

Cancer research output of North Africa did not contract after 2011 but turned inward: a controlled interrupted time-series and collaboration analysis, 1996 to 2025

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الإنتاج البحثي في السرطان في شمال إفريقيا لم ينكمش بعد عام 2011 بل تحول إلى الداخل: تحليل السلاسل الزمنية المتقطعة المضبوطة والتعاون، 1996 إلى 2025

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Abstract:

Background: Cancer research capacity across North Africa has grown unevenly, and the effect of Libya's post-2011 institutional disruption on its scientific output has not been measured. This study quantifies the Libyan trajectory against four regional comparators and tests whether it diverged after 2011.

Methods: All cancer-related records from Libya, Egypt, Tunisia, Algeria, and Morocco indexed in OpenAlex between 1996 and 2025 were retrieved (156,715 unique records). Annual counts were modeled with a controlled interrupted time series using negative binomial regression, with country fixed effects and cluster-robust standard errors, with Libya as the treated series and the interruption set at 2011. International co-authorship was modeled at the record level by logistic regression.

Results: Libyan output did not fall after 2011. The level change relative to the region was not significant (incidence rate ratio 0.88, 95% confidence interval 0.57 to 1.36), and the post-2011 slope exceeded the regional trend (incidence rate ratio 1.06 per year, 1.035 to 1.077). International collaboration diverged in the opposite direction: every comparator co-authorship rate rose after 2011, whereas Libya declined (odds ratio 0.73 per year, 0.65 to 0.82). The composition of Libyan collaboration also rotated: the share of international papers involving Western partners fell from 55 to 44 percent, while the regional Arab share rose from 25 to 59 percent, carried chiefly by a strengthening tie with Egypt. Contributing institutions per paper rose, indicating denser domestic networks rather than isolation.

Conclusions: Institutional disruption did not reduce the volume of Libyan cancer research, which continued to grow, but coincided with a turn toward domestic and regional rather than Western authorship. Quantity and integration moved in opposite directions, a pattern that volume-only bibliometrics would miss.

Keywords: Bibliometrics; Cancer Research; Libya; North Africa; Interrupted Time Series; Research Collaboration; OpenAlex.

المخلص:

الخلفية: نمت القدرة البحثية في مجال السرطان بشكل غير متساوٍ عبر شمال إفريقيا، ولم يتم قياس تأثير الاضطراب المؤسسي في ليبيا بعد عام 2011 على إنتاجها العلمي. تقوم هذه الدراسة بقياس المسار الليبي مقارنةً بأربع دول إقليمية واختبار ما إذا كان قد انحرف بعد عام 2011.

الطرق: تم استرجاع جميع السجلات المتعلقة بالسرطان من ليبيا ومصر وتونس والجزائر والمغرب المفهرسة في OpenAlex بين عامي 1996 و2025 (156,715 سجلاً فريداً). تم نمذجة العدادات السنوية باستخدام تحليل السلاسل الزمنية المتقطعة المضبوط عبر انحدار ثنائي سالب مع تأثيرات ثابتة للبلد وأخطاء معيارية قوية للعنقود، مع اعتبار ليبيا السلسلة المعالجة وتحديد نقطة الانقطاع في عام 2011. تم نمذجة المشاركة الدولية في التأليف على مستوى السجل من خلال الانحدار اللوجستي.

النتائج: لم ينخفض الإنتاج الليبي بعد عام 2011. لم يكن التغيير في المستوى مقارنة بالمنطقة ذا دلالة إحصائية (نسبة معدل الحدوث 0.88، فاصل ثقة 95% من 0.57 إلى 1.36)، وتجاوز الميل بعد عام 2011 الاتجاه الإقليمي (نسبة معدل الحدوث 1.06 سنوياً، من 1.035 إلى 1.077). اتجه التعاون الدولي في الاتجاه المعاكس: ارتفع معدل المشاركة في التأليف لكل دولة مقارنة بعد عام 2011، في حين انخفض في ليبيا (نسبة الأرجحية 0.73 سنوياً، من 0.65 إلى 0.82). كما تغير تكوين التعاون الليبي: انخفضت حصة الأوراق البحثية الدولية التي تضم شركاء غربيين من 55% إلى 44%، بينما ارتفعت الحصة العربية الإقليمية من 25% إلى 59%، مدفوعة أساساً بتعزيز العلاقات مع مصر. ارتفع عدد المؤسسات المساهمة في كل ورقة بحثية، مما يشير إلى وجود شبكات محلية أكثر كثافة بدلاً من العزلة.

الاستنتاجات: لم يقلل الاضطراب المؤسسي من حجم الأبحاث الليبية المتعلقة بالسرطان، والتي استمرت في النمو، ولكنه تزامن مع تحول نحو التأليف المحلي والإقليمي بدلاً من التأليف الغربي. تحرك الكمية والتكامل في اتجاهين متعاكسين، وهو نمط قد تقوته القياسات الببليومترية التي تعتمد على الحجم فقط.

الكلمات المفتاحية: القياسات الببليومترية؛ أبحاث السرطان؛ ليبيا؛ شمال إفريقيا؛ السلاسل الزمنية المتقطعة؛ التعاون البحثي؛ OpenAlex

Introduction

Cancer has become one of the leading causes of death worldwide, and successive global estimates show its incidence and mortality rising, with the sharpest relative increases now falling on low- and middle-income countries (Sung et al., 2021; Bray et al., 2018; Torre et al., 2015). North Africa sits within this shift. The region combines an aging and urbanizing population with a persistent load of infection-associated malignancies, and its cancer burden is growing faster than the health systems and research base that must respond to it (Abdul Sater et al., 2023).

Research capacity has not kept pace with that burden, and it has grown unevenly across the region. Egypt, Tunisia, and Morocco have built visible oncology research communities, whereas output from Libya has stayed comparatively thin and has attracted little bibliometric attention (Tashani, 2009). Knowing where and why regional research capacity diverges is a prerequisite for directing scarce research investment, yet most regional bibliometrics stop at descriptive counts and do not test whether a country departs from its neighbors.

Libya offers an unusual natural setting for studying how institutional stability shapes research output. The country entered a period of sustained disruption after 2011, and its higher education system split into competing administrations after 2014 (Tamtam et al., 2011; Milton, 2022). Neighboring states with comparable disease burden, language, and colonial history did not undergo the same rupture, which supports a controlled comparison rather than the single-country description that characterizes most regional work.

How institutional disruption affects national research is not obvious in advance. Analyses of the Arab Spring found that research productivity in several affected countries rose rather than fell, driven partly by heightened international attention (Ibrahim, 2018). A closer study of health research on Syria after 2011 reached a more specific conclusion: output grew, but the share of papers with a local first or last author fell, and articles with no author affiliated to a Syrian institution eventually overtook those with one (Abdul-Khalek et al., 2020). Broader surveys of Middle Eastern research performance describe the same tension between rising counts and uneven local participation (Gul et al., 2015). Volume and integration can therefore

move in opposite directions, and a count of publications alone can conceal a hollowing of domestic authorship.

International co-authorship is a standard marker of a research system's external integration. It has grown for decades across nearly all fields, organizing into a dense and self-reinforcing global network, and it is generally associated with greater visibility and impact (Adams, 2013; Wagner & Leydesdorff, 2005; Wagner et al., 2017; Katz & Martin, 1997). For a small and disrupted system, the rate and orientation of international co-authorship therefore carry information that publication counts do not. In the Middle East and North Africa specifically, collaboration and mobility patterns are strongly shaped by ties to Europe, North America, and, increasingly, the Gulf states (El-Ouahi et al., 2021).

Two questions follow. First, did the volume of Libyan cancer research change relative to its neighbors after 2011? Second, did the character of that research change, measured by the rate and orientation of international co-authorship? The two questions can diverge: output can grow while becoming more domestic, or shrink while integrating. This study was designed to separate them, using a controlled interrupted time series for volume and record-level models of collaboration, so that a change in one is not mistaken for a change in the other.

Materials and Methods

Data source and corpus

Bibliographic records were retrieved from OpenAlex, an open scholarly index of more than 250 million works (Priem et al., 2022). OpenAlex was chosen over subscription databases because its records can be redistributed in full, which makes the corpus fully reproducible, and because access does not depend on an institutional subscription. Independent assessments find its coverage suitable for bibliometric analysis and broadly comparable to the major commercial indexes for most purposes, while noting weaker coverage of some non-English and regional venues (Alperin et al., 2024; Culbert et al., 2025). A record entered a country corpus when at least one author affiliation resolved to an institution in that country, using the OpenAlex institution country code. Whole counting applied: a record with affiliations in two study countries counted once for each.

Cancer-related records were identified by a fixed title, abstract, and keyword query rather than by subject classification, because journal-level categories both admit non-oncology content and miss oncology work in specialty titles. The query and extraction date are available from the corresponding author. Publication years spanned 1996 to 2025 inclusive; 1996 is the earliest year with stable regional coverage. Articles, reviews, letters, editorials, book chapters, and preprints were included. Records were deduplicated on digital object identifier, retaining records without one. The final corpus held 156,715 unique records.

Primary analysis: volume

Annual counts were modeled with a controlled interrupted time series, an approach widely used to estimate the effect of a discrete shock on a time-ordered outcome (Lopez Bernal et al., 2017; Wagner et al., 2002). The estimator was negative binomial regression with a log link, chosen over Poisson because the counts were over-dispersed. Country fixed effects were included: contrasting Libya against a single pooled comparator intercept forces genuine rate differences among the four comparators into the dispersion term and inflates the standard errors, an effect confirmed by simulation before the real data were analyzed. The model estimated a Libya-specific level change at 2011 and a Libya-specific change in slope thereafter, and these two terms carried the primary inference. A population offset was tested and did not alter the estimates, because the country fixed effects already absorb between-country scale; it was therefore omitted from the reported model. Standard errors were clustered by country. The parallel-trends assumption was tested on the pre-2011 data alone.

The model took the form:

$$\log E[Y_{ct}] = \alpha_c + \beta_1 T_t + \beta_2 P_t + \beta_3 T^*_t + \beta_4 (L_c \times T_t) + \beta_5 (L_c \times P_t) + \beta_6 (L_c \times T^*_t)$$

where the outcome is the annual cancer publication count for country c in year t ; α_c are country fixed effects; T is calendar time; P indicates the post-2011 period; T^* is time elapsed since 2011; and L indicates Libya. The three Libya interaction terms (β_4 , β_5 , β_6) correspond to the pre-2011 trend difference, the level change at 2011, and the post-2011 slope change reported in Table 1.

Secondary analysis: international collaboration

A record was classified as internationally co-authored, for a given country, when its affiliation set contained any country outside that one. Collaboration was modeled at the record level by logistic regression with country fixed effects and a Libya-specific time trend, estimating whether the Libyan collaboration trajectory diverged from the regional trend before and after 2011. The composition of collaboration was then examined by classifying each international partner as Western (Europe or North America) or regional (Arab or North African; the regional category therefore spans the broader Arab world, including Gulf states such as Saudi Arabia, and is not restricted to the Maghreb) and by tabulating individual partner countries and the number of distinct contributing institutions per paper. Analyses were run in Python with statsmodels. Code and derived data are available as described in the Data and code availability section.

Results and Discussion

Corpus

The corpus comprised 156,715 unique records across the five countries. Egypt accounted for the largest share, followed by Morocco, Tunisia, Algeria, and Libya. Libyan cancer output rose from 2 records in 1996 to 14 in 2011 and 656 in 2025. Annual counts for all five countries appear in Figure 1.

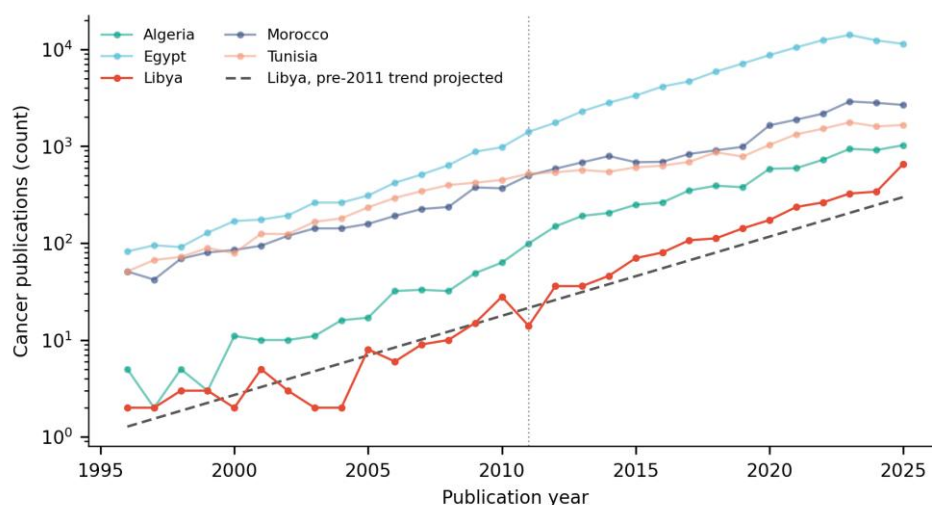


Figure 1. Annual cancer publication counts for the five countries, 1996 to 2025, log scale. The dashed line projects the pre-2011 Libyan trend; observed counts run above it, indicating continued growth rather than contraction. The dotted vertical line marks 2011.

Measured against the regional average, Libyan output stayed a small fraction of the comparator mean throughout the period but turned upward after 2011, rising from about 0.02 of the mean of the four comparators at the interruption to 0.16 by 2025 (Figure 2). The ratio shows gradual convergence from a very low base rather than the fall that a disruption account would predict.

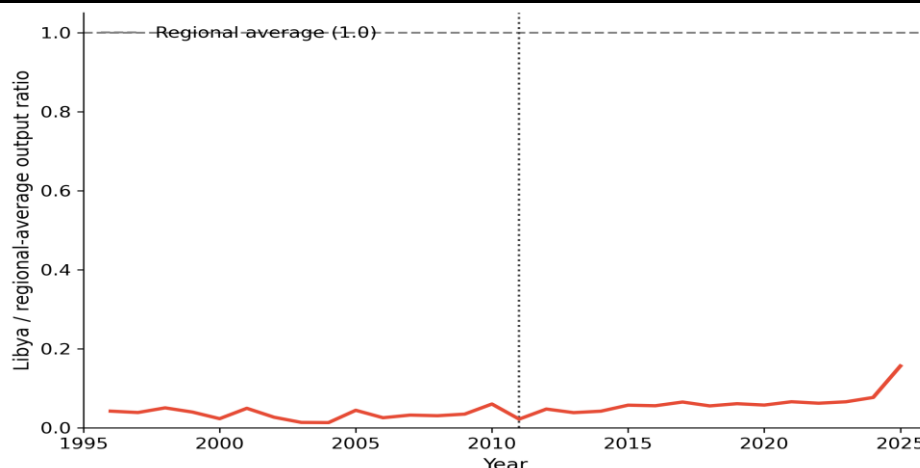


Figure 2. Libyan cancer output relative to the regional average, 1996 to 2025. The ratio is Libyan annual output divided by the mean annual output of Egypt, Morocco, Tunisia, and Algeria; the dashed line marks parity with the regional average and the dotted vertical line marks 2011.

Volume did not contract after 2011

The parallel-trends assumption held in the pre-2011 period (interaction coefficient 0.036, $p = 0.23$), supporting the controlled comparison. The Libya-specific level change at 2011 was not statistically significant (incidence rate ratio 0.88, 95% confidence interval 0.57 to 1.36, $p = 0.57$); there was no abrupt drop in output at the interruption. The post-2011 slope for Libya exceeded the regional trend (incidence rate ratio 1.06 per year, 1.035 to 1.077, $p < 0.001$). Libyan cancer output continued to grow after 2011, and grew somewhat faster than the regional trajectory rather than slower. Coefficients appear in Table 1. The small pre-2011 trend difference that Table 1 records for Libya (incidence rate ratio 1.02 per year, $p = 0.01$) reflects the precision of the pooled model rather than a substantive divergence: the design-appropriate parallel-trends test on the pre-2011 data alone does not reject parallel trends, and the estimated difference, about two percent per year, runs in the direction that would understate rather than exaggerate post-2011 growth. The projection of the pre-2011 Libyan trend understates the observed post-2011 counts rather than overstating them, the opposite of what a disruption-driven contraction would produce.

Table 1. Controlled interrupted time-series of annual cancer publication counts, negative binomial regression with country fixed effects and cluster-robust standard errors. Libya is the treated series; the interruption is set at 2011. IRR, incidence rate ratio; CI, confidence interval.

Term	IRR	95% CI	p
Level change at 2011 (Libya vs region)	0.88	0.57 to 1.36	0.57
Slope change after 2011 (Libya vs region)	1.06	1.035 to 1.077	<0.001
Libya pre-2011 trend vs region	1.02	1.006 to 1.042	0.01

Parallel-trends test on pre-2011 data: interaction coefficient 0.036, $p = 0.23$ (assumption retained).

International collaboration diverged downward

The collaboration analysis reversed the direction of the volume finding. In the years around 2011, Libya had the highest international co-authorship rate of the five countries, near 63 percent. By 2023 to 2025 it had fallen to about 55 percent, while every comparator rose over the same span: Egypt from 38 to 50 percent, Tunisia from 38 to 49 percent, Algeria from 50 to 60 percent, and Morocco from 41 to 42 percent. The logistic model estimated a significant downward divergence in the Libyan collaboration slope after 2011 (odds ratio 0.73 per year, 95% confidence interval 0.65 to 0.82, $p < 0.001$), against a rising regional trend. Figure 3 shows the trajectories, and Table 2 reports the model. Libyan output therefore grew in volume

while becoming progressively more domestic in authorship; the two measures moved in opposite directions across the same period.

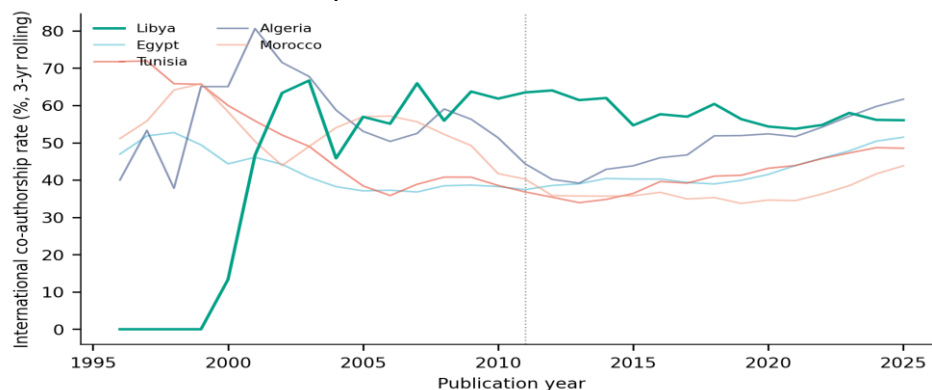


Figure 3. International co-authorship rate by country, 1996 to 2025, three-year rolling mean. Libya (bold) declines after 2011 while the comparators rise. The dotted vertical line marks 2011.

Table 2. Record-level logistic regression of international co-authorship, with country fixed effects and a Libya-specific time trend. OR, odds ratio; CI, confidence interval.

Term	OR	95% CI	p
Libya pre-2011 collaboration trend vs region	1.28	1.14 to 1.44	<0.001
Libya collaboration level shift at 2011	0.99	0.52 to 1.86	0.96
Libya collaboration slope shift after 2011	0.73	0.65 to 0.82	<0.001

Collaboration substituted regional ties for Western ones

The decline in collaboration was not uniform across partners. Before 2011, Libyan international papers were oriented toward Western partners: 55 percent involved a co-author in Europe or North America, against 25 percent involving a regional Arab or North African partner. After 2011 the orientation reversed. The regional share rose to 59 percent while the Western share fell to 44 percent (Figure 4). Because the two blocs are not mutually exclusive, these shares need not sum to 100 percent. Libyan cancer research did not simply collaborate less; it rotated its collaboration base from Western toward regional partners.

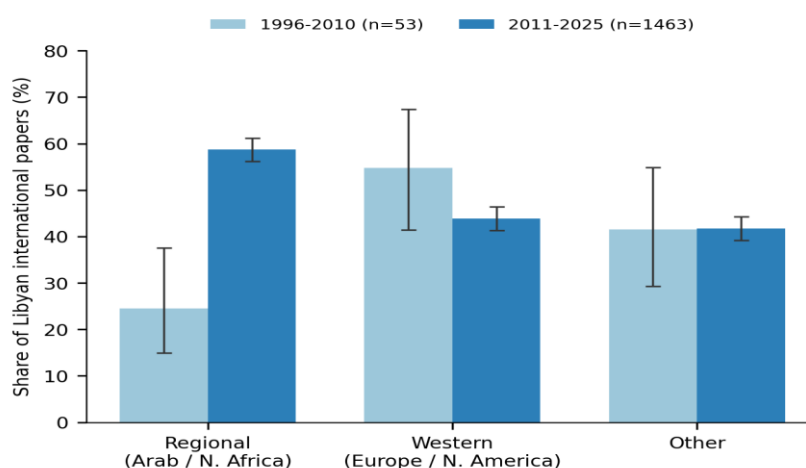


Figure 4. Composition of Libyan international cancer collaboration before and after 2011, with 95% Wilson confidence intervals. The regional Arab and North African share rose from 25% (95% CI 15 to 38) to 59% (56 to 61), while the Western share fell from 55% (41 to 67) to 44% (41 to 46); the two periods hold 53 and 1,463 international papers respectively. The wide pre-2011 intervals reflect the small early corpus. Blocs are not mutually exclusive, because a paper may involve partners from more than one.

The reorientation was concentrated in a small number of partners rather than spread evenly across the region. Egypt accounted for most of it: its share of Libyan international papers rose from about 13 percent before 2011 to 36 percent afterward, the largest single movement, with Saudi Arabia (6 to 19 percent) and the United States (9 to 17 percent) also rising. The two leading pre-2011 partners receded over the same period: the United Kingdom fell from 21 to 15 percent and India from 19 to 9 percent (Figure 5). The rise in the regional share is therefore driven largely by a strengthening tie with Egypt, with a secondary contribution from Saudi Arabia.

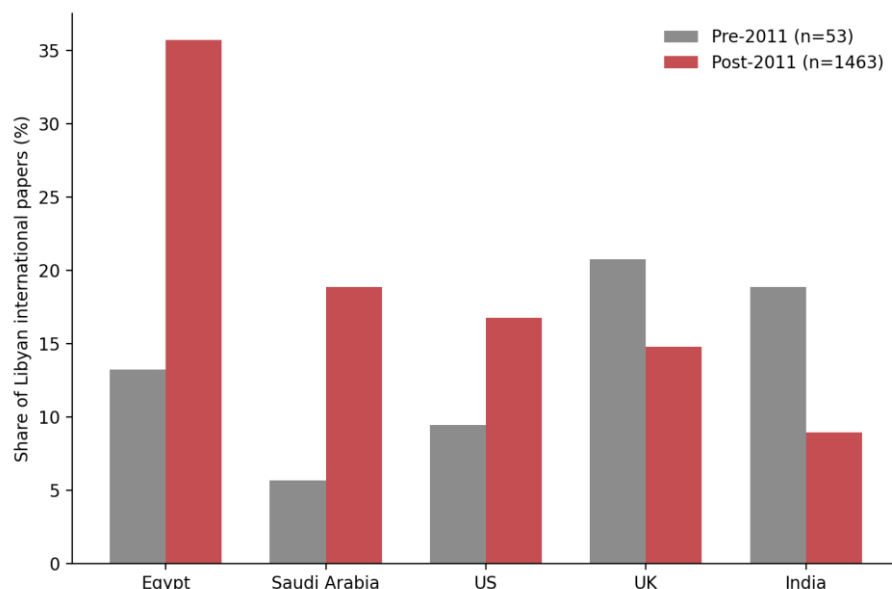


Figure 5. Share of Libyan international papers involving each of the five leading partner countries, before and after 2011 (pre-2011 n = 53; post-2011 n = 1,463). Egypt and Saudi Arabia rise while the United Kingdom and India fall.

This rotation was not an artifact of large multi-country consortia. The 45 Libyan papers with ten or more partner countries, the type produced by global disease-burden consortia, fell after 2011, which could in principle inflate every bloc at once. Excluding them left the pattern essentially unchanged: among the remaining post-2011 papers the regional share was 58.3 percent and the Western share 42.2 percent, against 59 and 44 percent for all post-2011 papers (Table 3). The rotation is therefore carried by ordinary bilateral collaborations rather than by a handful of large author lists. The pre-2011 comparison rests on 53 international papers, which is sufficient to establish the direction of the shift but not to place a narrow interval on its magnitude.

Table 3. Sensitivity of the collaboration-orientation shift to large multi-country consortia, post-2011 Libyan international papers.

Subset	n international papers	Western share	Regional share
All post-2011 papers	1,463	44%	59%
Excluding 45 papers with 10 or more partner countries	1,418	42.2%	58.3%

Shares are not mutually exclusive because a paper may involve partners from more than one bloc. Regional denotes Arab or North African partners; Western denotes partners in Europe or North America.

The inward turn coincided with denser domestic networks

The shift toward domestic authorship did not correspond to institutional isolation. The mean number of distinct institutions per Libyan paper rose from 2.12 before 2011 to 3.41 afterward, while the share of single-institution papers fell from 39 to 35 percent (Figure 6). Libyan

cancer research therefore drew on a wider set of contributing institutions after 2011, consistent with the growth of national rather than international collaboration.

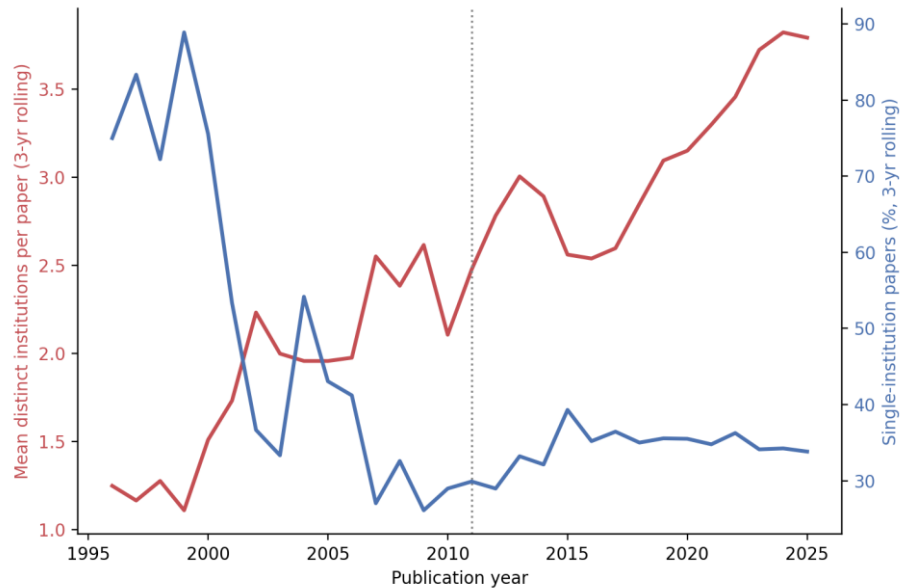


Figure 6. Domestic institutional breadth of Libyan cancer papers, 1996 to 2025, three-year rolling means. Mean distinct institutions per paper (left axis) rises while the share of single-institution papers (right axis) falls. The dotted vertical line marks 2011.

The venue mix shifted toward fee-free open access

The access profile of Libyan cancer papers also changed across the interruption. Before 2011, closed-access publication was the largest category, near 47 percent; after 2011 it fell to about 10 percent, and open access rose to roughly nine in ten papers. The single largest post-2011 category was diamond open access, that is, journals that charge neither authors nor readers, which accounted for about 37 percent of Libyan cancer papers (Figure 7). The pre-2011 profile rests on 100 papers and is correspondingly noisy, so this comparison is read as descriptive rather than tested.

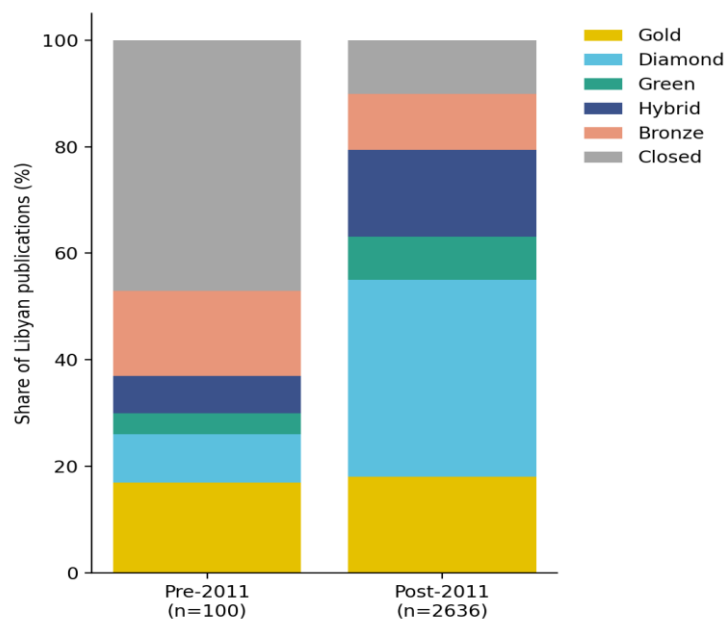


Figure 7. Open-access status of Libyan cancer publications before and after 2011 (pre-2011 n = 100; post-2011 n = 2,636). Closed access contracts while diamond and gold open access expand.

Discussion

Read together, the two analyses point in opposite directions: volume grew, if anything slightly faster than the regional trend, while international co-authorship fell as every comparator rose. This mirrors what has been reported for other Arab research systems under strain, where publication counts rose even as local integration weakened (Ibrahim, 2018; Abdul-Khalek et al., 2020). A volume-only analysis would have reported growth and stopped there, missing the shift in how that growth was produced.

The inward turn is the more informative result. A research system under institutional strain can maintain or increase output through domestic collaboration and local publication venues while its external ties weaken. Comparable contractions or reorientations of international collaboration have been documented in other national research systems under acute strain, including Ukraine after 2022 and the global research system during the first year of the COVID-19 pandemic (Damaševičius & Zailskaitė-Jakštė, 2023; Fry et al., 2020). That pattern is consistent with reduced travel, disrupted funding for international projects, and the fragmentation of institutional partnerships, though the present design cannot attribute the change to any single cause.

The composition of the change is more specific than its magnitude. Libyan collaboration rotated away from Western partners and toward regional ones after 2011, rather than contracting evenly, and that rotation was carried chiefly by a strengthening tie with Egypt. Several mechanisms are consistent with this. The benefits of international collaboration, including greater visibility and access to methods and funding, are well established (Katz & Hicks, 1997). Sustaining Western partnerships, however, carries high transaction costs tied to individual mobility, competitive grants, and formal institutional agreements, all of which are vulnerable to disruption (Landry & Amara, 1998). Regional collaboration draws instead on shared language, geographic proximity, and diaspora networks that are more robust to instability. Because the global collaboration network has continued to grow and densify over the same period (Wagner et al., 2015), the Libyan reorientation is better read as a redirection within an expanding system than as withdrawal from a shrinking one. Separating these mechanisms would require author-level mobility data beyond the present corpus.

The institutional data address one question directly. The rise in distinct institutions per paper, together with the fall in single-institution work, indicates that the inward turn was accompanied by denser domestic networks rather than by isolation. A parallel change appears in publication venues: Libya's open-access share rose from roughly one half of cancer papers before 2011 to about nine in ten afterward, with fee-free diamond journals becoming the single largest category. Openness of this kind is associated with wider reach for national research systems (Wagner et al., 2018), but a shift resting on no-fee regional and community venues also reflects the economics of publishing under constraint, where article processing charges are a genuine barrier for under-resourced authors (Ayeni & Larivière, 2026). This venue shift is descriptive and was not modeled, but it is consistent with a move toward regional and community outlets alongside regional co-authors. Any assessment of that shift should weigh a possible trade-off: open access in itself tends to widen readership, but the fee-free regional and community journals that now carry much of this output are typically less indexed and less internationally visible than the Western venues they partly displaced, so sustained volume need not translate into sustained reach, a tension that linking journal-level quality indicators would let future work test directly.

The study has clear limits. The interruption at 2011 is confounded with conflict, sanctions, currency collapse, and academic emigration, which coincide within a few years and cannot be separated using annual counts. OpenAlex coverage of regional and Arabic-language journals is incomplete and probably understates output most for Libya, a limitation noted in earlier bibliometric work on Libyan publications (Bakoush et al., 2007). The Libyan corpus is small in the early years, which widens the uncertainty on the pre-2011 trend; the full volume model

showed a marginally significant pre-2011 divergence ($p = 0.01$) even though the dedicated parallel-trends test on pre-period data alone did not, and readers should weigh the collaboration finding, which rests on the larger post-2011 record counts, more heavily than the precise shape of the early volume trend. Finally, international co-authorship is one measure of research integration and does not capture citation impact or the quality of the venues involved.

The natural extension is to link journal-level quality indicators once an open quartile source is joined, so that the reorientation in venues and partners can be weighed against changes in research quality, and to add author-level data that would let the domestic and diaspora components of the inward turn be distinguished.

Conclusion

The period of institutional disruption after 2011 did not reduce the volume of Libyan cancer research, which continued to grow. It coincided with a measurable turn away from international collaboration, against a regional trend in the opposite direction, and with a rotation of the remaining collaboration from Western toward regional partners, chiefly Egypt. The domestic side of that turn was denser rather than more isolated, as the number of contributing institutions per paper rose and publication moved toward fee-free regional venues. Research systems under strain can expand and reorient at once, and monitoring volume alone would miss both the reorientation and its direction. For research policy in Libya and comparable settings, tracking collaboration structure alongside output offers an earlier and more sensitive signal of a system under strain than publication counts provide on their own.

Conflicts of interest

The authors declare no conflict of interest.

Funding

This research received no external funding.

Ethics statement

This study used only publicly available, aggregated bibliographic metadata and involved no human participants, human data, or animals; ethical approval was therefore not required.

Author contributions

A.M.A. conceived and designed the study, performed the analysis, and drafted the manuscript. S.M.E. and R.A.A. contributed to data interpretation and critical revision. All authors read and approved the final manuscript.

Data and code availability

The full record set was obtained from OpenAlex, which is openly available and imposes no redistribution restriction. The extraction query and its date, the analysis code, and the derived annual-count and record-level datasets are available from the corresponding author on reasonable request. Because the underlying index is openly accessible, the corpus can be reconstructed from the query and every figure and coefficient reproduced without a subscription.

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