NORTHWESTERN
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Two by Two Table

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A probability analysis using a 2x2 table to demonstrate understanding of concepts centered on Sensitivity (Sn), Specificity (Sp), Pretest Probability, Prevalence and Positive Predictive Values (PPV)

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Problem Description

In a hypothetical elementary school class, 35% of the students are obese and 40% watch at least four hours of television each day. Twenty-five percent of the students are both obese and among the excessive television watchers.

Definitions (Hunink & Glasziou, 2009)

- **True Positive (TP)** – Probability of a positive test result given that the disease is present. Also known as the *Sensitivity.*
- **True Negative Rate (TN)** – Proportion of patients without the disease having a negative test result. Also known as the *Specificity*.
- **False Negative Rate (FN)** – Proportion of patients with disease who have a negative test result.
- **False Positive Rate (FP)** – Proportion of patients without the disease who have a positive test result.
- **Pretest probability –** Disease prevalence in population in a randomly chosen patient.

Assumptions and Givens

- The benchmark for "excessive television" → >= 4 hours per day
- Percentage with **Disease** is 35%, that is watched excessive television and were obese
- 40% watched excessive television (T+)
- TP is 25
- FN is 10 provided total diseased is 35% and TP is 25

Solution

2 x 2 Table

		Disease (35%)		**No Disease (65)**	**100**
+ (40%)	TP	**25%**	FP	15%	
- (60%)	FN	10%	TN	50%	
100%		**Sensitivity (Sn)**		= 0.72 (TP / (TP + FN)	
		Specificity (Sp)		= 0.77 (TN / (TN + FP)	

* **Green highlights** above indicate given variables.

Interpreted results:

FN (10%) = percentages of students who don't watch television excessively but are obese
FP (15%) = percentages of students who watch excessive television but are not obese
TN (50%) = percentages of students who are not obese and do not watch excessive television.

Formulas and Calculations

TP	= P (C/D) = .72 x 35 = 25
FN	= P(-C/D) = .28 x 35 = 10
TN	= P(-C/-D) = .77 x 65 = 50
FP	= P(C/-D) = .23 x 65 = 15

Test Efficiency	= (Sn + Sp / 2) = (1.8 /2) = 75%
Prevalence	= .35 (TP + FN) / (TP + FN + FP + TN) = 35/100

FNR	= 1 - Sn = 1 - .72 = .28 of 28%
FPR	= 1 - Sp = 1 - .77 = .23 or 23%

PLR	= Sn/ (1 - Sp) = 0.72 / 0.23 = 3
NLR	= 1-Sn / Sp = 0.72/0.77 = .9350

Pre-Test Probability	= Prevalence = 35%
Pre-Test Odds	= Pre-Test Prob / (1 - Pre-Test Prob) = 0.4 / 0.65 = 61.5%
Post-Test Odds	= Pre-test Odds x Likelihood Ratio = .615 x 3 = 1.845
Post-Test Probability	= Post-Test Odds / (1 + Post-Test odds) = 1.845 / 2.845 = .6485

If you were to randomly select a child from the class and find that they are among the group that watches television excessively, what is the probability that the child is also obese?

This is equal to the positive predictive value (PPV) or 62.5% and calculations for it are below. The negative predictive value has also been provided for reference.

PPV	= TP / (TP + FP) = 25/40 = .625% or 62.5%

Works Cited

Hunink, M., & Glasziou, P. (2009). *Decision making in health and medicine: Integrating evidence and values.* Cambridge, England: Cambridge University Press.