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Review Article

Propensity Score Analysis and Its Applications

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ABSTRACT

This review considers casual inference in observational studies which can prove medical treatment. The main aim of this study is to describe about its application in non-randomized clinical studies and in persons who support regulatory applications for marketing medical product. Propensity score makes an easy study about the large number of groups which cannot be randomized. By measuring the covariates, the methods which are used to measure the propensity score mimic the covariates. This study shows an illustration of the steps in the study and construction of propensity scores verses normal treatment of seriously ill individuals. Propensity score has the major advantage over alternate approaches when the treatment methods of illness do not overlap.

Keywords:- Propensity score, Treatment, Clinical Trials.

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Introduction:-

Propensity score analysis was first introduced by Rosenbaum and Rubin.(1).mPropensity score $e(x)$ for the subject with vector(x) of observed covariates is probability of receiving treatment ($z=1$) rather than control($z=0$)

$$e(x)=pr(z=1|x)$$

Propensity score analysis is a versatile statistical method for the casual inference in observational studies which can prove treatment. In recent years interest in applying this methodology to the following

(1)Non randomized clinical studies.

(2)Persons those who support regulatory applications for marketing medical products.

Propensity score helps in separating groups on a large number of covariates measured at a baseline. This process is helpful when participants cannot be randomized to treating conditions. At that time propensity score helps in equating the groups to match the other similar group. Various process used are matching, stratification, weighting or analysis of covariates procedure. According to this procedure the researches can differentiate treatment[t] and controlled[c] groups at baseline on a large number.

Propensity Score:-

Propensity score is balancing score in the sense that it is the function of observed covariates(x) such that the conditional distribution of x given $e(x)$ is the same for the subjects in treatment group and also subjects in the control group. If treatments assigned are ignorable, that is the treatment assignment(Z) and potential outcome(Y) are conditionally independent in the given covariates(X)

$$\text{i.e } Pr(Z(X),Y)=Pr(Z(X) \text{ And if } 0 < Pr e(X) < 1$$

for all X, then the average effect at each value of propensity score is unbiased estimate of true treatment effect at propensity score(1).The above assumption requires that all covariates relevant to both treatment assignment and potential outcomes are measured(no hidden bias). In practice the propensity score is estimated by modeling the probability of treatment group.

Eg:-Multiple logistic Regression/ discriminant analysis.

Propensity score matching, stratification, weighting, covariate adjustment and their combinations are used to produce unbiased estimate of treatment effect.(1-3) Propensity score is one dimensional summary of observed covariates such that propensity scores are balanced scores of two treatment groups, the distribution of all covariates balanced across two groups. Therefore, evaluating treatment

group overlap in terms of distribution of propensity scores that provides straight Forward Assessment of whether the two treatment groups are similar to baseline covariates. When overlap is present the propensity score analysis provides straight forward treatment. According to Rubin, the propensity score, prediction model should be reformulated or should conclude that covariate distribution should not overlap propensity score analysis.

Regulatory Setting:-

In Regulatory environment, it is crucial to start with comparison with patient population because propensity score analysis did not work well. When there is a serious imbalance in baseline covariates between two treatment groups unfortunately, it is sometimes impossible to predict in advance whether patient population with new treatment is comparable to that of control, which is risk to take into consideration. Unsuccessful non randomized is somewhat burdensome than randomized trial or study (4,5). Like other covariate adjustment methods, propensity score method adjust only observed covariates and not for unobserved ones. This is always a limitation for non randomized studies compared to randomized studies or trails. Randomization tends to balance both

(1) Observed covariates

(2) Unobserved covariates

Therefore, some sensitivity analysis for hidden bias is often desirable in a medical product regulatory submission based on non randomized study. It is very important that propensity score methods may not eliminate all the bias resulting from imbalance in observed covariates. Due to the limitation of propensity score modeling which typically uses a linear combination of covariates.

- Braitman and Rosenbaum(6) States that Propensity score methods work under 3 conditions

(1) When clinical outcome is rare

(2) When there is large number of patients in each treatment group

(3) When there are many covariates measured.

In Regulatory setting it may be inappropriate to conduct propensity score analysis when the sample size is small. All observed covariates could be balanced between two treatment groups by propensity scores. It is essential to collect a baseline covariates and this is potentially related to

(1) Treatment assignment

(2) Clinical outcomes

- Baseline covariates are well measured and used in data analysis. Rubin emphasizes importance of designing of observational studies.

Applications:-

- Matched sampling on univariate propensity score
- Multivariate adjustment on propensity score
- Visual representation of multivariate covariants by two dimensional plots.
- Serves as a vehicle for equating non randomized groups on large number of measured baseline covariates and mimics the balance achieved by randomization on those covariates.

Issues in propensity score approach:-

When practically and theoretically propensity score approach is applied by the researcher then issues may occur. The main issue arising in the propensity score analysis is the space limitation that is very less space is permitted for these issues.

Conclusion:-

From various observational studies, the practice of randomized controlled trials provide important information about various principles like principles of pre specification, blinding, use of diagnostics etc. These methods also ensure the safety of various medical products. Propensity score models should be constructed only on the basis of knowledge of baseline covariates and treatment assigned. The main goal of propensity score is to create a balance in each of the two groups.

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