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Item 33 of 40 Question Id: 1175

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A study compared drug A versus standard therapy in preventing recurrent pulmonary embolism (PE). The absolute risk reduction for drug A versus standard therapy was 4%. The incidence of recurrent PE in the standard therapy group was 6%. There were 24 patients who developed recurrent PE in the drug A group. How many total subjects were there in the drug A group?

- A. 600 (16%)
- B. 900 (6%)
- C. 1200 (67%)
- D. 1500 (4%)
- E. 1800 (3%)
- F. 2100 (1%)

Omitted
Correct answer
C

67%
Answered correctly

02 secs
Time Spent

2023
Version

Explanation

This question is meant to challenge your knowledge of how absolute risk reductions (ARR) are calculated. The ARR equals the event rate in the control group ($ER_{control}$) minus the event rate in the treatment group ($ER_{treatment}$). In this example, the event rate represents the incidence of recurrent pulmonary embolism (PE); $ER_{treatment}$ is the incidence of recurrent PE in the drug A group, and $ER_{control}$ is the incidence in the standard therapy group.

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$$ARR = ER_{control} - ER_{treatment}$$

$$4\% = 6\% - ER_{treatment}$$

$$ER_{treatment} = 2\% = 0.02$$

This value ($ER_{treatment}$) also represents the number of events in the treatment arm divided by the number of subjects in the treatment arm. Therefore, knowing the total number of events in the treatment arm (24 instances of recurrent PE in the drug A group), the number of subjects in the treatment arm can be easily calculated:

$$ER_{treatment} = \text{Number of events in the treatment arm} / \text{Number of subjects in the treatment arm}$$

$$0.02 = 24 / \text{Number of subjects in the treatment arm}$$

$$\text{Number of subjects in the treatment arm} = 24 / 0.02 = 1200$$

Educational objective:

Absolute risk reduction = event rate in the control group – event rate in the treatment group.

Biostatistics

Biostatistics & Epidemiology

Risk

Subject

System

Topic

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Item 34 of 40 Question Id: 8422

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A study is performed to compare the effect of tramadol when compared to placebo for painful polyneuropathy. Fifty patients are selected and randomly allocated to 1 of 2 treatment sequences: Tramadol followed by placebo, or placebo followed by tramadol. The initial treatment period is delivered for 4 weeks followed by an interim 1-week washout phase, after which the second treatment period is delivered for an additional 4 weeks. After each treatment period, patients use a 10-point numeric scale to rate pain, paresthesia, and tenderness. Which of the following best describes this study design?

- A. Case-control study (11%)
- B. Case series study (5%)
- C. Crossover study (64%)
- D. Cross-sectional study (3%)
- E. Prospective cohort study (12%)
- F. Retrospective cohort study (1%)

Omitted
Correct answer
C

64%
Answered correctly

03 secs
Time Spent

2023
Version

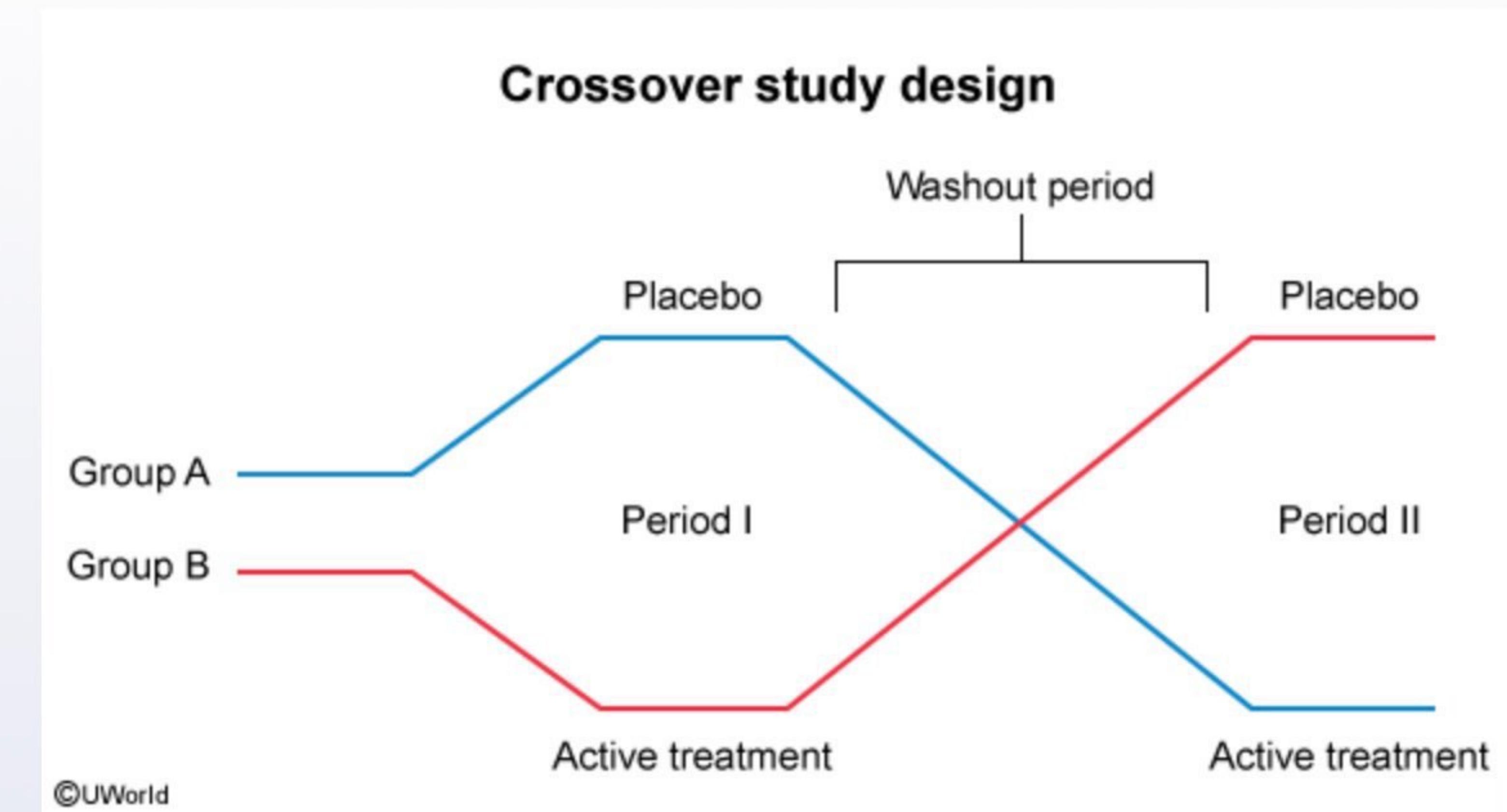
Explanation

Crossover study design

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In this example, patients are allocated to 1 of 2 treatment groups: Group A receives placebo followed by tramadol and Group B receives tramadol followed by placebo. After the initial 4-week treatment period and the 1-week washout phase, the **treatments are switched** and delivered for an additional 4 weeks. This is consistent with a **crossover study**, in which subjects are randomly allocated to a sequence of 2 or more treatments given consecutively. The simplest model is the AB/BA type of study in which half of the subjects are allocated to the AB study arm and receive treatment A followed by treatment B, while the other half of the subjects are allocated to the BA study arm and receive the same treatments but in reverse order. In this way, crossover trials allow the patients to serve as their **own controls**.

The principal drawback of crossover trials is that the effects of one treatment may **carry over** and alter the response to a subsequent treatment. To avoid this, a **washout phase** (no treatment) is often added between treatments. The washout period is designed to be long enough to allow the effects of prior treatment to wear off.

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(Choice A) A case-control study is designed by selecting patients with a particular disease (cases) and without that disease (controls), then determining their past exposure status to ≥ 1 risk factors believed to be associated with the disease of interest.

(Choice B) A case series is a descriptive study that tracks patients with a known condition (eg, a particular exposure, risk factor, or disease) to document the natural history or response to treatment. Unlike a case-control study, a case series is a descriptive study that cannot quantify statistical significance.

(Choice D) A cross-sectional study is also known as a prevalence study. It is characterized by the simultaneous measurement of exposure and outcome. It is a snapshot study design that frequently uses surveys. These studies are relatively inexpensive and easy to perform.

(Choices E and F) Prospective cohort studies identify 2 groups of individuals (ie, cohorts), based on their exposure status to a risk factor. These 2 cohorts are then followed over time to assess development of the disease of interest. Sometimes the exposure status is determined retrospectively, typically using medical records, and patients are tracked from the point of exposure onward.

Educational objective:

In a crossover study, subjects are randomly allocated to a sequence of 2 or more treatments given consecutively. A washout (no treatment) period is often added between treatment intervals to limit the confounding effects of prior treatment.

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Item 35 of 40 Question Id: 19195

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A research group conducted a study to compare the levels of creatine kinase-MB (CK-MB) between type 2 diabetes mellitus (T2DM) patients given statin therapy. Participants were divided into 4 groups based on treatment. Groups I, II, and III consisted of T2DM patients who had been given statin therapy (atorvastatin, simvastatin, rosuvastatin, respectively) for at least 6 months. Group IV consisted of T2DM patients who had not been given statin therapy. Which of the following statistical tests is most appropriate to compare the CK-MB levels between Groups I, II, III, and IV in this study?

- A. Analysis of variance (77%)
- B. Chi-square test (11%)
- C. Independent *t*-test (2%)
- D. Paired *t*-test (3%)
- E. Correlation analysis (4%)

Omitted
Correct answer
A

77%
Answered correctly

02 secs
Time Spent

2023
Version

Explanation

Dependent variable	
Qualitative (categorical)	Quantitative

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		Dependent variable	
		Qualitative (categorical)	Quantitative
Independent variable	Qualitative (categorical)	Chi-square, logistic regression*	t test, ANOVA, linear regression
	Quantitative	Logistic regression*	Correlation, linear regression

*Dependent variable must be dichotomous.

ANOVA = analysis of variance.

Variables are broadly classified as qualitative (ie, categorical) or quantitative (eg, continuous) based on their scale of measurement. **Qualitative variables** (eg, type of treatment, blood type) represent categories or groups, whereas **quantitative variables** (eg, temperature, glucose levels) represent numerical values, with quantitative variables (eg, temperature) sometimes transformed into qualitative variables (eg, "no fever" for <38 C [100 F]; "fever" for ≥38 C [100 F]). The scale of measurement of the dependent (eg, outcome) and independent (eg, exposures, risk factors) variables in a study determines the correct statistical test for any given situation.

The **analysis of variance (ANOVA)** test compares the **means of ≥3 groups**. It requires a categorical independent variable (ie, exposure) that is used to divide the study pool into ≥3 groups and a quantitative dependent variable (ie, outcome) for which an average (eg, mean) can be calculated. In this study:

- The quantitative dependent variable was the **levels of creatine kinase-MB (CK-MB)**.
- The categorical independent variable was type of statin therapy that was used to categorize **4 different groups** of patients with type 2 diabetes mellitus (T2DM): Group I (atorvastatin), Group II (simvastatin),

The screenshot shows a mobile application interface for a medical question. At the top, there is a header with the URL "apps.uworld.com". Below the header is a toolbar with various icons: a left arrow, a right arrow, a double arrow, a magnifying glass, a "Mark" icon, "Previous" and "Next" buttons, "Full Screen", "Tutorial", "Lab Values", "Notes", "Calculator", "Reverse Color", "Text Zoom", and "Settings". The main content area contains a list item and some explanatory text.

- The categorical independent variable was type of statin therapy that was used to categorize **4 different groups** of patients with type 2 diabetes mellitus (T2DM): Group I (atorvastatin), Group II (simvastatin), Group III (rosuvastatin), and Group IV (no statin).

An [ANOVA test](#) can determine whether there is a statistically significant difference in mean levels of CK-MB among T2DM patients given different statin therapies. A large, statistically significant difference in mean CK-MB levels among groups indicates that different statin therapies are associated with significant changes in CK-MB levels (ie, the null hypothesis is rejected).

(Choice B) The chi-square test evaluates the association between 2 categorical variables, as in a study evaluating the association between sex (ie, "male" and "female") and myocardial infarction (ie, presence of myocardial infarction, absence of myocardial infarction).

(Choices C and D) The *t*-tests compare the mean of a quantitative variable *between 2 groups*. A paired *t*-test is used when the groups are dependent (eg, comparing mean blood pressure [quantitative variable] in the same group of patients before and after antihypertensive therapy). An independent *t*-test is used when the groups are independent (eg, comparing mean CK-MB levels [quantitative variable] between a group of patients given statin therapy and another not given statin therapy).

(Choice E) A correlation analysis uses the [correlation coefficient](#) to describe the linear relationship between 2 quantitative variables, as in a study evaluating the [linear relationship](#) between hours of sleep and irritability score.

Educational objective:

The analysis of variance test compares the means of ≥ 3 groups. The test requires a categorical independent variable (ie, exposure) that is used to divide the study pool into ≥ 3 groups and a quantitative dependent variable (ie, outcome) for which an average (eg, mean) can be calculated.

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Item 36 of 40 Question Id: 108178

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A researcher conducts a study to determine the value of measuring kidney volume with computed tomography (CT) to help diagnose chronic kidney disease and quantify kidney damage. In total, 251 patients are enrolled in the study. Correlation analyses are then conducted to evaluate the relationships between kidney volume as measured on CT scans and both glomerular filtration rate and glycosylated hemoglobin (HbA1c). Initial study results show that lower values of HbA1c tended to relate to higher values of kidney volume, and that the relationship was strong and statistically significant. Based on this information, which of the following statements would best describe the associated correlation coefficient?

- A. It is negative and probably closer to -1 than to 0 (65%)
- B. It is negative and probably closer to 0 than to -1 (5%)
- C. It is positive and probably closer to 0 than to 1 (8%)
- D. It is positive and probably closer to 1 than to 0 (20%)

Omitted
Correct answer
A

65%
Answered correctly

01 sec
Time Spent

2023
Version

Explanation

Direction and strength of a linear relationship

Negative linear relationship

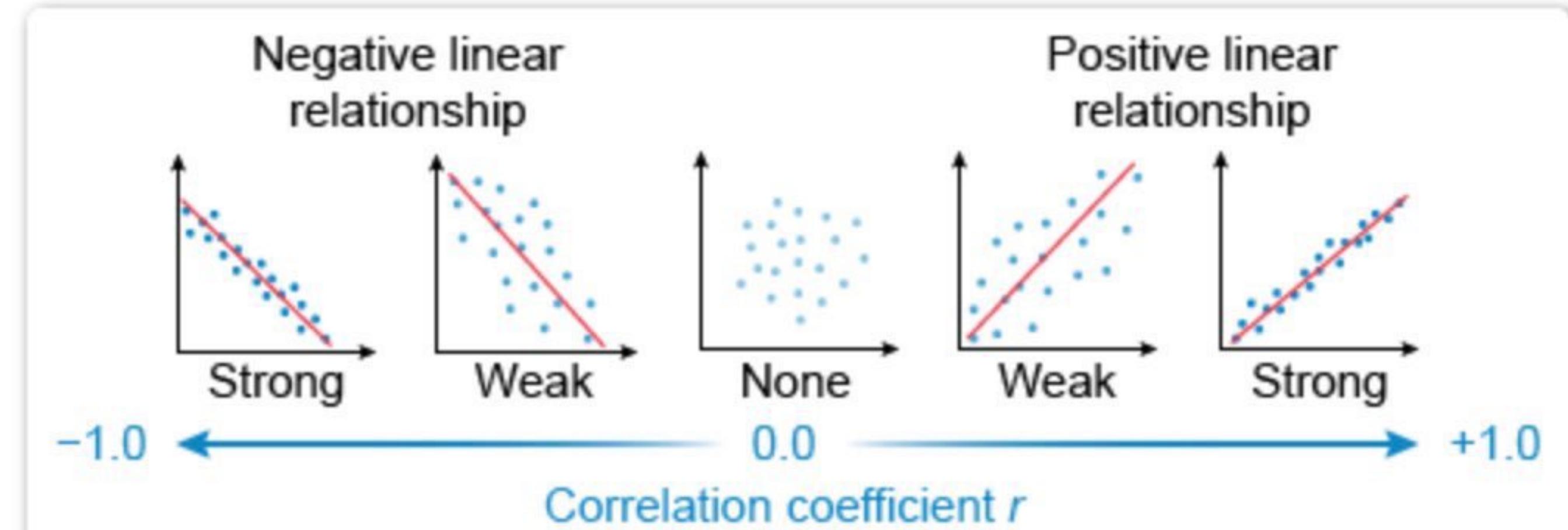
Positive linear relationship

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Direction and strength of a linear relationship

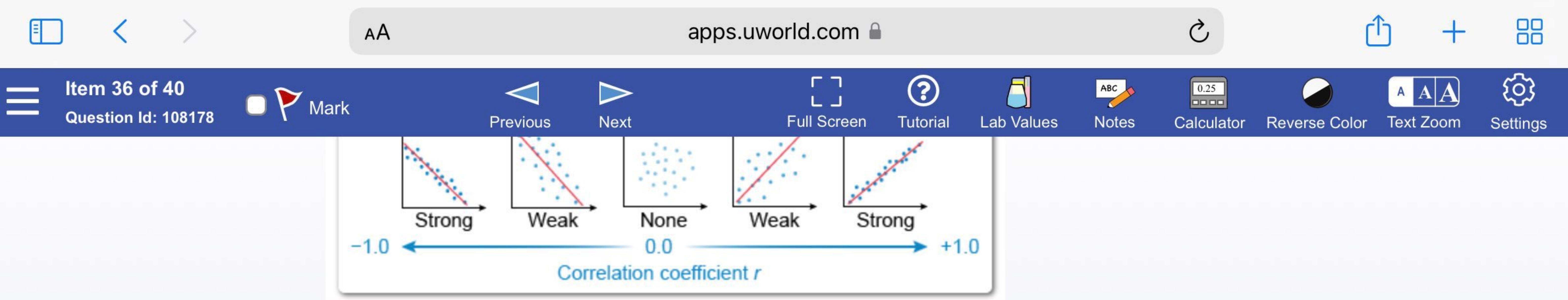


The **correlation coefficient r** describes the linear relationship between 2 quantitative variables by its direction (negative or positive) and its strength (a value closer to -1 or 1 indicates a stronger relationship).

- $r > 0$ (ie, **positive**) indicates a direct relationship, so **both variables increase (or decrease) together**. This means that higher (or lower) values of one variable tend to relate to higher (or lower) values of the other variable.
- $r < 0$ (ie, **negative**) indicates an inverse relationship, so as **one variable increases, the other variable decreases**. This means that higher values of one variable tend to relate to lower values of the other variable, and vice versa.

In this study, lower values of HbA1c tended to relate to higher values of kidney volume. This means that one variable increased as the other variable decreased, so the correlation coefficient must be negative (**Choices C and D**). Because the relationship was described as **strong**, the correlation coefficient must be **closer to -1 than to 0 (Choice B)**.

Educational objective:



The **correlation coefficient r** describes the linear relationship between 2 quantitative variables by its direction (negative or positive) and its strength (a value closer to -1 or 1 indicates a stronger relationship).

- $r > 0$ (ie, **positive**) indicates a direct relationship, so **both variables increase (or decrease) together**. This means that higher (or lower) values of one variable tend to relate to higher (or lower) values of the other variable.
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In this study, lower values of HbA1c tended to relate to higher values of kidney volume. This means that one variable increased as the other variable decreased, so the correlation coefficient must be negative (**Choices C and D**). Because the relationship was described as **strong**, the correlation coefficient must be **closer to -1** than to 0 (**Choice B**).

Educational objective:

The correlation coefficient r describes the direction (negative or positive) and the strength (a value closer to -1 or 1 indicates a stronger relationship) of the linear relationship between 2 quantitative variables. It does not necessarily imply causality.

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A meta-analysis of several trials on the effect of cocoa intake on systolic blood pressure (SBP) revealed the following results:

Study	Mean SBP in cocoa group – mean SBP in control group (mm Hg) [95% confidence interval]
1	-5.2 [-7.3, -3.4]
2	1.6 [-5.3, 10.4]
3	-4.2 [-8.1, -2.7]
4	-2.9 [-4.1, -1.4]
5	-2.8 [-5.2, -1.1]
6	0.8 [0.1, 1.2]
7	1.0 [-1.2, 3.3]
Total	-2.2 [-2.7, -1.3]

All the trials evaluated the difference in SBP at 2 weeks. Based on the data, which of the following is the most appropriate conclusion?

- A. A higher mean SBP was seen in the cocoa groups overall (2%)
- B. Cocoa intake should be recommended for blood pressure management (2%)
- C. Cocoa intake was associated with a statistically significant decrease in SBP (71%)

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not the same for all CIs. For an odds ratio or a relative risk (RR), the null value is 1 because these statistics are ratios (ie, RR = 1 represents no difference in risk between the groups). However, if the parameter of interest is a **difference** (eg, difference in mean SBP between cocoa intake and control groups), then the **null value is 0** because that represents no difference between the groups.

In this case, the 95% CI of $[-2.7, -1.3]$ does not include the null value of 0 and therefore the result is **statistically significant**. In summary, cocoa intake was associated with a statistically significant decrease in SBP.

(Choices A and E) The overall mean change in SBP was negative at -2.2 mm Hg, reflecting a lower SBP in the cocoa group compared to the control group. The change was statistically significant.

(Choice B) Although there was a statistically significant decrease in SBP in the cocoa intake group, the clinical significance may be limited as the absolute SBP decrease is only about 2 mm Hg. Furthermore, the trials measured SBP at 2 weeks, so it is possible that the effect of cocoa intake on SBP was short-lived. Finally, no information is provided regarding adverse effects of cocoa intake.

(Choice D) Given that the CI crossed the null value in studies 2 and 7, there was no statistically significant difference between the groups in these studies.

Educational objective:

A meta-analysis groups results of several trials to increase statistical power and provide an overall pooled effect estimate.

Biostatistics
Subject

Biostatistics & Epidemiology
System

Meta analysis
Topic

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Item 38 of 40 Question Id: 14859

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The aim of a prospective cohort study conducted in a group of adults with diagnosed type 2 diabetes mellitus (T2DM) is to investigate the association between the presence of morbid obesity ($\text{BMI} > 40 \text{ kg/m}^2$) and the risk of developing diabetic nephropathy. One of the groups in the study consists of adults with T2DM, a $\text{BMI} > 40 \text{ kg/m}^2$, and no diabetic nephropathy. Which of the following is the most appropriate comparison group for this prospective cohort study?

- A. Adults with T2DM who have morbid obesity ($\text{BMI} > 40 \text{ kg/m}^2$) and diabetic nephropathy (20%)
- B. Adults with T2DM who have normal weight ($\text{BMI} 18.5 \text{ to } < 25 \text{ kg/m}^2$) and diabetic nephropathy (8%)
- C. Adults with T2DM who have normal weight ($\text{BMI} 18.5 \text{ to } < 25 \text{ kg/m}^2$) and no diabetic nephropathy (60%)
- D. Adults without T2DM who have morbid obesity ($\text{BMI} > 40 \text{ kg/m}^2$) and no diabetic nephropathy (7%)
- E. Adults without T2DM who have normal weight ($\text{BMI} 18.5 \text{ to } < 25 \text{ kg/m}^2$) and diabetic nephropathy (1%)

Omitted
Correct answer
C

60%
Answered correctly

02 secs
Time Spent

2023
Version

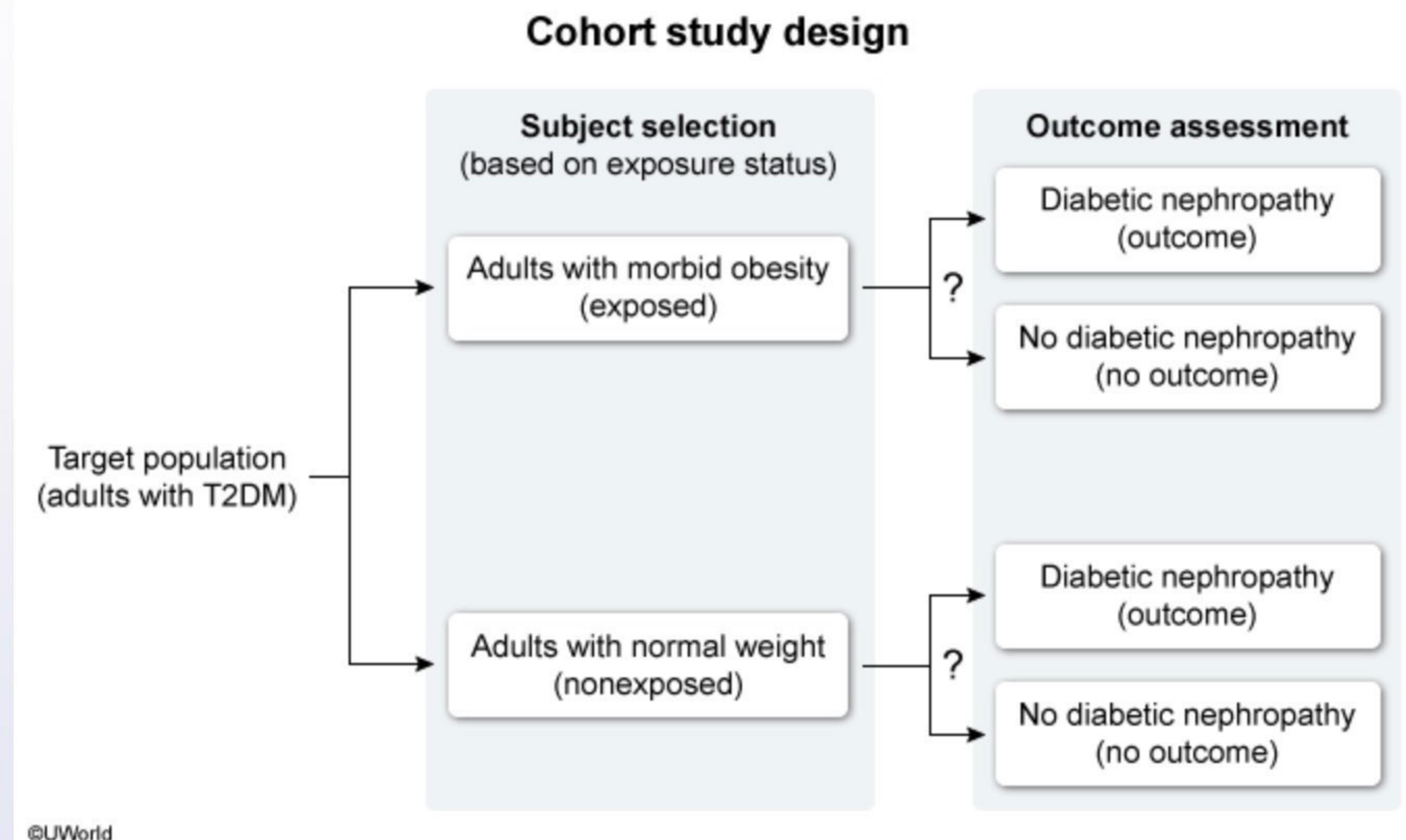
Explanation

Cohort study design

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A **cohort study** is an observational design in which potential participants in the **population of interest** are initially **identified as exposed or nonexposed** according to the independent variable (ie, exposure status to a risk factor). Once participants are categorized based on their exposure status, the occurrence (ie, incidence) of the dependent variable (eg, **outcome of interest**) over a specific period is determined in each group. Finally, the occurrence of the outcome is compared between exposed and nonexposed groups to estimate the association between the risk factors and the outcomes. If there is a statistically significant difference in outcome occurrence between the 2 groups, it is likely that the risk factor in question is associated with disease development.

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In this example:

- The **population** of interest is patients with **type 2 diabetes mellitus** (T2DM). Therefore, both the exposed and nonexposed groups must consist of patients with T2DM (**Choices D and E**).
- The **risk factor** of interest is **morbid obesity** ($BMI >40 \text{ kg/m}^2$). Therefore, the exposed group is adults with morbid obesity, and the nonexposed group is adults with normal weight ($BMI 18.5 \text{ to } <25 \text{ kg/m}^2$) (**Choice A**).
- The **outcome** of interest is **diabetic nephropathy**. Exposed and nonexposed subjects must be selected with **no history** of the outcome because the occurrence of the outcome is what is measured during the study period (**Choice B**).

Therefore, the exposed group is adults with T2DM who have morbid obesity and no diabetic nephropathy; the **nonexposed group** is adults with **T2DM** who have **normal weight** ($BMI 18.5 \text{ to } <25 \text{ kg/m}^2$) and **no diabetic nephropathy**. Comparing the frequency of the outcome (eg, diabetic nephropathy) between exposed and nonexposed groups is what determines whether exposure to the risk factor (eg, morbid obesity) is associated with the risk of developing the outcome (eg, diabetic nephropathy).

Educational objective:

In a cohort study, subjects should be initially selected from the population of interest (eg, T2DM) based on their exposure status to a risk factor (eg, presence or absence of morbid obesity). Subjects are then monitored during the study period for development of the outcome of interest (eg, diabetic nephropathy).

References

- Methodology series module 1: cohort studies.

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Item 39 of 40 Question Id: 18995

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A genome-wide association study (GWAS) of rheumatoid arthritis (RA) is performed in a cohort of Portuguese patients, including 907 cases with RA and 1,524 controls without RA. Logistic regression is used to test the association between RA and hundreds of thousands of loci. These association results are then compared with data from a European GWAS cohort of 4,036 patients with RA and 6,959 patients without RA. Finally, the Portuguese and European study results are combined into a meta-analysis. Based on these data, the investigators identify 3 new loci that are associated with RA based on a significance level threshold of 5×10^{-8} :

European study		Portuguese study		Meta-analysis		
Odds ratio	p-value	Odds ratio	p-value	Odds ratio	p-value	
Locus 1	0.53	8.36×10^{-7}	0.61	0.013	0.55	3.5×10^{-8}
Locus 2	1.16	8.40×10^{-7}	1.14	0.019	1.16	4.9×10^{-8}
Locus 3	1.63	0.0000015	1.77	0.0074	1.66	4.1×10^{-8}

Previous studies had identified 30 loci that accounted for <35% of disease heritability for RA. Which of the following statements is correct regarding this study?

- A. Combining the results of the European and Portuguese studies into a meta-analysis decreases the power (5%)
- B. Logistic regression is used because there is a stepwise increase in the strength of association from Locus 1 to Locus 3 (26%)
- C. The association between Locus 1 and RA in the meta-analysis is not statistically significant because the odds ratio is <1 (19%)

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C. The association between Locus 1 and RA in the meta-analysis is not statistically significant (19%) because the odds ratio is <1

D. The threshold used for the *p*-value in the meta-analysis is 5×10^{-8} because of the large number of loci studied (38%)

E. With this meta-analysis, the 33 identified loci account for most disease heritability in RA (10%)

Omitted
Correct answer
D

38% Answered correctly

05 secs Time Spent

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Explanation

Genome-wide association studies (GWAS) are typically case-control studies that involve scanning thousands of genetic markers in subjects with and without a disease to identify **associations between genetic variants** (eg, loci) and that **disease**. GWAS often use single-nucleotide polymorphisms (SNPs), with several million SNPs analyzed on 1 microscope slide.

In this case, GWAS are used to analyze **hundreds of thousands of loci** in Portuguese patients with and without rheumatoid arthritis (RA). The results are compared to those from a larger European cohort; both studies are then combined in a meta-analysis. A few loci have SNPs with an allele that is significantly more common among patients with RA than those without RA; these loci are therefore associated with RA.

Whenever **multiple tests** are performed simultaneously (eg, analyzing thousands of loci), the possibility of **false-positive results** increases. Using a much **smaller threshold for the *p*-value** is a method to minimize this.

Traditionally, a *p*-value $<5\%$ is considered statistically significant. However, if 100,000 loci are studied at that 5%

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Whenever **multiple tests** are performed simultaneously (eg, analyzing thousands of loci), the possibility of **false-positive results** increases. Using a much **smaller threshold for the p-value** is a method to minimize this. Traditionally, a *p*-value <5% is considered statistically significant. However, if 100,000 loci are studied at that 5% (ie, 0.05, 5×10^{-2}) level, then $100,000 \times 0.05 = 5,000$ false positives would be expected. With a much smaller *p*-value, this number decreases substantially. For this reason, a *p*-value of 5×10^{-8} ("genome-wide *p*-value"), as seen here, is often chosen in GWAS.

(Choice A) A meta-analysis combines results from different studies, thereby increasing sample size, which increases power (eg, to detect statistical differences between groups).

(Choice B) Logistic regression was used because it analyzes the association between exposures (eg, multiple loci) and binary outcomes (eg, yes = cases with RA; no = controls without RA).

(Choice C) An odds ratio (OR) <1 does not imply a lack of statistically significant association. If an OR >1 means that patients with RA have *higher* odds of having a specific locus compared to those without RA (ie, risk factor), an OR <1 means that patients with RA have *lower* odds of having that specific locus (ie, protective

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The top navigation bar includes icons for back/forward, search, and other functions. Below it is a toolbar with: Item 39 of 40, Question Id: 18995, Mark, Previous/Next, Full Screen, Tutorial, Lab Values, Notes, Calculator, Reverse Color, Text Zoom, and Settings.

Increases power (eg, to detect statistical differences between groups).

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(Choice C) An odds ratio (OR) <1 does not imply a lack of statistically significant association. If an OR >1 means that patients with RA have *higher* odds of having a specific locus compared to those without RA (ie, risk factor), an OR <1 means that patients with RA have *lower* odds of having that specific locus (ie, protective factor). The OR for the association between Locus 1 and RA is statistically significant because its *p*-value (3.5×10^{-8}) is less than the genome-wide *p*-value (5×10^{-8}).

(Choice E) GWAS help explain disease heritability (ie, effect of genotypic differences on phenotypic differences). Although this study identified 3 new loci, there is no indication that the full group of 33 loci will explain most RA disease heritability. GWAS have identified many genes associated with specific conditions, but these genes only seem to explain a small amount of the variance ("missing heritability").

Educational objective:

Genome-wide association studies aim to identify associations between thousands of genetic variants and a disease. Because of the increased risk of false-positive results when multiple tests are performed simultaneously, a smaller genome-wide *p*-value is typically used.

References

- [GWAS identifies novel SLE susceptibility genes and explains the association of the HLA region.](#)

Biostatistics

Subject

Biostatistics & Epidemiology

System

P-value and confidence interval

Topic

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Public health officials involved in developing nutritional guidelines commission a study to determine how dietary eating patterns influence total body iron stores in children age 5-17. As part of the study, researchers want to assess how 2 independent variables, red meat consumption and egg consumption (both reported in units of ounces/week), affect serum ferritin concentrations while adjusting for age and gender. Which of the following statistical techniques is most helpful for determining the association between the study variables?

- A. Analysis of variance (37%)
- B. Meta-analysis (6%)
- C. Odds ratio (5%)
- D. Regression analysis (40%)
- E. Relative risk (9%)

Omitted

Correct answer

D



40%

Answered correctly



20 secs

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Explanation

Dependent variable

Qualitative (categorical)

Quantitative

Chi-square, logistic

t test, ANOVA, linear

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		Dependent variable	
		Qualitative (categorical)	Quantitative
Independent variable	Qualitative (categorical)	Chi-square, logistic regression*	<i>t</i> test, ANOVA, linear regression
	Quantitative	Logistic regression*	Correlation, linear regression

*Dependent variable must be dichotomous.

ANOVA = analysis of variance.

Variables are broadly classified as qualitative (ie, categorical) or quantitative (eg, continuous) based on their scale of measurement. **Qualitative variables** (eg, type of treatment, blood type) **represent categories or groups** whereas **quantitative variables** (eg, temperature, glucose levels) **represent numerical values**. The scale of measurement of the dependent (eg, outcome) and independent (eg, exposures, risk factors) variables in a study determines the correct statistical test.

Regression analysis is used to describe the **association between 1 or more independent variables** (eg, exposures, risk factors), which may be quantitative or qualitative, and 1 quantitative dependent variable (ie, a **quantitative outcome** [eg, laboratory values]) while adjusting for other variables of interest. In this study:

- The quantitative dependent variable was serum ferritin concentration.
- The independent variables were consumption of red meat and eggs reported in ounces/week (2 quantitative variables).
- The effect of the main independent variables (eg, consumption of red meat and eggs) on the dependent

The screenshot shows a mobile application interface for a quiz. At the top, there's a header bar with a back arrow, a forward arrow, and a double arrow icon. The URL 'apps.uworld.com' is displayed in the center. On the right side of the header are icons for sharing, adding, and a grid. Below the header is a blue navigation bar with various icons: a menu icon, 'Item 40 of 40', 'Question Id: 19197', a 'Mark' icon, 'Previous' and 'Next' arrows, 'Full Screen', 'Tutorial', 'Lab Values', 'Notes', 'Calculator', 'Reverse Color', 'Text Zoom', and 'Settings'. The main content area contains a bulleted list of text.

- The independent variables were consumption of red meat and eggs reported in ounces/week (2 quantitative variables).
- The effect of the main independent variables (eg, consumption of red meat and eggs) on the dependent variable (eg, serum ferritin concentration) is adjusted to account for the effects of other independent variables, which are called adjustment variables (eg, age, gender). Controlling for these variables reduces the potential confounding.

Calculation of a regression line (eg, line of best fit) can then determine whether dietary consumption of red meat and eggs has a statistically significant effect on serum ferritin concentrations (after adjusting for age and gender).

(Choice A) The analysis of variance (ANOVA) test compares the mean of a quantitative variable of ≥ 3 independent groups. For example, it could be used in a study comparing serum ferritin concentrations (ie, quantitative variable) in children (age 0-12), adolescents (age 13-17), adults (age 18-59), and seniors (age ≥ 60).

(Choice B) Meta-analysis is a quantitative statistical technique used to combine and analyze data from several studies to conduct an analysis with a greater statistical power than that of the individual studies.

(Choices C and E) The odds ratio (OR) and the relative risk (RR) measure the strength of association between 2 categorical variables: a categorical risk factor (eg, smoker or nonsmoker) and a categorical outcome/disease (eg, presence or absence of myocardial infarction). The OR is used in case-control studies whereas the RR is used in cohort studies.

Educational objective:

A regression analysis is a statistical technique used to describe the effect that 1 or more independent variables (eg, exposures, risk factors), which may be quantitative or qualitative, can have on 1 quantitative dependent variable (ie, outcome).

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Item 16 of 40 Question Id: 1273 Mark Previous Next Full Screen Tutorial Lab Values Notes Calculator Reverse Color Text Zoom Settings

A geneticist is interested in the potential causes of a congenital abnormality. She hypothesizes that acetaminophen use during the first trimester of pregnancy might be associated with the abnormality. In her study, a sample of mothers of children with and without the abnormality are randomly selected from government birth records. Personal interviews are then conducted with the mothers to determine fetal exposure to acetaminophen. Results show that mothers of children who do not have the abnormality did not take acetaminophen as frequently during the first trimester. This type of study is most susceptible to which of the following types of bias?

- A. Allocation bias (0%)
- B. Detection bias (2%)
- C. Recall bias (92%)
- D. Referral bias (0%)
- E. Selection bias (4%)

Omitted
Correct answer
C

92%
Answered correctly

01 min, 02 secs
Time Spent

2023
Version

Explanation

Recall bias results from study participants' **inaccurate recall** of past exposure and occurs most often in **retrospective** studies such as **case-control** studies. People who have experienced an adverse event (eg,

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Question Id: 1273

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Recall bias results from study participants' **inaccurate recall** of past exposure and occurs most often in **retrospective** studies such as **case-control** studies. People who have experienced an adverse event (eg, congenital abnormalities in their children) are more likely to recall previous potential risk factors (eg, acetaminophen use) than people who have not experienced an adverse event.

Contrary to case-control studies, which evaluate exposure to potential risk factors retrospectively, **prospective studies** begin with exposed and unexposed individuals. Because the exposure status is determined at the time of enrollment in the study, recall bias is **minimized**.

(Choice A) Allocation bias can result from the way patients are *assigned* to the treatment and control groups. It may occur when subjects are nonrandomly assigned to the study groups of a clinical trial (eg, physicians may preferentially enroll sicker patients into the experimental group). Allocation bias is different from selection bias, which occurs when the studied sample does not represent the general population (eg, because of *nonrandom selection*).

(Choice B) Detection bias refers to the fact that a risk factor itself may lead to extensive diagnostic investigation and increase the probability that a disease is identified. For instance, patients who smoke may undergo increased imaging surveillance due to their smoking status, which would detect more cases of cancer in general.

(Choice D) Referral (admission rate) bias occurs when the case and control populations differ due to admission or referral practices. For instance, a study involving asbestos as a risk factor for lung cancer conducted at a hospital specializing in treating asbestosis may select patients with lung cancer (cases) from the respiratory department and a control group without lung cancer from other departments. Because the hospital specializes in asbestosis treatment, patients in the respiratory department with lung cancer are more likely to have a history of asbestos exposure (compared to patients with lung cancer at other, nonspecialized institutions). Therefore, the

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Question Id: 1273

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(Choice B) Detection bias refers to the fact that a risk factor itself may lead to extensive diagnostic investigation and increase the probability that a disease is identified. For instance, patients who smoke may undergo increased imaging surveillance due to their smoking status, which would detect more cases of cancer in general.

(Choice D) Referral (admission rate) bias occurs when the case and control populations differ due to admission or referral practices. For instance, a study involving asbestos as a risk factor for lung cancer conducted at a hospital specializing in treating asbestosis may select patients with lung cancer (cases) from the respiratory department and a control group without lung cancer from other departments. Because the hospital specializes in asbestosis treatment, patients in the respiratory department with lung cancer are more likely to have a history of asbestos exposure (compared to patients with lung cancer at other, nonspecialized institutions). Therefore, the study may erroneously report a stronger association than actually exists.

(Choice E) Selection bias occurs when the method of selection used in a particular study results in selection sample of participants who are not representative of the intended population. A common example is patients with cancer who fail standard therapy and who are therefore the most likely to enroll in experimental trials (self-selection), leading to results that are not applicable to patients with less advanced cancers.

Educational objective:

Recall bias results from study participants' inaccurate recall of past exposure and occurs most often in retrospective studies such as case-control studies. People who have experienced an adverse event are more likely to recall risk factors than those who have not experienced an adverse event.

Biostatistics
Subject

Biostatistics & Epidemiology
System

Bias
Topic

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Item 10 of 40 Question Id: 1203 Mark Previous Next Full Screen Tutorial Lab Values Notes Calculator Reverse Color Text Zoom Settings

400 women aged 20-35 coming for routine check-up are asked about their smoking status. 40% of the women are smokers. Over the next ten years, 25 smokers and 24 non-smokers developed breast cancer. Which of the following best describes the study design?

- A. Prospective cohort study (85%)
- B. Retrospective cohort study (4%)
- C. Case-control study (6%)
- D. Cross-sectional study (3%)
- E. Randomized clinical trial (0%)

Omitted
Correct answer
A

85%
Answered correctly

50 secs
Time Spent

2023
Version

Explanation

The scenario described above is a good example of prospective cohort study. Initially a group of subjects is selected (i.e., cohort) and their exposure status is determined (smoker/non-smoker). The cohort is then followed for a certain period of time and observed for development of the outcome (breast cancer). Sometimes, the exposure status is determined retrospectively and then patients are tracked from that point of time, typically using medical records (**Choice B**).

(Choice C) A case-control study is designed by selecting patients with a particular disease (cases) and without

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Question Id: 1203

Mark

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Explanation

The scenario described above is a good example of prospective cohort study. Initially a group of subjects is selected (i.e., cohort) and their exposure status is determined (smoker/non-smoker). The cohort is then followed for a certain period of time and observed for development of the outcome (breast cancer). Sometimes, the exposure status is determined retrospectively and then patients are tracked from that point of time, typically using medical records (**Choice B**).

(Choice C) A case-control study is designed by selecting patients with a particular disease (cases) and without that disease (controls) and then determining their previous exposure status.

(Choice D) A cross-sectional study is also known as a prevalence study. It is characterized by the simultaneous measurement of exposure and outcome. It is a snapshot study design that frequently uses surveys. They are relatively inexpensive and easy to perform.

(Choice E) A randomized clinical trial directly compares two or more treatments. Usually, the subjects are randomly assigned to an exposure (e.g., a medication) or placebo and then followed for the development of the outcome of interest.

Educational Objective:

Prospective cohort studies are organized by selecting a group of individuals (i.e., cohort), determining their exposure status, and then following them over time for development of the disease of interest.

Biostatistics

Biostatistics & Epidemiology

Subject

System

Study designs

Topic

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Item 5 of 40 Question Id: 1189 Mark Previous Next Full Screen Tutorial Lab Values Notes Calculator Reverse Color Text Zoom Settings

Researchers are interested in the association between colorectal carcinoma and nonsteroidal anti-inflammatory drug use. They first interview a group of patients with biopsy-proven colorectal carcinoma and then interview a group consisting of the patients' neighbors who are of similar age and race. The analysis is based on comparing the results of pairs of individuals (one from each of the 2 groups) who have similar characteristics. This design technique best helps address which of the following potential problems with this study?

- A. Ascertainment bias (3%)
- B. Confounding (45%)
- C. Observer bias (2%)
- D. Recall bias (5%)
- E. Selection bias (43%)

Omitted
Correct answer
B

45%
Answered correctly

01 min, 32 secs
Time Spent

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Explanation

Matching is a method generally used in the design stage of case-control studies to control **confounding** (ie, when a perceived association between an exposure and an outcome is actually explained by a confounding variable associated with both the exposure and the outcome). The initial step in matching involves selecting variables that could be confounders (eg, age, race). Cases and controls are then selected based on the

Explanation

Matching is a method generally used in the design stage of case-control studies to control [confounding](#) (ie, when a perceived association between an exposure and an outcome is actually explained by a confounding variable associated with both the exposure and the outcome). The initial step in matching involves selecting variables that could be confounders (eg, age, race). Cases and controls are then selected based on the matching variables so that both groups have a **similar distribution** in accordance with the variables.

In this scenario, the "cases" (patients with colorectal cancer) were matched with neighborhood "controls" of similar age and race. Selecting neighbors as controls has another advantage of matching the cases to controls by variables that are difficult to measure (eg, socioeconomic status, environmental factors). Gender and smoking status are other common confounders.

(Choices A, C, D, and E) Observer bias and ascertainment bias result from mislabeling exposed/unexposed or cases/controls. Recall bias could be a limitation of this study as the interviewed participants with colorectal cancer may be more likely to recall certain exposures. Selection bias is a potential problem in this study because the controls selected may not reflect the exposure experience of the general population. However, although these biases may be present, matching best addresses confounding rather than any of these biases.

Educational objective:

Matching is used in case-control studies in order to control confounding. Matching variables should always be the potential confounders of the study (eg, age, race). Cases and controls are then selected based on the matching variables so that both groups have a similar distribution in accordance with the variables.

References

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Item 3 of 40 Question Id: 1185 Mark Previous Next Full Screen Tutorial Lab Values Notes Calculator Reverse Color Text Zoom Settings

A 45-year-old man comes to the office for a routine visit. The patient has a first-degree relative with Alzheimer dementia and is concerned about his chances of developing the disease. He has read in the newspaper that decreased consumption of yellow and orange fruits and vegetables has been associated with Alzheimer disease and would like to know how likely he is to develop the disease. A medical literature review uncovers a recent cohort study that evaluated the association between blood carotene concentration and Alzheimer disease. The development of the disease was evaluated in a 20-year follow-up study of 200 middle-aged subjects who have a first-degree relative with Alzheimer disease. The results are as follows:

	Low carotene level	Normal carotene level	Total
Developed Alzheimer disease	18	42	60
Did not develop Alzheimer disease	27	113	140
Total	45	155	200

Assuming the patient has low carotene levels, what is his 20-year risk of developing Alzheimer disease?

- A. 0.19 (3%)

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Assuming the patient has low carotene levels, what is his 20-year risk of developing Alzheimer disease?

- A. 0.19 (3%)
- B. 0.23 (3%)
- C. 0.27 (4%)
- D. 0.30 (15%)
- E. 0.40 (73%)

Omitted
Correct answer
E

73%
Answered correctly

01 min, 31 secs
Time Spent

2023
Version

Explanation

Risk is the probability of developing a disease or other health outcome over the study period. In this example, it represents the probability of developing Alzheimer disease over a 20-year period among middle-aged subjects who have a first-degree relative with the disease. To calculate this probability in subjects with low carotene levels, divide the number of subjects who develop Alzheimer disease in the low carotene group (18) by the overall number of subjects in the low carotene group ($18 + 27 = 45$).

Risk of developing Alzheimer disease among subjects with low carotene = $18 / (18 + 27)$
 $= 18 / 45 = 0.40$

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Question Id: 1185

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Risk of developing Alzheimer disease among subjects with low carotene = $18 / (18 + 27)$
 $= 18 / 45 = 0.40$

This means that, among subjects with low carotene levels, there is a 40% probability of developing Alzheimer disease in 20 years.

Note that this is different from the **relative risk (RR)** of Alzheimer disease in subjects with low carotene levels compared to those with normal carotene groups:

RR = risk of developing Alzheimer disease among subjects with low carotene levels / risk of developing Alzheimer disease among subjects with normal carotene levels = $0.4 / [42 / (42 + 113)] = 0.4 / 0.27 = 1.48$

As the data is not presented in the standard [2 × 2 \(contingency\) table format](#), care must be taken to perform the calculations without relying on memorized formulas.

(Choices A and D) The prevalence of low carotene (exposure) among subjects who do not develop Alzheimer disease is $27 / (27 + 113) = 27 / 140 = 0.19$ (19%). The prevalence of low carotene (exposure) among subjects who develop Alzheimer disease is $18 / (18 + 42) = 18 / 60 = 0.3$ (30%).

(Choice B) The prevalence of low carotene in the entire cohort is $(18 + 27) / (18 + 42 + 27 + 113) = 45 / 200 = 0.23$ (23%).

(Choice C) As noted in the RR calculation above, the 20-year risk of developing Alzheimer disease among subjects with normal carotene levels is $42 / (42 + 113) = 42 / 155 = 0.27$ (27%).

Educational objective:

Risk is the probability of developing a disease over a certain period of time. To calculate this probability, divide the number of affected subjects by the total number of subjects in the corresponding exposure group.

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Item 18 of 40 Question Id: 1184 Mark Previous Next Full Screen Tutorial Lab Values Notes Calculator Reverse Color Text Zoom Settings

A case-control study was conducted to estimate the association between simvastatin therapy and serum levels of fibrinogen in patients who underwent percutaneous coronary intervention. Cases were identified as patients who underwent percutaneous coronary intervention and had high periprocedural levels of fibrinogen (>400 mg/dL), and controls were identified as patients who underwent percutaneous coronary interventions but had normal levels of fibrinogen (200-400 mg/dL). History of simvastatin therapy use was assessed through chart review for every patient. The number of patients corresponding to each classification criteria is given in the table below.

	Fibrinogen high (>400 mg/dL)	Fibrinogen normal (200-400 mg/dL)	Total
Simvastatin therapy	43	67	110
No simvastatin therapy	32	58	90
Total	75	125	200

Which of the following is the best statistical method to estimate the association between simvastatin use and high serum fibrinogen levels in this study?

- A. Analysis of variance (4%)
- B. Chi-square test (48%)
- C. Correlation analysis (17%)
- D. Meta-analysis (0%)
- E. Two-sample *t*-test (28%)

Omitted

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Item 18 of 40 Question Id: 1184 Mark Previous Next Full Screen Tutorial Lab Values Notes Calculator Reverse Color Text Zoom Settings

		Dependent variable	
		Qualitative (categorical)	Quantitative
Independent variable	Qualitative (categorical)	Chi-square, logistic regression*	<i>t</i> test, ANOVA, linear regression
	Quantitative	Logistic regression*	Correlation, linear regression

*Dependent variable must be dichotomous.
ANOVA = analysis of variance.

Variables can be broadly classified as qualitative (ie, categorical) or quantitative (eg, continuous) based on their scale of measurement. **Qualitative variables** (eg, disease status, blood type) represent **categories or groups**, whereas **quantitative variables** (eg, body weight, glucose levels) represent **numerical values**. Choosing the correct statistical test always depends on the type of dependent and independent variables under consideration.

The **chi-square test** for independence (also known as chi-square test for association) is used to evaluate the association between **2 categorical variables**. In this example, patients are divided into 2 groups based on serum **fibrinogen levels** (dependent categorical variable: **normal** [200-400 mg/dL], **high** [>400 mg/dL]) and then divided again based on **simvastatin exposure** status (independent categorical variable: **treated, not treated**), with the data recorded in a 2×2 table. A chi-square test may be conducted to determine whether a statistically significant association exists between simvastatin use and the high levels of serum fibrinogen. A large difference in the frequency of simvastatin use between cases and controls is indicative of an association between simvastatin use and high levels of fibrinogen (ie, the null hypothesis is rejected).

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with the data recorded in a 2×2 table. A chi-square test may be conducted to determine whether a statistically significant association exists between simvastatin use and the high levels of serum fibrinogen. A large difference in the frequency of simvastatin use between cases and controls is indicative of an association between simvastatin use and high levels of fibrinogen (ie, the null hypothesis is rejected).

(Choices A and E) The analysis of variance (ANOVA) and two-sample *t*-test are used to compare the *means* between groups. This would require the dependent variable (ie, outcome) to be a *quantitative* variable. The difference between these 2 tests resides in the number of groups compared. The *t*-test is used to compare 2 group means, whereas the ANOVA is used to compare ≥ 2 group means. Either of these tests would be appropriate in this example if fibrinogen levels were recorded as a quantitative variable (ie, the actual measured level in mg/dL) instead of a categorical variable (ie, normal or high).

(Choice C) The correlation coefficient is a measure of the strength and direction of a linear relationship between 2 *quantitative* variables. For example, a study may report a correlation coefficient describing the association between hemoglobin A1c levels and average blood glucose levels.

(Choice D) Meta-analysis is an epidemiological method of pooling the data from several studies to conduct an analysis having a relatively larger statistical power than that of the individual studies.

Educational objective:

A 2×2 table is normally used to record the presence or absence of exposure and disease in research. Rows and columns represent the different levels for each categorical (ie, exposure and disease) variable. The chi-square test for independence is used to evaluate the association between 2 categorical variables.

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Item 21 of 40 Question Id: 1202 Mark Previous Next Full Screen Tutorial Lab Values Notes Calculator Reverse Color Text Zoom Settings

Officials of a public health department report a higher than normal prevalence of acute myelogenous leukemia (AML) among children age 5-12 in their community. They observe that some households in the community are exposed to chemical waste from a nearby factory and worry that exposure to this waste is responsible for the increased prevalence of AML. A case-control study is designed to evaluate the health department officials' claim that exposure to chemical waste is associated with AML in childhood. Which of the following populations should be selected as the control group?

- A. Children who do not have AML and are exposed to chemical waste (19%)
- B. Children who do not have AML and are not exposed to chemical waste (20%)
- C. Children who do not have AML, regardless of exposure status to chemical waste (30%)
- D. Children who have AML and are exposed to chemical waste (0%)
- E. Children who have AML and are not exposed to chemical waste (23%)
- F. Children who have AML, regardless of exposure status to chemical waste (4%)

Omitted
Correct answer
C

30%
Answered correctly

02 mins, 47 secs
Time Spent

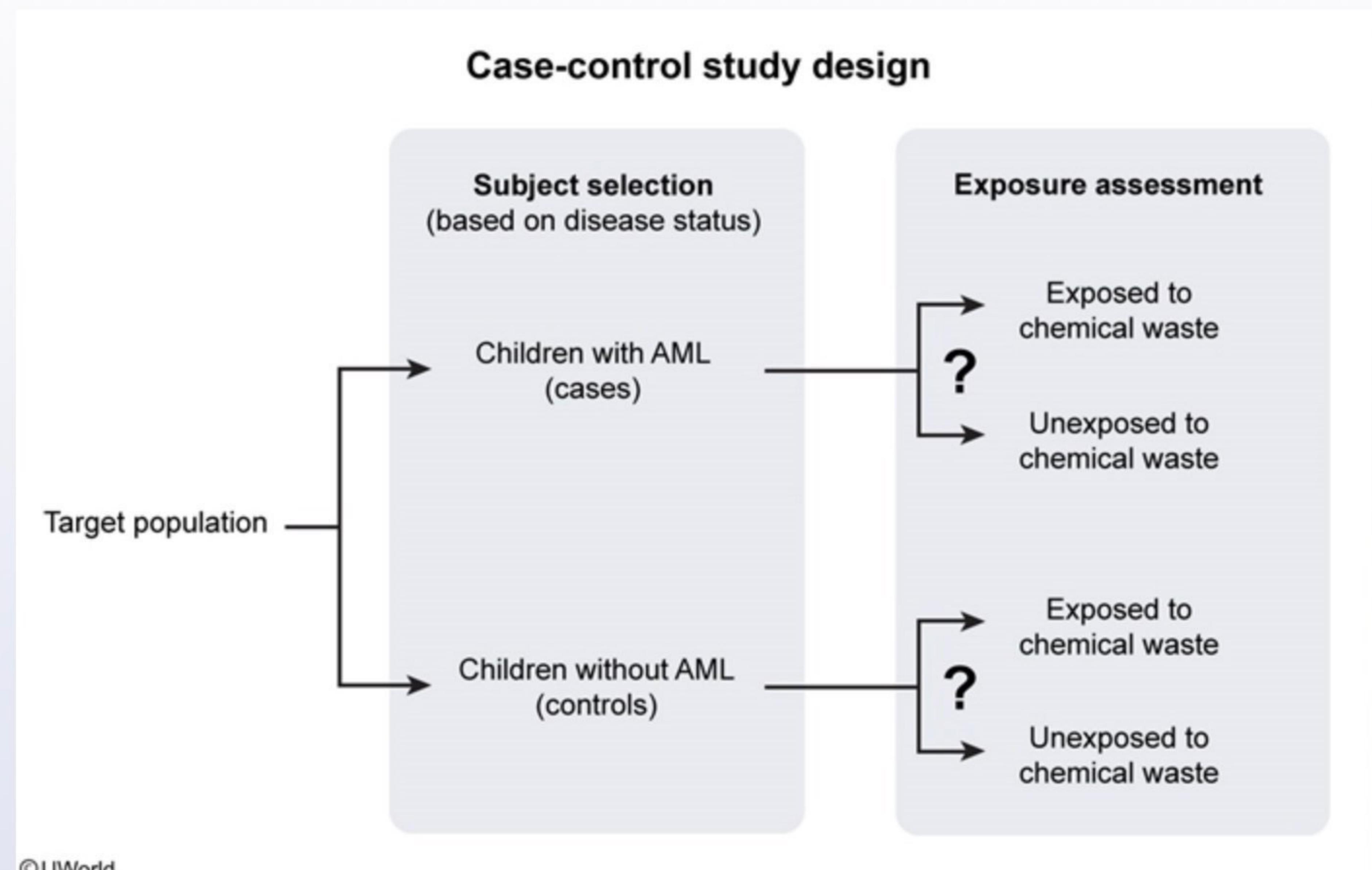
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Explanation

Case-control study design

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A **case-control study** is the most appropriate study design for evaluating the public health officials' claim. This is because the disease (acute myelogenous leukemia [AML]) is a rare condition occurring at a higher rate in this population, and a retrospective exposure (chemical waste exposure) needs to be evaluated. In case-control studies, 2 groups of subjects are created: **cases** (subjects **with** the disease of interest) and **controls** (subjects **without** the disease of interest). After the case and control groups are selected, exposure frequency to a specific variable (eg, chemical waste) within both groups is ascertained. If there is a statistically significant difference in exposure frequency between the 2 groups, it is likely that the variable in question is associated with