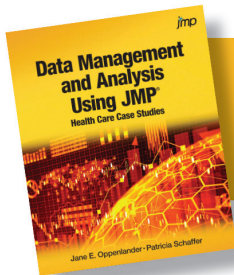


Data Management and Analysis Using JMP®

Health Care Case Studies

Jane E. Oppenlander • Patricia Schaffer



From *Data Management and Analysis Using JMP®*.
Full book available for purchase [here](#).

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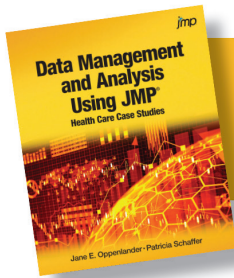
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Nurses' Perceptions of Evidence-based Practice: Does It Differ by Organization Level?

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Chapter Summary Concepts

Statistical Concepts	Data Management Concepts	JMP Features
Descriptive statistics	Treatment of missing data	Fit Y by X
Data visualization <ul style="list-style-type: none">Mosaic plot	Aggregating variables	Recode
X ² test of independence		Categorical
Validating assumptions		Tabulate

Background

This is the second case examining the results of a survey that assesses the state of evidence-based practice (EBP) at a 450-bed hospital that is pursuing magnet designation. Hospitals are recognized with magnet designation after successfully completing a rigorous process to demonstrate nursing excellence. Evidence-based practice is one component of nursing excellence and integrates nursing research, a nurse's clinical experience and skill, and patient values when providing patient care. Magnet hospitals benefit from improved patient outcomes and the ability to attract and retain high quality nursing staff.

To assess the nursing culture and the extent to which EBP is integrated into its culture, the Nursing Research and Evidence-based Practice Council sponsored a survey (Gale and Schaffer, 2009) which was offered to all of the hospital's registered nurses. Registered nurses fall into one of two categories, nurse leaders and nurse professionals. Nurse leaders include nurse managers, associate nurse managers, and nurse educators/quality specialists and are primarily responsible for supervision and education. Registered nurses, whose main responsibilities are to deliver direct patient care, are referred to as nurse professionals.

In the first case in this series, we prepared the data and analyzed one of the survey questions to provide an overall assessment of the nurses' opinions of EBP as implemented at the hospital. The important findings from that case were that the proportion of nurses that viewed EBP favorably is 0.33. A 95% confidence interval for the proportion is [0.27, 0.40] and accounts for the uncertainty associated with estimating the sample proportion.

In this case we will gain a deeper understanding of the nurses' perception of the implementation of EBP in their units. We will analyze their perceptions of EBP as related to both the workflow in their units and their practice setting. Examples of practice settings include emergency departments, operating rooms, or intensive care units. In addition, we will compare perceptions based on organization level (nurse leaders or nurse professionals).

Problem Statement

The Nursing Research and Evidence-based Practice Council would like to know if there are differences in how the leaders and nurse professionals view EBP changes with respect to the working environment, particularly unit workflow and practice setting.

The Data

The problem statement can be addressed by analyzing two of the seven survey questions that ask the nurses to rate the implementation of EBP in their hospital unit:

- "All of the practice changes so far have been practical and fit well with the workflow of the unit."
- "Evidence based practice does not take into account the limitations of my practice setting."

The online survey was offered to all registered nurses employed by the hospital. A total of 854 nurses were invited to participate. The survey includes seven rating questions that pertain to excellence in EBP. The nurses were asked to rate each of these questions on a five-point Likert scale. The responses for these seven questions and participant demographics are contained in the file EBP_Survey_Responses2 jmp. Data definitions are given at the end of this case. A copy of the complete survey can be found in the online resources that accompany this book.

Data Management

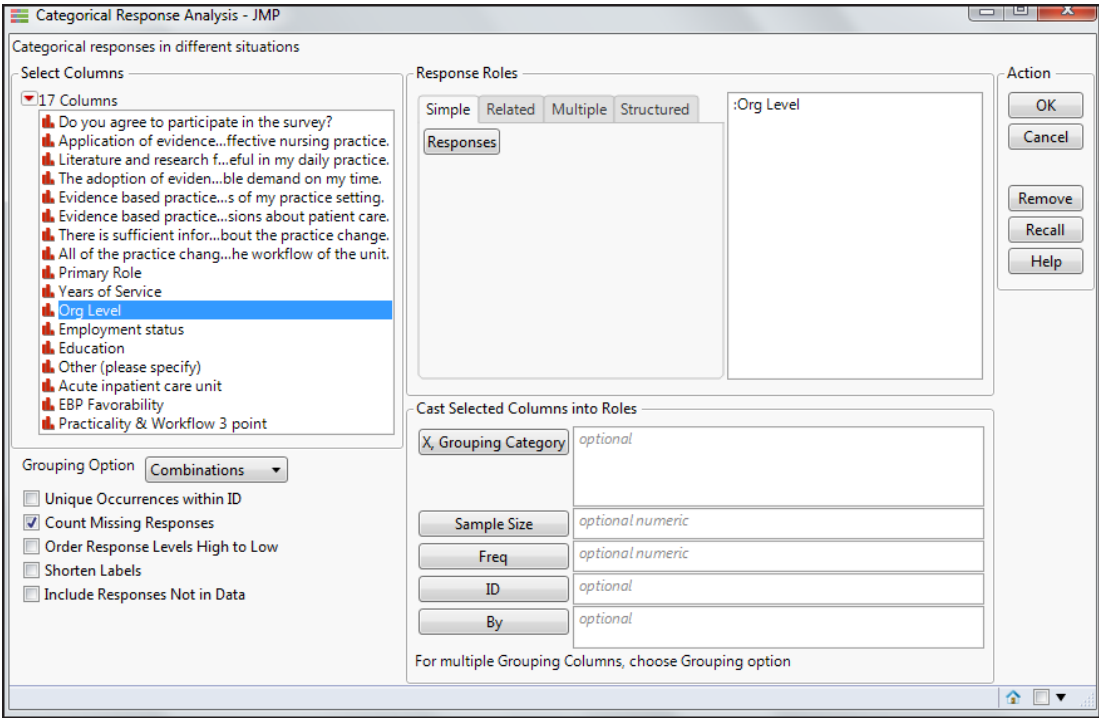
Creating a Column for Organizational Level

The problem statement is looking for differences in perception by organizational level, specifically between the nurse leaders and nurse professionals. The survey did not collect this information directly, but rather requested the respondent's specific job title. To address

the problem statement a new variable must be created that maps the various job titles into the two organizational categories. Highlight the column Primary Role and then select Cols > Utilities > Recode. Assign the nurse manager, associate nurse manager, and nurse educator/quality specialist the level “leader” and the registered nurse the level “nurse professional.” Create a new column entitled “Org Level” by selecting “New Column” from the Done drop-down menu.

The JMP Categorical platform can be used to create a table showing the number of responses and associated percentages in each of the two organizational levels. From the Analyze menu, select Consumer Research > Categorical with the “Count Missing Responses” option chosen as shown in Figure 3.1 on page 30.

Figure 3.1 Completed Categorical Dialog to Obtain Distribution of Organization Level



The resulting table is shown in Figure 3.2 on page 31.

Figure 3.2 on page 31 shows the distribution of nurse leaders and nurse professionals who responded to the survey which was obtained from Analyze > Consumer Research > Categorical with the “Count Missing Responses” option selected.

Figure 3.2 Distribution of Org Level

Responses(Org Level)				
Freq Share	Org Level			
		Leader	Nurse Professional	Total Responses
All	48 18.5%	25 9.7%	186 71.8%	259

Forty-eight (18.5%) nurses chose not to give their job title.

Calculating Survey Response Rate by Organizational Level

Examining non-response can provide valuable insights when interpreting survey results. Of the 259 nurses responding to the survey, 25 (10%) were leaders and 186 (72%) were nurse professionals. Table 3.1 on page 31 compares the response frequencies by organization level to the frequencies found in the hospital's nursing population.

Table 3.1 Non-response Analysis

Organization Level	Response Frequency (%)	Population Frequency (%)
Nurse Professional	186 (88)	811 (95)
Leader	25 (12)	43 (5)

The leaders responded to the survey in greater proportion than did the nurse professionals in comparison to their occurrence in the hospital's nursing population. This means that the opinions of the leaders are overrepresented in the survey.

Analytic Approach

In this case we are want to determine if there are differences in how the leaders and nurse professionals view EPB changes in their unit workflow and practice setting. The three questions below will guide the selection of appropriate statistical methods.

- 1 What is the response (Y) of interest and how is it measured? Two of the survey's rating questions are being analyzed in this case. There are five response options for each of these questions expressing the degree of agreement with each proposition. This is

referred to as a 5-point Likert scale and is an ordinal scale of measure. Since this is an ordinal scale, we are interested in the frequency (or proportion) of response in each of the five agreement categories.

- 2** Are predictor variables mentioned in the problem statement? If so, how many and what are their measurement levels? The problem statement concerns differences in the perception of EBP by organization level. In this case we are interested in comparing the opinions of leaders vs. nurse professionals. This means there is one predictor variable (X), the organization level.
- 3** What are you being asked to deliver? A data description, an interval estimate, an answer to a question, or a predictive model? We are being asked to answer a question. A test of hypothesis is an appropriate statistical method to answer a question based on a sample of data. For this case we will make two bivariate comparisons, where the response variable (Y) is the rating and the predictor variable (X) is the organization level. The appropriate statistical method is a chi-square test for independence.

Chi-Square Test for Independence

We want to know if a nurse's perception of EBP depends on their organizational level. A chi-square test is the appropriate method for comparing two nominal or ordinal variables. The null hypothesis for this test is that perception is independent of organization level. The alternative hypothesis is that perception depends on organization level.

If the null hypothesis is true, that there is no difference in perception by organization level, then we would expect to see the same proportion in each rating category for both the nurse professionals and the nurse leaders. If the proportions are not close between the nurse professionals and the nurse leaders, we would suspect that their perceptions of EBP differ. As with other hypothesis tests, we need to ascertain that the differences we see are statistically significant and not due to sampling error. We will use a chi-square test statistic. This measures the discrepancy between the frequencies we observed in our sample and what we would expect under the null hypothesis. The chi-square test statistic follows a chi-square distribution.

When comparing two nominal/ordinal variables, it is customary to present the data in a contingency table. In our case, we have two organization levels and five response levels, so our contingency table will have two rows and five columns. Each "cell" of the table contains the frequency for each combination of organization and response level. An important assumption in conducting a chi-square test for independence is that no more than 20% of the cells can have expected frequencies of five or less. We also assume that the survey responses are independent. The chi-square test concerns the independence of the two factors – organization level and perception. The assumption of independence has to do with how the data was collected, i.e., a participant's response is not influenced or related to the response of another participant.

JMP Analysis

Descriptive Analysis

Every analysis should begin by describing and graphing the data. In the case “Nurses’ Perception of Evidence-based Practice: Assessing the Current Culture” the demographic characteristics for all nurses were summarized with descriptive statistics as shown in Figure 1.5. Since we are interested in differences by organizational level we will summarize the nurses’ demographic characteristics by organizational level using Tabulate. Drag and drop the demographic characteristics into the drop zone for rows and then drag and drop N and Column % into the drop zone for columns. Now drag Org level to the top of the N and Column % cells. The complete table is shown in Figure 3.3 on page 34.

When expressing percentages in a table, there are three choices for how the percentage can be calculated: as a percent of total number of observations, as a percent of the column totals, or as a percent of the row totals. The choice of which percentage to display depends on the analysis objective. In this case we are interested in comparing by organizational level and since that is the column variable in the table, column % is selected. Comparing the demographic characteristics between nurse professionals and leaders we see that:

- Leaders have one of three different primary roles, while nurse professionals have only one primary role.
- Leaders tend to have more years of service than nurse professionals.
- Leaders are all full-time employees, while most nurse professionals are full-time with 19% having part-time employment status.
- Leaders tend to have higher education levels than nurse professionals.

Understanding the demographic differences between the two groups of nurses is valuable when interpreting the differences in their perceptions of EBP.

Figure 3.3 JMP Tabulate Output for Nurse Demographics by Organizational Level

Tabulate				
	Org Level			
	Leader		Nurse Professional	
Primary Role	N	Column %	N	Column %
Associate Nurse Manager	6	24%	0	0%
Nurse Educator/Quality Specialist	8	32%	0	0%
Nurse Manager	11	44%	0	0%
Registered Nurse	0	0%	186	100%
Years of Service				
Less than one year	0	0%	20	11%
1-3 years	1	4%	41	22%
3-5 years	5	20%	27	15%
5-10 years	9	36%	33	18%
10-20 years	4	16%	24	13%
20 years +	6	24%	41	22%
Employment status				
Full Time	25	100%	151	81%
Part Time	0	0%	26	14%
Per Diem	0	0%	9	5%
Education				
Associate's	11	44%	115	62%
Bachelor's	7	28%	45	24%
Diploma	2	8%	18	10%
Master's	3	12%	6	3%
Other degree	2	8%	2	1%

We will summarize the responses to the two survey questions of interest first overall and then by organization level using Analyze > Consumer Research > Categorical. Select Simple for the Response Roles and check the box for Count Missing Responses.

Figure 3.4 on page 35 shows the completed Categorical dialog.

Figure 3.4 Completed Categorical Dialog for Survey Question "All of the practice changes so far have been practical and fit well with the workflow of the unit"

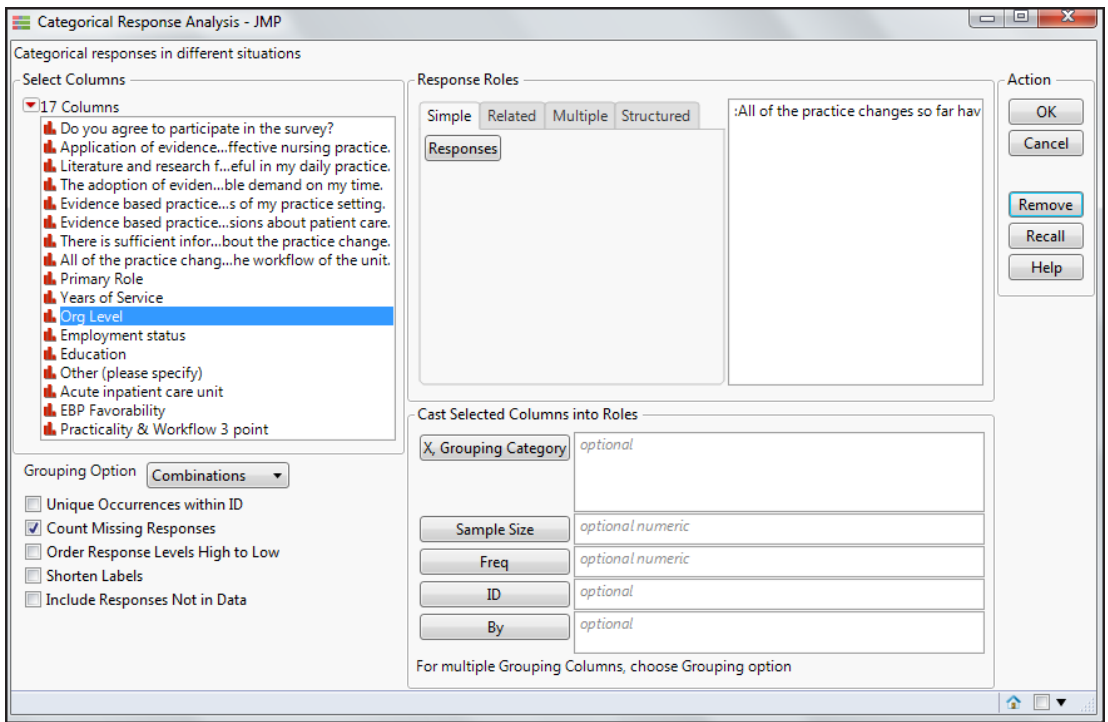
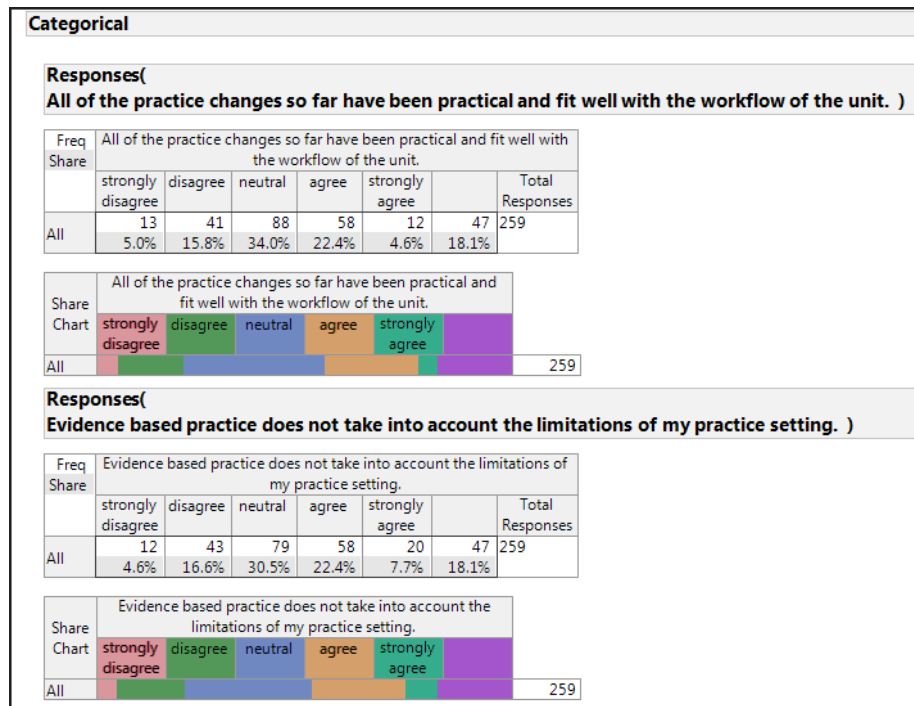


Figure 3.5 on page 36 shows a descriptive analysis for all respondents combined for the two survey questions "All of the practice changes so far have been practical and fit well with the workflow of the unit" and "Evidence based practice does not take into account the limitations of my practice setting" in both tabular and graphical form.

Figure 3.5 Categorical Response Analysis of Two Survey Questions

The tables give the count of missing responses and their percentage of the total responses. Alternatively, the missing values can be omitted by leaving "Count Missing Responses" unchecked in the Categorical dialog.

Both questions show a similar pattern of agreement and have the same number of nurses who did not offer a rating. Notice that the question about unit workflow is phrased positively and the question about practice setting is phrased in the negative. In general, the nurses are more positive about EBP with respect to practicality and workflow but view EBP more negatively in terms of practice setting. Best practice in survey design favors phrasing all questions positively. Mixing questions that are phrased both positively and negatively can be confusing to the respondent and may lead to unintended response choices.

Figure 3.6 on page 37 shows survey responses to the two questions by organization level. Again, you can obtain this output by selecting Analyze>Consumer Research>Categorical and enter the column Org Level into the X grouping category.

Figure 3.6 Categorical Response Analysis of Two Survey Questions by Organizational Level

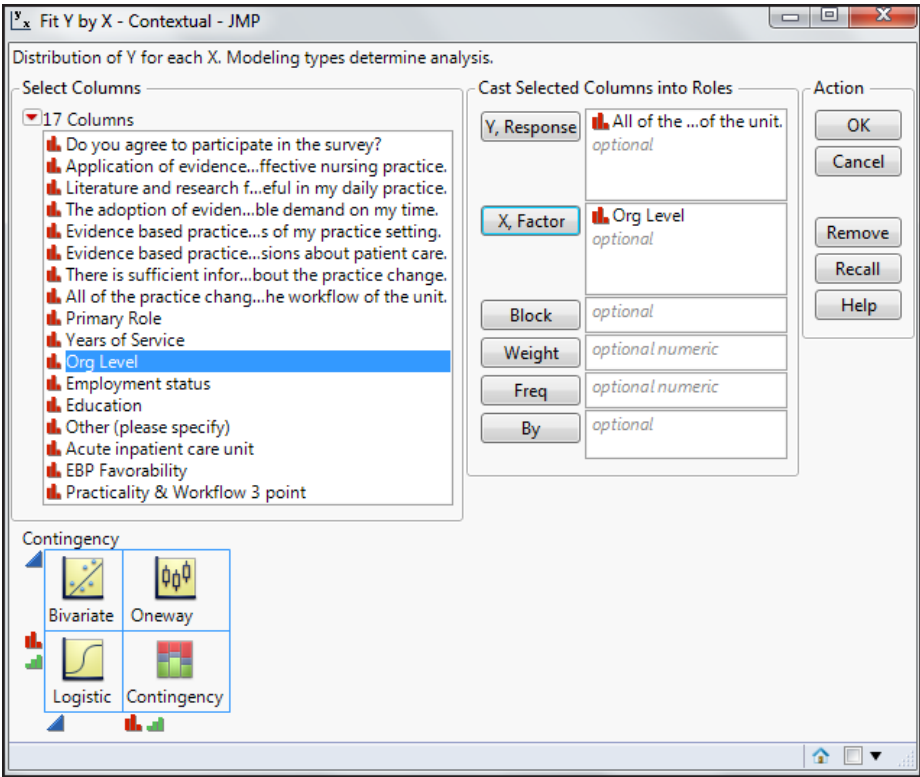


For the rating question on EBP practicality and workflow the nurse professionals had a higher level of neutral response than did the leaders who generally are in more agreement with the proposition. The leaders generally felt that EBP took practice settings limitations into account while nurse professionals did not. Descriptive analysis allows you to observe differences between the organizational levels but does not tell you if these differences are statistically significant. A test of hypothesis is needed to determine statistically significant differences.

Chi-square Test for Independence

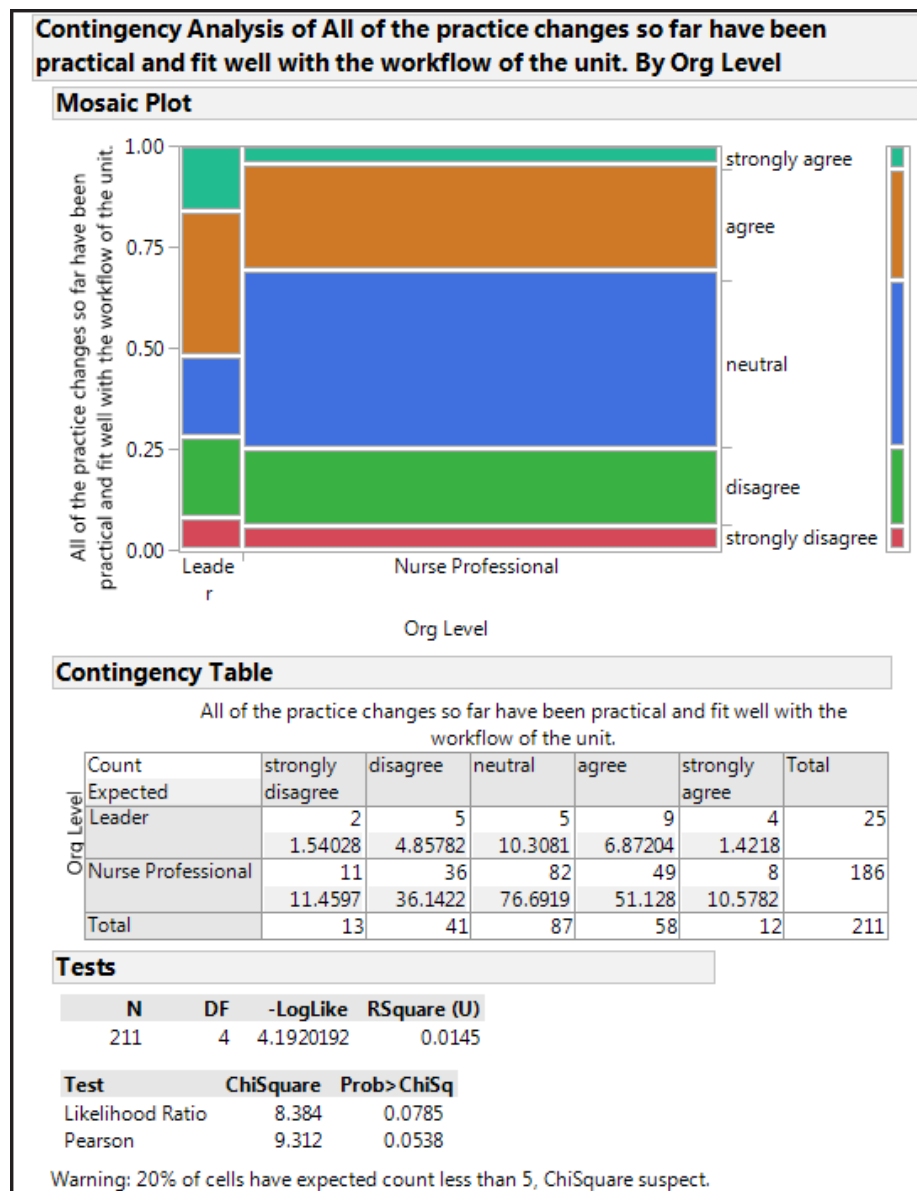
Fit Y by X is the appropriate platform to conduct a chi-square test for independence. For this analysis, the column containing the responses to a survey question is the Y and the variable Org Level is the X, as shown in Figure 3.7 on page 38.

Figure 3.7 Completed Fit Y by X Dialog.



To show the percentages on the mosaic plot, right click over one of the panels and select Cell Labeling > Show Percents. Figure 3.8 on page 39 shows the JMP output for the practicality and workflow question.

Figure 3.8 Chi-square Analysis for the Practicality and Workflow Question

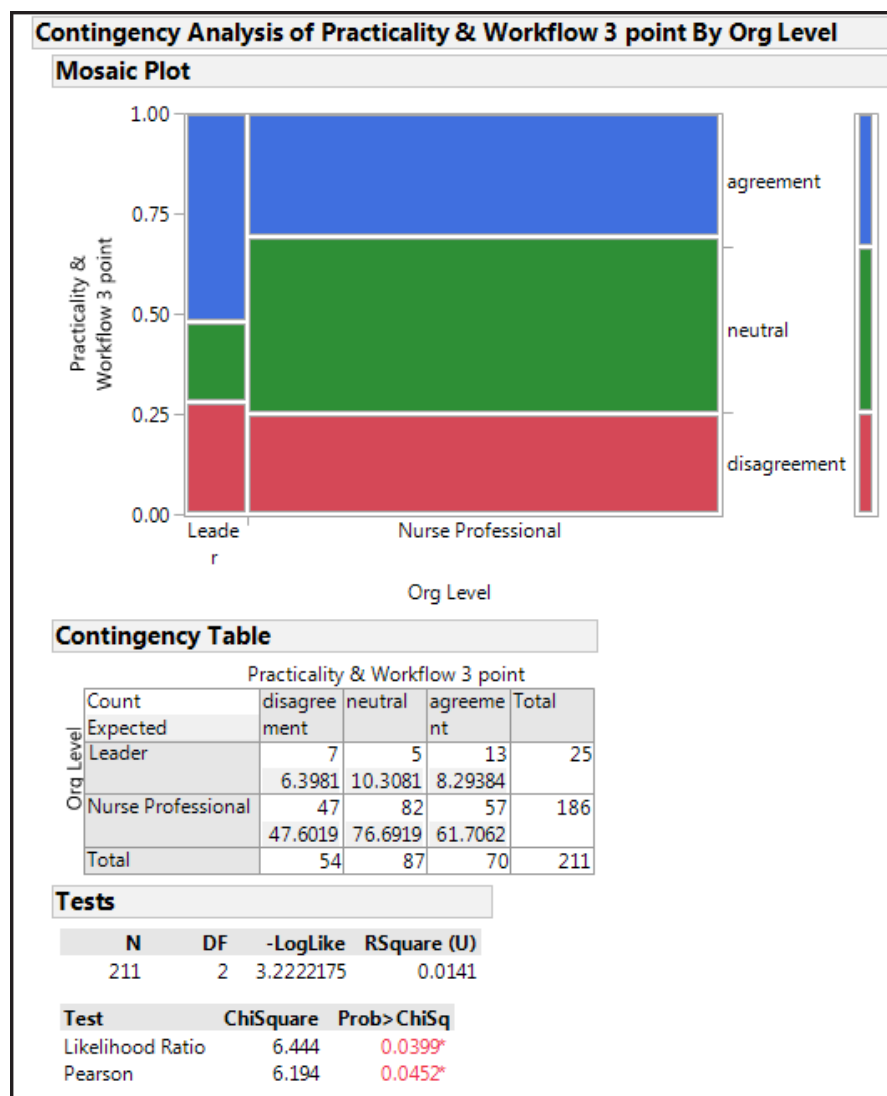


The large mosaic plot shows the proportion of responses in each rating category by each of the organization levels. The small mosaic plot to the right shows the proportion of responses in each rating category for both nurse professionals and leaders combined. This represents the null hypothesis of independence, i.e., both organization levels have the same proportion in each rating category. If the mosaic plots by organization level are similar, then this is consistent with the null hypothesis of independence. Less similarity between the mosaic plots for the two organization levels suggests the data is not consistent with the null hypothesis.

The contingency table displays the observed counts and the counts that would be expected if the pattern of agreement is independent of the organization level. The red triangle menu offers a variety of options that can be shown in the contingency table, including both conditional and unconditional relative frequencies. The chi-squared test for independence compares the observed frequency (Count in the JMP contingency table) to the expected frequency.

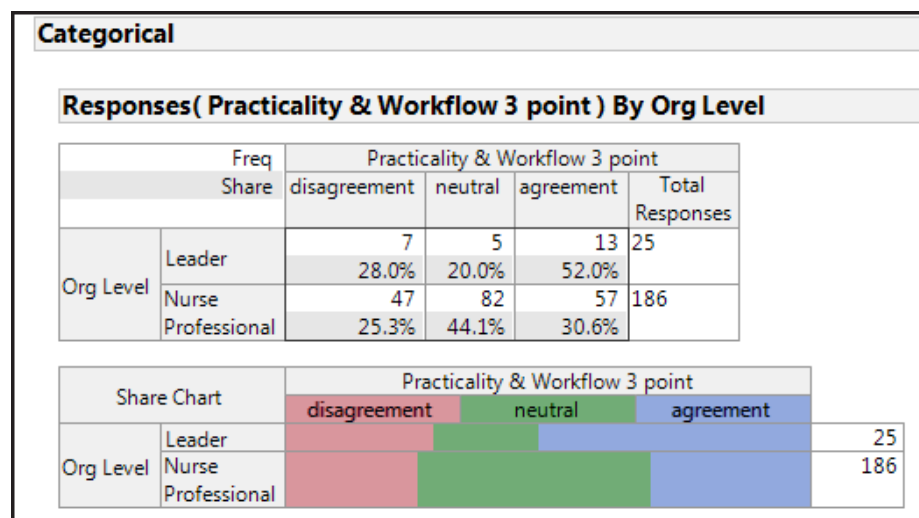
We can't establish statistical significance through visual comparison of graphs or comparing the counts in a contingency table. The chi-square test statistic and the associated p-value ($\text{Prob} > \text{ChiSq}$) are found in the Tests section. However, the warning at the bottom of the JMP output indicates that the chi-square assumption for the minimum number of cells with expected counts greater than 5 is not satisfied. You can remedy this problem by combining some of the response columns. In this case we can reduce the 5-point Likert scale to a 3-point scale by combining the strongly disagree and disagree categories and the strongly agree and agree categories. JMP's Recode feature provides an easy means to create a column containing the levels disagreement, neutral, and agreement. Rerunning the chi-square analysis yields the results in Figure 3.9 on page 41 .

Figure 3.9 Chi-square Analysis for the Practicality and Workflow Question with a 3-point Scale



Note that the chi-square assumption is now satisfied and we can safely use the p-value from the Pearson chi-square test (0.0452) which tells us that at the 5% significance level the perception of EBP with respect to practicality and workflow depends on whether you are a leader or a nurse professional. P-values that are less than the chosen significance level cause a rejection of the null hypothesis. A p-value is the likelihood of obtaining the sample outcome, or something more extreme, assuming the null hypothesis is true. Figure 3.10 on page 42 shows the distribution of the response for the two organization levels.

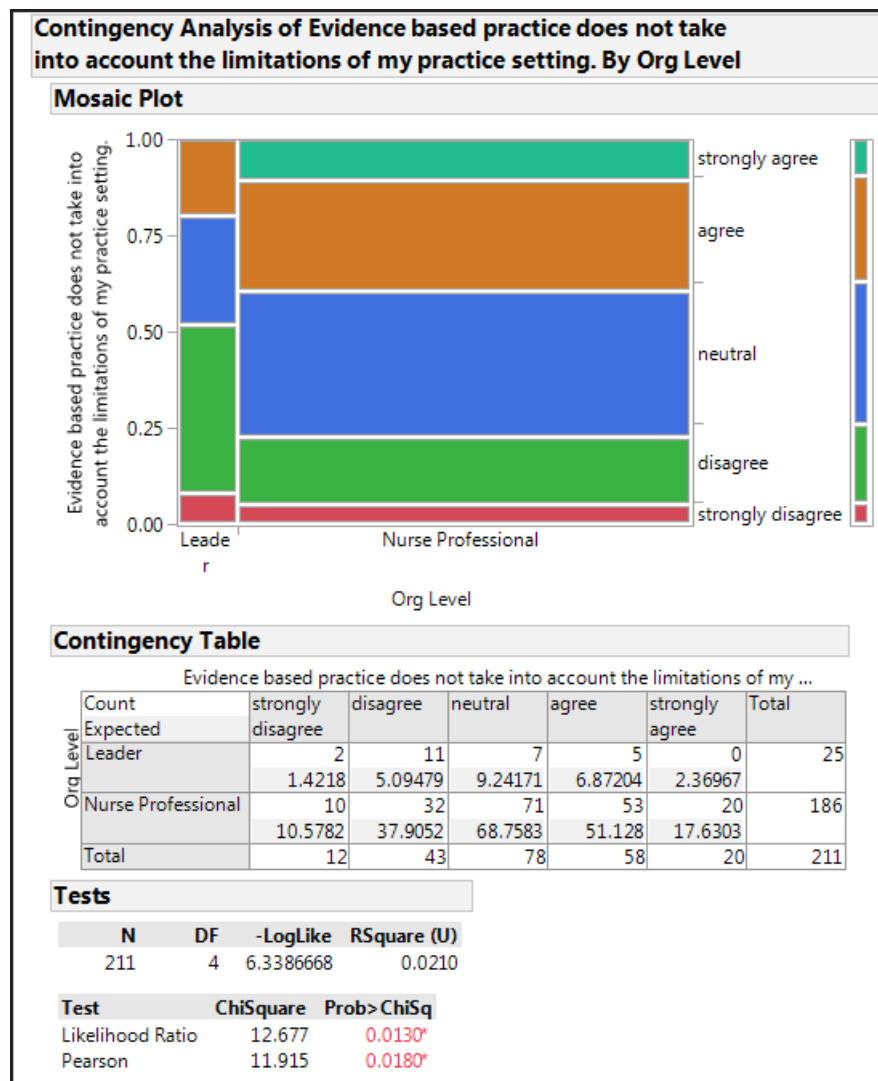
Figure 3.10 Categorical Response Analysis of the Practicality and Workflow Question by Organizational Level



The leaders show a slight majority in agreement while the nurse professionals most frequently respond with neutral and have slightly more in agreement than in disagreement. So for the proposition “All of the practice changes so far have been practical and fit well with the workflow of the unit,” the nurse professionals and nurse leaders differ in their patterns of agreement.

Finally, we consider the survey question “Evidence based practice does not take into account the limitations of my practice setting.” The chi-square analysis is shown in Figure 3.11 on page 43.

Figure 3.11 Chi-square Analysis for the Limitations of Practice Setting Question



For this survey question, the chi-square assumption for the minimum number of cells with counts of at least five is satisfied and the p-value of 0.0180 from the Pearson test indicates that there is a statistically significant difference at the 5% level in how leaders and nurse professionals view EBP in relation to the limitations of their practice setting. Figure 3.5 on page 36 shows the differences in the support for the proposition with leaders generally finding EBP is consistent with practice setting limitations while the nurse professionals do not.

Finally, we address the assumption of independence between survey respondents. This assumption is best satisfied during the design and administration of the survey. For example,

sending the survey link to a respondent's home email rather than their work email may reduce the influence of co-workers.

Analysis Implications

The analysis of two of the seven survey questions shows statistically significant differences in perception between leaders and nurse professionals. Based on these findings, the Nursing Research and Evidence-based Practice Council Analysis can take a number of actions to continue to refine their understanding of the barriers and facilitators to EBP. This can be done by continuing to analyze the survey results and further investigating the ways in which EBP has been implemented at the hospital. For example, have leaders received more training in EBP or do their work responsibilities allow them more time to engage in nursing research?

Our analysis showed a significant difference in how the different organization levels perceive EBP in the context of the practice setting, so a next logical step would be to examine the responses by the variable "Acute inpatient care unit" which identifies the care setting (e.g., intensive care, labor and delivery, and psychiatry) in which the nurse works. Also, the five remaining survey questions should be analyzed.

The influence of the other demographic variables should also be investigated. This may reveal the presence of lurking or confounding variables. A lurking variable is one that was not collected by the survey but has an influence on the relationship between EBP perception and organizational level. A potential lurking variable might be whether a nurse has previously worked at a magnet hospital. A confounding variable is one that is collected in the survey and has an influence on the relationship between EBP perception and organizational level. For example, all (or many) of the leaders may be older while many of the nurse professionals may be younger. In this situation organizational level is confounded with age. More advanced multivariate methods such as factor analysis may yield additional insight into the perception of EBP in the nursing workforce.

When interpreting the results you should be mindful of the limitations in the survey. The responses represent a non-random sample and the overall response rate was only 30%. Since this was a voluntary survey, self-selection bias may be present. It is possible that the nurses who chose to respond may be more engaged in EBP or hold stronger opinions about its implementation at the hospital. It is interesting to note that 18% of the nurses did not respond to these two survey questions. This suggests these nurses may be concerned about how the survey data will be used or that their responses can be personally identified from the demographic information. Despite these concerns, the survey and this analysis provide valuable information that could be used to advance the hospital's goal of achieving magnet designation.

Data Definitions

Primary Role	Job title: nurse manager/associate nurse manager/nurse educator or quality specialist/registered nurse
Years of Service	Number of years employed as a nurse at this hospital
Org Level	Organizational level is either Leader or Nurse Professional
Employment status	Full-time/part-time/per diem
Education	Highest nursing degree held
Acute inpatient care unit	Hospital unit where the nurse works
EBP Favorability	Aggregation of responses to the question “All of the practice changes so far have been practical and fit well with the workflow of the unit.” Favorable contains the agree and strongly agree responses, Unfavorable contains strongly disagree, disagree and neutral
Practicality & Workflow 3 point	Aggregation of responses to the question “Evidence based practice does not take into account the limitations of my practice setting.” Agreement contains the agree and strongly agree responses, Disagreement contains strongly disagree, disagree and neutral

Problems

- 1 Consider the two survey questions that pertain to resources to assist nurses with evidence-based practice: (a) Literature and research findings are useful in my daily practice, and (b) There is sufficient information available for me to access when I have questions about the practice change. Analyze the nurses' responses to these two questions using the methods presented in this case. Compare the nurses' responses to those of the two questions pertaining to implementing EBP on the unit that were analyzed in the case.
- 2 Create a summary table showing the responses for all seven rating questions by organization level using Tabulate. Include both counts and percentages within each organization level (nurse professionals and nurse leaders).
- 3 Repeat the analysis shown in this case for survey questions of your choice. Prepare a few presentation slides that summarize your findings.
- 4 The non-response analysis showed that nurse leaders responded to the survey in greater proportion than did the nurse professionals in comparison to their occurrence in the hospital's nursing population. Discuss possible reasons for this and how it influences your interpretation of the results.

References

Stevens, Kathleen R., "The Impact of Evidence-Based Practice in Nursing and the Next Big Ideas," *The Online Journal of Issues in Nursing*, Vol. 18, No.2, May 2013, accessed on November 9, 2015 at <http://nursingworld.org/MainMenuCategories/ANAMarketplace/ANAPeriodicals/OJIN/TableofContents/Vol-18-2013/No2-May-2013/Impact-of-Evidence-Based-Practice.html?css=print>.

Gale BVP and Schaffer MA, "Organizational readiness for evidence-based practice," *Journal of Nursing Administration*, 2009; 39(2):91-97.

About This Book

Purpose

Data Management and Analysis Using JMP: Health Care Case Studies bridges the gap between the traditional first statistics course and the successful application of statistical analysis in the workplace. It illustrates a holistic, step-by-step approach to analyzing health care data, showing practitioners and students how to solve real-world problems by example. We employ a problem-solving strategy that includes problem definition, data management, a framework for selecting analysis methods, step-by-step JMP instructions, and how to interpret statistical results in context.

The cases begin by illustrating techniques to prepare data for analysis, followed by applying appropriate statistical methods to explore and analyze the data, and, finally, disseminate results to stakeholders. The statistical analysis methods covered are the foundational techniques commonly applied to meet regulatory, operational, budgeting, and research needs in the health care industry. Groups of cases are organized around different scenarios and data sets and illustrate a logical progression for problem solving, beginning with data visualization and descriptive analysis and continuing to statistical inference and model building. Much of the data is open-source, drawn from a variety of health care settings.

Is This Book for You?

Data Management and Analysis Using JMP: Health Care Case Studies is designed for beginner and intermediate JMP users who are working or studying in health care fields. It is appropriate as either a textbook or supplement for an introductory statistics course focusing on health care applications. The cases and associated exercises can be used for classroom activities or for self-study. This book can also serve as a useful reference for working professionals in health care fields.

Prerequisites

This casebook assumes the reader has taken an introductory statistics course and has basic navigational facility with JMP.

Scope of This Book

This casebook covers basic data management techniques suitable for preparing data for analysis. JMP's data visualization capabilities, invaluable for exploring and presenting data, are included in each case. Statistical methods traditionally covered in introductory statistics courses are presented, including descriptive analysis, univariate and bivariate statistical inference, and simple and multiple regression analysis.

About the Examples

Software Used to Develop the Book's Content

JMP® 13 was used in the cases presented in this book.

Example Code and Data

The data files that accompany our cases can be downloaded from the authors' pages at <https://www.sas.com/sas/books/authors/jane-oppenlander.html> or <https://www.sas.com/sas/books/authors/patricia-schaffer.html>.

Output and Graphics Used in This Book

The cases give step-by-step instructions for solving problems using JMP. The relevant JMP dialogs and output are shown in each case.

Exercise Solutions

Instructors can request solutions to the exercises by writing to saspress@sas.com.

Additional Resources

Additional case studies can be downloaded from the JMP Case Study Library (www.jmp.com). These cover topics such as health care and quality improvement, statistics and biostatistics, analytics and predictive modeling, and business statistics.

The following resources provide more detailed explanations of data management, visualization, and analysis methods:

Cleveland, William S., *The Elements of Graphing Data*, 2nd ed., Hobart Press, 1994.

DAMA International, *DAMA Guide to the Data Management Body of Knowledge*, 2nd ed., Technics Press, 2017.

Few, Stephen, *Show Me the Numbers: Designing Tables and Graphs to Enlighten*, 2nd ed., Analytics Press, 2012.

Fowler, F. J., Jr., *Survey Research Methods*, 5th ed., Sage Publications, 2013.

Polit, D. F., *Statistics and Data Analysis for Nursing Research*, 2nd ed., Pearson, 2010.

Rossner, B., *Fundamentals of Biostatistics*, 8th ed., Cengage Learning, 2015.

Tufte, Edward R., *The Visual Display of Quantitative Information*, 2nd ed., Graphics Press, 2001.

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About the Authors



Jane E. Oppenlander is a professor at Clarkson University, where she teaches statistics for the School of Business and the Clarkson University-Ichan School of Medicine at Mount Sinai Bioethics Program. She has more than 30 years of experience applying statistics and operations research in the energy industry. Jane is a certified Six Sigma Master Black Belt. A long-time JMP and SAS user, she received her Ph.D. in Administrative and Engineering Systems from Union College in Schenectady, New York.



Patricia Schaffer is President of Total Quality Associates, Inc., a New York-based consulting firm. Pat has worked with private and public sector information systems for over 30 years with a concentration in the design, development, implementation, and quality assurance of data warehouse and master data management solutions. She also held the position of adjunct professor of Management Information Systems at Union Graduate College in Schenectady, NY.

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