CPH Exam

Quick Reference Review

Second Edition

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JONES AND BARTLETT PUBLISHERS
Sudbury, Massachusetts
BOSTON TORONTO LONDON SINGAPORE

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World Headquarters
Jones and Bartlett Publishers
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Sudbury, MA 01776
978-443-5000
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www.jbpub.com

Jones and Bartlett Publishers
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Mississauga, Ontario L5V 1J2
Canada

Jones and Bartlett Publishers
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London W6 7PA
United Kingdom

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Production Credits
Publisher: Michael Brown
Editorial Assistant: Catie Heverling
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Senior Production Editor: Tracey Chapman
Senior Marketing Manager: Sophie Fleck
Manufacturing and Inventory Control Supervisor: Amy Bacus
Composition: Arlene Apone
Cover Design: Scott Moden
Cover Image: © Daniela Illing/ShutterStock, Inc.
Printing and Binding: Malloy, Inc.
Cover Printing: Malloy, Inc.

Library of Congress Cataloging-in-Publication Data
Holmes, Larry, 1960-
CPH exam quick reference review / Larry Holmes Jr. -- 2nd ed.
p. ; cm.
Includes bibliographical references and index.
ISBN-13: 978-0-7637-7475-2 (pbk.)
ISBN-10: 0-7637-7475-8 (pbk.)
1. Public health--Examinations, questions, etc. I. Title. II. Title: Certification in public health exam quick reference review.
[DNLM: 1. Public Health--Problems and Exercises. WA 18.2 H751c 2009]
RA430.H65 2009b
362.1076--dc22
2009013947

8678

Printed in the United States of America
13 12 11 10 09 10 9 8 7 6 5 4 3 2 1

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DEDICATION

To the memory of Mrs. Elizabeth Kolwes of Brenham, Texas, whose life and dedication to her children, grandchildren, and great-grandchildren reflect a true leadership in public health.

To the memory of my mother, who passed away during the gestational period of the *Basics of Public Health Core Competencies* book. You will always be remembered for your love of scholarship and for infusing the same in us.

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CONTENTS

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FOREWORD

Public health, the science and art of disease prevention and health promotion, remains significant in the advances of medical and health sciences in ameliorating the health of the population. The contributions of public health to the health of the U.S. population has been remarkable in the 21st century, and it continues to be so as public health confronts emerging challenges due to the aging U.S. population, climate changes, global warming, bioterrorism, and emerging pathogenic microbes. Remarkably, the epidemiologic transition from infectious diseases as the leading cause of mortality in the 1900s to chronic diseases today came as a result of persistent immunization and the reduction in vaccine-preventable diseases, thanks to public health efforts. Illustratively, public health achievements in the 21st century are viewed in light of their contributions to motor vehicle safety, safer workplaces, infectious disease control, decline in coronary artery disease and stroke mortality, safer and healthier food, healthier mothers and babies, family planning, fluorination of drinking water, vaccination, and recognition of tobacco as a health hazard.

The scope of public health is broad and reflects what we, as a society, do collectively to ensure the conditions necessary for people to remain healthy. Within this scope, the framework for public health performance recommends the collaboration between governmental agencies (federal, state, and local), public and private sectors, and the communities. The Institute of Medicine, in its 1988 response to "public health in disarray," clearly described the core functions of public health as: (1) assessment, (2) policy development, and (3) assurance. The process upon which public health carries these out requires the integration of its core functions into the essential public health services, namely, (1) health services monitoring and identification of community health needs; (2) diagnoses and investigation of health problems and health hazards in the community; (3) informing, educating, and empowering people about health issues; (4) mobilizing community partnerships to identify and solve health problems; (5) enforcing laws

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and regulations that protect and ensure safety; (6) linking people with needed personal health services and ensuring the provision of health care when otherwise unavailable; (7) ensuring a competent public health and personal healthcare workforce; (8) evaluating effectiveness, accessibility, and quality of personal and population-based health services; and (9) researching new insights and innovative solutions to health problems.

The training of public health professionals to address the essential public health services requires a curriculum that integrates the core functions of public health into the core disciplines of public health, mainly (1) epidemiology, (2) biostatistics, (3) behavioral and social sciences, (4) environmental sciences, and (5) management and policy sciences. The knowledge of these areas and the application of cross-cutting core competencies (such as communication and informatics, diversity and culture, animal control, public health biology and pathology, professionalism, programs planning, and systems thinking) serve to provide the graduates of public health programs with the preparation (knowledge and skills) needed to succeed in this field today.

The author and the contributors of this text, the *CPH Exam Quick Reference Review*, have presented—in a simplified and concise manner—the introduction to public health as public health principles and practice, which is rarely presented in graduate programs, and have discussed the mission, goal, core functions, history, and challenges of public health. Whereas graduates of public health tend to focus on a set module or discipline, in spite of our recommendation of the broad knowledge of the public health core disciplines, this review has made it possible for graduates and potential graduates of public health to acquire competency in these core areas. This book is intended to prepare graduates of public health for an important examination that will bring collegiality and credibility to this profession. I hope that this review will point readers in a direction that will stimulate their appetite to learn more about the assessment of health issues in the population, about making sense of data, about the role of behavior in health, about the impact of environment on health, and about policy

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development in the management of public health services. The practice test as presented here serves to introduce readers and candidates of this examination to proper test-taking skills. Therefore, as you attempt these questions, note that your ability to interpret similar questions will enhance your success in the upcoming examination. My hope is that this review will enhance rather than disable your success in the examination. If you believe that all books are perspectives, then no book, no matter the volume, will be able to present all the subject matter of any given field. Therefore, increase your score by using these materials in combination with similar sources of information judged to be relevant in public health examination review.

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ACKNOWLEDGMENTS

Public health is an interdisciplinary science, requiring many subspecialties in its approach to disease prevention and health promotion. This review would never have been prepared without contributions from my colleagues from the various disciplines that sustain essential public health functions and research infrastructures.

The idea to write this book stems from the absence of materials available to aid in the preparation for the first National Public Health Certification Examination in the United States during summer 2008. A certification examination in this perspective is challenging—and will remain so, pending transition in the presentation of public health core areas and their core competencies at the graduate level. Schools of public health had traditionally prepared students to focus on their module or discipline with very little exposure to mastery in the five core disciplines: epidemiology, biostatistics, behavioral and social sciences, environmental sciences, and management and policy sciences. Realistically, graduate programs are designed to create a focus, thus gearing toward specialized knowledge. However, a broad knowledge of these core disciplines requires not only introductory courses in these core areas but some level of formation and application of these concepts in the real world. With this gap in mind, this review has made it possible for graduates of public health programs to acquire some mastery in these core areas and the cross-cutting areas (communications and informatics, diversity and culture, leadership, public health biology, professionalism, programs planning, and systems thinking).

Many sources of information were consulted during the gestational period of this review. I am very grateful to all authors whose works we have consulted prior to the preparation of this review. I sincerely appreciate the knowledge and information gained from your intense and meaningful contributions to the field of public health. However, if you feel you have not been adequately acknowledged, I am willing to do so at the first opportunity.

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I am indebted to my colleagues at the Texas Medical Center, who provided instant assistance when required to assemble research materials for the many sections in this book that required extra-intense review. Jennifer Thompson, MS, MA, MPH, and Priya Veherdra, MS, MPH, assisted in making sure that the Environmental Sciences in Public Health chapter of this book covered the basics of the environmental sciences enough to provide a broad knowledge of this discipline for public health graduates, regardless of their module, discipline, or concentration. There are others who provided similar assistance. I acknowledge, with thanks, your contributions.

I owe the basic sciences of public health chapters to the experience gained from teaching graduate students in Texas and medical students in the Caribbean over the many years of my teaching career. Because teaching is a learning experience, I have learned by teaching epidemiology and biostatistics in these settings. I hope this experience reflects the information provided in these two chapters.

I am indebted to my parents for never asking me not to ask them "Why?" I am grateful to Jenni, my spouse and "chair" of our family affairs; Maddy, MacKenzie, and Landon, our children; and their grandparents, Dalton and Sue, for their patience and unconditional acceptance even when I avoided contact with them and turned to the computer in order to complete a sentence or section of this review.

Public health is not an exact science. We have consulted with sources of information judged to be valid during the period of the preparation of this review. However, information presented today is subject to change as new information becomes available tomorrow. Therefore, readers are required to consult with similar sources for the confirmation of information provided here.

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ABOUT THE AUTHOR

Larry Holmes, Jr., PhD, DrPH, CPH, has over nine years of experience as a reviewer of the United States Medical Licensing Examination (USMLE) questions (1994–2003). During this period, he taught the quantitative medicine (epidemiology, biostatistics), among other courses, and was responsible for both the summative and formative examination preparation materials for the medical schools in the Caribbean.

At the International University of the Health Sciences (IUHS) in St. Kitts, Holmes directed the assessment for the basic medical sciences and clinical correlates and managed over 18 thousand questions in the examination bank. He was responsible for preparing the summative examination of 350 questions for every organ system in the USMLE learning objectives, and these examinations were offered every three months at IUHS. Holmes also wrote review questions for immunology and infectious diseases, quantitative medicine (epidemiology and biostatistics), preventive medicine, behavioral sciences, geriatrics, and pharmacology.

Dr. Holmes is currently a Clinical Epidemiologist at the Alfred I. duPont Hospital for Children in Wilmington, Delaware, where he directs the clinical research methodology (modern epidemiology and biostatistics) research and education program. He is the head of Molecular Epidemiology Lab at the Nemours Center for Childhood Cancer Research, and teaches the Clinical Trial course as Adjunct Associate Professor at the University of Delaware, Newark. He is a published primary or senior author in many peer-reviewed scientific journals, a reviewer for scientific journals including *Military Medicine* and *AIDS Care*, and a member of the American College of Epidemiology.

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INTRODUCTION

Public health can be defined as what we as a society can do to remain healthy. This broad notion of public health is indicative of the shared responsibility of the governmental agencies, public and private sectors, and the community in meeting the demands of the core functions of public health, namely assessment, policy, and assurance. These core functions are fused into the essential public health services: (1) health services monitoring and identification of community health needs; (2) diagnoses and investigation of health problems and health hazards in the community; (3) informing, educating, and empowering people about health issues; (4) mobilizing community partnerships to identify and solve health problems; (5) enforcing laws and regulations that protect and ensure safety; (6) linking people with needed personal health services and ensuring the provision of health care when otherwise unavailable; (7) ensuring a competent public health and personal healthcare workforce; (8) evaluating effectiveness, accessibility, and quality of personal and population-based health services; and (9) researching new insights and innovative solutions to health problems.

The core functions of public health and the essential public health services serve as the reference point for the core disciplines and cross-cutting areas in public health. The competencies in these core areas are indicative of the broad knowledge of public health in fulfilling its substance as declared by the Institute of Medicine in *The Future of Public Health*: *Disease control prevention and health promotion.* The core competencies simply set the path regarding the volume of knowledge, attitude, and skills required of graduates of public health in delivering public health direct services, research, and teaching.

There is a need to standardize these core disciplines in terms of the core competencies in order to administer an examination that will fairly test knowledge and performance in these core disciplines and their cross-cutting areas. Using the core disciplines in public health and the cross-cutting areas,

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we reviewed public health knowledge and practice with the intent to provide candidates with the information needed to obtain a high yield in the National Public Health Certification Examination.

The National Public Health Certification Examination is based on the core competencies (epidemiology, biostatistics, behavioral and social sciences, environmental sciences and health policy, and management sciences) and the cross-cutting areas (communication and informatics, diversity and culture, leadership, public health biology, professionalism, programs planning, and systems thinking). The examination, which is computer based, comprises 200 multiple-choice questions to be taken in 4 hours. There are 4 blocks consisting of 50 questions, with questions from each block representing the 5 core competencies and cross-cutting areas.

This book is not a substitute for the recommended textbooks used in these various public health disciplines. To benefit from this book, graduates of public health are expected to have had a good exposure to these core disciplines prior to graduation. If less time was dedicated to these areas, readers or candidates for the certification examination will find this book useful as well, but it may initially appear to be challenging. Therefore, for optimal success in using this review, we recommend that candidates read these materials at least twice prior to attempting the chapter review questions on the book's companion Web site (http://publichealth.jbpub.com/cph/2e). Perhaps the most effective way to attempt the questions in the last chapter (practice test) is to allow yourself 72 seconds to answer each question; as you proceed, indicate your answer beside each question. By complying with these suggestions, you will be approximating the time limits imposed by the Examination Board. After answering all the questions in the practice test, spend some time verifying your answers by carefully reading the explanations. Although you may pay much attention to the questions you answered incorrectly, you should read all explanations if provided or return to the sections within the text to verify the accuracy of the answer. However, if after reading the explanation and the illustrations in the text, you feel you need more information about the materials covered, you should

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consult the references indicated with the explanations or other sources of similar information judged to be accurate. This revised edition has incorporated the recalls from the first examination during August 2008. These recalls are supposed to assist you in focusing on the areas of concentration as well as the difficulty level of the exams, as you begin to prepare for an examination that is still in its infant stage. Realistically it will provide you with answers to what to expect and how to prepare for the upcoming examination. Because of the perceived imbalance from the first examination, which pulled an estimated 56% of the total questions from epidemiology and biostatistics, it is essential to study these two cores in-depth and be able to interpret epidemiologic results, and apply epidemiologic statistics to hypothesis testing and the interpretation of 95% CI, as well as types of errors in hypothesis testing. The terminologies used in marketing, though not related to public health, were examined. Understanding public health terminologies, especially in management sciences and policy, will increase your yield. We have provided at the end of each chapter, except Chapter One, materials that candidates should focus on, with the intent to better prepare you for the next examination in August 2009. In addition, a compilation of related electronic resources for each core competency, as well as chapter quizzes and flashcards of key terms, are available through the book's new companion Web site: http://publichealth.jbpub.com/cph.2e.

Finally, because public health is an ever-changing science, we have consulted with information judged to be reliable at the time of the presentation of these materials. In spite of this, and because of the possibility of human error, the author, contributors, and publisher cannot be held responsible for any errors resulting from the use of this information. Therefore, readers are advised to consult other texts for the confirmation of the data presented herein.

We sincerely welcome suggestions, criticisms, and remarks for improvement of this review as examination recall materials become available. Therefore, all suggestions should be addressed to: drlholmesjr@gmail.com.

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PUBLIC HEALTH CERTIFICATION EXAMINATION REVIEW PRETEST*

Take this test online at http://publichealth.jbpub.com/cph/2e.

CPH SAMPLE QUESTIONS

Directions: There are 18 questions in this test, ALL of which must be attempted. The questions are either multiple choice or matching. Please select the best response. The time allowed is 20 minutes.

Questions 1–3 (Vignette)

A study investigated the effects of radiation exposure to fallout from the Hanford Nuclear site in Washington State in the 1940s and 1950s and subsequent development of thyroid cancer among persons exposed as children and adolescents. Scientists used birth data from the study area to trace and contact subjects to participate in the study. Screening consisted of thyroid palpation, ultrasonography of the thyroid gland, and measurement of hormone concentrations in serum and urine. Individual thyroid radiation doses were estimated from interview data covering place of residence and dietary histories. As a result of screening, 19 subjects were diagnosed with thyroid cancer.

1. Which of the following terms best describes the type of study design?

- **a.** Case-control
- **b.** Cross-sectional
- **c.** Ecological
- **d.** Prospective cohort
- **e.** Retrospective cohort

*The 18 sample test questions are taken from the National Board of Public Health Examiners' Web site at www.publichealthexam.org. The annotations for the answers that follow are provided by the author.

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2. Which of the following is the most appropriate measure of the effect of this type of study?

- **a.** Correlation coefficient
- **b.** Odds ratio
- **c.** Prevalence odds ratio
- **d.** Regression coefficient
- **e.** Risk ratio

3. Which of the following terms is most appropriate to describe the cases of thyroid cancer identified during the first screening in this study?

- **a.** Incident
- **b.** Interval
- **c.** Prevalent
- **d.** Recurrent
- **e.** Concurrent

Questions 4–6 (Vignette)

A pilot study is conducted to determine whether a new drug effectively decreases cholesterol levels over a six-week period. Twelve subjects are enrolled, and serum cholesterol levels are measured before and after the six-week treatment period. Investigators plan to use a paired *t*-test to determine whether the drug was effective in reducing cholesterol levels.

4. The paired *t*-test is more appropriate for analysis of the results than a two-sample *t*-test for which of the following reasons?

- **a.** Dependence between the pretest and posttest measurements
- **b.** Elimination of noise due to confounders
- **c.** Heterogeneous variances of the two groups
- **d.** Non-randomness of the timing of the measurements
- **e.** Potential non-normality of the response

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5. Which of the following are the degrees of freedom in the paired *t*-test?

a. 9
b. 10
c. 11
d. 12
e. 13

6. If the *p* value was calculated to be 0.015, which of the following would be the most appropriate interpretation of the *p* value?

a. The probability of seeing a result as unusual as the observed under the alternate hypothesis is very small
b. The probability of seeing a result as unusual as the observed under the null hypothesis is very small
c. The probability that the alternate hypothesis is false is very small
d. The probability that the alternate hypothesis is true is very small
e. The probability that the null hypothesis is true is very large

Questions 7 and 8 (Vignette)
The ministry of health of a developing country is considering the nationwide implementation of a test using biomarkers to screen for breast cancer. The test is delivered to health clinics in two similar regions of the country with the following results:

	Region A	Region B
Specificity	70%	80%
Sensitivity	85%	95%

The positive and negative predictive values are different between the 2 regions.

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7. Which of the following is the most likely cause of the difference in the test's sensitivity and specificity between the two regions?

- **a.** The incidence of the disease is different between the two regions
- **b.** Length-biased sampling has occurred
- **c.** The prevalence of disease is different between the two regions
- **d.** The test is detecting the disease earlier in its natural history in one of the regions
- **e.** The test was not administered in similar conditions in the two regions

8. Which of the following is the most likely cause of the differences in the test's predictive values between the two regions?

- **a.** The incidence of the disease is different between the two regions
- **b.** Length-biased sampling has occurred
- **c.** The prevalence of disease is different between the two regions
- **d.** The test is detecting the disease earlier in its natural history in one of the regions
- **e.** The test was not administered in similar conditions in the two regions

9. A community-based study of a program to increase physical activity is conducted, and the findings are evaluated. A small *p* value with an estimate is reported. Which of the following is the best interpretation of the result?

- **a.** It is likely the estimate differs from the true value because of bias
- **b.** It is likely the estimate differs randomly and systematically from the norm because of inter-rater variability
- **c.** It is unlikely the estimate differs from the average because of chance
- **d.** It is unlikely the estimate differs from the expected value because of confounding
- **e.** It is unlikely the estimate differs from the expected value because of random variability

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10. Which of the following statements best describes an intent-to-treat analysis?

- **a.** Analysis compared characteristics of participants who did versus did not adhere to the randomized treatment
- **b.** Analysis excluded all participants who did not adhere to the assigned randomized treatment
- **c.** Analysis maintained the original randomized assignment of treatments in the definition of intervention and control groups
- **d.** Analysis reorganized participants into intervention and control groups based on their actual participation

11. A study is conducted to examine whether elderly women in at-home care settings maintain more cognitive ability than women who are residents of skilled nursing care facilities. Two groups of 30 elderly women are recruited independently. One group includes women living at home with a caregiver; the second group includes women living in skilled nursing care facilities. The women are asked to perform a task and then receive a score on the execution of the task (high scores indicate higher cognitive functioning). Which of the following is the most appropriate approach for analyzing the data?

- **a.** Chi-square (χ^2) test
- **b.** Correlation analysis
- **c.** Paired *t*-test
- **d.** Trend test
- **e.** Two-sample *t*-test

12. A study is conducted to evaluate the relationship between pet ownership and having depressive symptoms. Seventy (70) participants are recruited. Each subject is identified as a current pet owner or non-pet owner. Participants are categorized as having or not having symptoms of depression. Which of the following is the most appropriate method to evaluate the

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association between pet ownership and having depressive symptoms in this population?

a. Chi-square (χ^2) test
b. Correlation analysis
c. Paired *t*-test
d. Trend test
e. Two-sample *t*-test

13. The epidemic of methyl mercury poisoning in Minamata, Japan, in the 1950s illustrated contamination of which of the following?

a. Dairy product
b. Feed grain
c. Fish
d. Soil
e. Water

Questions 14–18 (Matching)
For each public health scenario, select the most appropriate lead organization (a–e).

a. Bill and Melinda Gates Foundation
b. Centers for Disease Control and Prevention
c. Local public health agencies
d. National Institutes of Health
e. State public health agencies

14. Focuses on crisis-oriented infectious diseases such as anthrax diagnosed in postal workers

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15. Focuses on basic sciences research aimed at curing human diseases such as investigating the use of statin drugs to reduce the incidence of Alzheimer's disease

16. Primarily focuses on improving global health, addressing diseases such as HIV, malaria, and tuberculosis

17. Holds the primary constitutional authority to address policies concerning improvement of birth outcomes, including birth weight, preterm births, and infant mortality and morbidity

18. Focuses on day-to-day operations of public health clinics

ANNOTATED ANSWERS

1. The correct answer is **E** (retrospective cohort study design). Cohort studies are traditionally classified as (a) prospective and (b) retrospective, depending on the temporal relationship between the initiation of the study and the outcome (occurrence of disease or event of interest). A design is considered a retrospective cohort, which also is termed historical cohort or nonconcurrent prospective study, if the exposures and the outcomes of interest (disease, for example) have already occurred prior to the initiation of the study. In prospective design, the exposure, which defines the cohort, has occurred in the exposed group prior to the initiation of the study but the outcome (disease) has not occurred. In this context, both groups are followed to assess the incidence rate of the disease, comparing the exposed to the unexposed. Both designs compare the exposed group to the unexposed group to assess

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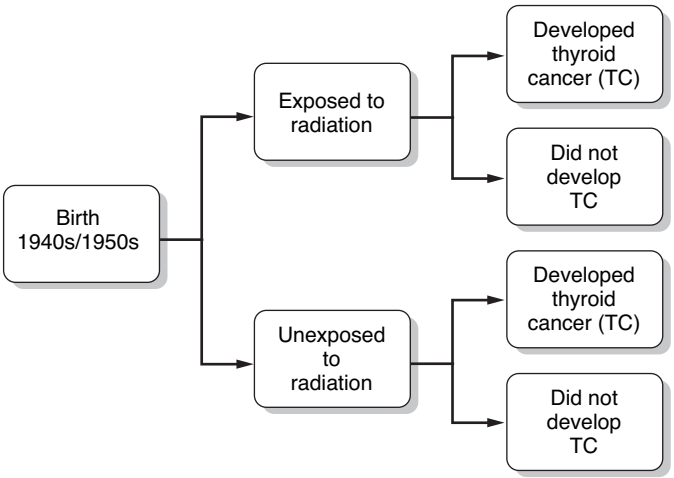

Figure 1 Illustration of retrospective cohort design. Thyroid cancer had occurred prior to the initiation of the study, and both the exposed and unexposed are screened for thyroid cancer and compared with respect to the risk of thyroid cancer in the exposed (radiation) versus the unexposed.

the measure of effect. However, the main distinction between these two designs is the calendar time. In the retrospective design, as illustrated in this vignette, exposure to radiation is ascertained from birth data (medical record) and the outcome (thyroid cancer) at the beginning of the study (no follow-up).

Cross-sectional studies also termed surveys and prevalence studies are designed to assess both the exposure and outcome simultaneously. However, since exposure and disease status are measured at the same point in time (snapshot), it is difficult, if not impossible, to distinguish whether the exposure preceded or followed the disease, and thus cause and effect relationships are not certain, lacking temporal sequence.

A case-control design classifies subjects on the basis of outcome (disease and non-disease or comparison group) and then looks backward to identify the exposure. This design could be prospective as well. In this design, the history or previous events for both cases and comparison groups are assessed in an attempt to identify the exposure or risk factors for the disease.

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2. The correct answer is **E** (effect measure/size/point estimate in cohort design). Cohort studies are designed to determine whether there is an association between the exposure and the development of a disease. This association is determined by the ratio of the risk of disease in the exposed to the risk of disease in the unexposed. The relative risk (RR) is computed by risk in exposed/risk in unexposed. Relative risk can be computed as well by incidence in the exposed/incidence in unexposed. Further, risk ratio (RR) is often used, which is the disease risk in exposed/disease risk in the unexposed. In retrospective cohort design, risk ratio is an appropriate measure of effect.

3. The correct answer is **C** (prevalent cases and retrospective design). Incidence refers to new cases, whereas prevalence refers to existing cases (both old and new cases). In this example, the screening test does not differentiate between old and new cases. The cases diagnosed with thyroid cancer constitute both old and new cases, and hence it is very appropriate to identify them as prevalent cases.

4. The correct answer is **E** (assumptions and rationale for paired *t*-test). The *t*-test is an appropriate statistical test that compares the means of two groups of observations. The observations should be randomly assigned to the two groups, so that any difference in response is due to the treatment and not to other factors. The paired *t*-test compares two paired groups so one can make inferences about the size of the average treatment effect, implying the average difference between the paired measurements. The rationale for using a paired *t*-test is to control for experimental variability as well as potential nonnormality of the response. Thus by analyzing only the differences, a paired *t*-test corrects for those sources of scatter or variability.

5. The correct answer is **C** (estimation of degrees of freedom in *t*-test). When the population standard deviation is unknown and the sample size is less than 30 ($n < 30$), the distribution of the test statistic cannot be guaranteed to be normal. Hence, the test statistic can be said to conform to a *t* distribution. The *t* distribution is similar to the standard normal distribution in that

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it is symmetrically distributed around a mean value. However, the *t* distribution varies from the standard normal, in that its standard deviation is determined by the number of degrees of freedom. Degrees of freedom (DF) are calculated from the size of the sample. Simply, DF is a measure of the amount of information from the sample data that has been utilized. Thus whenever a paired *t*-test statistic is calculated from a sample, one degree of freedom is used up. In this example, the DF $= n - 1 \rightarrow (12 - 1) = 11$.

6. The correct answer is **B** (*p* value interpretation). The level at which a result is considered significant is known as the type I error rate or α. A *p* value is a measure of how much evidence one has against the null hypothesis. The smaller the *p* value, the more evidence one has. One may combine the *p* value with the significance level to make a decision on a given test of hypothesis. A *p* value is not the probability that the null hypothesis is true but should be seen as the measure of the strength of the evidence provided by the data in favor of the null hypothesis.

Table 1 Hypothesis Testing and Relationship between Type I and Type II Errors

	Null Hypothesis	
Test Results	**False**	**True**
Significant	Power	Type I error
Non-significant	Type II error	

7. The correct answer is **E** (diagnostic test). Sensitivity and specificity are properties of a diagnostic test and should be consistent when the test is used in similar patients and in similar settings. Predictive values, though related to the sensitivity and specificity of the test, will vary with the prevalence of the condition or disease being tested. The difference in the sensitivity and specificity

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of the test is most likely a result of the test not being administered in similar conditions (patients and settings).

8. The correct answer is **C** (relationship between disease prevalence, sensitivity, specificity, and predictive values). The prevalence simply means the probability of the condition before performing the test (i.e., pretest probability). The predictive values refer to the probability of the disease being present or absent after obtaining the results of the test. Using the 2×2 table, positive predictive value (PPV) is the proportion of those with a positive test who have the disease ($a/(a + b)$) while the negative predictive value (NPV) is the proportion of those with a negative test who do not have the disease ($d/(c + d)$). The predictive values will vary with the prevalence of the disease or condition being tested for. Therefore the probability of the diseases before (prevalence) and the probability of disease after (predictive value) will be interrelated, with the differences in predictive values driven by the differences in the prevalence of the disease.

9. The correct answer is **E** (*p* value interpretation and sampling variability). The *p* value gives an indication of how plausible the null hypothesis is, but it is *not* the probability of the null hypothesis being true. Simply, the *p* value is the probability of observing a result as extreme as or more extreme than the one actually observed by chance alone; that is, if the null hypothesis is true.

Table 2 Hypothesis Testing and Type I Error

	Truth	
Test Results	**No Association**	**Association**
No association	Correct	Type II error
Association	Type I error*	Correct

* *p* value is the probability of a type I error.

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10. The correct answer is **C** (analysis strategies in intervention trial—intent to treat versus efficacy analysis). Two types of analytic approaches are often used in clinical trials (randomized), namely efficacy and intent-to-treat. The latter is a method of analysis used in which all patients randomly assigned to one of the treatments arms are analyzed together, regardless of whether or not they completed or received that treatment. On the other hand, efficacy analysis is performed only on those who comply with the assigned treatment.

11. The correct answer is **E** (test statistic and hypothesis testing). The unpaired *t*-test, two sample *t*-test, or independent-samples *t*-test compares the means of two groups, assuming that data are sampled from Gaussian populations (normal distribution). If the *p* value is small (< 0.05), for instance, then it is unlikely that the observed difference is due to random variability or sampling error.

12. The correct answer is **A** (test statistic and hypothesis testing). The chi-square statistic is a non-parametric analytic method used to compare the observed frequency of some observation with an expected frequency. The comparison of observed and expected frequencies is used to calculate the value of the chi-square statistic, which in turn can be compared with the distribution of chi-square to make an inference about a statistical issue such as the relationship between pet ownership and depressive symptoms, hypertension and sodium intake, maternal preconception weight and low birth weight, etc.

Table 3 Choice of Statistical Test for Selected Data Types

Data Distribution	Groups (Number)	Test Statistic—Independent Sample	Test Statistic—Paired Sample
Continuous (non-normal)	2	Mann–Whitney U test	Wilcoxon signed-rank test
Continuous (normal)	2 ($n > 30$)	*t*-test	Paired *t*-test

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Table 3 Choice of Statistical Test for Selected Data Types *(continued)*

Data Distribution	Groups (Number)	Test Statistic—Independent Sample	Test Statistic—Paired Sample
Normal (non-normal)	≥ 3	Kruskal–Wallis test	Friedman test
Normal (normal)	≥ 3	ANOVA*	Repeated measures ANOVA
Ordinal	2	Mann–Whitney U test	Wilcoxon signed-rank test
	≥ 3	Kruskal–Wallis test	Friedman test
Nominal	2	Fisher exact test, chi square	McNemar test
	≥ 3	Pearson chi-square test	Cochran Q test
Binary outcome	—	Unconditional logistic regression	Conditional logistic regression
Continuous	—	Linear regression	—

*Analysis of variance = ANOVA

13. The correct answer is **C** (environmental contaminants). In 1907 the Chisso Corporation built a factory in the small fishing village of Minamata, Japan, along the shore of Minamata Bay. The fish populations began to decline in 1925, and by 1950 fish began to float to the surface, and shellfish and other aquatic organisms began to perish as well.

14–18. The correct answers are **B**, **D**, **A**, **E**, and **C**, respectively (agencies and public health responsibilities). The CDC focuses on crisis-oriented infectious diseases, such as anthrax diagnosed in postal workers. The NIH focuses on basic sciences research aimed at curing human diseases, such as investigating the

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use of statin drugs to reduce the incidence of Alzheimer's disease. The Bill and Melinda Gates Foundation primarily focuses on improving global health diseases, such as HIV, malaria, and tuberculosis. State health departments hold the primary constitutional authority to address policies concerning improvement of birth outcomes, including birth weight, preterm births, and infant mortality and morbidity. Local health departments (county and city) focus on day-to-day operations of public health clinics.

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