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Tattoo pigment migration to lymph nodes: biological, immunological and clinical implications

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ABSTRACT

Introduction: Tattoo pigments can move beyond the skin and reach regional lymph nodes. Although most of the ink remains in the tattooed area, some pigment particles can enter lymphatic vessels and accumulate in nearby nodes, where they may interact with immune cells. *Methods*: We reviewed selected literature available in PubMed from January 1992 to March 2026 concerning tattoo pigment migration, its accumulation in lymph nodes, and possible health effects of its long-term presence in the lymphatic system. *Results*: Studies show that tattoo pigment can be transported from the skin to regional lymph nodes. Macrophages can take up pigment particles and carry them through lymphatic vessels. Tattoo ink components have been identified in lymphatic tissue using microscopic and physicochemical methods. Their migration may depend on pigment composition and particle size. Pigment in lymph nodes has been accompanied by inflammatory changes and altered immune-cell activity in experimental studies. However, the long-term significance of these findings remains unclear. At the same time, pigment can help during microscopic examination of a lymph node, as it may indicate material transported from a tattooed area. *Conclusions*: Tattoo pigment can reach regional lymph nodes and remain there for years. Its presence shows that tattoo-related effects are not limited to the skin. Whether long-term pigment persistence in lymph nodes causes lasting changes in immune responses or other health effects remains uncertain.

Keywords: tattoo, tattoo ink, lymphatic system, lymph nodes, pigment migration

1. INTRODUCTION

Tattooing permanently inserts ink containing pigments into the dermis. After the procedure, some pigment remains at the application site, but some particles may migrate beyond the tattoo area. A key factor in characterizing tattoo inks is the physicochemical properties of their pigments. Analyses of commercial inks revealed nanometric particles. Høgsberg et al., (2011) found nanoparticles in most of the analyzed ink samples, particularly in black inks. Nanoparticles may affect the biological properties and kinetics of inks in the body, but the body's response to these particles requires further study. Once the pigment enters the skin, it contacts

immune cells. Macrophages can engulf ink particles, which may contribute to their retention in tissues.

At the same time, the pigment can be transported via lymphatic drainage. Studies conducted in an animal model have shown that pigment components can be rapidly transported to regional lymph nodes. A 28-day study in a porcine model demonstrated that components derived from tattoo pigment translocated to lymph nodes. Their levels in the nodes reached relatively stable levels within the first week after tattooing (Cambiaso-Daniel et al., 2024). These results suggest that the lymphatic system plays a role in transports ink components from the tattoo site to the lymph nodes. In mice, tattoo ink reached the draining lymph nodes shortly after tattooing, and much of the pigment was found inside macrophages. Eight weeks after tattooing, inflammatory activity was still visible in the lymph nodes examined by Capucetti et al., (2025). The pigment can become particularly problematic when one of these nodes is examined because of suspected cancer. Dark deposits from a tattoo may give the node an appearance similar to melanoma spread, making it difficult to tell the two apart during surgery. A darkly pigmented node, for example, may look similar to a metastatic lesion during surgery, which can raise concern for melanoma even when the pigmentation is related to the tattoo rather than the tumour.

Several cases have been reported in which tattoo pigment in regional lymph nodes resembled melanoma metastases. To distinguish tattoo pigment from melanoma metastases in such cases, histopathological examination was required, including analysis of pigment location within cells and immunohistochemistry (Dujmović et al., 2020). This diagnostic difficulty is not limited to melanoma. Pigment in the lymph nodes can also complicate the assessment of the sentinel node in patients with other types of cancer. In a study involving patients with breast cancer who had tattoos on the same side of the body, tattoo pigment was detected in some of the lymph nodes that had been removed. Pigment in the lymph nodes can also present a problem during sentinel node biopsy in breast cancer patients. Soran et al., (2017) reported cases of nodes containing tattoo pigment that did not contain either the blue dye or the Tc-99m tracer used to identify the sentinel node. This may lead to the removal of additional lymph nodes. However, in the studied group, pigmentation did not result in any metastatic sentinel nodes being missed. The presence of tattoo pigment in a lymph node does not mean that malignancy is absent.

Jaigirdar et al., (2009) described cases in which tattoo pigment was found together in the same sentinel node as a melanoma metastasis. This shows that pigment cannot be used to rule out malignancy. In the context of melanoma diagnosis, the possibility that tattoo pigment and metastatic lesions may look similar is especially important. Anderson et al., (1996) described the case of a patient with melanoma and previous tattoos who was found to have black lymph nodes during surgery, which raised the suspicion of metastasis. However, histopathological examination showed preserved lymph node architecture and a large amount of black pigment. Mass spectrometry confirmed that the pigment was consistent with tattoo ink. This case shows that macroscopic staining of a lymph node is not enough to diagnose metastasis and that histopathological confirmation is required. Another aspect of tattoo pigments in the body is their possible toxicological importance. The inks may contain, among other things, metals, polycyclic aromatic hydrocarbons, and primary aromatic amines, some of which may harm health.

Nevertheless, the real clinical significance of this kind of exposure still needs to be investigated (Negi et al., 2022). This paper summarizes current knowledge about the migration of tattoo pigments through the lymphatic system, their accumulation in lymph nodes, and their possible biological and clinical consequences. It also examines inflammatory and immune responses associated with pigment in lymphatic tissues and the clinical importance of this phenomenon in diagnosing lymph node diseases.

2. REVIEW METHODS

We searched the PubMed database for relevant scientific publications on tattoo pigments, pigment migration, the lymphatic system, lymph nodes, lymphadenopathy, inflammation, immune responses, and the possible health effects of tattooing. The publications reviewed were those from January 1992 to March 2026. The PubMed search included combinations of the following terms: “tattoo”, “tattoo ink”, “tattoo pigment”, “lymph node”, “lymphatic system”, “lymphadenopathy”, “inflammation”, “immune response”, and “lymphoma”. Studies that were experimental, clinical, histopathological, epidemiological, or review type were included if they were relevant to the aims of this review. Publications that did not directly deal with tattoo pigments, lymphatic involvement, or the possible health effects of tattooing were excluded. The article screening process followed the PRISMA guidelines (Figure 1).

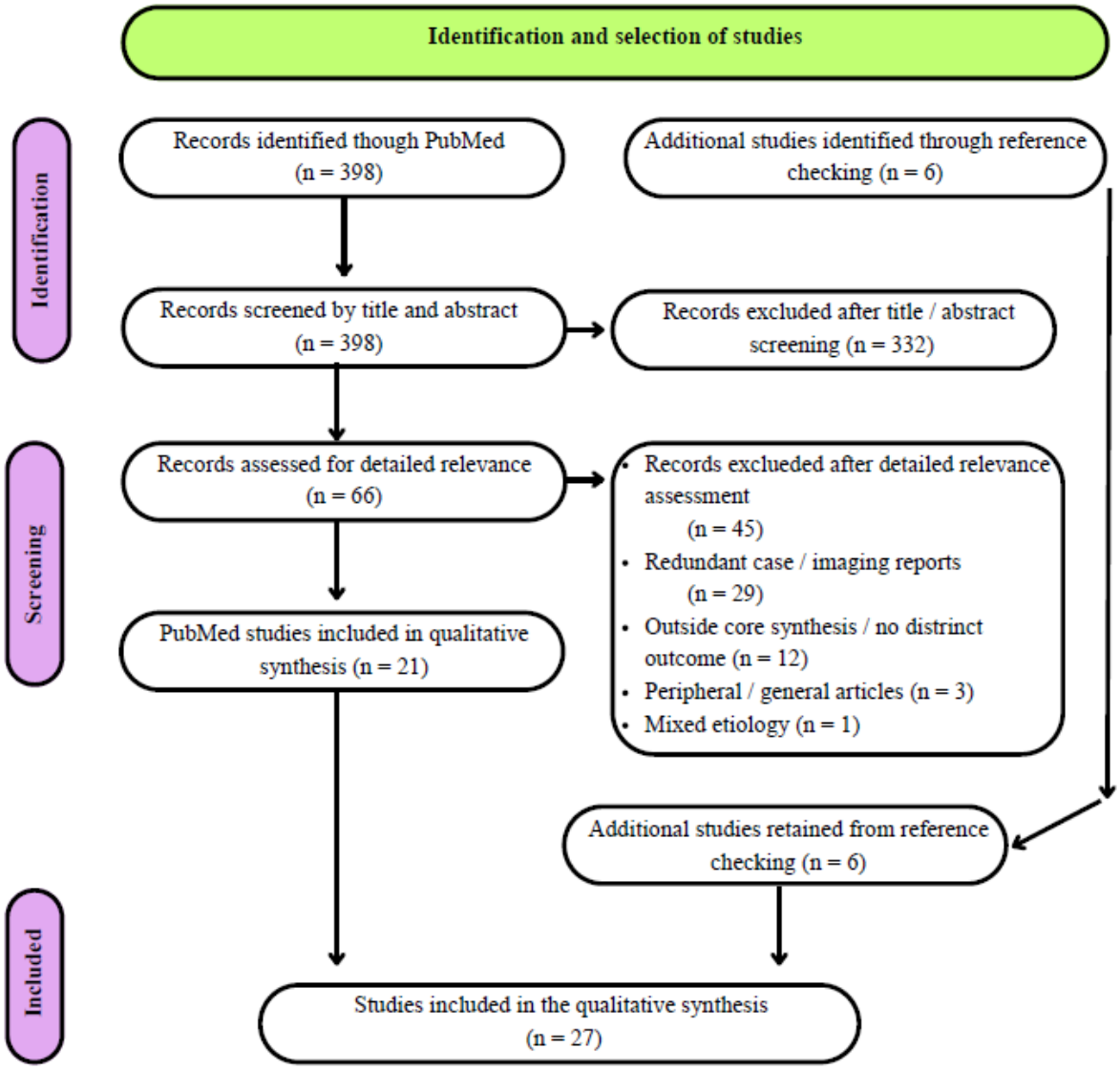


Figure 1. PRISMA flow diagram of the literature search and study selection process.

3. RESULTS AND DISCUSSION

The migration of tattoo pigment to lymph nodes

After tattooing, some pigment remains at the application site, while some may migrate beyond the tattooed area. One place where pigment is found is in the regional lymph nodes, and autopsy studies have also shown that pigment can migrate there. Hellerich, in his analysis of 275 autopsies, discovered tattoos on the upper limbs in 31 people, in all of whom pigmentation of the axillary lymph nodes was almost always present. The composition of the deposited pigment matched that found in the tattooed skin, confirming its migration to regional lymph nodes (Hellerich, 1992).

The migration might involve more than just the nearest lymph node. In the case of a patient who had cervical cancer, tattoo pigment was found in several pelvic and para-aortic lymph nodes. The greater amount of black pigment in the left-sided pelvic nodes as compared to the para-aortic nodes corresponded to the position of the tattoo on the left lower limb and indicated that the pigment

had migrated along the lymphatic drainage pathways (Tamura et al., 2019). These findings show that pigmentation in the lymph nodes may be linked to a particular area of the skin and its lymphatic drainage.

The presence of pigment in lymph nodes and lymphadenopathy

Pigment in lymph nodes doesn't have to be asymptomatic. The medical literature includes instances of lymph node enlargement, both locally and affecting several nodal groups. One case report described generalized lymphadenopathy associated with tattoo pigments, showing that the reaction can extend beyond a single regional lymph node (Hennedige et al., 2009). Localized lymphadenopathy can also cause symptoms. A young patient was reported to have a painful enlargement of an inguinal lymph node. Imaging showed an enlarged, darkly pigmented lymph node, which raised suspicion of malignancy. However, histopathological examination showed that the black pigment came from a tattoo on the lower limb. Following the removal of the affected lymph node, the symptoms disappeared (Balasubramanian et al., 2013).

The pigmentation of lymph nodes as a problem in diagnosis

A major practical result of pigment migration is that it can be mistaken for a malignant lesion. This is especially relevant in people who have been diagnosed with melanoma, since darkly coloured lymph nodes can look, when seen with the naked eye, like metastases. In subungual melanoma, the sentinel lymph node biopsy showed black, firm axillary nodes. The intraoperative findings initially suggested metastasis, but histopathological examination showed tattoo pigment rather than cancer cells (Peterson et al., 2008). A similar issue has been noted in the case of vulvar cancer. The patient had inguinal and femoral nodes that were considerably enlarged, and this could have been taken to mean that there was metastasis. Finally, histopathological examination showed tattoo pigment and reactive follicular hyperplasia, with no evidence of metastasis (Beavis et al., 2012). This case shows that a history of tattooing can be important when diagnosing lymphadenopathy.

Tattoo pigment can also make the interpretation of imaging findings more difficult. In one case, pigment deposits were found in the axillary lymph nodes and appeared as calcifications on breast imaging. This raised a concern about possible lymph node disease. However, after taking the patient's history of tattooing into account, histopathological examination confirmed that the changes were caused by tattoo pigment and were benign (Sokolovskaya and Shariff, 2015).

Why pigment is important in sentinel node biopsy

A specific clinical issue is the presence of pigment in the sentinel nodes of patients who have melanoma. In cases of extensive tattooing, pigment may build up in the regional lymph nodes, making them appear dark. In this case, two enlarged, black sentinel nodes strongly indicated that melanoma had metastasized. Yet, on histopathological examination, no neoplastic changes were found, and the pigment was mainly situated in the subcapsular spaces and sinuses of the nodes (Manganoni et al., 2014). The same kind of difficulty can arise in the context of treatments for other types of cancer. Because lymph nodes become pigmented, they might be mistaken for sentinel nodes even though they are not functionally such nodes. Lymphoscintigraphy showed that the pigmented cervical node was not a sentinel node. Histopathological examination confirmed tattoo pigment (Pinto et al., 2015).

The inflammatory reactions associated with the presence of pigment

Tattoo pigment in lymph nodes may also be accompanied by inflammatory changes. Particular attention should be paid to granulomatous reactions linked with tattoos since these can appear within the tattooed area and, in certain cases, may occur alongside systemic sarcoidosis. Reports describe both local granulomatous reactions limited to the tattooed area and cases in which skin lesions were associated with an underlying systemic disease (Ali et al., 2008). Current observations also indicate that both local and generalized lymphadenopathy can be associated with tattoos. Reported cases also show that tattoo pigment may be found in enlarged lymph nodes. In patients with more widespread lymphadenopathy, granulomatous changes have been reported in mediastinal and hilar lymph nodes. Because these changes can look similar to those seen in neoplastic disease, they may sometimes result in additional diagnostic tests or invasive procedures (Jacobi et al., 2026).

Tattoo pigment is not always confined to the tattooed skin. It has been found in regional lymph nodes, sometimes together with inflammatory changes in the node tissue. Dodig et al., (2024) included local inflammation and systemic symptoms among the complications reported after tattooing. These observations raise a broader question about retained pigment: although its presence in lymph nodes has been documented, its significance for health over longer periods has not yet been established.

The possible consequences of having pigment present for a long time

It is still unclear whether the long-term presence of pigment in lymph nodes affects health. The presence of pigment in a lymph node does not necessarily indicate disease. A study involving patients with melanoma examined the impact of nodal pigmentation on prognosis. The researchers found that tattoo pigment in lymph nodes did not affect survival in patients with melanoma (Müller et al., 2018). On the other hand, epidemiological evidence indicates a possible link between tattooing and the development of lymphoma. Nielsen et al., (2024) reported a higher occurrence of lymphoma among tattooed people in a Swedish population-based study. They did not find a clear explanation for this difference, and the data did not show that tattoo ink was responsible.

More recent histopathological studies have nevertheless identified tattoo pigment in lymph nodes with some frequency. In an analysis of 90 lymph nodes containing tattoo pigment, the authors observed several histopathological features, including perivascular and sinusoidal pigment deposits, follicular hyperplasia, plasmacytoid infiltrates, and foreign body reactions. The 90 lymph nodes examined by O'Malley et al., (2026) showed considerable variation in the way tattoo pigment was distributed and how the surrounding tissue responded. Pigment was observed around blood vessels and within lymphatic sinuses, and some nodes also showed changes in lymphoid follicles, accumulation of histiocytes, or granuloma formation. In other words, tattoo pigment was not associated with a single consistent histopathological pattern. The authors focused on describing these tissue changes rather than determining whether retained pigment alters lymph node function over time. Studies do not give a clear answer about whether tattooing is associated with lymphoma. Evidence on cancer risk is still inconsistent. In a recent Danish twin study, lymphoma and some skin cancers were diagnosed more often in participants with tattoo exposure. This finding is not supported by all available evidence, however. A systematic review and meta-analysis did not detect a statistically significant link between having tattoos and lymphoma. Because these studies reached different conclusions, it is not yet possible to say that tattoo exposure directly causes lymphoma (Clemmensen et al., 2025; McConnell et al., 2025). Larger epidemiological studies with long follow-up periods are needed to determine whether prolonged exposure to tattoo pigment has any measurably effects on the risk of lymphoma or other diseases.

The effect of tattoo pigment on the immune response

After entering the skin, the pigment is taken up by immune cells, including macrophages. This may partially explain why the pigment remains in the tissues for a long time. In a study by Vitipon et al., (2025), human macrophage-like cells rapidly took up ink components. The response was not the same for every tattoo ink tested. Some formulations affected cell viability and function more than others, which may reflect differences in their pigment composition. This is relevant given that Sozer Karadagli et al., (2024) detected trace amounts of cadmium, mercury, lead, and chromium in the inks they analysed. The presence of these metals provides a possible explanation for why different formulations produced different cellular responses. They noted that exposure to these metals caused dose- and color-dependent reductions in the viability of human keratinocyte viability. Keratinocytes produced more IL-18 when treated with certain tattoo inks. Similar effects have been reported in macrophages. Vitipon et al., (2025) observed signs of mitochondrial dysfunction after treatment with iron oxide pigments, together with increased oxidative stress and higher secretion of IL-6 and TNF-α. Taken together, these observations point to changes in inflammatory signalling at the cellular level, although the responses differed depending on the cell type and pigment involved.

The nature of these effects depended on the type of pigment, suggesting that the immune response may be related to the physicochemical properties of the ink components. Tattoo pigment does not necessarily stay at the site of injection. After entering the lymphatic system, it can accumulate in nearby lymph nodes and has also been detected in nodes farther from the tattooed area. In these nodes, pigment deposits have been associated with visible pigmentation, enlarged nodes, and inflammatory changes. This can create a diagnostic problem, particularly when altered lymph nodes are investigated for possible malignancy, because pigment-related changes may resemble pathological findings. What is much less clear is whether this accumulation has consequences for health after many years. An important area of research is the possible link between long-term exposure to tattoo ink components and diseases of the lymphatic system, including lymphoma. The main findings of the studies included in this review are summarized in Table 1.

Table 1. Summary of the main findings on tattoo pigment in the lymphatic system.

Study	Type of study	Main finding	Lymphatic effect	Clinical relevance
Hellerich, 1992	Autopsy study	Tattoo pigment was found in regional lymph nodes.	Migration of pigment to lymph nodes	Confirms lymphatic transport of tattoo pigment

Jaigirdar et al., 2009	Case report	Tattoo pigment and melanoma metastasis were found in the same lymph node.	Pigment accumulation	Pigment does not exclude malignancy
Soran et al., 2017	Clinical study	Tattoo pigment was found in lymph nodes during sentinel node assessment.	Nodal pigmentation	May complicate sentinel node evaluation
Müller et al., 2018	Clinical study	Nodal tattoo pigment was not associated with survival differences in melanoma patients.	Persistent nodal pigmentation	No clear prognostic effect demonstrated
Tamura et al., 2019	Histopathological study	Pigment was found in pelvic and para-aortic lymph nodes.	Migration along lymphatic pathways	Shows that pigment may reach more distant nodes
Cambiaso-Daniel et al., 2024	Animal study	Pigment components rapidly reached lymph nodes.	Rapid lymphatic distribution	Experimental evidence of pigment transport
Nielsen et al., 2024	Epidemiological study	An association between tattooing and lymphoma was reported.	Possible long-term effect	Requires further investigation
Capucetti et al., 2025	Experimental study	Tattoo ink reached draining lymph nodes and was associated with inflammatory and immune changes.	Inflammation and immune response	Suggests possible biological effects of pigment

4. CONCLUSION

Tattoo pigment can move from the skin to nearby lymph nodes through the lymphatic system and can remain there for a long time. In some cases, it may cause visible pigmentation or inflammatory changes in the lymph nodes. This is important in clinical practice because tattoo pigment can sometimes resemble malignant changes during lymph node examination. At present, it is still not clear whether the long-term presence of tattoo pigment in lymph nodes has important effects on health. Further studies are needed to better understand its possible long-term consequences.

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Conceptualization: Karolina Katarzyna Hermanowska

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Writing-review, Editing, Visualization & Supervision: Karolina Katarzyna Hermanowska
All authors have read and agreed to the published version of the manuscript.

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Conflict of interest
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Data and materials availability
All data associated with this study will be available based on the reasonable request to the corresponding author.

REFERENCES

1. Ali SM, Gilliam AC, Brodell RT. Sarcoidosis appearing in a tattoo. J Cutan Med Surg 2008; 12(1):43-48. doi:10.2310/7750.2007.00040.
2. Anderson LL, Cardone JS, McCollough ML, Grabski WJ. Tattoo pigment mimicking metastatic malignant melanoma. Dermatol Surg 1996; 22(1):92-94. doi:10.1111/j.1524-4725.1996.tb00578.x.
3. Balasubramanian I, Burke JP, Condon E. Painful, pigmented lymphadenopathy secondary to decorative tattooing. Am J Emerg Med 2013; 31(6):1001.e1-1001.e2. doi:10.1016/j.ajem.2013.02.011.
4. Beavis A, Amneus M, Aoyama C, Holschneider CH. Tattoo pigment lymphadenopathy mimicking metastasis in vulvar cancer. Obstet Gynecol 2012; 120(2 Pt 2):442-444. doi:10.1097/AOG.0b013e3182583be2.
5. Cambiaso-Daniel J, Luze H, Meschnark S, Fink J, Schreiver I, Rappl T, Goessler W, Kotzbeck P, Kamolz LP. Tattoo Pigment Biokinetics in vivo in a 28-Day Porcine Model: Elements Undergo Fast Distribution to Lymph Nodes and Reach Steady State after 7 Days. Dermatology 2024; 240(2):304-311. doi: 10.1159/000536126.
6. Capucetti A, Falivene J, Pizzichetti C, Latino I, Mazzucchelli L, Schacht V, Hauri U, Raimondi A, Virgilio T, Pulfer A, Mosole S, Grau-Roma L, Bäumler W, Palus M, Renner L, Ruzek D, Goldman Levy G, Foerster M, Chahine K, F Gonzalez S. Tattoo ink induces inflammation in the draining lymph node and alters the immune response to vaccination. Proc Natl Acad Sci USA 2025; 122(48):e2510392122. doi: 10.1073/pnas.2510392122.
7. Clemmensen SB, Mengel-From J, Kaprio J, Frederiksen H, von Bornemann Hjelmborg J. Tattoo ink exposure is associated with lymphoma and skin cancers – a Danish study of twins. BMC Public Health 2025; 25: 170. doi: 10.1186/s12889-025-21413-3.
8. Dodig S, Čepelak-Dodig D, Gretić D, Čepelak I. Tattooing: immediate and long-term adverse reactions and complications. Arh Hig Rada Toksikol 2024; 75(4): 219–227. doi: 10.2478/aiht-2024-75-3921.
9. Dujmović A, Jurišić N, Mance M, Bulić K, Vrbanović Mijatović V, Mijatović D. Tattoo Pigment within Regional Lymph Nodes Mimicking Cutaneous Melanoma Metastasis. Acta Dermatovenerol Croat 2020; 28(1):47-48.
10. Hellerich U. Tattoo pigment in regional lymph nodes--an identifying marker? Arch Kriminol 1992; 190(5-6):163-170.
11. Hennedige A, Joseph L, Zeiton A. An unusual case of tattoo pigments and systemic lymphadenopathy. Eur J Dermatol 2009; 19(6):654-655. doi:10.1684/ejd.2009.0799.

12. Høgsberg T, Loeschner K, Löf D, Serup J. Tattoo inks in general usage contain nanoparticles. Br J Dermatol 2011; 165(6):1210-1218. doi:10.1111/j.1365-2133.2011.10561.x.
13. Jacobi MM, Bereswill S, Heimesaat MM. Tattoos causing local and even generalized lymphadenopathies including sarcoidosis. Eur J Microbiol Immunol (Bp) 2026; 16(1):59-66. doi:10.1556/1886.2026.00009.
14. Jaigirdar AA, Yeh MW, Sharifi E, Browne LW, Leong SPL. Coexisting tattoo pigment and metastatic melanoma in the same sentinel lymph node. J Cutan Med Surg 2009; 13(6):321-5. doi: 10.2310/7750.2009.08056.
15. Manganoni AM, Sereni E, Pata G, Ungari M, Pavoni L, Farisoglio C, Calzavara-Pinton PG, Farfaglia R. Pigmentation of axillary sentinel nodes from extensive skin tattoo mimics metastatic melanoma: case report. Int J Dermatol 2014; 53(6):773-776. doi:10.1111/ijd.12417.
16. McConnell T, Xu J, Freeman J, Zak I, Frain J. Investigating the potential association between tattoos and lymphoma: an exploratory systematic review and meta-analysis. EClinical Med 2025; 89: 103563. doi: 10.1016/j.eclinm.2025.103563.
17. Müller CSL, Gräber S, Therre J, Körner R, Pföhler C, Vogt T. Nodal pigmentation due to tattoo pigment does not influence survival of melanoma patients. J Dtsch Dermatol Ges 2018; 16(7):917-918. doi:10.1111/ddg.13557.
18. Negi S, Bala L, Shukla S, Chopra D. Tattoo inks are toxicological risks to human health: A systematic review of their ingredients, fate inside skin, toxicity due to polycyclic aromatic hydrocarbons, primary aromatic amines, metals, and overview of regulatory frameworks. Toxicol Ind Health 2022; 38(7):417–434. doi:10.1177/07482337221100870.
19. Nielsen C, Jerkeman M, Saxne Jöud A. Tattoos as a risk factor for malignant lymphoma: a population-based case-control study. EClinicalMedicine 2024; 72:102649. doi:10.1016/j.eclinm.2024.102649.
20. O'Malley DP, Cherry DA, Burack WR. More Than Skin Deep: Histopathologic Assessment of Tattoo Ink Deposition in Lymph Nodes. Int J Surg Pathol 2026; 34(6):1440-1445. doi: 10.1177/10668969261435590.
21. Peterson SL, Lee LA, Ozer K, Fitzpatrick JE. Tattoo pigment interpreted as lymph node metastasis in a case of subungual melanoma. Hand (N Y) 2008; 3(3):282-285. doi:10.1007/s11552-008-9107-1.
22. Pinto A, Wieshmann H, Triantafyllou A, Shaw R. Tattoo-pigmented cervical lymph node that masqueraded as the sentinel lymph node in oral squamous cell carcinoma. Br J Oral Maxillofac Surg 2015; 53(9):886-887. doi:10.1016/j.bjoms.2015.06.017.
23. Sokolovskaya E, Shariff Y. Calcifications in axillary lymph nodes on negative mammograms: tattoo pigment mimicking axillary lymph node calcifications. Breast J 2015; 21(6):678-679. doi:10.1111/tbj.12510.
24. Soran A, Menekse E, Kanbour-Shakir A, Tane K, Diego E, Bonaventura M, Johnson R. The importance of tattoo pigment in sentinel lymph nodes. Breast Dis 2017; 37(2):73-76. doi: 10.3233/BD-170282.
25. Sozer Karadagli S, Kaftan G, Cansever I, Armagan G, Sogut O. Tattoo inks: evaluation of cellular responses and analysis of some trace metals. Biometals 2024; 37(2):495-505. doi: 10.1007/s10534-023-00564-z.
26. Tamura D, Maeda D, Terada Y, Goto A. Distribution of tattoo pigment in lymph nodes dissected for gynecological malignancy. Int J Surg Pathol 2019; 27(7):773-777. doi: 10.1177/1066896919846395.
27. Vitipon M, Akingbagbohun E, Devime F, Diemer H, Hirschler A, Fenel D, Ravanel S, Carapito C, Rabilloud T. Beyond the ink: Cellular and molecular effects of iron-based pigments on macrophages. NanoImpact 2025; 39:100578. doi:10.1016/j.impact.2025.100578.