SYSTEMATIC REVIEW

Accuracy of Tactile Assessment of Fever in Children by Caregivers: A Systematic Review and Meta-analysis

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Context: Fever is the most common complaint in the pediatric and emergency departments. Caregivers prefer to detect fever in their children by tactile assessment.

Objective: To summarize the evidence on the accuracy of caregivers' tactile assessment for detecting fever in children.

Evidence-acquisition: We performed a literature search of Cochrane Library, PubMed, Web of Knowledge, EMBASE (ovid), EBSCO and Google Scholar, without restriction of publication date, to identify English articles assessing caregivers' ability of detecting fever in children by tactile assessment. Quality assessment was based on the 2011 Quality Assessment of Diagnostic Accuracy Studies (QUADAS-2) criteria. Pooled estimates of sensitivity and specificity were calculated with use of bivariate model and summary receiver operation characteristics plots for meta-analysis.

Results: 11 articles were included in our analysis. The summary estimates for tactile assessment as a diagnostic tool revealed a sensitivity of 87.5% (95% CI 79.3% to 92.8%) and specificity of 54.6% (95% CI 38.5% to 69.9%). The pooled positive likelihood ratio was 1.93 (95% CI 1.39 to 2.67) and negative likelihood ratio was 0.23 (95% CI 0.15 to 0.36). Area under curve was 0.82 (95% CI 0.7 to 0.85). The pooled diagnostic odds ratio was 8.46 (95% CI 4.54 to 15.76).

Conclusion: Tactile assessment of fever in children by palpation has moderate diagnostic value. Caregivers' assessment as "no fever" by touch is quite accurate in ruling out fever, while assessment as "fever" can be considered but needs confirmation

Keywords: *Assessment, Measurement, Parents and Pyrexia*.

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Fever is the most common complaint in the pediatric out-patient and emergency departments, accounting for almost one-third of these visits [1,2]. Fever is a vital symptom for diagnosis. In a child, many infections disease either single or in combination could present with fever [3]. Although thermometers are readily available at home, parents still prefer to detect fever by touch. A study from New York revealed that although 78% parents owned a thermometer at home, 48% still used palpation as the usual method to detect fever, and up to 87% of parents used palpation at least occasionally [4], similar to that reported by other authors [5,6]. It is a fact that tactile assessment of fever by palpation is universal due to its convenience.

The initial diagnosis of fever in a child is based almost entirely on the assessment by the caregivers [7]. The ability of caregivers to detect fever accurately in children by tactile examination is critical in preventing a first stage delay in the management of childhood illnesses [8]. The World Health Organization and United Nations Children's Fund assume that mothers are able to assess their children by palpation for the presence of fever [9]. However, it is controversial about whether caregivers have the ability to accurately evaluate their children' body temperature. Some studies suggest that there are significant inaccuracies in tactile assessment of body temperature, and objective measurement of temperature is recommended [8-10]. While findings in other studies showed that caregivers were able to provide accurate information about the presence or absence of fever in their children by palpation without the use of a thermometer [11-13]. Therefore, tactile assessment could be accept as a reliable screening tool for fever determination, and caregivers' description of their children' history of fever should be considered when giving medical decisions [11-13].

Teng, *et al*. [10] conducted a systematic review in 2007 about the accuracy of mother's touch to detect fever in children. Many new studies have since been published in the topic. We, therefore, conducted this updated systematic review on the accuracy of palpation by caregiver to detect fever.

METHODS

This systematic review was conducted according to the guidance of the Preferred Reporting Items for Systematic Review and Meta Analyses (PRISMA) Statement [14].

Search Strategy

We searched the databases of Cochrane Library, Pub Med, Web of knowledge, EMBASE (Ovid), EBSCO and Google Scholar for diagnostic studies in English comparing tactile assessment of fever with objective method using a thermometer, without date restrictions. We used the following search terms: child or children, fever or febrile, palpate or palpation or touch or tactile or subjective assesment. Hand-search was performed after screening the reference lists of the retrived articles for pertinent publications. Abstracts were reviewed and full-text articles were obtained for studies that met the eligibility criteria.

Study Selection

Inclusion criteria: (*a*) published original papers in English; (*b*) evaluated the accuracy of palpation by parents as a method of detecting fever in children, compared with thermometer measurement; and (*c*) provided detailed information on the sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) of tactile assessment. We contacted the corresponding authors to obtain missing information when necessary.

Exclusion criteria: (*a*) tactile assessment was not done during the study, which means tactile assessment was done at a different time and could not be compared against thermometer measurement at the same time; (*b*) publication with only title and abstract, and full text could not be obtained after contacting the corresponding authors twice; and (*c*) duplications, letters and reviews.

Data were extracted independently through a standardized protocol by two reviewers. Disagreements between the two of them were recorded and resolved by consultation with a third author. We recorded characteristics of the study (author, design, year of publication, study country, and setting), study population (sample size, age range, inclusion and exclusion criteria, and prevalence of fever), reference standard (axillary temperature or rectal temperature or others, diagnostic cut-off), and index tests (definition, procedures, and link with inclusion criteria) on predefined forms. The diagnostic performance measure for index tests: sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), positive likelihood ratio (–LR), negative likelihood ratio (–LR) were also collected.

Quality Assessment

We assessed the quality of selected studies and potential risk of bias with the 2011 revised version of the Quality Assessment of Diagnostic Accuracy Studies (QUADAS-2), adapted to the review diagnostic accuracy studies, as recommended by the Cochrane Collaboration. This tool is composed of four domains that consider patient selection, index test, reference standard and flow of patients through the study, and timing of the index tests [15]. The quality assessment was done independently by two authors. Any disagreement was resolved through discussion and consensus.

Data Synthesis and Analysis

Statistical analysis was performed using STATA software version12.0 (Stata Corporation, College Station, Texas, USA). Bivariate binomial mixed model was chosen and computed using the Midas program, as recommended by the Cochrane Collaboration for meta-analysis of diagnostic accuracy studies [16]. Meta-analytic integration of appointed studies was used for pooled estimated sensitivity, pooled estimated specificity, positive likelihood ratio, negative likelihood ratio, diagnostic odds ratio and variations (Chi-square, I-square, LRT p) for heterogeneity assessment. A summary receiver operating characteristic (SROC) curve was drawn to identify diagnostic performance of tactile assessment from the area under the curve (AUC). Publication bias was explored using Egger's test and Funnel plots.

RESULTS

The study selection process is displayed in ***Fig.* 1**. Eleven full-text articles [4,10,13,17-24] were included in the quantitative study and underwent quality assessment using QUADAS-2(*http://www.bristol.ac.uk/social-community-medicine/projects/quadas/quadas-2/*). ***Table* I** summarizes the characteristics of the included studies. The 11 included studies were conducted in various countries/regions in the world and included a total of 3,625 children. Major variations in sensitivity, specificity, positive predictive value, negative predictive value existed in these studies ***Table* II**.

Quality assessment: Risk of bias and applicability of the included studies are displayed in ***Table* III**. Overall the 11 studies were rated with an average acceptable applicability. The majority of the included studies were at low risk for two categories with respect to applicability, including the patient and index test. Most studies used convenience samples, leading to high risk of bias in the patient section domain.

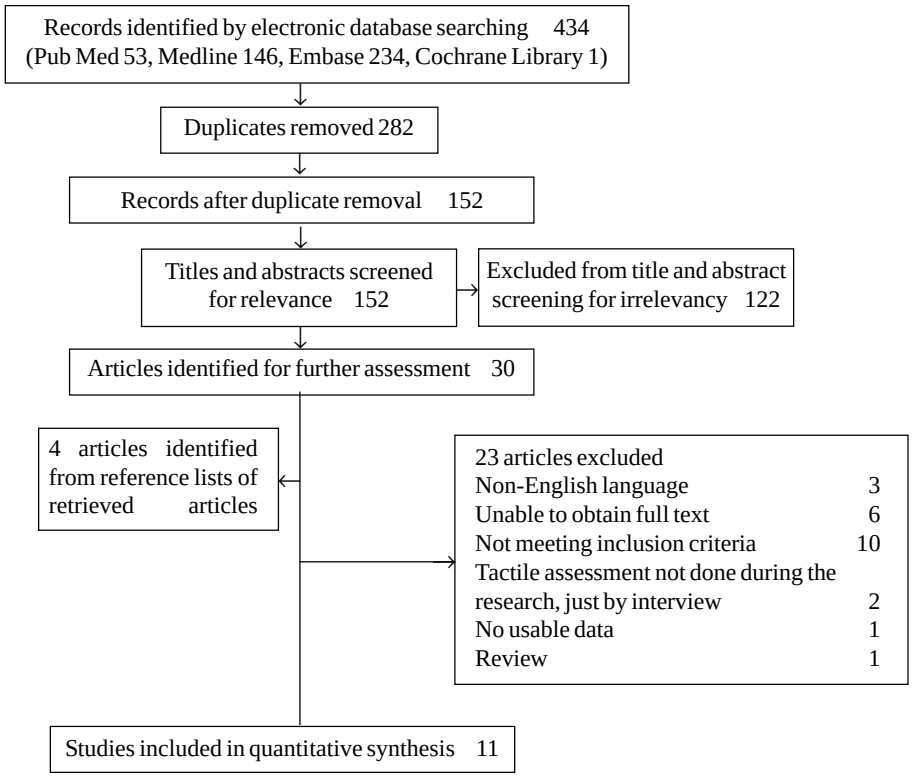

***Fig.* 1** *Flow diagram of the study selection process.*

Meta-analysis: The pooled sensitivity of tactile assessment as a method of detecting fever was 87.5% (95% CI 79.3% to 92 8%) and the pooled specificity was 54.6% (95% CI 38.5% to 69.9%). The pooled diagnostic odds ratio was 8.46 (95%CI, 4.54 to15.76). Significant heterogeneity was found among studies (P<0.001, I^2=99.3).

Forest plot for sensitivity and specificity of tactile assessment is showed in ***Fig.* 2**. The funnel plot and the test indicates no publication bias (P=0.11).

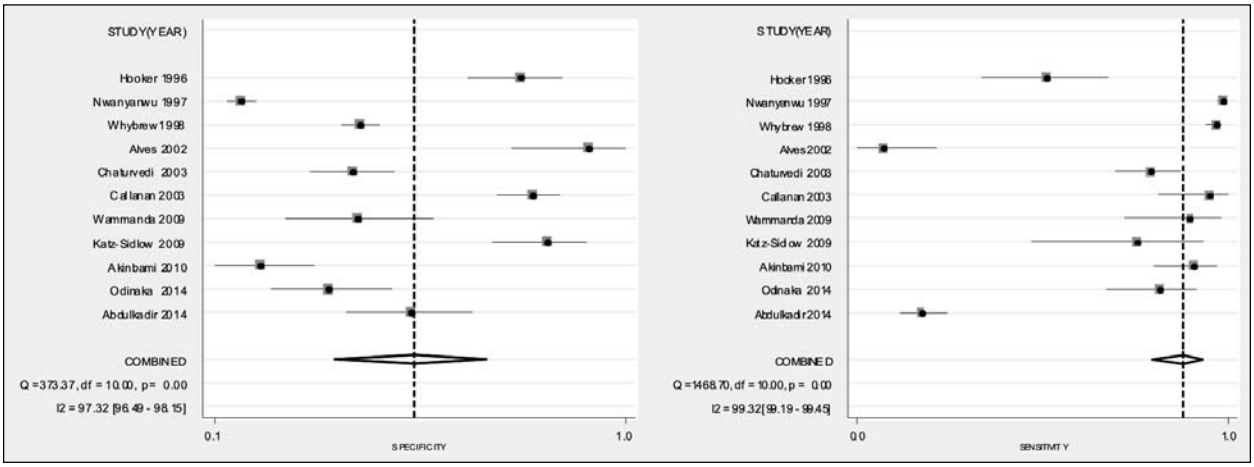

FIG. 2 *Forest plot for sensitivity and specificity of tactile assessment.*

TABLE I CHARACTERISTICS OF INCLUDED DIAGNOSTIC STUDIES

Author (y) [Ref.]	*Setting*	*Sample size*	*Age range*	*Prevalence of fever (%)*	*Inclusion criteria*	*Reference standard*		*Index test*	*Study outcome*
						Method	*Fever threshold*		
Abdulkadir, *et al.* (2014)[13]	Nigeria; pediatric emergency department	409	≥5 y	84.6	Children with fever as part of complaint	U-mecdigital thermometer	Rectal temperature ≥38.0°C	Touching site not mentioned	Tactile assessment is not reliable.
Odinaka, *et al.* (2014)[17]	Nigeria; children outpatient Clinic and emergency room	113	≥5 y	45.1	Not mentioned	Mercury in glass thermo-meter; 5 min	Axillary temperature ≥37.5°C	Touching of forehead (30.1%)	Tactile assessment is a sensitive screening method. Palpation with the palmer surface of the hand using multiple sites improves the reliability of tactile assessment of fever
Akinbami, *et al.* (2010)[24]	Nigeria; pediatric emergency department	182	6 to 59 mo	61.5	Not mentioned	Rectal mercury-in-glass thermo-meter; 4min	Rectal temperature ≥38°C	Touching site not mentioned	Tactile assessment may over estimate the prevalence of fever, but rarely miss fever, and children who do not feel hot by tactile perception may still have fever.
Katz-Sidlow, *et al.* (2009)[4]	USA; Pediatric emergency department	88	≥3mo	24	Children with any complaint	Rectal temperature thermometer (Dinamap Pro 400 V2 or IVAC Turbo Temp)	Rectal temperature ≥38°C	Mostly touching of forehead	Tactile assessment is unreliable. It may over estimate the prevalence of fever, but rarely miss fever.
Wammanda, *et al.* (2009)[9]	Nigeria; pediatric outpatient department	126	2 mo to 5 y	65.1	Children with fever as part of complaint	Mercy in glass thermo-meter	Axillary temperature ≥37.2°C	Touching of forehead	Tactile assessment is reliable.
Callanan, *et al.* (2003)[22]	USA; pediatric hospital	179	≥3mo	12.8	Children with any complaint	Rectal thermometer (WelchAllyn, San Diego,CA)	Rectal Temperature ≥38°C	Touching site not mentioned	Tactile assessment is not reliable. It may over estimate the prevalence of fever.
Chaturvedi, *et al.* (2003)[23]	India; pediatrics department	200	0-1y (100) and 6-12 y (100)	34.0	Children with fever as part of complaint	Rectal thermometer for infants (0-1 y) and oral thermo-meter for child-ren (6-12 y)	Rectal temperature ≥38°C; Oral temperature ≥37.5°C	Touching of body	The reliability of touch to assess body temperature needs to be critically assessed.

Contd.....

Table I (continued)

Author (y) [Ref.]	*Setting*	*Sample size*	*Age range*	*Prevalence of fever (%)*	*Inclusion criteria*	*Reference standard*		*Index test*	*Study outcome*
						Method	*Fever threshold*		
Alves, *et al.* (2002)[23]	Brazil; pediatric emergency department	169	2 mo to 13 y	81.1	Children with fever as part of complaint	Axillary mercy thermometer; 2min	Axillary temperature ≥38.0°C	Touching of neck	Tactile assessment is reliable.
Whybrew, *et al* (1998)[20]	Zambia; hospital	862	1 mo to 16 y	27.3	Not mentioned	Mercury thermometer; 3 min	Axillary temperature ≥37.8°C	Touching of abdomen, fore-head, and neck	Tactile assessment may overestimate the prevalence of fever, but rarely misses fever
Nwanyanwu, *et al* (1997)[19]	Malawian; outpatient's clinics	1120	<5 y	36.7	Children with any complaint	Not mentioned	Rectal temperature ≥38.0°C	Touching of forehead	Tactile assessment is not reliable.
Hooker, *et al* (1996)[18]	USA; a tertiary care children' hospital	180	<5 y	55.0	Not mentioned	Rectal glass mercury thermometer	Rectal temperature ≥38.0°C	Touching site not mentioned	Tactile assessment are not perfect at detecting fevers, but should not be ignored.

The SROC curve of sensitivity *vs*. specificity of tactile assessment suggests diagnostic cut-off located in the point where sensitivity was 0.88 and specificity 0.55. It also indicates that there was no threshold effect. Area under curve was 0.82 (95% CI 0.7 to 0.85), predicting moderate diagnostic value (***Fig.* 3**). When looking at the likelihood ratios (measures that are more meaningful for clinical decisions), pooled estimates of positive likelihood ratio were 1.93 (95% CI 1.39 to 2.67), and pooled estimates of negative likelihood ratio were 0.23 (95% CI 0.15 to 0.36).

DISCUSSION

This systematic review and meta-analysis documented that tactile assessment of fever by caregiver in children had moderate diagnostic value. The reasonably high sensitivity and low negative likelihood ratio indicated that caregivers' assessment of 'no fever' were quite accurate. When a child had no fever, the caregiver can perhaps accurately judge it by palpation. On the other hand, the specificity and the positive likelihood ratio were not good enough, meaning thereby that caregivers' assessment of 'fever' was not that reliable and confirmation was needed. Tactile assessment was therefore more useful to exclude fever rather than to confirm fever.

There are some limitations of this review. First, six potentially relevant articles could not be included because of missing information [25-30]. In the abstract of four of these studies, it was stated that caregivers' assessment of fever was reliable [25-27,30] with relatively high sensitivity. Abstracts of the other two articles could not be found [28,29]. Second, the quality of the results was moderate to low. Also there was significant heterogeneity among the chosen studies for the meta-analysis. Although bivariate binomial mixed model allowing for heterogeneity was used in our analysis [31], the heterogeneity could not be eliminated through statistical

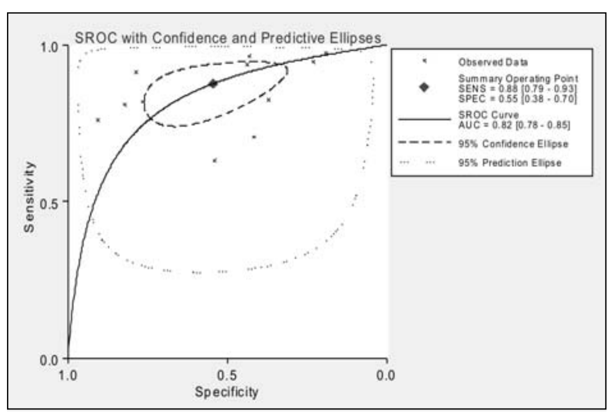

FIG. 3 *SROC curve of sensitivity versus specificity of tactile assessment.*

TABLE II THE DIAGNOSTIC PARAMETERS OF TACTILE ASSESSMENT IN THE INCLUDED STUDIES

Studies	*TP/n*	*FP/n*	*FN/n*	*TN/n*	*Sen/%*	*Spe/%*	*PLR*	*NLR*	*DOR*
Abdulkadir, *et al.* (2014)	218	29	128	34	63.0	54.0	1.37	0.69	2.00
Odinaka, *et al* .(2014)	42	39	9	23	82.4	37.1	1.31	0.48	2.75
Akinbami, *et al.* (2010)	106	54	6	16	94.6	22.9	1.23	0.23	5.23
Katz-Sidlow, *et al.* (2009)	17	12	4	55	81	82	4.52	0.23	19.48
Wammanda, *et al.* (2009)	79	25	3	19	96.3	43.2	1.70	0.08	20.01
Callanan, *et al.* (2003)	21	33	2	123	91.3	78.8	4.32	0.11	39.14
Chaturvedi, *et al.* (2003)	48	75	20	54	70.5	40.9	1.21	0.70	1.73
Alves, *et al.* (2002)	104	3	33	29	75.9	90.6	8.10	0.27	30.46
Whybrew, *et al.* (1998)	221	353	15	273	93.6	43.6	1.66	0.15	11.39
Nwanyanwu, *et al.* (1997)	399	574	11	136	97.3	19.2	1.20	0.14	8.59
Hooker, *et al.* (1996)	81	19	18	62	81.8	76.5	3.49	0.24	14.68

Notes: TP: true positive; FP: false positive; TN: true negative; FN: false negative; Sen: sensitivity; Spe: specificity; PLR: positive likelihood ratio; NLR:negative likelihood ratio; DOR: diagnostic odds ratio; n: number of children.

TABLE III BIAS AND APPLICABILITY: THE RELATIVE LEVEL BIAS ASSESSMENT OF BIAS RISK AND APPLICABILITY CONCERNS ACROSS THE INCLUDED STUDIES

Study	*Risk of bias*				*Applicability concerns*		
	Patient selection	*Index test*	*Reference standard*	*Flow and timing*	*Patient selection*	*Index test*	*Reference standard*
Abdulkadir, *et al.* (2014)	High	High	Low	Low	Low	High	Low
Odinaka, *et al.* (2014)	Low	Low	Low	Low	Low	Low	Low
Akinbami, *et al.* (2010)	High	Low	Low	Low	Low	High	Low
Katz-Sidlow, *et al.* (2009)	High	Low	High	Low	High	Low	Low
Wammanda, *et al.* (2009)	High	Low	High	Low	Low	Low	High
Callanan, *et al.* (2003)	High	High	High	Low	High	High	Low
Chaturvedi, *et al.* (2003)	High	Low	Low	Low	High	Low	High
Alves, *et al.* (2002)	Low	Low	Low	Low	Low	Low	High
Whybrew (1998)	High	Low	Low	Low	Low	Low	High
Nwanyanwu, *et al.* (1997)	Low	Low	High	Low	Low	Low	Low
Hooker, *et al.* (1996)	High	High	Low	Low	Low	High	Low

methods. The heterogeneity was supposed to be caused by the significant differences in educational background, severity of pyrexia, age of child, methods of temperature recording, fever threshold and research design in the included studies.

The results of our study were similar to the findings of a previous systematic review [10]. The diagnostic odds ratio was different from that of the earlier review, but the 95% confidence level was still above one. We added area under curve to indicate diagnostic value, which is more convincing when the diagnostic cut-off is different.

As a subjective method, tactile assessment of fever had not reached a uniform standard so far. There were only few studies exploring the effect of different palpation method (site used, part of hand used) on reliability of tactile assessment. Odinaka's study [17] revealed that palpation with the palmar surface of the hand using multiple sites improves the reliability of tactile assessment of fever. Since detecting fever by touch has some value for reference, we can explore some techniques to improve the reliability of this method and carry out relevant education to caregivers.

Contributors: YWL: conceptualized and designed the study, carried out the analyses, interpreted the data, drafted the initial manuscript, and approved the final manuscript as submitted;

LSZ: conceptualized and designed the study, assisted in the interpretation of the results, revised the manuscript, and approved the final manuscript as submitted; XL: assisted in data extraction and the interpretation of the results, and approved the final manuscript as submitted.

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