Palmar Angle of Tri-Radius Measurement for Breast Cancer Screening in Women: Rapid review

This document is a supplement to the rapid policy brief on the issue.

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Competing interests
The authors do not have any relevant competing interests.

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List of abbreviations

AIGGPA - Atal Bihari Vajpayee Institute of Good Governance and Policy Analysis
ATD – Angle of Tri-radius
CBE – Clinical Breast Examination
DTA – Diagnostic Test Accuracy
HWC – Health and Wellness Centre
MP – Madhya Pradesh
NCDs – Non-Communicable Diseases
NPCDCS - National Program for Prevention and Control of Cancer, Diabetes, Cardiovascular Diseases and Stroke
PIRD – Population, Index test, Reference test, Diagnosis of interest
RES – Rapid Evidence Synthesis
SHSRC – State Health Systems and Resource Centre
USG – Ultra Sonography

Executive Summary

Breast cancer is a commonly reported cancer among women in India, with an annual incidence of approximately 1,44,000. India's National Program for Prevention and Control of Cancer, Diabetes, Cardiovascular Diseases and Stroke (NPCDCS) mandates breast cancer screening for all women above 30 years of age through clinical breast examination (CBE) followed by ultra-sonography (USG) (with mammography if available in women aged over 35 years). However, there are resource implications and implementation challenges with the use of existing breast cancer screening methods. Therefore, there is a need to examine alternative cost-effective and non-invasive screening methods for breast cancer. We received a request to conduct a rapid evidence synthesis (RES) from the Atal Bihari Vajpayee Institute of Good Governance and Policy Analysis (AIGGPA), Madhya Pradesh to examine evidence on the angle of tri-radius measurement (ATD-angle) for screening breast cancer in women. The ATD-angle is a quantitative parameter of dermatoglyphics, which involves the study of epidermal ridges and patterns on palms and soles.

The primary objective of this RES was to identify and summarise evidence on the diagnostic test accuracy of palmar ATD-angle measurement for breast cancer screening in women. The specific aim was to examine the utility of ATD-angle in clearly identifying patients with breast cancer (sensitivity), as well as those without the condition (specificity). The evidence around cost-benefits and barriers and enablers to utilisation of this test was considered for examination only in the presence of confirmatory diagnostic accuracy of the test. We conducted a rapid review and searched for published and unpublished studies on diagnostic accuracy of ATD-angle, as the first step. Two reviewers independently screened all citations and reviewed full text articles of selected studies based on pre-specified inclusion criteria.

Overall, we identified 108 studies in our searches. Following a study selection process, 44 studies were deemed eligible for full text retrieval and examination. We were able to retrieve full texts of 38 studies. None of the studies met our pre-specified eligibility criteria for measuring the diagnostic accuracy of the test. Studies were excluded because of their focus on other populations of interest, unavailability of comparative methods of screening (reference tests), lack of detail on sensitivity and specificity of the test, and study designs not matching our criteria.

This RES highlighted the lack of evidence on the diagnostic accuracy of ATD-angle measurement as a screening tool for breast cancer in women. Further, the RES did not identify any studies that examined the costs, barriers or enablers for utilising ATD-angle measurement. The RES has identified the need to conduct a pilot study using a rigorous and an appropriate study design to understand the sensitivity, specificity and costs of ATD-angle measurement in relation to existing community screening modalities for breast cancer. Based on available evidence, we cannot recommend for or against the use of ATD-angle measurement for breast cancer screening in women. Future studies should consider measuring the sensitivity and specificity of ATD-angle measurement by comparing it existing reference screening methods.

1. Background

Breast cancer is a malignant tumor of the mammary glands. According to Indian Council of Medical Research (ICMR), the India has approximately 1,44,000 new cases a year.(1) Breast cancer is the most commonly reported cancer among women, particularly in urban India.(1, 2) There are several risk factors for breast cancer in women, which include: age, genetic mutations, family history, estrogen and progesterone exposure, geographical and social factors, radiotherapy, and lifestyle factors.(3-5)

The ICMR suggests that the threshold for adopting a screening method in routine practice should be based on the strength of evidence for long term clinical and cost benefits, as well as resource implications.(1, 2) The National Programme for the Prevention and Control of Cancer, Diabetes, Cardiovascular Diseases and Stroke (NPCDCS) recommends effective primary screening for breast cancer among women as a key strategy.(2) The current guidelines recommend the use of Clinical Breast Examination (CBE), followed by Ultra Sonography (USG) in CBE positive cases. Mammography is recommended in women above 35 years of age, in addition to USG, if available. In suspected cases of malignancy, core biopsy or fine needle cytology is recommended to confirm diagnosis.(2)

Diagnostic tests are an essential component of health care, and policy makers are usually interested to know if testing improves population outcomes. Well-designed diagnostic test accuracy studies could help in making these decisions. **Diagnostic accuracy** is the ability of a test to clearly differentiate between patients who have the target condition of interest and those who do not. Ideally, the accuracy of a test is determined by comparing the results of the index test (test under evaluation) with those of a reference test on the same series of patients.(6-9) Diagnostic test accuracy is predominantly represented by two measures, sensitivity and specificity. The **sensitivity** of a test is its ability to correctly identify people who have the disease (i.e. the proportion of all patients with disease identified as positive by the test).(6-9) The **specificity** of a test is its ability to correctly identify patients without the disease (i.e. the proportion of all patients without disease identified as negative by the test).(6-9)

The most valid study design for assessing the accuracy of diagnostic tests is a cross-sectional study design that compares an index test with a reference test in the same study population.(6-8) Diagnostic case–control studies (patients with and without the disease are identified before the index test is performed), have been shown to provide larger estimates compared to a single series of consecutive patients to evaluate the same test.(6-8)

Dermatoglyphics is the scientific study of epidermal ridge patterns in palms, finger tips and soles, which is reported to be unique to every individual. Dermatoglyphic pattern variations

have been studied in patients with genetic diseases like Down's syndrome, schizophrenia, and certain cancer types, like, breast and ovarian cancer.(3, 4) Dermatoglyphics may include the study of qualitative and/or quantitative parameters. The ATD-angle, a quantitative parameter is a widely used method in dermatoglyphics. The more distal the position of t, the larger is the ATD-angle. The ATD-angle is formed by the lines drawn between the triradii below the first and last digits and the most proximal triradius on the hypothenar region of the palm.(3-5, 10-12)

Rapid evidence synthesis (RES) is an emergent research approach undertaken to provide synthesised information in short timeframes for decision making.

The *primary objective* of this RES was to determine the diagnostic accuracy of ATD-angle measurement compared to clinical breast examination/mammography as a reference test for breast cancer screening in women. The *secondary objectives* were:

a. To summarise the evidence on the costs of ATD-angle measurement for breast cancer screening.
b. To summarise barriers and facilitators for utilisation and acceptability of providers and recipients of ATD measurement for breast cancer screening (for example over diagnosis and overtreatment, anxiety, and pain).

2. Methods

This section describes the methods used in the development of the policy brief.

Inclusion Criteria (PIRDS)

We included studies, which met the following criteria.

Population

Our population of interest was women aged 30 years and above, as defined by relevant national guidelines. If there were studies conducted with a wider age group, we included them only if the mean or median age of included participants was more than 30. If age is specifically not reported we will still include, provided the studies are conducted in adult women.

Index test

Index test is the diagnostic test whose accuracy was investigated, which in this case was 'angle of tri-radius measurement.'

Reference test

Reference test is the gold standard test (clinical breast examination alone or in conjunction with ultrasonography/ mammography) to which the results of the index test were compared.

Diagnosis of interest

The diagnosis of interest was breast cancer as confirmed by histocytopathology/ mammography.

Study designs

We identified primary diagnostic test accuracy studies in which all participants were subjected to both index and reference test and compared with a confirmatory diagnosis. The study types primarily included cross-sectional studies and diagnostic case-control studies that reported measures of interest.

Search methods

A comprehensive search was conducted to identify published studies and grey literature (unpublished/unindexed) involving human subjects, and those available in the English language. There was no date restriction for the search. The following databases and grey literature sources were searched for the relevant studies of interest. Detailed search strategies for each database are provided in Appendix 1 for each database.

Electronic databases searched included:

- Medline (PubMed)
- CINAHL
- Cochrane Library
- EMBASE
- ProQuest Dissertations & Theses Global

Grey literature sources searched included:

- Google Scholar
- WHOLIS - WHO Library Database (http://kohahq.searo.who.int/)
- LILACS – Latin American and Caribbean Health Sciences Literature (https://lilacs.bvsalud.org/en/)
- WorldCat (https://www.worldcat.org/)

Data collection and analysis

Selection of studies

The titles and abstracts of studies for inclusion were screened, which then enabled retrieval of full texts of eligible studies for examination and selection. Two reviewers independently applied the inclusion criteria to the retrieved publications. Discrepancy, if any was resolved by consensus.

Assessment of risk of bias in included studies

Risk of bias was not assessed because there were no eligible studies for inclusion. We planned to use standardised checklists to appraise the quality of studies.

Data extraction

Relevant data was not extracted as there were no eligible studies for inclusion. Reasons for exclusion of articles were provided by two authors independently. Discrepancy, if any was resolved by consensus.

Data Synthesis

A narrative summary, aided by tables wherever possible is presented to address the review question/s and document relevant findings. We planned to use the GRADE approach for assessing the certainty of evidence and where applicable, using a summary of findings table.

3. Results

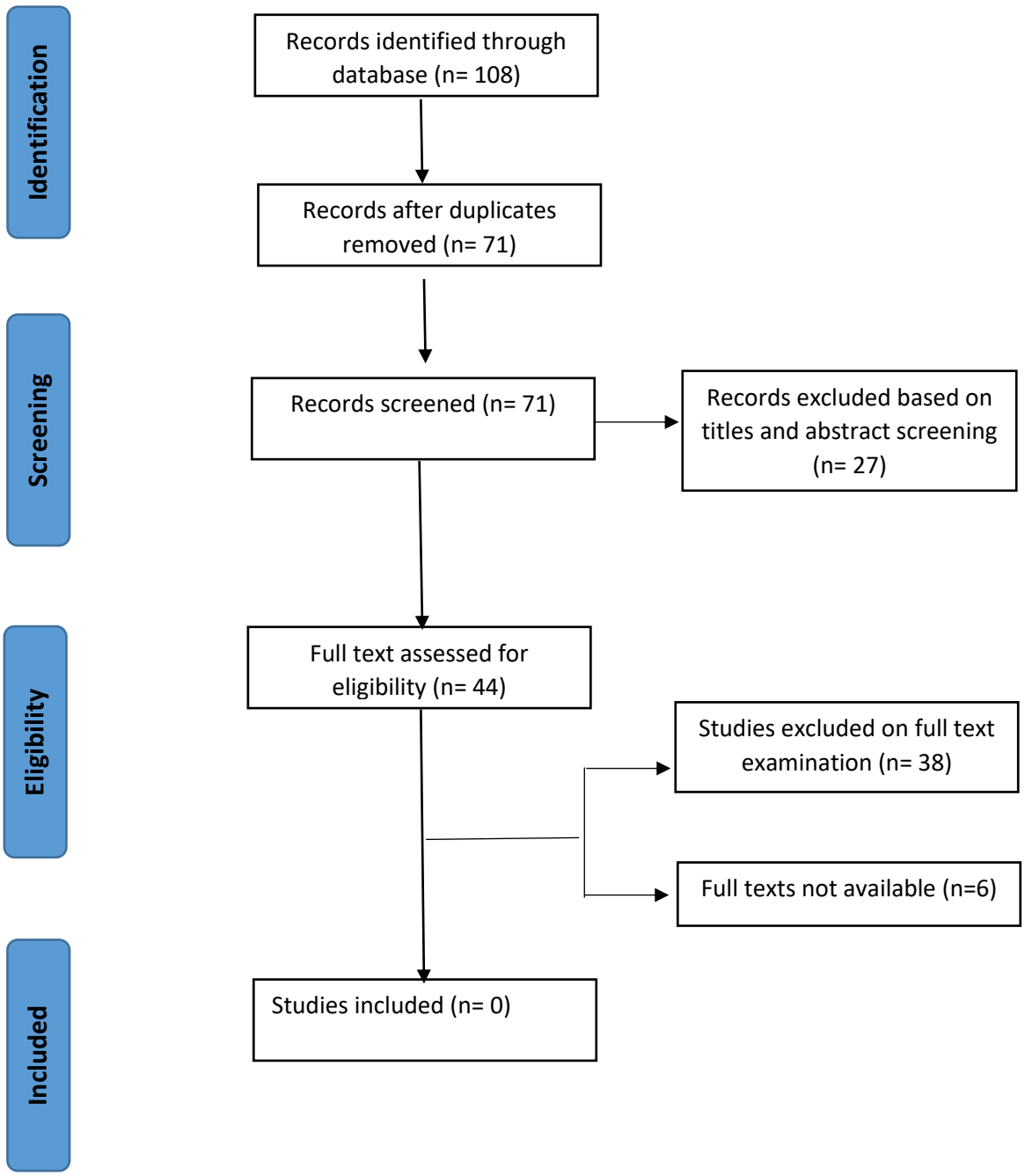
Description of studies

Search Results and Study Selection

Overall, the literature search identified 108 studies. Thirty seven studies were identified as duplicates and excluded. Following this step, 71 studies were screened based on their title and abstracts. Based on the pre-specified inclusion criteria, 44 studies (a majority of them published after year 2000) were considered potentially eligible for inclusion in the report. Full texts of 38 studies were available for examination. On full-text examination of these studies, none were considered relevant and/or eligible for inclusion in this policy brief. Majority of the excluded studies used inappropriate study design (case-control) and/or did not compare ATD-angle measurement (sensitivity/specificity) with a standard screening method to examine diagnostic test accuracy. Figure 1 depicts the study selection through the different phases of a review, using the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) statement.(13)

For policy decision-makers to promote the use of a new diagnostic (index) test, evidence is required that using the new test increases test accuracy over existing reference tests, or has equivalent accuracy (but offer cost/implementation advantage). Therefore, studies should conduct comparative analyses of the index and the reference/s tests, and not focus on evaluating the diagnostic accuracy of a test in isolation.

Figure 1: PRISMA Study Selection Flow Chart(13)



Summary of excluded studies

The following section briefly summarises the findings from excluded studies that used ATD—angle measurement for breast cancer screening in women. A list of excluded studies with reasons for exclusion is provided in Appendix 2. Overall, 16 out of 44 studies examined the use of ATD-angle for breast cancer screening in women.(3-5, 10-12, 14-23) Majority of the studies were conducted in India (n=12), a couple from Eastern Europe, and one each from Italy and Nigeria. The studies in India were conducted in the following States and Union Territories: Goa, Jammu and Kashmir, Karnataka, Madhya Pradesh, Maharashtra, Tamil Nadu, and Telangana).(3, 4, 10, 12, 14-17, 19-22) A couple of studies were conducted in Bosnia-Herzegovina,(5, 18) one study in Nigeria,(11), and one in Italy.(23) The studies compared the use of ATD-angle measurement in women with breast cancer (cases) with healthy controls, i.e. women without breast cancer. Breast cancer in the case group was mostly confirmed histopathologically. Essentially, the studies examined the association between dermatoglyphic traits, including ATD-angle and breast cancer. The palmar impressions in the studies were taken to determine the ATD-angle, which was generally measured using a protractor.

The results from excluded studies indicated that there was a significantly wider ATD-angle or an increase in the angle in the group of breast cancer patients compared to the healthy controls.(5, 10, 11, 16, 18, 19, 22) This suggested that the women were probably at-risk of breast cancer. However, a few studies showed that there was no statistically significant difference in the ATD angle between the two groups.(12, 23)

Overall, there was mixed evidence on the utility of ATD-angle measurement as a tool for non-invasive screening of breast cancer in women, particularly in women at an increased risk (e.g. positive family history). Further, a majority of the studies conducted in India reported that this non-invasive screening tool could prove to be useful in resource-poor settings and/or rural settings. However, authors concluded that further large scale studies are required to confirm the findings.

5. Policy options

- Research done so far on ATD-angle measurement for breast cancer did not use appropriate and rigorous study designs to test its diagnostic accuracy. Specifically, the studies did not measure the required parameters (sensitivity and specificity) to understand if ATD-angle measurement could be used instead of CBE (alone or in conjunction with USG/mammography) for community screening.
- Decision-makers may consider prioritising funding for a pilot study to assess the diagnostic accuracy of ATD-angle measurement for breast cancer screening in women using an appropriate study design.

6. Recommendations for future research

- Future studies in this area should use a cross-sectional study design, and evaluate the sensitivity and specificity of palmar ATD-angle against a reference standard test (CBE alone or in conjunction with USG/ mammography) in the same cohort of women (i.e. all women >30 years who undergo both the ATD-angle measurement and the reference standard test, along with confirmation by gold standard test).
- Case–control study designs are generally not representative of a test's accuracy in clinical practice, in that they overestimate the accuracy of the test. Cross-sectional study designs are generally the preferred study designs to provide valid estimates of diagnostic accuracy.
- A greater commitment for collaboration between policy makers, researchers and oncogeneticists will likely improve the evidence base to help formulate robust policy recommendations.

7. Strengths and Limitations of the policy brief

- In terms of its strengths, this RES is a first of its kind to examine the evidence on an emerging diagnostic modality for breast cancer screening in women. The review was comprehensive in terms of the robust methods utilised, and the search strategies employed. Further, the reviewers engaged with stakeholders, including content experts throughout the RES process.
- This RES is limited by the quality and availability of primary diagnostic test accuracy studies that addressed and reported on the main measures of the test; i.e. sensitivity and specificity.

8. Next steps

Further dialogue and engagement with relevant actors is recommended, particularly in relation to further pursuing research that may inform decisions. Dissemination and circulation of the policy brief report to key actors may support this.

9. References

1. Indian Council of Medical Research (ICMR). Consensus Document for Management of Breast Cancer. 2016. Available from: https://www.icmr.nic.in/sites/default/files/guidelines/Breast_Cancer.pdf.
2. National Programme for Prevention and Control of Cancer D, Cardiovascular Diseases and Stroke. Training Module for Medical Officers for Prevention, Control and Population Level Screening of Hypertension, Diabetes and Common Cancer (Oral, Breast &

Cervical). 2017. Available from: http://nhsrcindia.org/sites/default/files/Module%20for%20MOs%20for%20Prevention%2CControl%20%26%20PBS%20of%20Hypertension%2CDiabetes%20%26%20Common%20Cancer.pdf.
3. Edward I. Study of Palmar Dermatoglyphics in Breast Cancer Patients. Ann Arbor: Dr. NTR University of Health Sciences (India); 2011.
4. Karthikeyan G. A study on dermatoglyphic pattern in women with breast cancer [Masters]. Chennai: Dr MGR Medical University; 2013.
5. Metovic A, Musanovic J, Alicelebic S, Pepic E, Sljuka S, Mulic M. Predictive Analysis of Palmar Dermatoglyphics in Patients with Breast Cancer for Small Bosnian-Herzegovinian Population. Med Arch. 2018;72(5):357-61.
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8. Sotiriadis A, Papatheodorou SI, Martins WP. Synthesizing Evidence from Diagnostic Accuracy TEsts: the SEDATE guideline. Ultrasound Obstet Gynecol. 2016;47(3):386-95.
9. Whiting PF, Rutjes AW, Westwood ME, Mallett S. A systematic review classifies sources of bias and variation in diagnostic test accuracy studies. J Clin Epidemiol. 2013;66(10):1093-104.
10. Natekar PE, DeSouza FM. Fluctuating asymmetry in dermatoglyphics of carcinoma of breast. Indian J Human Genetics. 2006;12(2):76-81.
11. Oladipo G, Paul C, Bob-Manuel I, Fawehinmi H, Edibamode E. Study of digital and palmar dermatoglyphic patterns of Nigerian women with malignant mammary neoplasm. J App Biosci. 2009;15:829-34.
12. Sridevi NS, Delphine Silvia CR, Kulkarni R, Seshagiri C. Palmar dermatoglyphics in carcinoma breast of Indian women. Rom J Morphol Embryol. 2010;51(3):547-50.
13. Moher D, Liberati A, Tetzlaff J, Altman DG. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. PLoS Med. 2009;6(7):e1000097.
14. Gul S, Jabeen N, Gupta S, Raina S. Palmar dermatoglyphic and breast cancer: A possible correlation. Int J Med Health Res. 2018;4(2):53-5.
15. Krishnan S, Natesan D. Dermatoglyphics in carcinoma breast. J Evolution Med Dent Sci. 2016;5(89):6630-4.
16. Lavanya J, Saraswathi P, Vijayakumar J, Prathap S. Analysis of dematoglyphic traits in patients with breast cancer. J Pharma Biomed Sci. 2012;23(23).
17. Madhavi D, Dorairaj S, Dorairaj SSJ, Kommuru H. Dermatoglyphic study in breast carcinoma patients. Int J Sci Res. 2016;10:8.6.
18. Musanovic J, Metovic A, Pepic E, Kapic D, Cosovic E, Rebic D, et al. Predictive values of quantitative analysis of finger and palmar dermatoglyphics in patients with breast cancer for Bosnian-Herzegovinian population. J Evolution Med Dent Sci. 2018;7(24):2855-60.
19. Rawat A, Ganesh N. Novel tumor markers of breast cancer. J Sexual Med. 2017;14(4):e185.
20. Sridevi N. Cross sectional study of palmar dermatoglyphic pattern in patients with carcinoma breast. Bangalore: RGUHS; 2006.
21. Sukre SB, Laeeque M, Mahajan A, Shewale SN. Dermatoglyphics in the identification of women either with or at risk of breast cancer. Int J Basic Med Sci. 2012;3(5):160.

22. Bhardwaj DN, Guleria SS, Shrivastava PK, Sidhu BS. Dermatoglyphic studies in breast cancer. Acta Anthropogenetica. 1978;2(4):9-24.
23. Sanna E, Floris G, Paderi R. Some dermatoglyphic traits in breast carcinoma. International Journal of Anthropology. 1986;1(1):87-8.

10. Appendix

Appendix 1: Search Strategies

MEDLINE (PubMed)

No.	Search Query	Number of hits
#1	breast neoplasms[MeSH] OR breast neoplasm*[tw] OR breast cancer[tw] OR breast tumor*[tw] OR breast tumour*[tw] OR mammary cancer*[tw]	358532
#2	mass screening[MeSH] OR screening[tw] OR health screening[tw]	581531
#3	angle of tri radius[tw] OR dermatoglyphic*[tw] OR axial triradius[tw] OR ATD-angle[tw]	5834
#4	#1 AND #2 AND #3	3
#5	#1 AND #3	**25**

CINAHL

No.	Search Query	Number of hits
#1	MH breast neoplasms OR TX “breast neoplasm*” OR TX “breast cancer*” OR TX “breast tumor*” OR TX “breast tumour*” OR TX “mammary cancer*”	114800
#2	MH health screening OR TX “mass screening” OR TX screening	229896
#3	TX “angle of tri radius” OR TX dermatoglyphic* OR TX axial triradius OR TX “ATD-angle”	345
#4	#1 AND #2 AND #3	2
#5	#1 AND #3	**6**

Cochrane Library

No.	Search Query	Number of hits
#1	“breast cancer” OR “breast neoplasm” OR “breast tumor” OR “breast tumour” OR “mammary cancer”	34144
#2	screening OR “mass screening” OR “health screening”	53486
#3	“angle of tri radius” OR dermatoglyphic OR “axial triradius” OR “ATD-angle”	7
#4	#1 AND #2 AND #3	0
#5	#1 AND #3	**0**

EMBASE

No.	Search Query	Number of hits
#1	“breast cancer”/de OR “breast cancer” OR “breast neoplasm” OR “breast tumor” OR “breast tumour” OR “mammary cancer”	583855
#2	screening OR “mass screening” OR “health screening”	1,025,707
#3	“angle of tri radius” OR dermatoglyphic OR “axial triradius” OR “ATD-angle”	1729
#4	#1 AND #2 AND #3	7
#5	#1 AND #3	21
#6	#5 AND [embase]/lim NOT [medline]/lim	**10**

Google Scholar

No.	Search Query	Number of hits
#1	Dermatoglyphics AND “breast cancer”	2770
#2	#1 AND Manual study screening based on title and abstract relevance	**47**

ProQuest Dissertations & Theses Global

No.	Search Query	Number of hits
#1	Dermatoglyphics AND "breast cancer"	50
#2	#1 AND Manual study screening based on title and abstract relevance	**1**

Other Grey (Unpublished) Literature Sources Searched

No.	Source	Number of hits	Number of potentially relevant studies following manual screening
1	WHOLIS (WHO Library Database) http://kohahq.searo.who.int/	0	**0**
2	LILACS – Latin American and Caribbean Health Sciences Literature https://lilacs.bvsalud.org/en/	0	**0**
3	WorldCat https://www.worldcat.org/	61	**19**

Appendix 2. List of Excluded Studies with Reasons for Exclusion

No.	Bibliographic citation	Reasons for exclusion
1.	Abbasi S, Einollahi N, Dashti N, Vaez-Zadeh F. Study of dermatoglyphic patterns of hands in women with breast cancer. Pakistan Journal of Medical Sciences. 2006;22(1):18-22.	• No comparative method of screening reported • Qualitative parameters of dermatoglyphics used • Whorls and loops
2.	Abilasha S, Harisudha R, Janaki CS. Dermatoglyphics: A predictor tool to analyze the occurrence of breast cancer. Inte Jour of Medi Res & Health Sci International Journal of Medical Research & Health Sciences. 2014;3(1):28.	• No comparative method of screening reported • Qualitative parameters of dermatoglyphics used • Whorls, loops and arches
3.	Ajeena EH. Study the advantage of dermatoglyphics in detecting women with breast cancer. Magazine of Al-Kufa University for Biology. 2015;7(3):1-13.	• Qualitative parameters of dermatoglyphics used • Whorls, loops and arches • Insignificant results
4.	Anibor E, Igbigbi P, Avwioro O, Okpor A. Palmar and digital dermatoglyphic patterns in the Ndokwas of Delta State, Nigeria. African journal of medicine and medical sciences. 2011;40(3):181-5.	• Wrong population

5.	Bhardwaj DN, Guleria SS, Shrivastava PK, Sidhu BS. Dermatoglyphic studies in breast cancer. Acta Anthropogenetica. 1978;2(4):9-24.	• No comparative method of screening reported • Case-control study • Qualitative: whorls, loops and arches • Quantitative: a-b,b-c and c-d ridge counts, t-d ridge count, total finger ridge count(TFRC), **atd angle** • **Sensitivity and specificity of ATD-angle not measured** • Results were significant for whorls (qualitative) • Total finger ridge count (TFRC), **atd angle** and t-d ridge count were **statistically significant.**
6.	Bierman HR, Faith MR, Stewart ME. Digital dermatoglyphics in mammary cancer. Cancer Invest. 1988;6(1):15-27.	• Qualitative parameters of dermatoglyphics used • Accidentals, transitionals, horizontal and angled ulnar loops, angled radial loops significantly associated with breast cancer
7.	Caiqun H. The Features of the Hand De-rmatoglyphics in 200 Cases Breast Cancer. Hereditas (Beijing). 1989(4):10.	• Full text not available
8.	Chen Y, Zhang H. A dermatoglyphic study of the Minnan people of Taiwan. 2007.	• Full text not available
9.	Chintamani, Arya D, Kh, elwal R, Mittal A, Saijanani S, et al. Quantitative dermatoglyphic traits in patients with breast cancer - A preliminary report of an ongoing study. Journal International Medical Sciences Academy. 2006;19(1):69-70.	• No comparative method of screening reported • Both quantitative and qualitative parameters measured. • Quantitative: mean ridge count and mean pattern intensity index used • Qualitative: whorls, loops and arches • Results were significant for both quantitative and qualitative parameters
10.	Chintamani, Kh, elwal R, Mittal A, Saijanani S, Tuteja A, et al. Qualitative and quantitative dermatoglyphic traits in patients with breast cancer: a prospective clinical study. BMC Cancer.2007; 7:44.	• No comparative method of screening reported • Both quantitative and qualitative parameters of measured. • Quantitative: mean ridge count and mean pattern intensity index used

		• Qualitative: whorls, loops and arches • Results were significant for both quantitative and qualitative (Only Whorls) parameters
11.	de Andrés Basauri L, Barneo L, Carulla J. Genetic factors in breast cancer. Identification of a high risk group by means of dermatoglyphic investigation. Oncology. 1975;32(1):27-33.	• Other quantitative parameters measured: total finger ridge count (TFRC), main line index
12.	Edward I. Study of Palmar Dermatoglyphics in Breast Cancer Patients. Ann Arbor: Dr. NTR University of Health Sciences (India); 2011.	• No comparative method of screening reported • Qualitative: whorls, loops and arches • Quantitative: a-b,b-c and c-d ridge counts, t-d ridge count, total finger ridge count(TFRC), **atd angle** • **Sensitivity and specificity of ATD-angle not measured** • Results were significant for whorls (qualitative) • Total finger ridge count (TFRC), **atd angle** and t-d ridge count were **statistically significant.**
13.	Floris G, Sanciu M, Sanna E. Dermatoglyphics in the Pathology of Breast Cancer and Cervix Carcinoma. Springer; 1990. p. 177-81.	• Other quantitative parameters measured: a-b, a-d ridge counts, total finger ridge count (TFRC), axial triradius
14.	Floris G, Sanciu MG, Sanna E. Dermatoglyphics in pathology with emphasis on breast cancer and cervix carcinoma: Some results. Int J Anthropol International Journal of Anthropology. 1990;5(2):125-8.	• No comparative method of screening reported • Quantitative: a-b, a-d ridge counts, total finger ridge count (TFRC), axial triradius
15.	Galina Y, Ingilizova G. Main line patterns of palmar dermatoglyphics in female breast cancer patients. MOJAP MOJ Anatomy & Physiology. 2018;5(6).	• Other quantitative parameters measured: main line patterns
16.	Gamel JW. Digital dermatoglyphics in mammary cancer. Cancer Invest. 1989;7(3):301-2.	• Wrong article type – Letter to the editor/comment on another article by Bierman et al 1988 • ATD-angle not measured
17.	Gul S, Jabeen N, Gupta S, Raina S. Palmar dermatoglyphic and breast cancer: A possible correlation.	• No comparative method of screening reported • Quantitative: total finger ridge count (TFRC), **atd angle,** a-b ridge counts.

		• **Sensitivity and specificity of ATD-angle not measured** • Total finger ridge count (TFRC), **atd angle** and a-b ridge count were **statistically significant**
18.	Haggag AA. Study of fingerprints pattern in breast cancer patients in sharkia governorate, a case–control retrospective clinical study. Zagazig university medical journal. 2018;24(1).	• No comparative method of screening reported • Both quantitative and qualitative parameters measured • Qualitative: whorls, loops and arches • Quantitative: Ridge counts • Whorls, ridge counts: Significant
19.	Karthikeyan G. A study on dermatoglyphic pattern in women with breast cancer. 2013.	• No comparative method of screening reported • Both quantitative and qualitative parameters measured (**ATD**, dat and adt angles, a-b ridge count) • **Sensitivity and specificity of ATD-angle not measured** • **ATD-angle** showed no statistical significance.
20.	Krishnan S, Natesan D. Dermatoglyphics in carcinoma breast. Journal of Evolution of Medical and Dental Sciences. 2016;5(89):6630-4.	• No comparative method of screening reported • Both quantitative and qualitative parameters measured • Total finger ridge count (TFRC), absolute finger ridge count (AFRC), a-b ridge count, **ATD-**angle • **Sensitivity and specificity of ATD-angle not measured** • A significant association of **ATD-**angle less than 45 degree.
21.	Lavanya J, Saraswathi P, Vijayakumar J, Prathap S. Analysis of dematoglyphic traits in patients with breast cancer. Journal of Pharmaceutical and Biomedical Sciences©(JPBMS). 2012;23(23).	• No comparative method of screening reported • Both quantitative and qualitative parameters measured • Total finger ridge count (TFRC), a-b ridge count**, Palmar ATD-angle** • **Sensitivity and specificity of ATD-angle not measured**

		• A significant association of **ATD**-angle
22.	Lavanya J, Vijayakumar J, Prathap S, Alagesan J. Digital and palmar dermal ridge patterns in population with breast carcinoma. Biomedicine (India). 2014;34(3):315-21.	• Only first page of the full text available
23.	Lu H, Huo ZH, Gao P, Chen J, Li T, Shi ZY, et al. Fluctuating asymmetry of dermatoglyphy in breast cancer patients. Acta Anatomica Sinica. 2009;40(1):37-40.	• Article in Chinese
24.	Lynch HT, Kaplan AR, Moorhouse A, Krush AJ, Clifford G. Dermatoglyphic peculiarities in members of a high-cancer-risk kindred. Prog Exp Tumor Res. 1974;19:325-32.	• Other quantitative parameters measured: total finger ridge count (TFRC), main line index
25.	Madhavi D, Dorairaj S, Dorairaj SSJ, Kommuru H. Dermatoglyphic study in breast carcinoma patients. Arches. 2016;10:8.6.	• Study conducted in Nellore, AP, India • Qualitative and quantitative parameters studied including **ATD-angle of right and left hands** • Case-control study design with health controls • No comparative screening test • **Sensitivity and specificity of ATD-angle not measured** • **ATD-angle** significantly decreased when compared with the control group in both right and left hands.
26.	Metovic A, Musanovic J, Alicelebic S, Pepic E, Sljuka S, Mulic M. Predictive Analysis of Palmar Dermatoglyphics in Patients with Breast Cancer for Small Bosnian-Herzegovinian Population. Med Arch. 2018; 72(5):357-61.	• Study conducted in Sarajevo, Bosnia and Herzegovina • Qualitative and quantitative parameters studied including **ATD-angle of right and left hands** • Case-control study design with healthy controls • Pathohistologically confirmed breast cancer diagnosis • No comparative screening test • **Sensitivity and specificity of ATD-angle not measured** • atd D–the angle of the triangle a, t and d on the right palm, measured in degrees • **ATD** L–the angle of the triangle a, t and d on the left palm, measured in degrees

		• **ATD-angle** was higher in the case group of breast cancer patients compared to the control group
27.	Musanovic J, Metovic A, Husremovic F, Bejic S, Haskovic A, Babic A, et al. Digital dermatoglyphics in the evaluation of the genetic basis of breast cancer in Bosnian-Herzegovinian population - quantitative analysis. Med Glas (Zenica). 2020; 17(1).	• Study conducted in Sarajevo, Bosnia and Herzegovina • Quantitative parameters examined except atd angle • Case-control study design with healthy controls • Pathohistologically confirmed breast cancer diagnosis
28.	Musanovic J, Metovic A, Pepic E, Kapic D, Cosovic E, Rebic D, et al. Predictive values of quantitative analysis of finger and palmar dermatoglyphics in patients with breast cancer for Bosnian-Herzegovinian population. J Evolution Med Dent Sci. 2018;7(24):2855-60.	• Study conducted in Sarajevo, Bosnia and Herzegovina • Qualitative and quantitative parameters examined including **ATD-angle** • atd-D and atd-L measured • Case-control study design with healthy controls • No comparative screening test • **Sensitivity and specificity of ATD-angle not measured** • **ATD-angle** was higher in the breast cancer patients
29.	Natekar PE, DeSouza FM. Fluctuating asymmetry in dermatoglyphics of carcinoma of breast. Indian Journal of Human Genetics. 2006;12(2):76-81.	• Study conducted in Goa, India • Qualitative and quantitative parameters examined including **ATD-angle** • Case-control study design with healthy controls • No comparative screening test • **Sensitivity and specificity of ATD-angle not measured** • **ATD-angle** was higher in the breast cancer patients
30.	Oladipo G, Paul C, Bob-Manuel I, Fawehinmi H, Edibamode E. Study of digital and palmar dermatoglyphic patterns of Nigerian women with malignant mammary neoplasm. Journal of Applied Biosciences. 2009;15:829-34.	• Study conducted in Nigeria • Qualitative and quantitative parameters examined including **ATD-angle** • Case-control study design with healthy controls • No comparative screening test • **Sensitivity and specificity of ATD-angle not measured** • Mean **ATD-angle** was lower in the breast cancer patients

31.	Pahuja K, Singh J, Aggarwal S. Analysis of the qualitative and quantitative dermatoglyphic traits in breast cancer patients association with ABO blood group. Asian Journal of Pharmaceutical and Health Sciences. 2013;3(2).	• Study conducted in Bikaner, Rajasthan, India • Qualitative and quantitative parameters examined • ATD angle was not measured
32.	Prathap L, Jagadeesan V, Suganthirababu P, Ganesan D. Association of quantitative and qualitative dermatoglyphic variable and DNA polymorphism in female breast cancer population. Online J Health Allied Sci Online Journal of Health and Allied Sciences. 2017;16(2).	• Study conducted in Chennai, Tamil Nadu, India • Qualitative and quantitative parameters examined including atd angle • Objective and outcome/s not relevant
33.	Rawat A, Ganesh N. Novel tumor markers of breast cancer. Journal of Sexual Medicine. 2017;14(4):e185.	• Study conducted in Madhya Pradesh, India • Qualitative and quantitative parameters examined including **ATD-angle** • No comparative screening test • **Sensitivity and specificity of ATD-angle not measured** • Case-control study design with healthy controls
34.	Rudan P, Pisl Z, Basek B, Skrinjaric I, Budiman F, Nola P, et al. Quantitative dermatoglyphic traits in patients with breast cancer--preliminary report. Acta Med Iugosl. 1980;34(2):73-9.	• Full text not available
35.	Sakore Shubhangi D, Waghmare Ramesh S, Kamble R. Digital Dermatoglyphics in Carcinoma Breast. Indian Journal of Anatomy. 2016;5(3):287.	• Full text not available
36.	Sanna E, Floris G, Paderi R. Some dermatoglyphic traits in breast carcinoma. International Journal of Anthropology. 1986;1(1):87-8.	• Study conducted in Italy • Qualitative and quantitative parameters examined including **ATD-angle** • No comparative screening test • **Sensitivity and specificity of ATD-angle not measured** • Case-control study design with healthy controls
37.	Sharma K, Arora R, Pareek A. A Study of Dermatoglyphic Patterns (angles' atd''tad''tda') of Hands in Patients of Breast Cancer in Jhalawar Region. Indian Journal of Anatomy. 2015;4(2):61.	• Full text not available
38.	Singh D, Prabhakar BR, Bhalla SS. Dermatoglyphic study in breast carcinoma. Indian J Pathol Microbiol. 1979; 22(1):27-32.	• Qualitative parameters of dermatoglyphics used • No significant association was reported with breast cancer

39.	Sridevi N. Cross sectional study of palmar dermatoglyphic pattern in patients with carcinoma breast: RGUHS; 2006.	• Study conducted in Bengaluru, India • Qualitative and quantitative parameters examined including **ATD-angle** • No comparative screening test • **Sensitivity and specificity of ATD-angle not measured** • Case-control study design with age-matched controls
40.	Sridevi NS, Delphine Silvia CR, Kulkarni R, Seshagiri C. Palmar dermatoglyphics in carcinoma breast of Indian women. Rom J Morphol Embryol. 2010;51(3):547-50.	• Study conducted in Bengaluru, India • Qualitative and quantitative parameters examined including **ATD-angle** • No comparative screening test • **Sensitivity and specificity of ATD-angle not measured** • Case-control study design with age-matched controls
41.	Sukre SB, Laeeque M, Mahajan A, Shewale SN. Dermatoglyphics in the identification of women either with or at risk of breast cancer. International Journal of Basic Medical Science. 2012;3(5):160.	• Qualitative and quantitative parameters examined including **ATD-angle** • No comparative screening test • **Sensitivity and specificity of ATD-angle not measured** • Case-control study design
42.	Vishwanath G, Mascarennas A. Dermatoglyphic analysis of Breast Cancer patients from Bangalore institute of Oncology. Bangalore; 2002.	• Full text not available
43.	Yaneva G, Dimitrova T, Cherneva D, Ivanova N, Maslarski I, Sivkov S, et al. Comparative dermatoglyphic study of the palmar ridge count in breast carcinoma patients from Northeast Bulgaria. Acta morphologica et anthropologica. 2018;25:1-2.	• Study conducted in Northeast Bulgaria • atd angle was not measured • palmar ridge count measured
44.	Yaneva GA, Dimitrova TS, Cherneva DP, Ivanova ND, Fialkovska NA, rova, et al. Quantitative dermatoglyphic study of the finger ridge count in breast carcinoma patients from Northeastern Bulgaria. Scripta Scientifica Salutis Publicae. 2018;4:51-5.	• Study conducted in Northeast Bulgaria • atd angle was not measured • Finger ridge count measured