
	Colon and rectal cancers	3.78%	Pancreatic cancer	4.90%
Southeast Asia	Breast cancer	20.13%	Tracheal, bronchus and lung cancer	10.90%
	Tracheal, bronchus and lung cancer	10.86%	Breast cancer	9.40%
	Lymphomas, multiple myeloma	7.52%	Cervical and uterine cancer	7.80%
	Leukemia	3.79%	Liver cancer	6.80%
	Prostate cancer	3.21%	Esophagus cancer	6.70%
	Colon and rectal cancers	3.21%	Mouth and oropharyngeal cancer	6.50%
Europe	Breast cancer	12.87%	Tracheal, bronchus and lung cancer	19.40%
	Tracheal, bronchus and lung cancer	9.08%	Colon and rectal cancers	21.10%
	Lymphomas, multiple myeloma	11.66%	Breast cancer	7.20%
	Leukemia	7.47%	Pancreatic cancer	6.90%
	Prostate cancer	6.70%	Prostate cancer	5.60%
	Colon and rectal cancers	8.54%	Stomach cancer	5.20%
Eastern Mediterranean	Breast cancer	29.93%	Breast cancer	10.90%
	Tracheal, bronchus and lung cancer	4.93%	Tracheal, bronchus and lung cancer	10.20%
	Lymphomas, multiple myeloma	4.10%	Liver cancer	9.60%
	Leukemia	7.07%	Stomach cancer	6.40%
	Prostate cancer	2.84%	Colon and rectal cancers	6.20%
	Colon and rectal cancers	8.33%	Leukemia	5.20%
Americas	Breast cancer	12.61%	Tracheal, bronchus and lung cancer	16.60%
	Tracheal, bronchus and lung cancer	9.22%	Colon and rectal cancers	9.60%
	Lymphomas, multiple myeloma	11.73%	Breast cancer	7.50%
	Leukemia	9.58%	Prostate cancer	6.90%
	Prostate cancer	7.88%	Pancreatic cancer	6.50%
	Colon and rectal cancers	5.14%	Liver cancer	5.10%
Africa	Breast cancer	22.09%	Cervical and uterine cancer	13.00%
	Tracheal, bronchus and lung cancer	14.42%	Breast cancers	12.20%
	Lymphomas, multiple myeloma	11.45%	Prostate cancer	8.50%
	Leukemia	2.97%	Liver cancer	6.80%
	Prostate cancer	8.49%	Colon and rectal cancers	6.30%
	Colon and rectal cancers	3.68%	Tracheal, bronchus and lung cancer	4.50%

Fig. 5 | Imbalance between tumor-specific mortality and research focus. This figure shows the six most deadly cancer types within each WHO region along with the proportion of all recruiting cancer clinical trials in that region that targeted the specific cancer type. This allows for a region-specific burden context. Shading reflects the range of values from high (red) to low (blue) for ease of comparison.

is one that assigns participants to 'one or more health-related interventions to evaluate the effects on health outcomes' (ref. 27). Thus, knowledge of the diagnostics research landscape is severely limited worldwide. A strategic shift in research priorities is required to ensure that nonpharmaceutical, preventative and diagnostic interventions receive adequate attention. Considering the multidisciplinary nature of cancer care, the research agenda must encompass all the various therapeutic modalities and diagnostic advancements. To attract domestic and external funding and encourage local investment, particularly in disproportionately unfunded areas such as prevention, early detection, surgery, radiotherapy and supportive care, a compelling investment case must be made, showing the return on such investments[13]. This

BOX 2

Evidence-informed priority actions

1. **Build enabling trial ecosystems in LMICs.** The cancer clinical trial landscape remains largely dominated by HICs. Targeted investments in regulatory capacity, ethics review, data infrastructure and workforce training for investigators, coordinators and monitors are essential to create sustainable, locally led research platforms in low-resource settings.
2. **Align research with disease burden and context.** Funding allocations must be weighted toward cancers that account for the greatest mortality in each setting. Integrating implementation science methods will ensure that study designs, end points and recruitment strategies fit local epidemiology and health system capacity.
3. **Prioritize adequately powered, inclusive trials.** 63% of studies enroll fewer than 100 participants, while only 3.3% include children and 28% explicitly enroll older adults. Funders should favor robust sample sizes and mandate age-disaggregated recruitment targets to enhance statistical power and representativeness.
4. **Expand multicountry collaboration.** Only 3% of recruiting trials are multinational. Incentivizing cross-country collaboration and establishing regional south–south consortia can raise this share, lowering costs, improving oversight and enhancing data generalizability.
5. **Diversify intervention portfolios.** Radiotherapy, surgery and diagnostic studies currently represent less than 10% of all oncology trials. Dedicated, ring-fenced funding calls, embedded in national cancer control plans, should stimulate research across the full continuum of cancer care.
6. **Strengthen registration and real-time oversight.** With 17% of ICTRP records missing key fields, enforcing timely, complete registry updates and integrating automated quality checks will improve transparency, accountability and the usefulness of secondary analyses.

exercise can facilitate the prioritization of research by governments and its inclusion into national health agendas.

Gaps and limitations

Our Review has several limitations that need to be considered. First, we focused exclusively on interventional studies. Observational studies, which may not consistently appear in international trial registries, were deliberately excluded from our analyses at this stage. Second, we did not collect information on the intervention, trial protocol, design, composition, demographics, outcome results, statistical analysis plan, informed consent forms or safety data of studies, which are crucial components for a comprehensive analysis of clinical trials. Third, variations in regulations across different registries and countries, in definitions, uncertainty in accuracy, consistency and quality of the data in the registry as well as the risk of duplicate entries, posed considerable challenges. These limitations, common to any trial database, introduced the potential for incomplete data and discrepancies between fields across the WHO Trial Registration Data Sets. Forth, while we provide a global overview, the use of WHO regions may mask substantial intra-regional disparities. We also acknowledge that our analysis does not fully capture intra-nation heterogeneity. More granular insights and country-level analyses will be available through forthcoming regional reports and interactive visualizations on the WHO Global Observatory on Health R&D, available in the WHO landscape of clinical trials on cancer. We also acknowledge that our analysis does not evaluate trial quality, a key determinant of scientific validity and clinical impact, nor does it include comprehensive data on funding sources. Consequently, variations in methodological rigor, end point robustness and funder influence remain unexamined.

Lastly, on a broader note, it is well known that a substantial number of trials are not registered[28]. The quality and completeness of clinical trial registration remain key challenges in ensuring transparency and accountability in global cancer research. This depends on individual investigators submitting trial details correctly and providing timely updates. Delayed or incomplete registration can lead to underrepresentation of recent trials, affecting the reliability of trial data for policy and research planning. Despite several global agreements and ethical frameworks emphasizing the importance of trial registration[28–30], legal requirements vary by country, potentially influencing compliance rates and data quality across regions. To enhance the integrity and usability of trial registries, stronger enforcement of registration policies, increased oversight and greater incentives for timely updates are needed. Harmonizing global registration standards, strengthening compliance mechanisms and promoting data transparency will be crucial to ensure that clinical trial data effectively inform cancer research and healthcare decision-making worldwide.

These limitations collectively underscore the need for caution in the interpretation of our findings, acknowledging the inherent complexities in analyzing clinical trial data on a global scale, and also highlight areas for further research and analysis. Despite these caveats, we believe that the global overview of interventional cancer clinical trials provided here is comprehensive and reliable.

Translating data into action

This Review represents the most exhaustive global landscape analysis of cancer clinical trials to date, focusing on equity and inclusion and addressing a major gap in the existing literature. Previous mappings have primarily focused on single cancer types, specific funding streams or therapeutic product pipelines, predominantly within high-income settings and relying largely on ClinicalTrials.gov or bibliographic databases[6,31–34]. Our findings highlight both the remarkable progress and persistent disparities in global cancer trials across regions and income settings. These inequities threaten the external validity of trial results, undermine their applicability in diverse settings and perpetuate unequal access to potentially life-saving innovations. Our findings provide the critical empirical evidence to inform policy, practice and investment decisions, supporting WHO's commitment to assist member states and non-state actors in advancing high-quality, patient-centered, locally relevant and equitable cancer research. Key actionable outputs directly supported by our data are included in Box 2.

These six outputs translate our core findings into concrete, measurable actions that the WHO, member states and partners can begin to implement immediately to reduce equity gaps and maximize the global impact of cancer clinical research. Nevertheless, translating these outputs into practice across heterogeneous settings is inherently complex; reforming the cancer clinical trial ecosystem and realizing the full transformative potential of clinical trials requires sustained political commitment, coordinated multisectoral governance and integrated, resource-optimized implementation strategies. Importantly, cancer clinical trials cannot be addressed in isolation. They must be integrated into the broader clinical research agenda to benefit from system-wide reforms in trial regulation, infrastructure, financing and oversight. Embedding cancer-specific priorities within these cross-cutting frameworks is essential to maximize synergies, promote efficiency and ensure that oncology research contributes meaningfully to broader goals of health equity and universal health coverage. In this context and in line

with the mandate conferred by World Health Assembly resolution WHA75.8 (2022) on strengthening clinical trials, the WHO (in collaboration with partners) has developed the guidance for best practices for clinical trials[14]. This guidance sets normative standards for ethical, scientifically rigorous and patient-centered research, along with the global action plan for clinical trial ecosystem strengthening[35], which translates these standards into nine strategic priorities, including leadership and governance, community engagement, innovative design, workforce development, regulatory efficiency, health system integration, transparency, sustainable financing and international collaboration.

Building upon this collaborative approach, the WHO (together with the International Agency for Research on Cancer and the global oncology community) has both the opportunity and the responsibility to support the development of a coherent, equity-focused cancer research agenda, particularly one that addresses unmet needs and underrepresented populations. Advancing such an agenda is critical to ensure that transformative, practice-changing evidence equitably benefits all patient populations. Realizing these objectives will contribute to the establishment of sustainable, resilient and high-quality cancer research ecosystems, reduce disparities in cancer care and outcomes and ultimately strengthen health systems globally while accelerating progress toward universal health coverage and the health-related Sustainable Development Goals.

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