

STAT.Ibrahim.Abdulkhaleq@MS c.2024.Non Parametric Statistics

by Ibrahim Abdulkhaleq

Submission date: 27-Dec-2023 10:46PM (UTC+0200)

Submission ID: 2265164909

File name: aleq_MSc.2024.Non_Parametric_Statistics_-_Ibrahim_Abdulkhaleq.pdf (581.45K)

Word count: 4349

Character count: 25405

Salahaddin University-Erbil

College of Administration and

Economics

High Education: MSc

Department : Statistics and informatics

Subject : Non-Parametric

Semester: First



McNemar's Test

"Analytical review"

Student's Name

Ibrahim Abdulkhaleq Othman

Student Email: ibrahimabdulkhalq447@gmail.com

Under the Supervision of the Subject Assist Professor

Dr.Nazeera Sedeek Kareem

Academic year

2024-2023

Abstract

Title: A Comprehensive Analysis of the Application and Effectiveness of McNemar's Test in Biomedical Research

The McNemar test, a statistical method used to analyze paired nominal data, has been a fundamental component of biological research for many years. This review article seeks to provide a thorough examination of the use, importance, and effectiveness of McNemar's test in several research fields.

The article starts by clarifying the core concepts of the McNemar test, highlighting its appropriateness for examining paired data that is either dichotomous or nominal in nature. The analysis explores the fundamental assumptions of the test and emphasizes its effectiveness in identifying variations or disparities between matched data.

This study consolidates several research that have used McNemar's test in a wide range of disciplines, including medicine, epidemiology, diagnostics, and quality assurance. The evaluation thoroughly assesses the test's strengths and weaknesses across several settings, recognizing its resilience in certain instances while highlighting possible drawbacks in diverse situations.

In addition, the evaluation examines current progress in the utilization of McNemar's test, including adaptations, expansions, and power calculations customized for distinct experimental configurations. The text presents a comparative analysis of McNemar's test and different statistical techniques, highlighting situations when the test demonstrates superior performance or complements other analytical approaches.

In conclusion, this study consolidates the key position of McNemar's test as a flexible and effective statistical instrument in biomedical research. The statement emphasizes the importance of the test in clarifying changes in paired categorical data and highlights the need of careful application considering the unique features of the study setting.

Keywords: McNemar test, Non-parametric test, Binary data analysis, Paired nominal data, Statistical significance

Introduction: McNemar's test is a statistical tool developed to examine categorical data in paired samples. It retains special importance in domains like as medicine, psychology, sociology, and numerous scientific disciplines where researchers deal with dichotomous categorical data. Named for the statistician Quinn McNemar, this test is crucial in evaluating proportions or frequencies in paired data, particularly in cases where typical chi-square tests would not be effective owing to the reliance between observations.

The basis of McNemar's test rests in its capacity to analyze changes or differences in paired categorical data while accounting for the matched or paired character of the samples. It's widely applied in "before-and-after" studies, intervention evaluations, or any circumstance where the data is naturally matched. For instance, imagine a research examining the efficacy of a new medicine where each participant's reaction to the medication is assessed both before and after treatment. McNemar's test becomes beneficial here in examining if the percentage of persons demonstrating progress substantially changes between the before and after phases.

At its foundation, McNemar's test assesses the discordant and concordant pairings within the data. A discordant pair happens when the two observations within a pair fall into different categories (e.g., one member of the pair exhibits a good result while the other shows a negative outcome). Conversely, a concordant pair describes cases when the two observations are identical considering the category variable being analyzed.

The test depends on a 2x2 contingency table, summarizing the frequencies of the matched categories. The table normally has four cells: Cell a represents the count of pairings where both observations are positive (i.e., both before and after measurements fall into the positive category). Cell b depicts couples where the before measurement is positive while the after measurement is negative. Cell c depicts couples where the before measurement is negative while the after measurement is positive. Cell d indicates pairings when both observations are negative.

¹² McNemar's test statistic is computed as $\frac{[(b-c)-1]^2}{(b+c)}$, which follows a chi-square distribution with one degree of freedom under the null hypothesis of no difference between the proportions of discordant pairings and concordant pairs.

This statistical test is resilient in cases where the assumption of independence between observations doesn't apply, which is typical with paired or matched data. By concentrating on changes within pairs, it reduces the effect of confounding factors that are constant within pairs, making it a strong tool in research and clinical investigations.

In summary, McNemar's test serves as an important way for comparing proportions or frequencies in paired categorical data, delivering a reliable approach to examine changes or differences while accounting for the paired structure of the observations.

Main body / Summary Section

In 1990 (Willems, Campbell and Bailey) Published a paper on “Progress on the CSE Diagnostic Study”¹⁶ The authors offer an extension of McNemar's test that may be used to assess diagnostic ability when numerous statements are derived from computer analysis or visual interpretation of the ECG. If two or more diagnostic assertions are made, by definition only one can be accurate for the cases in the CSE pilot database, which were chosen for single, clinically well documented, anomalies. If one remark stood out from others as being stated with the greatest degree of confidence, that was accepted as the one interpretation, correct or wrong. However, when two or more claims were made with the same degree of confidence and only one statement was true, then in the prior application of McNemar's test that interpretation was awarded credit for being correct. In the extension of the method presented in this article, such an interpretation is given partial credit for the one correct statement and partial discredit for any incorrect statement, thereby reporting the results more properly in the sensitivity and specificity statistics for the different diagnostic categories.

In 1990 (Schriger, Baraff and Fink) Published a paper on “A Comparison of Implicit and Explicit Methods of Process Quality Assurance for Blunt Trauma Patients”¹⁴ We contrasted explicit (objective) and implicit (subjective) techniques of process quality assurance to understand how the results of each approach are connected. The files of 100 blunt trauma patients who were admitted to the ICU, had surgery, or died in the emergency department were assessed for compliance with six specific process-of-care criteria previously developed by the ED faculty. The findings of this explicit review were contrasted with the outcomes of a continuing quality assurance program that employs implicit review. In the implicit review, a faculty member evaluated patients' files and answered to three questions addressing the process of treatment. All blunt trauma patients who satisfied the admission criteria were to be included in this study. Only 44 of the 100 charts were submitted to implicit assessment. Of these, 26 were declared acceptable by both ways, two were judged unsatisfactory by both methods, two failed just the implicit review, and 14 failed only the explicit review. The null hypothesis, that the two approaches were similar, was rejected (McNemar's test, $P < .003$). These results suggest that process-of-care evaluations of the quality of care must be evaluated with caution since they are technique dependent and may not correspond with patient outcomes.

In 2008 (Kajima, Murakami, Yamasaki, Kaji, Fukasawa, Inaba, Sugimura) Published a paper on “Diagnostic accuracy of integrated FDG-PET/contrast-enhanced CT in staging ovarian cancer: comparison with enhanced CT”¹³ Purpose The purpose of the study is to evaluate the accuracy of integrated positron emission tomography and computed tomography (PET/CT) with 18F-fluorodeoxyglucose (FDG) with IV contrast for preoperative staging of ovarian cancer, in comparison with enhanced CT, using surgical and histopathological findings as the reference standard. Materials and procedures Forty patients with ovarian cancer had FDG-PET/contrast-enhanced CT scans for staging before primary debulking surgery. PET/CT and the CT

component individually, were interpreted by two experienced radiologists by agreement for each study. Status with relation to lesion within and outside the pelvis was established on the basis of histology. The significance of discrepancies between the two imaging modalities was assessed using the McNemar test. Results Staging showed stage I in 18 patients (IA, n=9; IB, n=3; IC, n=6), stage II in seven (IIA, n=2; IIB, n=3; IIC, n=2), stage III in 14 (IIIA, n=1; IIIB, n=3; IIIC, n=10), and stage IV in one. The findings of CT and PET/CT were concordant with the final pathological staging in 22 out of 40 (55%) and 30 out of 40 (75%) patients, respectively. The total lesion-based sensitivity increased from 37.6% (32 out of 85) to 69.4% (59 out of 85), specificity from 97.1% (578 out of 595) to 97.5% (580 out of 595), and accuracy from 89.7% (610 out of 680) to 94.0% (639 out of 680) between CT and PET/CT. There were substantial variations in sensitivity and accuracy, with p values of 5.6×10^{-7} and 1.2×10^{-7} , respectively. Conclusion Integrated FDG-PET/contrast-enhanced CT is a more reliable imaging technique for staging ovarian cancer and effective for determining suitable therapy than enhanced CT.

In 2010 (Agrawal, Spencer and Faas) Published a paper on “Method of LDL Cholesterol Measurement Influences Classification of LDL Cholesterol Treatment Goals: Clinical Research Study” Low-density lipoprotein cholesterol (LDL-C) has been clearly related with the risk of developing coronary heart disease. The best and most practical technique for detecting LDL-C has been under considerable attention in recent years. We offer comparisons of the Friedewald computed LDL-C (C-LDL-C) and direct LDL-C (D-LDL-C) utilizing 3 different homogeneous tests. This highlights differences between the 2 methods of LDL-C measurement and how this affects the classification of samples into different LDL-C treatment goals as determined by the National Cholesterol Education Program Adult Treatment Panel III guidelines thus potentially affecting treatment strategies. Our findings emphasize D-LDL-C measurements utilizing 3 distinct assays throughout 3 different times. In all tests, there is a notable lack of agreement between D-LDL-C and C-LDL-C, which, in most instances, resulted in higher D-LDL-C values than C-LDL-C. This leads to clinically substantial misclassification of patient’s LDL-C to a different LDL-C treatment target, which would possibly result in increased medication consumption, thereby exposing patients to more possible bad effects and at a much larger expense with no evidence of benefit.

In 2013 (Leary, Parashar, Crane, Allison, Stokley, Beaty, Brtnikova, Hurley and Kempe) Published a paper on “Adoption of Rotavirus Vaccine by U.S. Physicians: Progress and Challenges” Pentavalent rotavirus vaccination (RV5) was recommended for regular use in 2006 followed by monovalent rotavirus vaccine (RV1) in 2008. The acceptability of RV has risen, and hurdles to usage have diminished. Among doctors, current safety worries concerning RV1 have not altered usage of RV, but they have raised safety concerns.

In 2013 (Fagerland, Lydersen and Laake) Published a paper on “The McNemar test for binary matched-pairs data: mid-p and asymptotic are better than exact conditional” Statistical approaches that employ the mid-p approach are important tools to examine categorical data,

especially for small and intermediate sample sizes. Mid-p tests achieve a compromise between too cautious precise approaches and asymptotic methods that regularly violate the nominal level. Here, we analyze a mid-p variation of the McNemar exact conditional test for the study of paired binomial proportions. The easy-to-calculate mid-p test is a great alternative to the complicated precise unconditional test. Both may be suggested for usage in any scenario. We also advocate the asymptotic test if modest but frequent breaches of the nominal threshold is acceptable.

In 2016 (Redelmeier and Tibshirani) Published a paper on “A simple method for analyzing matched designs with double controls: McNemar’s test can be extended” To provide a novel analytic technique for matched research, where precisely two controls are connected to each case (double controls rather than solitary controls). The objective is to expand McNemar’s test for one-to-two matching (instead of one-to-one matching) when analyzing binary predictors and outcomes. The novel methodology presents a practical, simple, and fast way for assessing matched designs with double con-trols.

In 2018 (Jalalizadeh, Alshiek, Santoro, Wieczorek and Shobeiri) Published a paper on “Six-Year Experience in Teaching Pelvic Floor Ultrasonography Using Pelvic Floor Phantoms” To examine our 6-year experience (2009– 2015) in delivering three-dimensional pelvic floor ultrasonography courses that employed pelvic floor phantoms in the framework of an Objective Structured Assessment of Technical Skills approach. Our Objective Structured Assessment of Technical abilities seminars using pelvic floor phantoms boosted trainees’ pelvic floor ultrasound diagnostic abilities.

In 2018 (Wu) Published a paper on “Power calculation of adjusted McNemar’s test based on clustered data of varying cluster size” McNemars test is typically used to compare two proportions derived from paired data. When the observations are collected in clusters, modification is essential to guarantee that the size of McNemars test does not exceed the nominal threshold. Eliasziw and Donner (1991) created an adjustment to McNemars test that includes first calculating the correlation between discordant pairings inside a cluster, then utilizing the estimate of the correlation to modify the conventional McNemar’s test statistic. Gönen (2004) developed two estimates for determining the power and sample size for the updated McNemar’s test. He showed that the accuracy of the two estimates is compromised for big value of intracluster correlation and small value of fraction of discordant pairings; the inaccuracy of the approximation might be more than 10 per cent. In this study, we expand his power formula, created under fixed cluster size assumption, to cover the condition when the cluster sizes are not constant. We demonstrate via simulations that the theoretical powers estimated from our proposed power formula are close to their empirical equivalents under a range of conditions. More notably, in the situation of constant cluster size, our reduced power formula gives a more accurate power estimate than Gönen’s power formula independent of the values of intracluster correlation and the fraction of discordant pairings.

8
In 2019 (Pedoia, Lee, Norman, Link and Majumdar) Published a paper on “Diagnosing osteoarthritis from T2 maps using deep learning: an analysis of the entire Osteoarthritis Initiative baseline cohort” We intend to explore to what degree conventional and deep-learning-based T2 relaxometry patterns are able to discriminate between knees with and without radiographic osteoarthritis (OA). In this article, we proposed a Magnetic Resonance Imaging (MRI)-based data-driven platform employing T2 measures to describe radiographic OA. Our findings revealed that feature learning from T2 maps has promise in discovering information that might possibly better diagnose OA than basic averages or linear patterns decomposition.

1
In 2019 (Pum) Published a paper on “Evaluation of analytical performance of qualitative and semi-quantitative assays in the clinical laboratory” As is true for quantitative tests, qualitative and semi-quantitative assays, giving stringent binary or ordinal findings, must undergo a verification procedure prior to their use for regular clinical laboratory testing. Standard technique validation criteria employed for quantitative tests, however, do not apply here. Rather, contingency tables, Bayesian statistics and statistical hypothesis testing for inter-rater agreement must be utilized. This article presents an overview of basic, practical instruments, which may be used to check the analytical performance of such tests. Topics presented include the verification of precision and accuracy using a single experiment strategy and running technique comparison studies for assays with binary or ordinal findings. Acceptance criteria are proposed for each exam to give a uniform framework for performance evaluation. The technique is suited for all CE/IVD-marked and CLIA-waived tests and will guarantee compliance with CAP, ISO 17025 and ISO 15189 criteria.

6
In 2022 (Sanghavi, Reisch and Tomer) Published a paper on “Diversity in Selected Leadership Positions in United States Academic Pediatric Gastroenterology Programs: A Review and Call to Action” Women and minorities are underrepresented in leadership roles in academic fields. We evaluated participation of women and minorities in chosen leadership roles and in fellowships in North American academic pediatric gastroenterology programs (PGP) using voluntary questionnaires. We also investigated for variables impacting diversity. We discovered that 45.8% of Program Directors (PD), 75% of division heads (DC), and 71% of Pediatrics department chairs were male. Sixty-three % of the PG fellows were women. Most DCs were male academics. Most PDs, DCs, and department chairmen were White (70%, 80%, and 88.3%), with Blacks being the least represented group in leadership and also among fellows. We discovered a greater possibility of having a White PD if the department head was White. We identified gender and racial discrepancies in all PGP leadership roles. This data may serve as a guidance in attempts to foster diversity for both gender and race at all occupations and academic rankings.

Decision and Comparison

1. Willems, J.L., Campbell, G., and Bailey, J.J. (1990): This research focuses on diagnostic testing in electrocardiology, reviewing the use of McNemar's test. It stresses its significance in monitoring improvements in diagnostic accuracy, highlighting the test's versatility in medical research.

2. Schriger, D.L., Baraff, L.J., and Fink, A. (1990): Here, the contrast between implicit and explicit techniques of quality assurance for trauma patients is investigated. The McNemar test may have been used to investigate the differences in results between different strategies, underscoring its importance in healthcare quality evaluation.

3. Kitajima, K., Murakami, K., et al. (2008): This research goes into the diagnostic accuracy of imaging modalities in staging ovarian cancer. The comparison between combined FDG-PET/contrast-enhanced CT and enhanced CT presumably uses the McNemar test to examine the differences in diagnostic performance between these modalities.

4. Agrawal, M., Spencer, H.J., and Faas, F.H. (2010): Focusing on cholesterol measuring methods and their influence on treatment objectives, this study may have applied the McNemar test to analyze disparities in categorization based on various measurement methodologies.

5. O'Leary, S.T., Parashar, U.D., et al. (2013): Examining the uptake of rotavirus vaccination by US doctors, this research may have employed the McNemar test to evaluate variations in vaccine acceptability over time or across various physician groups.

These works jointly illustrate the McNemar test's adaptability in many research settings, from medical diagnostics to healthcare quality evaluation and vaccine acceptance studies. Its capacity to examine changes or differences in paired categorical data makes it a helpful tool in evaluating various treatments, diagnostic procedures, and treatment regimens across multiple disciplines. Moreover, it shows the test's lasting relevance in resolving research concerns involving paired nominal data, underlining its application and usefulness in current scientific investigation.

Let's go into the core of a handful of these research that reference the McNemar test and compare their important results and contributions:

6. Fagerland, M.W., Lydersen, S., and Laake, P. (2013): This research analyzes the performance of multiple forms of the McNemar test for binary matched-pairs data. Their findings implies that mid-p and asymptotic techniques produce superior outcomes compared to the precise conditional method. This is essential as it underlines the relevance of adopting the right statistical strategy when doing the McNemar test, stressing the superiority of particular approaches in specific scenarios.

7. Redelmeier, D.A., and Tibshirani, R.J. (2017): The emphasis here is on expanding the use of McNemar's test to assess matched designs with double controls. By suggesting a simple approach to broaden the usage of the test in a particular experimental setting, the study contributes to the flexibility of McNemar's test, displaying its adaptability to diverse research methods.

9. Wu, Y. (2018): This article addresses power estimates for an updated version of McNemar's test based on clustered data of varied sizes. By addressing the statistical power of the test in clustered data situations, it gives useful insights for researchers wanting to employ McNemar's test in studies including clustered observations.

10. Pedoia, V., Lee, J., Norman, B., Link, T.M., and Majumdar, S. (2019): This work addresses the application of deep learning in diagnosing osteoarthritis using T2 maps. While the emphasis may not be directly on the McNemar test, it demonstrates developments in diagnostic techniques, which might indirectly affect the interpretation and implementation of statistical tests like McNemar's in future osteoarthritis research.

These works jointly stress the growing landscape of statistical techniques, notably in improving and widening the applicability of the McNemar test. They underline the need of choosing suitable versions or extensions of the test depending on the unique study setting, whether it clustered data, duplicate controls, or developments in diagnostic tools. Moreover, they emphasize the continuing attempts to expand the test's application in numerous study fields, confirming its relevance and flexibility in modern statistical studies.

The two essays, although diverse in their subject matter, contribute to various fields of research. Let's analyze their results and implications:

11. Pum, J.K. (2019): This research assesses the performance of qualitative and semi-quantitative tests in clinical laboratory settings. The emphasis certainly entails assessing the accuracy, reliability, and effectiveness of several distinct kinds of tests. The decision-making here could focus around discovering which assay type works better in various diagnostic or analytical settings. For instance, if one test type routinely delivers more accurate findings or has better sensitivity, it might be suggested for particular clinical uses. The research may explore how the findings effect clinical decision-making and the selection of relevant tests in laboratory practice.

12. Sanghavi, R., Reisch, J., and Tomer, G. (2022): This article focusses on diversity in leadership roles within academic pediatric gastroenterology programs in the United States. The decision-making component in this context requires identifying and fixing gaps or inequities in leadership representation. The report likely emphasizes the existing level of diversity, identifies areas for development, and proposes tactics or ideas for fostering inclusion and equality in leadership positions. The decision-making can entail lobbying for policies or programs targeted at increasing diversity in leadership, so possibly altering the academic and professional environment in pediatric gastroenterology.

Comparing both studies, they operate in various domains - one focuses on analytical assays in clinical laboratories, while the other examined diversity in academic leadership. However, they have a similar theme of influencing decision-making within their respective fields. The first research changes choices linked to test selection and clinical practice, possibly altering diagnostic accuracy and patient care. Meanwhile, the second research supports for actions oriented towards encouraging diversity and inclusiveness in academic leadership, possibly altering the future of pediatric gastroenterology programs by establishing a more representative and fair leadership environment. Both studies illustrate the significance of evidence-based decision-making and its far-reaching ramifications within their specialized professions.

Conclusion

The McNemar test, a statistical procedure used in paired nominal data analysis, serves as a strong tool for examining changes or differences in paired proportions. In essence, it examines if the marginal frequencies for two categorical variables are identical or not. This test is especially effective in instances when researchers are interested in comparing two similar groups or treatments, generally before and after an intervention. By concentrating on discordant pairings (where one variable varies across paired observations), it helps identify whether the change seen between these pairs is statistically significant or just due to random chance.

The conclusion derived from a McNemar test is based on the resultant p-value. A low p-value (usually below 0.05) provides strong evidence against the null hypothesis, showing a substantial difference between the matched proportions. In contrast, a larger p-value shows that there isn't enough evidence to reject the null hypothesis, showing similarity between the proportions.

Interpreting the McNemar test needs careful evaluation of its assumptions and limits. It presupposes matched pairings, independence between pairs, and an acceptable sample size for reliable findings. Additionally, it may not be ideal for instances involving more than two categories or for studying continuous data.

In conclusion, the McNemar test provides a good tool for assessing paired nominal data and detecting if changes in proportions between paired observations are statistically significant. Its interpretation depends on the resultant p-value, assisting researchers in forming valid inferences regarding the link between the categorical variables under inquiry.

References:

1. Willems, J.L., Campbell, G. and Bailey, J.J., 1990. Progress on the CSE diagnostic study: application of McNemar's test revisited. *Journal of electrocardiology*, 22, pp.135-140.
2. Schriger, D.L., Baraff, L.J. and Fink, A., 1990. A comparison of implicit and explicit methods of process quality assurance for blunt trauma patients. *Annals of emergency medicine*, 19(7), pp.736-740.
3. Kitajima, K., Murakami, K., Yamasaki, E., Kaji, Y., Fukasawa, I., Inaba, N. and Sugimura, K., 2008. Diagnostic accuracy of integrated FDG-PET/contrast-enhanced CT in staging ovarian cancer: comparison with enhanced CT. *European journal of nuclear medicine and molecular imaging*, 35, pp.1912-1920.
4. Agrawal, M., Spencer, H.J. and Faas, F.H., 2010. Method of LDL cholesterol measurement influences classification of LDL cholesterol treatment goals: clinical research study. *Journal of Investigative Medicine*, 58(8), pp.945-949.
5. O'Leary, S.T., Parashar, U.D., Crane, L.A., Allison, M.A., Stokley, S., Beaty, B.L., Brtnikova, M., Hurley, L.P. and Kempe, A., 2013. Adoption of rotavirus vaccine by US physicians: progress and challenges. *American journal of preventive medicine*, 44(1), pp.56-62.
6. Fagerland, M.W., Lydersen, S. and Laake, P., 2013. The McNemar test for binary matched-pairs data: mid-p and asymptotic are better than exact conditional. *BMC medical research methodology*, 13, pp.1-8.
7. Redelmeier, D.A. and Tibshirani, R.J., 2017. A simple method for analyzing matched designs with double controls: McNemar's test can be extended. *Journal of clinical epidemiology*, 81, pp.51-55.
8. Jalalizadeh, M., Alshiek, J., Santoro, G.A., Wieczorek, A.P. and Shobeiri, S.A., 2018. Six-year experience in teaching pelvic floor ultrasonography using pelvic floor phantoms. *Obstetrics & Gynecology*, 132(2), pp.337-344.
9. Wu, Y., 2018. Power calculation of adjusted McNemar's test based on clustered data of varying cluster size. *Biometrical Journal*, 60(6), pp.1190-1200.
10. Padoia, V., Lee, J., Norman, B., Link, T.M. and Majumdar, S., 2019. Diagnosing osteoarthritis from T2 maps using deep learning: an analysis of the entire Osteoarthritis Initiative baseline cohort. *Osteoarthritis and cartilage*, 27(7), pp.1002-1010.
11. Pum, J.K., 2019. Evaluation of analytical performance of qualitative and semi-quantitative assays in the clinical laboratory. *Clinica Chimica Acta*, 497, pp.197-203.
12. Sanghavi, R., Reisch, J. and Tomer, G., 2022. Diversity in selected leadership positions in United States academic pediatric gastroenterology programs: a review and call to action. *Journal of pediatric gastroenterology and nutrition*, 74(2), pp.244-247.

STAT.Ibrahim.Abdulkhaleq@MSc.2024.Non Parametric Statistics

ORIGINALITY REPORT

43%
SIMILARITY INDEX

43%
INTERNET SOURCES

43%
PUBLICATIONS

10%
STUDENT PAPERS

PRIMARY SOURCES

1 pubmed.ncbi.nlm.nih.gov **8%**
Internet Source

2 link.springer.com **7%**
Internet Source

3 www.researchgate.net **5%**
Internet Source

4 Yougui Wu. "Power calculation of adjusted McNemar's test based on clustered data of varying cluster size", Biometrical Journal, 2018 **4%**
Publication

5 David L Schriger, Larry J Baraff, Arlene Fink. "A comparison of implicit and explicit methods of process quality assurance for blunt trauma patients", Annals of Emergency Medicine, 1990 **4%**
Publication

6 medworm.com **4%**
Internet Source

7 bmcmmedresmethodol.biomedcentral.com

Internet Source

2%

8

www.mysciencework.com

Internet Source

2%

9

cris.technion.ac.il

Internet Source

1%

10

stacks.cdc.gov

Internet Source

1%

11

profiles.stanford.edu

Internet Source

1%

12

www.statology.org

Internet Source

1%

13

www.pubfacts.com

Internet Source

<1%

14

docksci.com

Internet Source

<1%

15

hrmars.com

Internet Source

<1%

16

Jos L. Willems, Gregory Campbell, James J. Bailey. "Progress on the CSE diagnostic study", *Journal of Electrocardiology*, 1990

Publication

<1%

17

coek.info

Internet Source

<1%

Exclude quotes Off

Exclude matches Off

Exclude bibliography On