Conducting Public Health Research on the World Wide Web

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Abstract

There is a growing wealth of resources on the World Wide Web (Web) (WWW) to assist health promotion and public health professionals in developing and executing research activities. Web resources exist that can help the researcher conduct literature reviews, locate background information on research methods, and help explore strategies to manage the research project. This article explores the ten major activities associated with conducting research, and helpful Web resources available to assist those activities.

Introduction

As the Internet grows, the World Wide Web (WWW) is providing a wealth of resources to help researchers explore topics, analyze data, and publish findings. Although there are many databases and information resources not yet available electronically, the WWW has become rich enough to provide important first stops for researchers and young professionals developing their research skills. This publication will highlight some of the helpful and detailed resources available on the WWW for researchers, but it is not meant to be exhaustive. As the Internet grows, new resources will appear that could be helpful additions to the researcher's tool bag. We encourage public health researchers to begin their own collection of favorite links and websites to help make their research activities easier and more productive.

Phases of Conducting Public Health Research

A researcher commits time, energy, and attention to conduct research activities and prepare a professional publication. One way to envision how these personal and professional resources are spent is to imagine ten major phases where different skills and resources are used to perform specific activities that accomplish related, but unique goals. These ten major phases of conducting public health research are:

1. Develop a Foundation on the Research Topic
2. Define the Research Problem
3. Conduct a Literature Review of the Research Problem
4. Choose an Appropriate Research Strategy
5. Create or Locate Appropriate Measurement Tools
6. Obtain Approval for Institutional Research
7. Obtain Funds / Resources for Research
8. Manage and Conduct Research Activities
9. Analyze and Interpret Data Obtained
10. Prepare and Disseminate Research Results

While these phases are listed above in numerical order, the researcher often moves in a nonlinear fashion from one state to another state because of their interdependence in making research decisions and plans. For example, a researcher might define a research problem and begin to conduct a literature review, only to discover that more recent research publications require the research problem be modified. The literature review might change as a different emphasis is selected in the research problem. Selecting an appropriate research strategy to examine the research problem may be altered depending on whether funds or resources are obtained, or how a research project is modified because of institutional review. While conducting a literature review, the researcher might discover a new measurement tool or an innovative research method that could make later phases easier and more effective. The ten phases are a helpful way to look at the research process, but are somewhat arbitrary. The dynamic interplay between phases is how research gets accomplished, but the researcher must delve into each of these ten phases when going through the full research process.

Phase 1: Develop a Foundation on the Research Topic

One of the first steps in writing a research paper or article is becoming familiar with the current literature in the subject discipline. The reasons for this are twofold: first, writing a research paper can be likened to entering into a conversation with the archive of literature in the subject area (Davidson & Crateau, 1998). To be successful in the conversation, the researcher must be conversant in the subject discipline. Second, the literature should be consulted to determine if there is a need for further research. Examination of the domain of literature gives the researcher a feel for

research already conducted and a glimpse of the treatment other scholars have given the subject.

There are a variety of texts available that highlight WWW and other Internet-based resources for health promotion and public health efforts. For example, HealthNet (Ryer, 1997) provides an overview of important internet websites for examining health conditions, diseases, and information resources. It also does an excellent job of highlighting the role that chat groups, Usenet newsgroups, and automated email groups can play in providing social support and connections with other people facing similar problems and information needs. Researchers may get valuable insight on topics and possible research subjects by becoming a part of an informal chat group or discussion group. Health Online, a book by Tom Ferguson (1996), guides the reader through the tools often used on the Internet for gathering health information and communicating with others: e-mail, America Online, mailing lists, newsgroups, the WWW, gopher, Internet Relay Chat, Bulletin Board Systems, and more. There have even been texts that provide an introduction to the WWW for special populations; for example, seniors looking for health and other information (Johnson & McFadden, 1997), as well as educators locating websites to supplement their own knowledge base or enhance their teaching experiences in the classroom (Bigham & Bigham, 1998)

On the WWW, a good starting place for novice researchers to look for general information on any topic is an encyclopedia such as Britannica.com (http://www.britannica.com). Then, for more specific details the researcher can visit consumer health websites such as WebMD (http://www.webmd.com) and Drkoop.com (http://www.drkoop.com). To locate research articles and reviews on focused research, electronic article databases such as PubMed (http://www.ncbi.nlm.nih.gov/PubMed) should be consulted. Additionally, the researcher could look at meta-websites (i.e. a website of websites) such as The Virtual Library - Public Health (http://www.ldb.org/vl) to get a glimpse of the type of public health information that is available on the Web.

In the initial perusal of the literature, researchers should ask themselves the following questions. Is there a gap in the subject archive that needs to be filled? Where have other researchers left room for further exploration? Are there research methods and tools found in the literature the researcher could use in their own project?

Phase 2: Define the Research Problem

The most important phase in conducting research is stating the research question. Through this activity the researcher decides where—within the myriad of possible topics—the attention and focus of resources will be directed. Spending extra time here carefully formulating and delimiting an area of study will save the researcher many hours in the future. A well-formed research question will identify the variables important to examine, the nature of the relationship among the variables, and the population within which these variables play their relevant roles. This research question should not be chosen idly, but selected based upon important criteria: 1) its value to the profession and field of public health, 2) its interest to the researcher and the enthusiasm to see the project to its conclusion, and 3) its ability to be examined thoroughly within the resource constraints (money, time, energy, equipment, expertise, etc.) of the researcher (Portney & Watkins, 1993; Neutens & Rubinson, 1997). One problematic area in the statement of research problems or hypotheses is the lack of practical, concrete detail when describing the problem. Almost all research questions must provide *operational definitions* of concepts and variables so others can understand how these concepts or variables are interpreted and measured within a study. A "reduction in binge drinking" sounds like a laudable item to examine, but does this mean an average decrease in self-reported alcohol consumption as assessed by a monthly survey of college freshmen, or fewer reported DWI citations by state police officers patrolling the campus vicinity, or fewer athletes consuming 5 or more drinks at one sitting, or something entirely different? An operational definition clarifies to the researcher and to the reader of research how variables are examined and what measures are used to represent the constructs in a study. Good examples of operational definitions for child abuse and neglect, for example, can be found at Connecticut's Department of Families and Children website (http://www.state.ct.us/dcf/defns.htm).

There are suggested guidelines on the Internet that help budding researchers explore the characteristics of a good research question. For example, the Kansas City Public Schools Collaborative Resource Network provides basic guidelines for researchers, teachers, and

students in framing a research question. Authors Mary Mikijanis and Dee Thomas discuss helpful characteristics of research problems and subproblems on their website (http://kancrn.kckps.k12.ks.us/guide/question.html). Sometimes a statement of the problem can explore many different dimensions to help a reader understand the complexity associated with a problem, (c.f., Public Health Guidelines for Enhancing Diabetes Control at CDC's Wonder (http://wonder.cdc.gov/wonder/prevguid/p0000166/p0000166.asp), but specific research efforts require that the statement of a problem be narrowed so that the corresponding research is feasible. Examples of a health-related research problem can help model the construction of effective ones. A sample problem statement about the effect of dietary management on the improved survival of nutritionally linked cancers is at (http://www.tmc.tulane.edu/cancer_center/pubs/diet/dietmgmt.html). The Research Knowledge Base provides additional information on the formation of a problem at (http://trochim.human.cornell.edu/kb/probform.htm).

Phase 3: Conduct a Literature Review of the Research Problem

Traditionally, only researchers affiliated with large universities or research facilities have been able to access specialized print and electronic indexes and databases. Today anyone with a computer and Internet access can bring the world of research information to their desktop.

Literature Review Resources on the World Wide Web

Databases

Databases are large collections of information. They generally focus on a particular subject or discipline and can be searched electronically by using keywords and other commands. Bibliographic databases such as Combined Health Information Database (http://chid.aerie.com) provide citations to journal articles, books and research reports. Statistical databases like The National Center for Health Statistics (http://www.cdc.gov/nchswww/default.htm) and the U.S. Department of Health and Human Services CDC Wonder (http://wonder.cdc.gov) contain factual information that is arranged for analysis. Often a researcher can download raw or summarized datasets from statistical databases and manipulate the data with a statistical software package to meet their need for specific information.

The National Library of Medicine (NLM) (http://www.nlm.nih.gov) provides free access to a number of different types of databases particularly helpful to the public health researcher. Notable NLM database sites include:

1. PubMed (http://www.ncbi.nlm.nih.gov/entrez): a searchable database to over 10 million journal citations derived from Medline, HealthSTAR and selected journal publishers.
2. Special Information Services (SIS) (http://sis.nlm.nih.gov/index.cfm) searchable databases on HIV/AIDS and Toxicology.
3. TOXNET (Toxicology Data Network) (http://toxnet.nlm.nih.gov) a series of bibliographic and statistical databases on human toxicity, environmental health and emission release information.

Electronic journals

In addition to locating journal information through research databases, researchers can retrieve information directly from journal publishers and professional organizations. Publishers, such as Elsevier (http://www.elsevier.com) and Academic Press (http://www.apnet.com) offer electronic versions of their journals on the Web. Professional organizations like the American Public Health Organization (http://www.apha.org) have websites with links to their publications. Most publishers and organizations offer abstract and table of content information only. For full-text access, a paid subscription to the journal is generally needed. However, there are some journals that are being developed exclusively for web-based dissemination. For example, one health education journal available only via the Web is the *International Electronic Journal of Health Education*, at (http://www.iejhe.org).

Researchers trying to find up-to-date journal table of content information on the Web, might also try ingenta (http://www.ingenta.com). The ingenta database contains tables of contents for more than 25,000 journals, with 50% of these journals in the engineering or science disciplines. The database can be searched by keywords in the journal article title and by author and journal title. For a fee, researchers can order the full-text of journal articles through ingenta's document delivery service.

In addition to finding electronic journal information on the Web, many health organizations, such as the Oregon Health Division

(http://www.ohd.hr.state.or.us/welcome.htm), provide full-text research—published and unpublished—on their Web pages. Some sites like the World Health Organization (WHO) (http://www.who.int) provide a search engine which make subject keyword searching of their entire website possible. Other value-added features of these organization websites are links to other websites where similar information can be found.

Electronic Discussion Lists

Another place to gather information on a research topic is electronic discussion lists. Experts and novices use the lists to introduce information, ask questions and debate major issues in a particular discipline. Frequently these discussion groups have archives of past discussions that are searchable by subject keyword. Websites such as Topica, a mailing list directory (http://www.topica.com), provide subject access to discussion lists, as well as specific instructions for subscribing to individual discussion lists.

Web Search Engines

Finally, search engines can be used to gather information on a particular subject. This strategy is effective whether searching for something well-known or obscure. Finding information by means of a search engine is similar to searching a database. However, instead of a subject specific database, the information being searched is the unorganized mass of the WWW. Just as there are different types of databases, there are different types of search engines. For example, some search engines like Hotbot (http://hotbot.com) allow the searcher to construct searches using boolean operators, search for images and multimedia files, and limit the search by date. There are also search engines such as MetaCrawler (http://www.metacrawler.com) and Dogpile (http://www.dogpile.com) that allow a searcher to search many search engines simultaneously. Other Web resources, like Yahoo (http://www.yahoo.com) and About (http://www.about.com), are constructed as a hierarchical directory. Information is arranged in broad categories, and the user can travel down the hierarchy to more and more specific content categories.

One of the benefits of using a search engine to retrieve information is the vast amount of information that a researcher can retrieve. However, because there is no control over what is being posted on the WWW, it is critical the researcher evaluate the information retrieved. The researcher should cast a critical eye on the authority of the author of the site, whether or not the author demonstrates objectivity and balance of their treatment of the topic, and the currency of the site. There are many sites on the Web that instruct the researcher in how to effectively evaluate Web resources. For example, The Virtual Library site "Evaluation of information Sources" (http://www.vuw.ac.nz/~agsmith/evaln/evaln.htm) lists numerous sites that offer instruction in evaluating websites and website information. The explosion of health-related information on the Web has led to concerns about who can provide what health advice or information. The Health On the Net (HON) website provides standards for health websites to follow at the HON Code of Conduct page (http://www.hon.ch/HONcode).

Literature Review

Once the researcher is familiar with the tools to find current literature within the discipline, and a topic for research for has been identified, the next step in the process is a literature review. Arlene Fink describes the literature review as "a systematic, explicit, and reproducible method for identifying, evaluating, and interpreting the existing body of recorded work produced by researchers, scholars and practitioners" (Fink, 1998). The literature search identifies related research and establishes the contextual basis for the research. As the literature search is being conducted, the researcher should identify methods used by other researchers to explore concepts, and to collect and analyze information, as well as, gather recommendations for future research. Websites, such as, the University of Indiana's "Community Health Research Methods: Lit Search How-to" at http://isu.indstate.edu/gabanys/course341/s2howto.htm and the University of Toronto Health Sciences Centre's "Writing a literature review in the health sciences and social work" (http://www.utoronto.ca/hswriting/litreview.htm) contain detailed descriptions and tips on conducting a literature review.

Structuring your Research

Taking time to organize and structure information from the literature search as it is discovered saves the researcher time and effort when writing up the final results of the research project. There are a variety of organizational methods that can be used and modified by the researcher for his/her own particular use. These methods range from keeping a set of index cards containing journal and book citations with a short

abstract for all literature reviewed during the search to bibliographic software management packages.

For those who like a visual, non-linear approach to organization, creating concept maps or hierarchical trees may be appealing. William M. Trochim of Cornell University offers a impressive overview of concept mapping on the Web at the Research Methods Knowledge Database (http://trochim.human.cornell.edu/kb/conmap.htm).

Evaluating the Results of your Literature Search

While conducting the literature search, the researcher should have in mind various criteria to evaluate the results of the search. Not all results received from the search will have equal value. Fink recommends evaluating the literature search through two screens (Fink, 1998). The first screen is how well the literature gathered covers the topic being researched. At this point in the literature search, the researcher might ask, "How do I know I have complete coverage of the subject?" One strategy that can be used to determine sufficient coverage is triangulation. In other words, is the researcher beginning to recognize that there is a pattern to the literature being cited? Is the researcher beginning to see the same authors and journal citations being repeated in article after article with few leads to new literature? The second screen is for quality. Questions a researcher may ask to establish quality are: Is the study well-designed? Does the article provide enough information about the method to allow the literature searcher to accurately review the quality of the study?

Phase 4: Choose an Appropriate Research Strategy

A research question can be examined using many different strategies. Some strategies generate a detailed description of occurrences within a population, while other strategies inject more rigor and help to establish a causal link between variables within the population. Different approaches to studying the research problem can yield different kinds of information—not necessarily different answers. Within the field of public health and health education some of these strategies are given more endorsement by the profession than others because they provide the kinds of evidence to which public health professionals are accustomed. However, because many different professionals—from many different fields—conduct research activities in public health, many research study designs are present in the literature.

When selecting a design for examining a research problem, approaches can use epidemiologic designs (e.g., case-control, cohort analysis, clinical trial, community trial). The Internet provides summaries to many of these designs, including one site that lists the strengths and weaknesses associated with each design. The General Clinical Research Center of Tufts University School of Medicine and the New England Medical Center have worked to create a helpful orientation to epidemiologic research designs (http://www.auster.com/gcrc/toc.html).

Those who have had an exposure to research through education or psychology often have a grounding in true experimental designs (e.g., pretest and posttest, control group design; Solomon 4-group design) and quasi-experimental designs (e.g., time series design; counterbalanced design). An excellent orientation to experimental and quasi-experimental designs on the Internet is Dr. William Trochim's (http://trochim.human.cornell.edu) *Center for Social Research Methods* .

More recently, sociological and anthropological approaches have grown in popularity as strategies for examining research. The field of nursing, in particular, has found value in using these approaches, as well as the more traditional design strategies. For an example, see the Royal Windsor Society for Nursing Research website for a quick introduction to phenomenological inquiry, grounded theory, and other approaches (http://www.windsor.igs.net/~nhodgins/design_and_analysis.html). These strategies are sometimes subsumed under another descriptive term: qualitative research.

Qualitative research has grown in popularity within the last decade, and many point out that the rich information it provides helps complement the quantitative, numerical analyses from statistical approaches. There are excellent sites to help provide an orientation to qualitative evaluation as well as pointing researchers to some of the tools and electronic communications links available via the Internet. A rich resource on the theoretical underpinnings of qualitative research, and a source of software tools for conducting qualitative research, can be found in the University of California (Riverside) Center for Social and Behavioral Science Research website (http://www.chass.ucr.edu/csbsr/qualitative.html).

Keep in mind that different study designs speak to different audiences with different messages. Rigorous experimental designs with quantitative analyses

reinforce the idea of looking for measurable changes in specified variables within a sample of subjects that are representative of a population, while qualitative research designs with analysis of rich prose descriptions and experiences reinforce the discovery of new understandings about the complex interplay of constructs in a socio-cultural context. Which is most appropriate for the researcher's question? It depends on the question being asked; the state of clarity in the current research about the question; and the need for data that describe and provide insight, or data that confirm and test the significance of relationships.

Finally, the Office for Human Research Protections has compiled an online Institutional Review Board (IRB) Guidebook at it's website: (http://ohrp.osophs.dhhs.gov/irb/irb_guidebook.htm). This guide has a helpful chapter describing various research strategies used in the examination of human populations (observational, clinical trials, survey, epidemiologic, historical, et al.) and the ethical and research considerations when using research designs. The chapter addresses important issues regarding random assignment of subjects, informed consent within groups in a study design, placebo treatments, and more. There is an excellent bibliography and a description of important research terms included at this site.

Phase 5: Create or Locate Appropriate Measurement Tools

Another important phase in conducting public health research is identifying measurement tools and techniques for gathering data on the variables of interest. As discussed earlier, there are many ways to measure the same variable, and your method of measurement will influence the quantity and quality of information obtained.

Developers of quantitative measurement tools are interested in two major characteristics: validity—the ability of the tool to measure what it is supposed to measure—and reliability—the stability or consistency of a measurement tool and process. Without these two characteristics the researcher is not certain that a tool can provide credible data for further examination. Creating a new measurement tool, whether a questionnaire, observational method, or clinical test requires establishing its validity and reliability before using it to collect data. Otherwise, the data obtained with the new measurement tool may be useless or misleading. A discussion of these two criteria

for measurement tools is authored by Ilene Decker at Northern Arizona University's Nurs390: Nursing Research website (http://jan.ucc.nau.edu/~mezza/nur 390/Mod4/reliability/lesson.html) and at a tutorial in Bill Trochim's Center for Social Research Methods (http://trochim.human.cornell.edu/tutorial/colosi/lcolo si2.htm). If the researcher decides to create a new tool, there are resources on the Internet to help guide good survey construction at Infopoll: (http://www.infopoll.com/support/resources/tips/net_ papers.htm) and at StatPac: (http://www.statpac.com).

Instead of creating a new instrument for research efforts, a seasoned researcher will check if a credible tool already exists. Using existing measurement tools may have the advantages of established credibility, validity, and reliability, and may provide reference standards for a researcher to compare results. Check possible measurement tools carefully, because not all tool developers establish the validity and reliability of their tools. Also, tools are often tested with a specific population of interest; just because a tool is valid and reliable with one population does not mean it is valid and reliable with another. Researchers should examine what tools are used in existing research articles (and discussed in the Methodology section of the articles) and should check with nationally recognized centers for existing credible tools. For example, two surveys used to collect national data by the Centers for Disease Control and Prevention include the Behavioral Risk Factor Surveillance Survey—with details posted at (http://www.cdc.gov/nccdphp/brfss/brfsques.htm)—and the Youth Risk Behavior Survey, (http://www.cdc.gov/nccdphp/dash/yrbs/survey99.htm). The National Center for Health Statistics (http://www.cdc.gov/nchs/express.htm) posts many national surveys, the survey findings, and national data collection strategies at their Surveys and Data Collection Systems website. The United Kingdom has a comparable tool at The National Survey of Health Patients website (http://qb.soc.surrey.ac.uk).

Researchers can search through compilations of measurement tools that have already been created. The ERIC/AE Test Locator is a web-based database of measurement tools, jointly sponsored by the ERIC Clearinghouse on Assessment and Evaluation, the Educational Testing Service (ETS), the Buros Institute of Mental Measurement, and others. It is located at (http://ericae.net/testcol.htm). Researchers can type in a key concept like "stress" and get a compilation of

measurement tools related to the term. (The Test Locator returned 362 hits for the word, "stress.") Another useful site is the Hardin Library for the Health Sciences at the University of Iowa. They have posted information about online databases, print resources, and other Internet resources to access collections of health-related measurement tools (http://www.lib.uiowa.edu/hardin-www/hnet16.html). The University of Minnesota has additional helpful information on Finding Tests, Surveys, and Questionnaires (http://www.biomed.lib.umn.edu/tsq.html).

Phase 6: Obtain Approval for Institutional Research

Even after all of the preceding steps are completed, research usually cannot proceed until granted approval by a review panel. At institutions of higher education, hospitals and clinics, school district headquarters, and other centers where research will occur, review protocols are in place to prevent human or animal subjects from being exposed to unwarranted risks, unethical practices, and potentially dangerous research activities. The process of review of proposed research activities typically examines whether research benefits outweigh its risks and human or animal subjects are treated ethically. The use of human subjects usually includes an informed consent of potential risks and benefits of participating in the research study, provisions of anonymity or confidentiality for subjects and their research data, and explicit acknowledgement that subjects may withdraw from the research study at any time if they desire (Neutens & Rubinson, 1997; Portney & Watkins, 1993).

Universities and other institutions have explicit guidelines for research involving human or vertebrate animal subjects. For example, the University of Minnesota has an online Protecting Human Subjects Guide detailing the protocols and paperwork necessary for human subject research (http://www.research.umn.edu/subjects/humans/guide/index.html). The National Institutes of Health has its own Office of Human Subjects Research - (http://ohsr.od.nih.gov) (See also their documentation for Protection of Human Subjects) (http://ohsr.od.nih.gov/mpa/45cfr46.php3). Again, The Office for Human Research Protections in the Department of Health and Human Services has compiled an online Institutional Review Board (IRB) Guidebook located at http://ohrp.osophs.dhhs.gov/irb/irb_guidebook.htm.

Medical research institutions typically have a review board to review and approve human subject research studies. For example, at the Lawrence Livermore National Laboratory website, there exists helpful documentation for principal investigators (PI) of research who want to review Use of Human Subjects protocols (http://www.llnl.gov/HumanSubjects/irb-home.html). Large schools and school districts have institutional review boards to control access to their students for research activities not initiated within the school's administrative jurisdiction. Those interested in conducting research on school-age children within such a school setting will need to deal with an institutional review board and its policies. Hospitals and health service centers must also provide protection for subjects in research. As an example, Fairview Health Services provides an overview of their review board process (http://www.fairview.org/prof/research/human_subj.htm).

Phase 7: Obtain Funds / Resources for Research

Frequently researchers need funding to complete their projects. The Web has an abundance of tools to assist the researcher with locating funding resources. There are searchable electronic databases, e-mail services that alert researchers of new funding opportunities, and websites that contain information on how to write up research proposals.

The federal government gives free access to a number of searchable funding databases at their Grants and Awards Databases website (http://library.ucok.edu/gov/browsetopics/grants.html). This site contains three major federal funding databases:

1. The Federal Domestic Assistance Catalog is a searchable database of Federal programs, projects, services, and activities
2. FinanceNet links 24 federal government agencies together and is a clearing site for information on the public sale/auction of surplus government property.
3. GrantsNet is a searchable database sponsored by the U.S. Department of Health and Human Services. It contains information on how to find a grant, searching for funding, applying for funding and links to other funding agencies.

The Grants & Awards Database website also offers access to individual government agencies, such as the

National Institutes of Health (NIH) (http://www.nih.gov) and the National Science Foundation (NSF) (http://www.nsf.gov), which also have information on funding opportunities specific to the agency.

In addition to governmental sites, there are corporate websites where information about research opportunities and the funding process can be found. The Foundation Center (http://fdncenter.org) site contains links to a guide to funding research and resources, a weekly digest that announces funding opportunities, an online library and other useful information. Other sites on the WWW such as TRAM Research Funding Opportunities and Administration (http://tram.east.asu.edu/) and The Grantsmanship Center (http://www.tgci.com) guide the researcher through the grant writing processes.

Phase 8: Manage and Conduct Research Activities

Skills of project management are essential to help the research project reach completion on time. Most of the time, grant funding or institutional approval is dependent on reaching milestones of progress within specific timeframes. Skilled researchers use project management tools to help ensure resources are ready and available when needed, staff are engaged productively, and lines of communication provide advance warning when problems might arise. Small research activities might use a simple Gantt chart that visually outlines the activities needed to get the research project completed. The major grants have their own administrator with staff, regular planning meetings, sub-contractees, and may use professional project management software tools. For an example of one graphic program planning tool, visit SmartDraw.com. This can be found on the web (http://www.smartdraw.com/drawing/gantt/index.asp). This site offers information not only about their drawing tool, but also about producing Gantt charts for planning projects, managing staff time, and scheduling interconnected program events

There are many organizations, online publications, software tools, and information resources to help the researcher learn more about project management. Visit the resource collection provided by JOURNYX (http://www.jump.net/~curt/project_management/project_management.html) or The Hampton Group's excellent website - (http://www.4pm.com). This latter resource has a variety of free articles and resources to

learn about project management from a practical perspective.

Project management is a profession and a field of study in its own right. There are organizations that support the development of skills in project management and provide professional membership. For example, visit the Project Management Institute at (http://www.pmi.org) and examine their training and development opportunities, publications on project management, and links to other project management resources.

Phase 9: Analyze and Interpret Data Obtained

Once the research study has completed the phases of execution and data collection, there is still the challenging and rewarding phase of data analysis and interpretation. While smaller public health research activities may collect data on as few as two or three variables in 15 to 30 subjects, large studies may collect data on hundreds of variables in hundreds of thousands subjects. Data management is but one issue during this phase.

After data sets are prepared and cleaned, the researcher will need to choose appropriate tools to summarize and analyze (or characterize) the data. Quantitative approaches will rely on descriptive and inferential statistics to create meaningful information from the data, while qualitative approaches will use data collation and interpretation techniques to create insightful summaries that weave a rich tapestry of the details of what has been observed. The Quantitative Epidemiology link in the Virtual Library for Epidemiology located at http://chanane.ucsf.edu/epidem/epidem.html, the Virtual Library for Statistics (http://www.stat.ufl.edu/vlib), and the Virtual Library for Biostatistics that can be found at http://www.biostat.washington.edu/Xvlib. They are all excellent sites for statistical software, tutorials, references to analytical strategies, short courses and training programs, and more.

Three other excellent websites with a wealth of information about statistical software (some shareware or freeware) and educational / informative websites are Clay Helberg's Statistics on the website (http://www.execpc.com/~helberg/statistics.html), STATISTICS.COM (http://www.statistics.com), and Michael Friendly's Statistics and Statistical Graphics Resources website (http://www.math.yorku.ca/SCS/StatResource.html).

Researchers interested in Qualitative Research are encouraged to visit Eugene Horber's Qualitative Data Analysis website at the University of Geneva— (http://www.unige.ch/ses/sococ/qual/qual.html).

Selecting analysis tools is dependent upon the research questions posed and the study design selected. Research questions that look at the relationship between two variables within the context of an epidemiological design, for example, may choose to examine odds ratios and discover if these odds ratios are significantly different from 1.00. There are tools on the Internet that will help guide the researcher through the decision-making process to help determine the statistical tools needed for analysis, or even perform the statistical analyses needed on the data. Researchers can visit Help With Statistical Analysis, Dr. Robert Knodt's Help Page, (http://members.aol.com/statware/pubpage.htm) and use the decision tree to select the appropriate statistical tool based upon the characteristics of the dataset. The Interactive Statistical Page (http://members.aol.com/johnp71/javastat.html) has links to web pages with built-in JAVA scripts that will perform various statistical computations, plot data, and provide tutorials for the researcher. The PROPHET StatGuide has a good collection of tutorials online to help the researcher learn how to prepare graphics for descriptive statistics, and more (http://www.basic.nwu.edu/statguidefiles/list.html).

Phase 10: Prepare and Disseminate Research Results

The final step in any research process is writing up the results of the research. Whether the researcher wants help with the technical aspects of writing or information on how to publish the results in a peer-reviewed journal, the Web has numerous tools that can help.

Mechanics of Writing

There are hundreds of websites that can help a researcher with the mechanics of writing. Bartleby.com Great books (http://www.bartleby.com/index.html) is a commercial website offering free access to William Strunk's Elements of Style a handbook for writing and grammar, Roget's II Thesaurus, Third Edition, and The American Heritage Book of English Usage.

Another place to find advice on the mechanics of writing are online writing centers of various universities. The primary mission of these centers is to improve students' research and writing skills. A comprehensive listing of online writing centers can be found at The National Writing Centers Association

website (http://nwca.syr.edu). In addition, this site contains links to writing center handouts, a grammar hotline directory, and online tutoring sites.

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In some cases, the researcher may want to copyright their work or obtain permission to use another author's work. The U. S. Copyright Office Homepage (http://lcweb.loc.gov/copyright) contains general and detailed information on U.S Copyright regulation and legislation. The Copyright Clearing Center (http://www.copyright.com) is a commercial site that a user must register to use and involves a fee for services. The site provides licensing systems for the reproduction and distribution of over 1.75 million copyrighted materials throughout the world.

Style Guides

When submitting a paper for publication, researchers need to be aware of the bibliographic style and other editorial information the publisher requires. The Raymond H. Mulford Library at the Medical College of Ohio has compiled a website entitled Health Related Style Guides for journal articles (http://www.mco.edu/lib/instr/libinsta.html). The site contains instruction to authors for over 3,000 journal titles in the health sciences. Alternatively, researchers can use a Web search engine to locate a publisher or journal website and link to the instructions for authors.

A publisher may request that a particular style be used when writing a paper. Two common style guides are the American Psychological Association Publications Manual and the MLA Style Guide. These guides give the author instructions for the format of the paper and preparing bibliographic references. The American Psychological Association (APA) style is used in behavioral and social sciences. While the whole APA guide is not available on the Web, there are sites such as the University of Wisconsin's Writing Center that lists major aspects of documentation in APA style. This particular site is located at http://www.wisc.edu/writing/Handbook/DocAPA.html.

Citing Web Resources

The WWW has affected the way we cite resources in our bibliographies. Many of the organizations that prescribe a standard citation style, such as the American Psychological Association (APA) and The Modern Language Association (MLA), have just recently begun addressing how to cite internet and Web resources in bibliographies. Both the APA (http://www.apa.org/journals/webref.html) and MLA

(http://www.mla.org) have websites that addresses citing electronic resources

Conclusion

As the Web expands and new technology is introduced, an even broader array of tools and resources will be available to the future researcher. This article has examined how a researcher can develop a basic foundation of knowledge on a research topic by looking at consumer health websites, online encyclopedias, and health-related article databases. However, before too many details are collected, the researcher needs to define a specific research problem to maintain a directed and narrowed focus. Some helpful websites provide guides for developing a good research problem. During a successful literature review, the researcher can draw from electronic journals, databases, discussion lists, and Web search engines to reach a clear understanding of the research topic. As the researcher reviews previous studies, relevant research designs need to be considered and identified by the researcher. To better understand the strengths and weaknesses of different approaches to conducting research, various websites offer descriptions and details about these designs. Whenever human subjects are involved, institutional or community review processes must be considered, and websites of Institutional Review Board guidelines can help prepare the researcher for this phase. Resources to complete the research project may be needed, and many websites help the researcher look for funding or other support. Once underway, research projects—especially when large or complex—require good project management skills. Websites exist that provide software tools, helpful resources, and suggestions for successful implementation of the research project. After the researcher gathers data from the study, the Web can provide resources to help prepare a data analysis strategy and identify appropriate statistical tools for discerning significant results. The final preparation and dissemination of research results can be enhanced with websites that describe appropriate writing styles and protocols for submitting research materials for publication.

A few caveats are in order: Many resources on the WWW are not designed to be comprehensive nor objective; therefore, users of Web information must be critical consumers of the information they take and use. Also, many of the Web resources are impermanent—they may be available this month, but removed or relocated next month. We are entering an age where information may have a shelf life—what is deemed relevant today may be obsolescent next month—and web pages and even websites can appear and disappear as quickly. Finally, researchers should be aware that while the Web is a useful and powerful tool for conducting public health research, it is not the only tool that should be used. Many excellent resources still exist only within existing collections of paper, microfiche, and videotape.

The public health researcher of the future needs to be aware of the benefits and the problems of accessing information on the WWW. In addition, researchers need to know how to adopt this technology and enhance their own research activities through the published knowledge and wisdom of others. The global information network is here to stay.

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