Marketing Research and Analysis - II
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Lecture – 40
ANCOVA & MANCOVA in SPSS

Hi friends welcome to the course of Marketing Research and Analysis, the second part, so in the last few lectures in fact we have been discussing about some of the experimental designs and the various techniques in world in experimental designs such as the ANOVA and ANCOVA, MANOVA. These things are they look very you know very complex and tough but because thanks to technology and the use of softwares things are become much easier now a days.

And it has been simple and everybody can utilize them and very nice research papers and publish good research papers with the help of such techniques, so today we will be; in last the lecture we have discussed about analysis of covariance where we discussed we said that is a condition where is just like a analysis of variance but only think is that there is an extra element which is the covariate.

So in the ANOVA you had a dependent continuous dependent variable and a categorical independent variable which is discrete independent variable but plus in this case there is a covariate which is a extraneous variable and confounding variable which is a you know measured in the continuous scale. So, this covariate is basically required that there should be some there should be correlation between the covariate and the dependent variable but we do not want that there should be any correlation between the independent variable and the covariate.

So when the covariate is present so how when you control this covariate at different levels of the independent variable what happens to the dependent variable that is what we measure in case of ANCOVA. ANCOVA is very powerful technique. So it helps you to even measuring interaction effects with a controlled variable which is the covariate.

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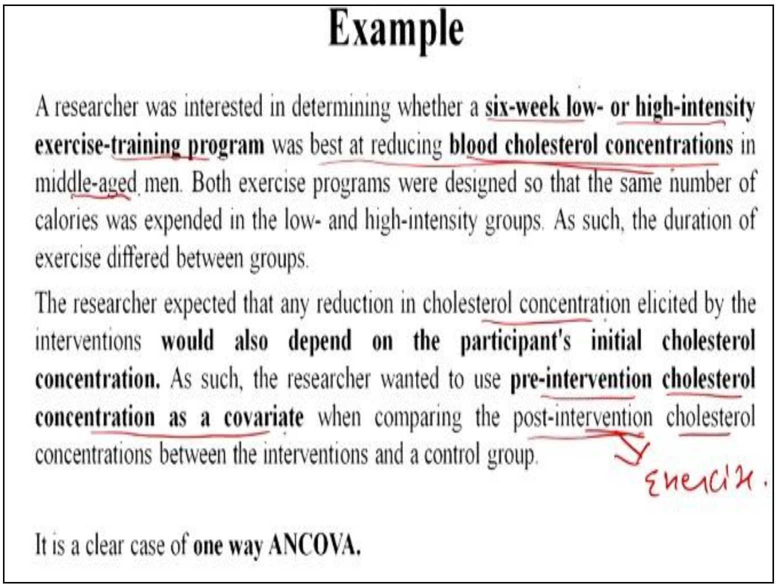

Example

A researcher was interested in determining whether a **six-week low- or high-intensity exercise-training program** was best at reducing **blood cholesterol concentrations** in middle-aged men. Both exercise programs were designed so that the same number of calories was expended in the low- and high-intensity groups. As such, the duration of exercise differed between groups.

The researcher expected that any reduction in cholesterol concentration elicited by the interventions **would also depend on the participant's initial cholesterol concentration.** As such, the researcher wanted to use **pre-intervention cholesterol concentration as a covariate** when comparing the post-intervention cholesterol concentrations between the interventions and a control group.

It is a clear case of **one way ANCOVA.**

So today we will start with this examples so let us go with the problem, A researcher was interested in determining whether a six-week low-or high-intensity exercise program was good at reducing the blood cholesterol concentration in middle-aged men, so this is a very general problem, both exercise programs high and low intensity were designed so number of calories was expended in the low and high intensity groups.

As such, the duration of exercise differed between groups. The researcher expected that any reduction in the cholesterol concentration elicited by the interventions would also depend on the participants initial cholesterol concentration that means what whatever change in the cholesterol is happening that is not necessarily only due to the exercise program but also due to the fact with the another factor as to be measured and taken to consideration.

That what was is earlier you know cholesterol level we cannot expect miracles to happen, so if somebody had a very high cholesterol level before you do not expect that because of just an exercise program drastically reduces it and very, very high reduction is there, but if that is why the earlier value the pre exercise value is also important to know ok. As such, the researcher wanted to use pre-intervention cholesterol concentration as a covariate.

So before what was it so that is a covariate when comparing the post-intervention intervention is the exercise here ok do not confuse with the words it is very simple intervention cholesterol concentration between the interventions and a control group. It is a clear case of one way ANCOVA so you have one covariate one dependent variable which is the blood cholesterol concentration post exercise and what is the independent variable the exercise the duration of the exercise intensity of high or low, this is my two groups.

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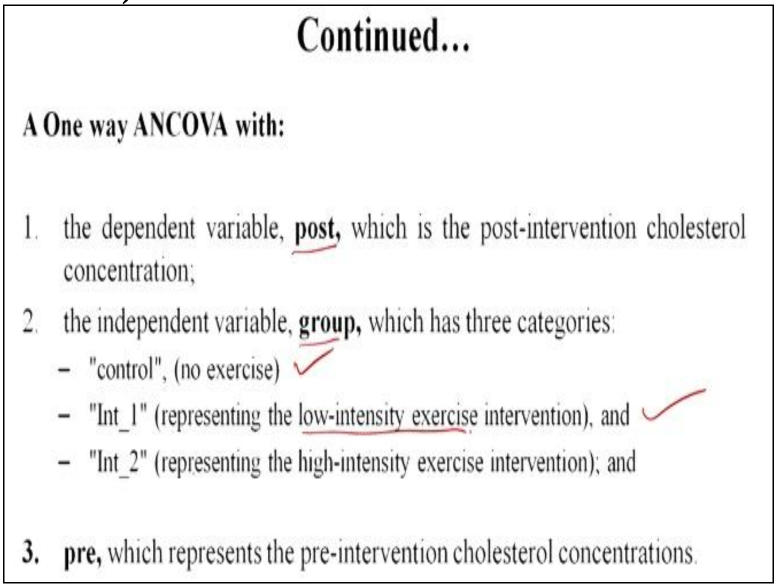

So a One way ANCOVA with the dependent variable which the post which is the post-intervention cholesterol the independent variable is the group which has three categories so we have three categories are here, so one is no exercise which is the control group so we are saying let us not give any exercise to somebody intervention one is the low-intensity exercise and intervention 2 is the high-intensity exercise.

So one group; so let us say there are 30 peoples, so 10 peoples are ask not to do any exercise another 10 people are given a mild exercise and another 10 people given heavy intensity exercise and pre, which represents the pre-intervention cholesterol concentrations that means before the exercise of program what was the cholesterol you know level of all these three groups of people you know these people, so how do conduct this One way ANCOVA in SPSS.

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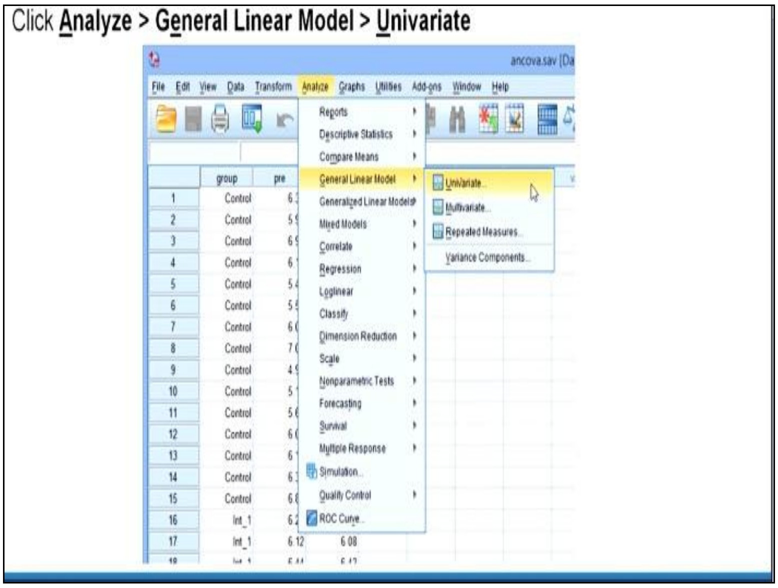

So the simple is you go to analyse and in analyse there is a general linear model, so these techniques ANOVA sorry Two way, N-way ANOVA, ANCOVA, one factor, more than one factor MANOVA, MANCOVA they are all coming under the general linear model techniques, so here, see is there is only the one dependent variable we say it is a univariate technique.

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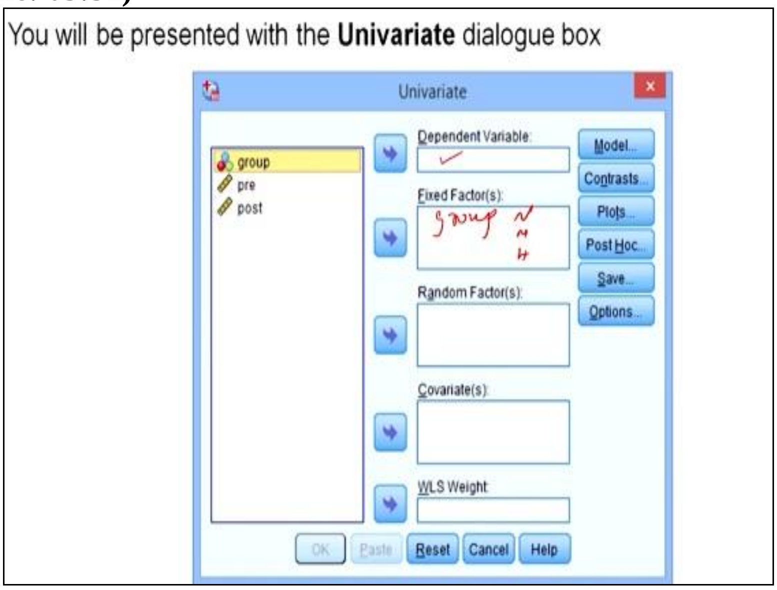

So once you go to the univariate then next is you have to take here a variables in to the dependent, independent and the covariate box. So, here we say the group is my fixed factor, so this is what the treatment we are giving and my pre what was my pre cholesterol level is my covariate because that is what is effecting my condition my cholesterol condition and the post exercise is my dependent variable.

So after doing my exercise what is the result of my cholesterol that comes under the dependent variable my group is my this is my fix factor what group you come in to so no exercise or little exercise or mild exercise and heavy exercise ok and the pre cholesterol level is taken as my covariate ok.

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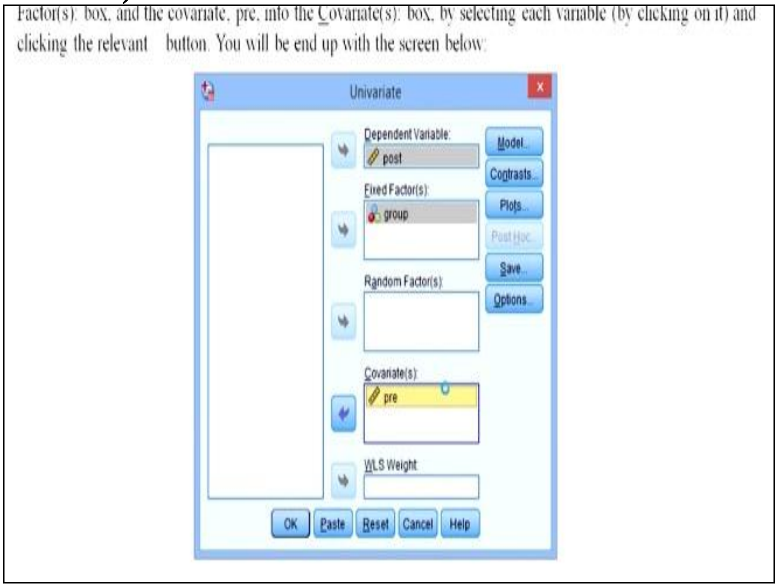

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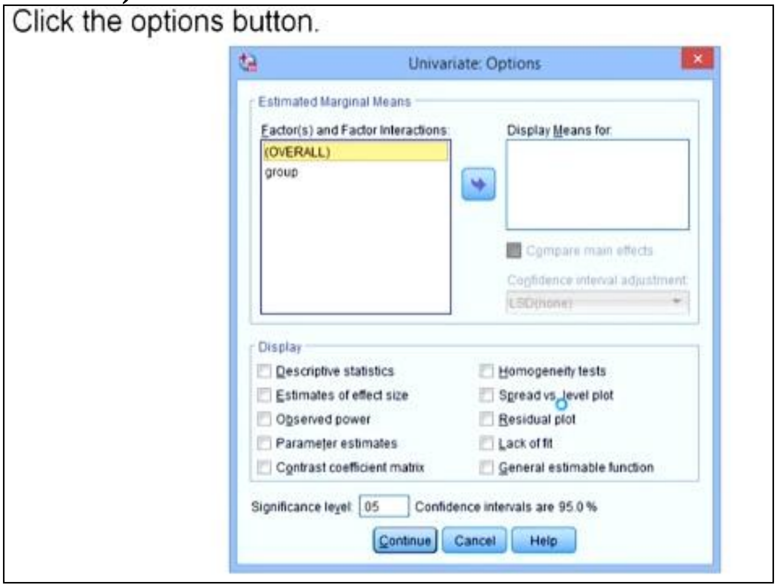

The next is after doing this we what we do is, we will check for the you know this option where we are trying to display the means, so here you see if you go back transferred the dependent variable in to the dependent variable box the independent variable group in to the fix factor and the covariate in to the covariate box by selecting each variable and clicking the relevant button, so this is how it goes and then we come to the options button you see this options, this option so you come to the options button so you get this kind of a screen.

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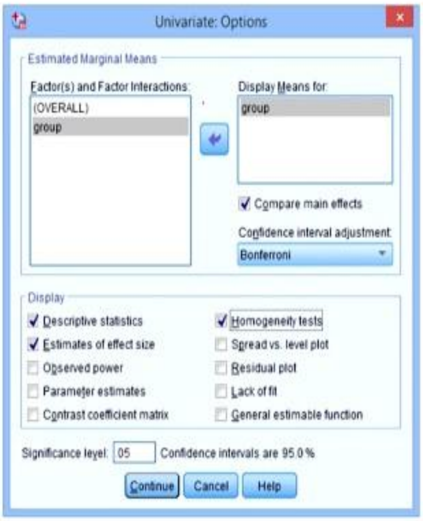
Transfer the variables, and select the Bonferroni option



So, here we will take check for few things, so what are few things, the first we will try to see the means for the group, so group are 3 groups no exercise, light and heavy exercise and we want to see the compare the main effects so what is the main effects means the effect of exercise you want to see that bonferroni is taken because the small sample sizes whenever the conditions are there.

So you use the bonferroni test, otherwise you can to check for LSD and other test are there, descriptive, effect of size and effect size and the homogeneity of variance. These 3 things also required and we are checking at 5% level of significance you can change that 1% also .001 also it is up to you.

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Descriptive Statistics

Dependent Variable: post

group	Mean	Std. Deviation	N
Control	6.0467	.61449	15
Int_1	5.8273	.60412	15
Int_2	5.3113	.50174	15
Total	5.7284	.64307	45

The **Descriptive Statistics** table (shown above) presents descriptive statistics (mean, standard deviation, number of participants) on the dependent variable, **Post**, for the different levels of the independent variable, **Group**. These values do not include any adjustments made by the use of a covariate in the analysis.

Now what is the output so in this case I will show you first before we go to that. So let me show you let me take this case I have brought the data set

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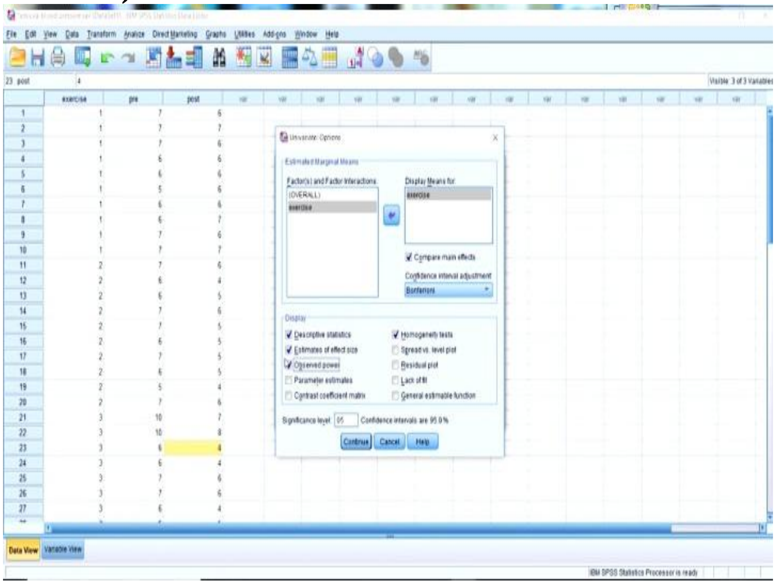

Let us start go to analyze, go to general linear model, go to univariate, so you can let us do it again so exercise we take it to the fixed factor, my post cholesterol is my dependent variable my pre cholesterol is my covariate ok. So now what I am going to do is, I am going to you see there are two things here you want to check here full factorial model, this is by default this full factorial model actually is the model which helps you to test whether the effects of your covariate and the independent variables are they significant or not that means the different levels what is the change in the dependent variable or is that significant change or not.

So, continue and then we go to options here we want to see the impact of the exercise that display the means for exercise that means for exercise for when no exercise is there and there is high level of exercise or the low level of exercise, now you want to compare the main effects so to compare the main effects you can take this bonferroni test, now you want to check descriptive statistics we want to estimates of effect size and homogeneity you when you can check the observed power, so these four; now let us see what is coming.

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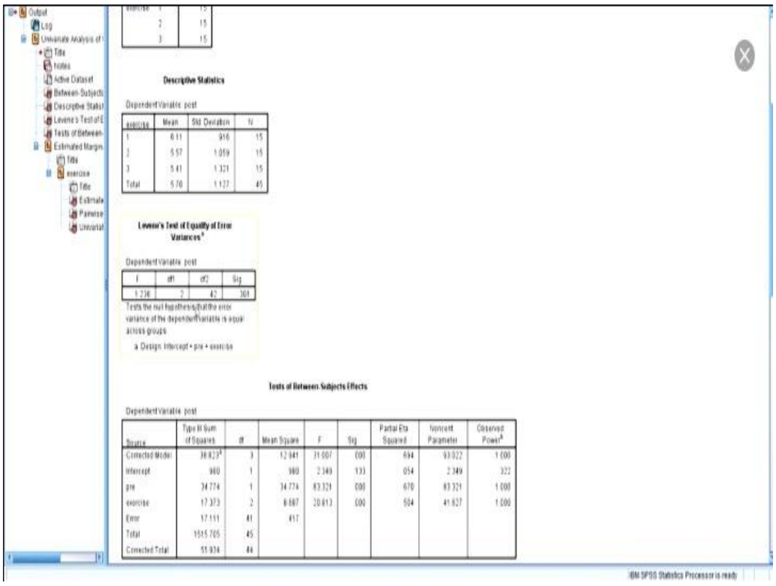

So when we have done it now we will see there are three you know groups of exercises so 15, 15 people and the means for the first exercise group is a 6.11 then 5.57 and 5.41 right now equality of variance levene's test is saying that were it is say .301 means null hypothesis which is said that levene's test say the homogeneity of variance that means the group should have equal variance otherwise they should not be compared.

So this null hypothesis has been accepted in this case because it is greater than .05, had it been less than 0.5 you could have rejected the null hypothesis and said well the variance among the groups is not same and not equal. Then let us come to the test of you know between subject effects, now you see, we want to see the effect of exercise, now is exercise having the significant effect on the cholesterol level well the F-ratio says if you look at the F-ratio what it is 20.813 and it is significant at .001 level and if I see the Partial Eta Squared, Partial Eta Squared is nothing but my effects size.

So, what is the effect size it tells us, it is like the you know the Eta squared is nothing but similar to the R squared that you talk about the regression, how much the variance is being explained by the independent variable so and the observed power of the test is almost 1 so it ranges between 0 and 1 so if it is 1 it is very strong. So, you see in the R squared adjusted R squared as per is .694 so the Eta squared is something very close. As I said, it explains similar to the R squared in the regression.

So, now we have a test where we can say easily well the exercise, level of exercise does have an effect on the cholesterol level of the patients or the people. Now but can we say which cholesterol which group which exercise is having the highest effect that means no exercise moderate or high exercise, to do this we have a post hoc test which is the pair comparison.

Now let us look at the first 1 and 2, so 1 - 2 is 1.095 the difference that means it is positive, that means 1 is giving larger effect than the cholesterol level is more in case of 1 than 2, and is the significant difference? Yes it is a significant difference. 1 and 3 the differences is 1.624, so again you see when somebody has done no exercise, the cholesterol level is still higher because it is the cholesterol level. Higher the cholesterol level it is bad for the person.

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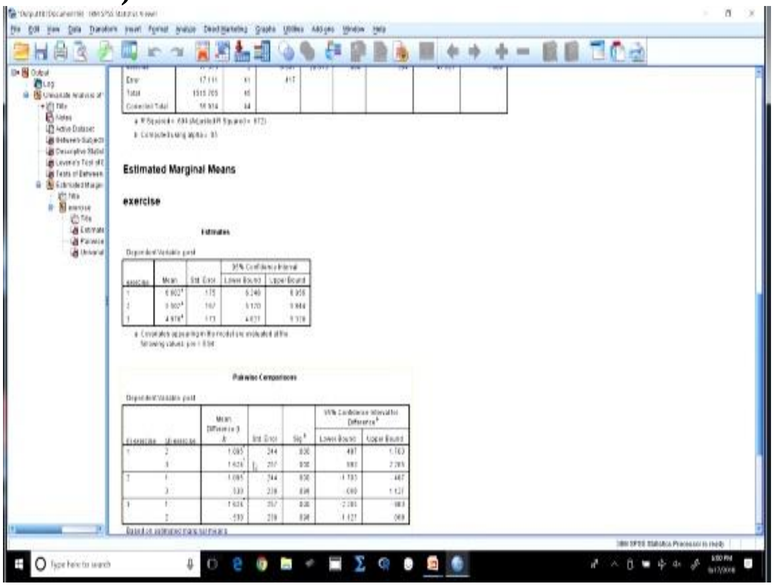

So we want actually to be lowest, so in this case which is lower 1 2, 1 3 so if you see it seems that 3 is the lowest then followed by 2 and then followed by 1. Let us compare between it is significant, yes both were significant. Now let us compare between 2 and 3 others have been compared. So 2 and 3 if you see 2 and 3 it is not coming significant because the value is .098 that means much higher than .05 which we usually take for significant testing.

By this we can say, well the difference in the exercises, between that means no exercise and moderate exercise is significant on the cholesterol level 1 and 3 that is no exercise and heavy exercise is significant, But moderate exercise which was like you know people walking and hard exercise which is with machines you know that actually made no significant differences. So this helps us to test the effect of the treatment on the dependent variable, so this is what we have been finding.

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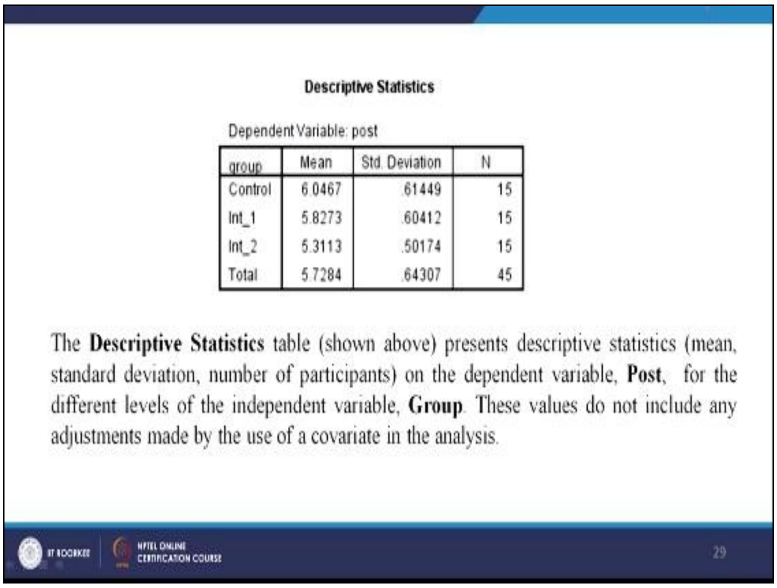

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But the question is, is it enough? How do we write it now, now see how do we write? When you write in paper, this is how you show, so the descriptive statics this is what it shows, it shows that the mean standard deviation and the number of participants, we saw that these values do not include any adjustments. These are not showing any adjustments, so what was the purpose of ANCOVA that it helps you to adjust for the change in the dependent variable, made by the use of a covariate which is helping into that. Now the results if you look at the results.

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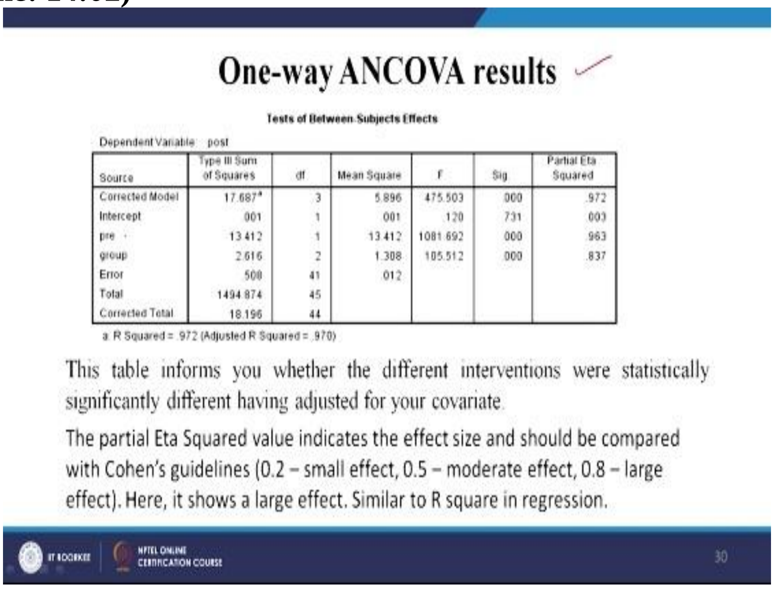

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	17.687^a	3	5.896	475.503	.000	.972
Intercept	.001	1	.001	.120	.731	.003
pre	13.412	1	13.412	1081.692	.000	.963
group	2.616	2	1.308	105.512	.000	.837
Error	.508	41	.012			
Total	1494.874	45				
Corrected Total	18.196	44				

Now look at this, this is the pre, this is the group so group is the exercise level, low exercise, high exercise and all that. So this table informs whether the different interventions were statistically significantly different having adjusted for your covariate. The partial Eta Squared this value indicates the effect size and should be compared with Cohen's guidelines this is something which says it is between 0.2 under 0.2 this value, so these two values for example, if it is a small effect, so the effect is very little.

If it is 0.5 then the effect is moderate effect if it is 0.8 and larger which we is coming to true in both our cases that means the pre cholesterol levels which is covariate also has the very high effect on my post cholesterol level and which exercise category I am coming into that also has very high level on the post cholesterol, But if you have seen comparison that means by previous condition is having a larger effect even than the exercise that I am doing may be because the duration of exercise is less. I could extended for let us say not 6 weeks but 6 months then it could change, and it shows the large effect true similar to the R squared regression.

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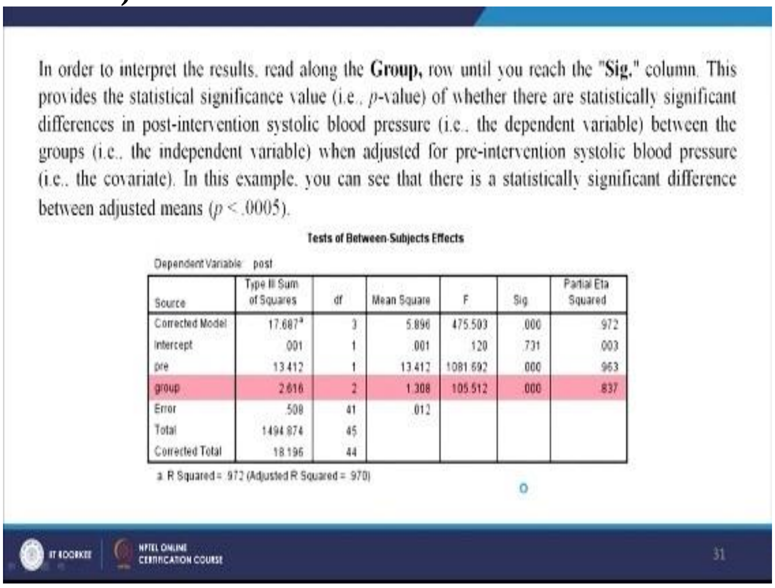

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In order to interpret the results read along the group, until you reach the significance level, so this, the point we are taking about taking the point. This provides the statistical significance of whether there are statistically significant differences in the post intervention blood pressure or cholesterol whatever you know. I am not a medical person so you can understand between the groups well adjusted for the blood pressure that is the pre blood pressure that is the covariate; in this example we see there is the statistical difference, significant difference between the adjusted means. So it is saying, from here we can say that the effect is significant ok.

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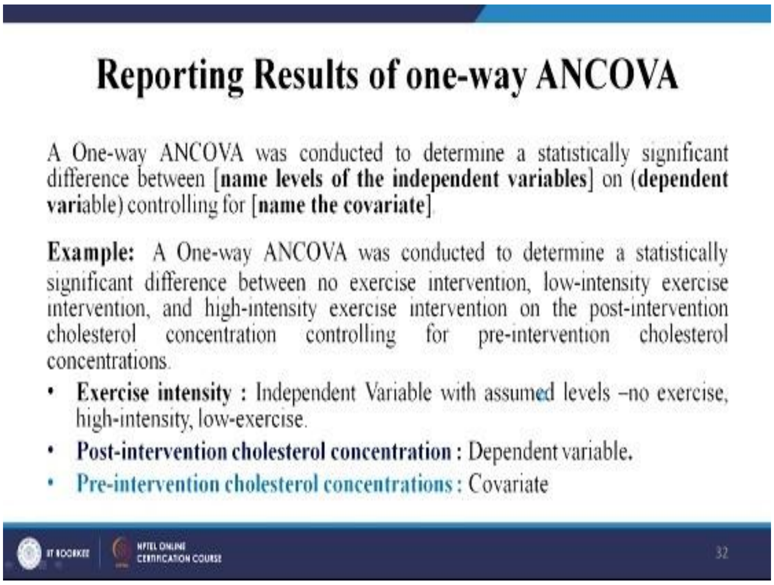

How do you report the result it is very very important because many of times I have seen people do a test but they are not able to write it. So how do you write, A one-way ANCOVA was conducted to determine a statistically significant difference between the levels of the independent variable that is in this case whatever our level of exercise on the dependent variable which is in this case a post cholesterol.

For the pre cholesterol level, so they are controlling the pre cholesterol level. A one way ANCOVA was conducted to determine a statistically significant differences between no exercise, low-intensity and high-intensity exercise on the post intervention cholesterol concentration controlling for pre intervention cholesterol so the same thing I have written here. Exercise intensity, no exercise, high-intensity, low-exercise. Post intervention is my dependent variable, pre intervention is my covariate.

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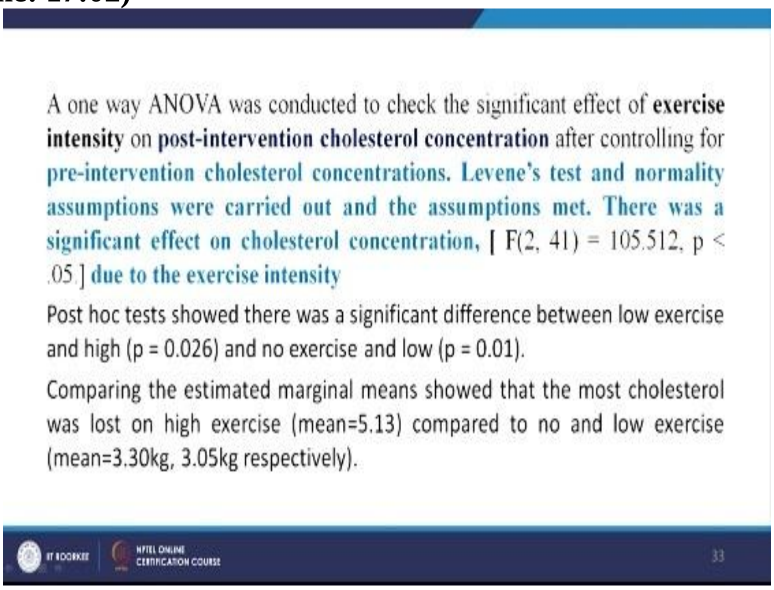

A one way ANOVA, this is how you write, was conducted to check the significant effect of exercise intensity on post-intervention cholesterol concentration after controlling for the pre intervention cholesterol this means you are clear, that means what was the previous cholesterol level, if you do not control it then you just cannot compare because somebody had a high cholesterol level and somebody had a low cholesterol level.

Now you do not expect a similar kind of change with a same by giving the same exercise to both these people, so that is why you have to control the pre cholesterol level. Levene's test and normality assumptions were carried out and the assumptions met. So you have to check this Levene's test homogeneity of variance test all these. There was a significant effect on cholesterol concentration.

So, this is how you write so $F(2,41)$ this is my degrees of freedom the numerator and the denominator is equal to this much and my p is this much my significant level due to the exercise intensity. Post hoc test which was the paired comparisons showed there was a significant difference between low-exercise and high, this is 1 and 3 you can say and no exercise and low, which is 1 and 2.

Comparing the estimated marginal means showed that the most cholesterol weight was lost and high exercise with the mean of this much compared to no and low exercise. So, this is how you report. So, this is estimation of marginal means and the effect of the finally the F-ratio, we calculate and we report it in the research paper. So, this is what we talk about in the ANCOVA.

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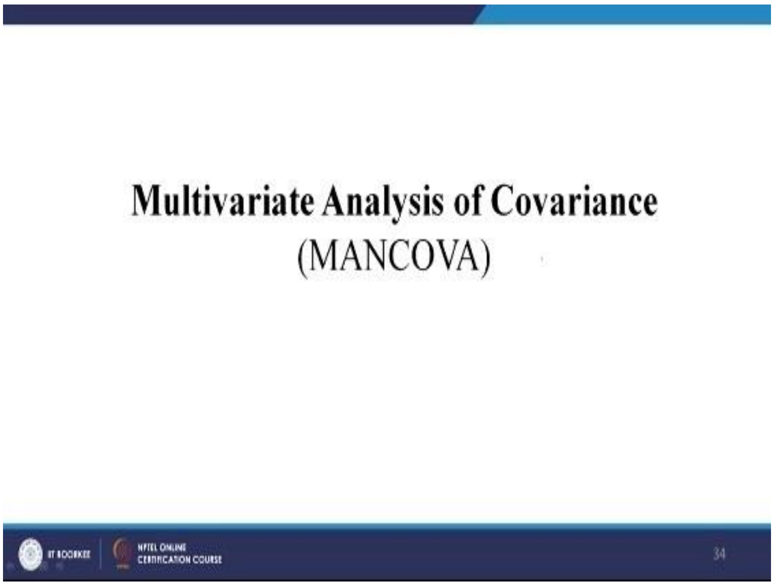

Now I will move into another technique which is the Multivariate Analysis of Covariance, now what is the difference it is just an extension of ANCOVA, an extension from the ANCOVA.

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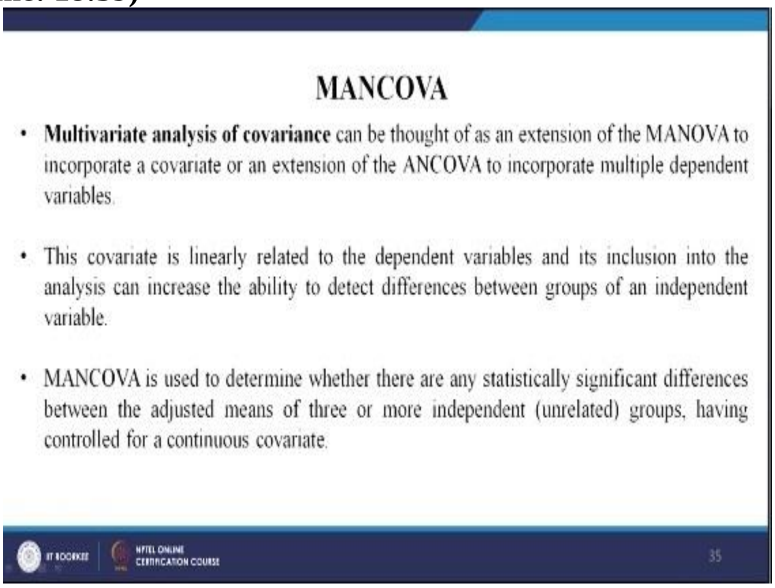

The multivariate analysis of Covariances is an extension of the MANOVA to incorporate a covariate, so from ANOVA to MANOVA similarly from ANCOVA to also MANCOVA or an extension of the ANCOVA as it says, to incorporate multiple dependent variables. In ANCOVA what was happening, you are having one dependent variable which was continuous then you had a covariate and you had a treatment level, a treatment factor which had 1, 2 or 3 or 2 or more than 2 levels ok. Now you are saying well it is like a MANOVA thing, in the MANOVA you have more than one dependent variable so and the presences of a covariate, so this study now here this is the clear case of MANCOVA.

The covariate is linearly related to the dependent variables the covariate is related to the; we said earlier also the covariate should be having a some correlation between the, there should be some correlation between the dependent variable and the covariate. And it is inclusion into the analysis increase the ability to detect the differences between groups of an independent variable. I am sure why you have understood by now in the last example also when I explain how the treatment levels that means the exercises were, effecting the post cholesterol level.

But then just saying that and not including the, what was his pre-cholesterol level will be wrong. So if you take the pre-cholesterol level, what was is suppose for example somebody is weight how will it change with exercise. But suppose you do not consider the earlier weight and you think everybody should be coming down to let us say less as 60 kilo but actually somebody was 90 earlier and somebody was 70 and yourself both of them 60 is wrong.

So that is why the covariate is very important. MANCOVA is used to determine whether there are any statistically significant differences between the adjusted means of 3 or more independent groups. That means in one factor there are 3 groups more than that, having controlled for a continuous covariate.

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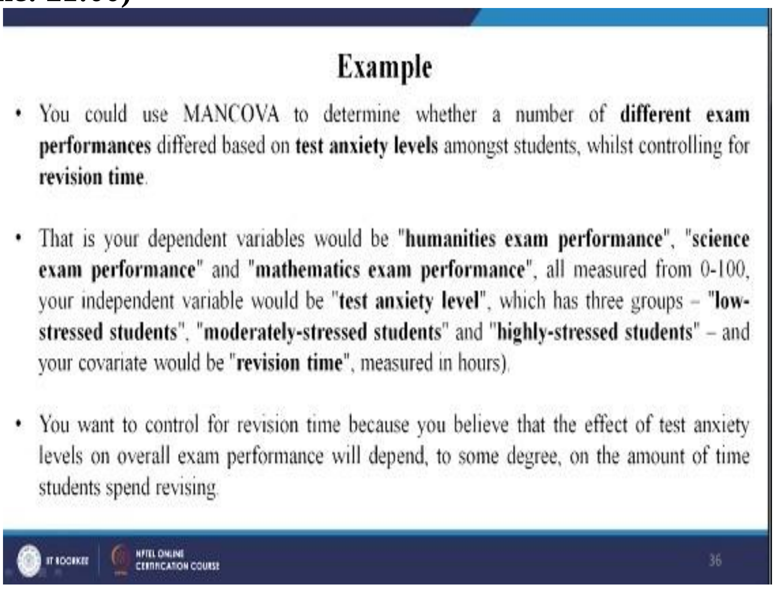

You could use MANCOVA to determine whether a number of different exam performances difference differed based on test anxiety levels amongst students, while controlling for revision time. So let us see this example that is your dependent variables would be what is humanities exam performance, science exam performance and maths exam performance, three exams are there, so three dependent variables are there, all measured from 0-100.

How much score a student has scored, independent variable would be the test anxiety level, which has several levels. What are they? three groups, low-stressed students, moderately-stressed students and highly-stressed students, so we are trying to see whether the stress level of student does it have effect on the exam performance for humanities, science and mathematics equally or is it differently. So let us see that, but here if you do that then supposed some student has already done the lot of revision work and somebody has not done any revision, will their performance are in spite of being you know difference level of anxieties will the performance be same, no.

Because if somebody is well prepared his chances or her chances of do perform better in the exam at whatever level of stress maybe is always better. So and your covariate would be the revision time which is measured in hours. You want to control for revision time because you believe that the effect of test anxiety levels on overall performance will depend to some degree on the amount of time spend on revision ok.

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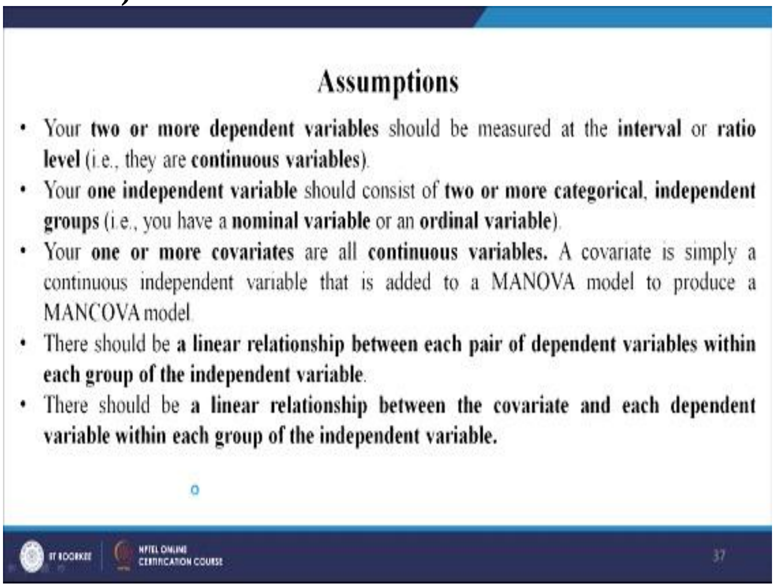

So assumptions are more or less the same like ANCOVA. You have 2 or more dependent variable should be measured at as continuous variables. One independent variable if it is a one way MANCOVA then it is only one independent variable, Consist of two are more categorical independent groups. Your one or more covariates all are continuous ok. So what is a covariate? The covariate is simply a continuous independent variable that is added to the MANOVA model. MANOVA in the MANOVA there was no covariate if you add a covariate it become a MANCOVA.

There should be a linear relationship between each pair of dependent variables, so if there are more than one dependent variable there should be a strong correlation between them. Within each group of the there should be linear relationship between each pair of dependent variables within each group of the that means independent variables we are talking about is the factor, levels of the factors ok, levels, factor levels. So that should be a relationship between the dependent variables.

There should be a linear relationship between the covariate and each dependent variable there should be within each group of the; but there should not be any within the covariate and the independent variable. It should be a different level of independent variable there has to be a correlation between the covariate and the dependent variable, Simple up to this much.

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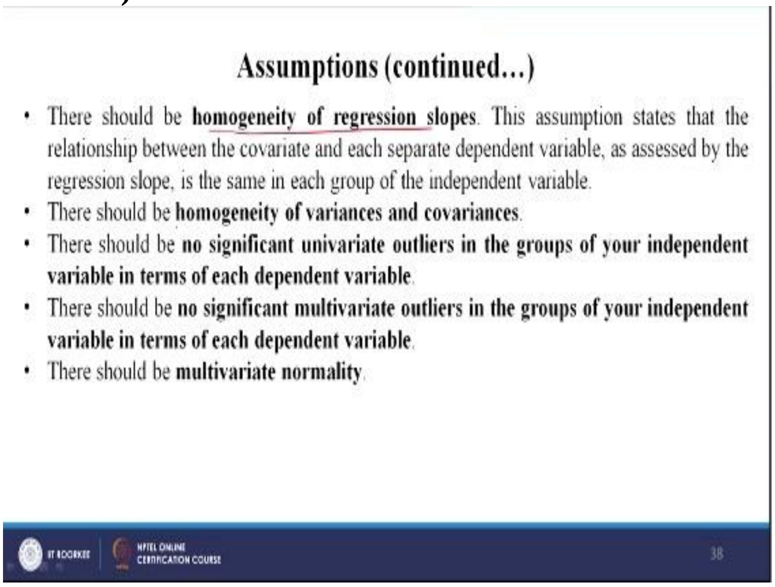

Homogeneity of regression again like ANCOVA has to be checked ok. Homogeneity of variance and covariance has to be checked. There should not be significant outliers ok that was also the same. There should be no significant multivariate outliers, so well this is both for outliers, so will keep it normally and normality should be present. And one more thing we missing data should not be there if it is there you kindly correct. So if it is not normal if it is skewed kindly transform the data.

If there are outliers you may remove them or you may correct them, if this is not homogeneity of variance is not showing kindly think of transforming if there is no homogeneity of regression or variance it was the group then you can think of transforming the data and trained to see if whether it is coming or not. If still it is not coming then maybe statistical test, parametric test are not applicable. Now take this example.

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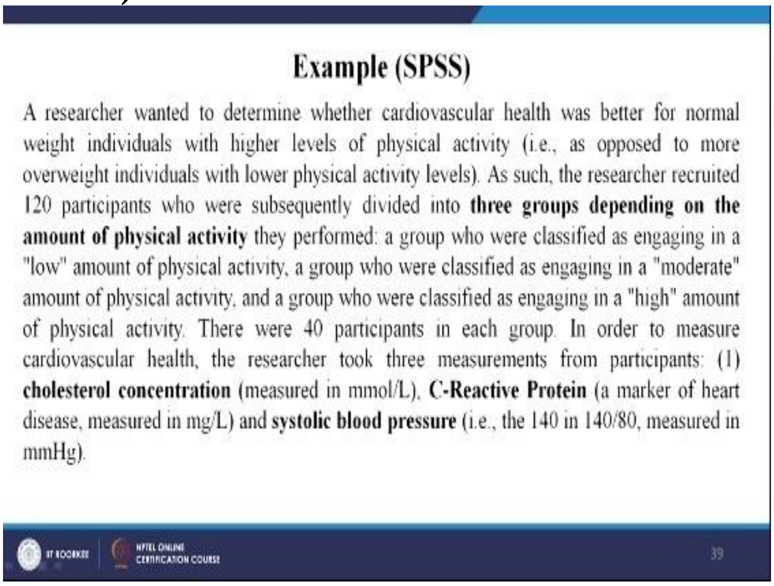

A Researcher wanted to determine whether cardiovascular health was better for normal weight individuals with higher levels of physical activity that is as opposed to more overweight individuals with lower physical activity levels ok. As such the researcher recruited 120 participants who were subsequently divided into three groups depending on the amount of physical activity.

So, each group let us say was the balance group 40, 40, 40. A group who were classified as engaging in a low amount of physical activity 40 people, a group who classified as engaging in a moderate 40 people, and high amount of physical activity another 40 people. There 40, 40 on in each group. In order to measure cardiovascular health the researcher took three measurements from the participants.

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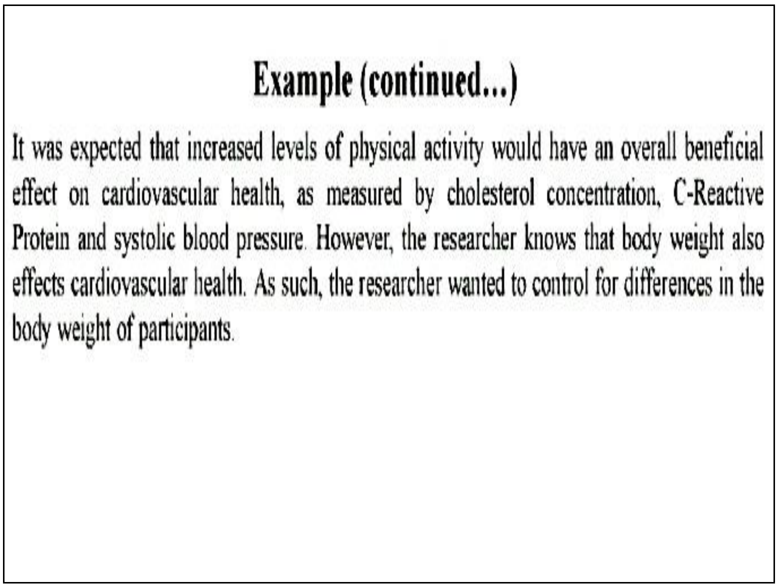

It was expected that increased levels of physical activity would have an overall beneficial effect on cardiovascular health, as measured by cholesterol concentration C-Reactive protein and systolic blood pressure. However the researcher knows that body weight also effects, the cardiovascular health. So if your body weight is high your chances are having a cardiovascular problem maybe high. As such the researcher wanted to control for differences in the body weight of participants. Just understand just imagine had I not taken the body weight then it would not be justices, would not be the right way of research.

You cannot say that any body weight the effect of exercise of on the you know heart of people would be same for all types of body weights, no it cannot be true. So what is next, how to conduct the MANOVA, MANCOVA in SPSS?

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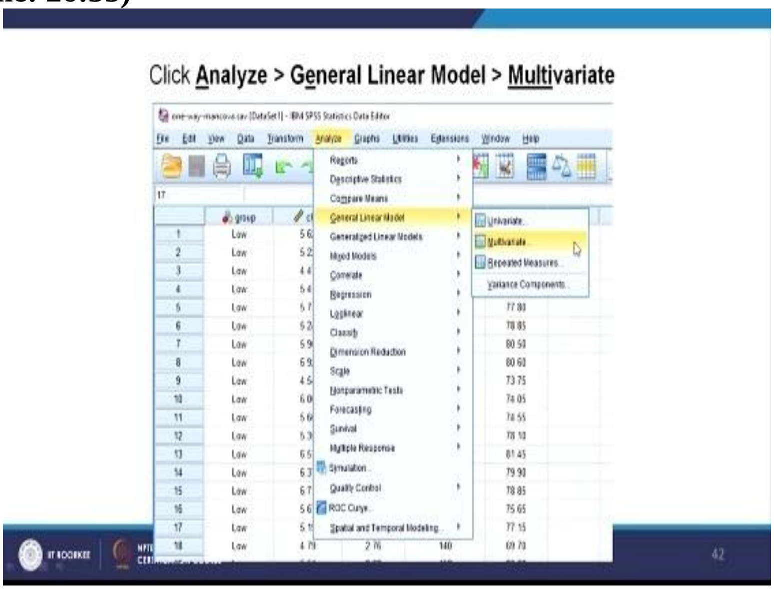

So here go to general linear model earlier when we are doing ANCOVA we are going for the univariate. But this time sees we have more than one dependent variable we go for the multivariate,

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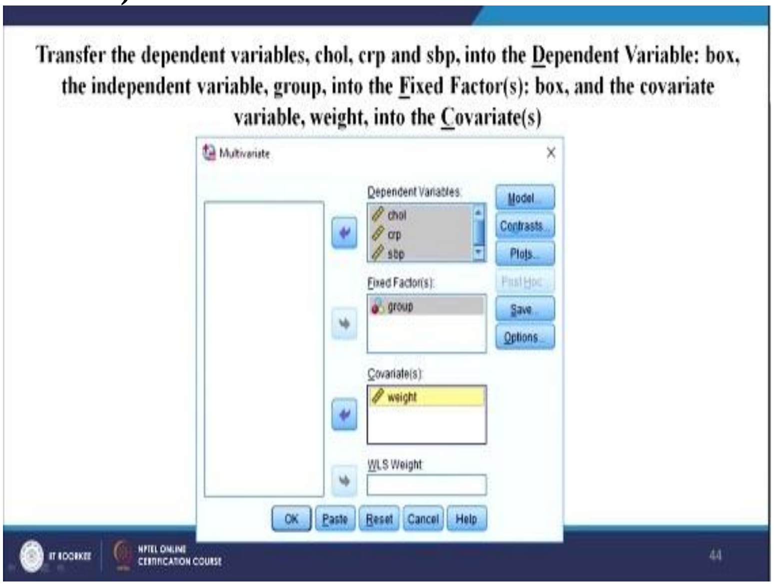

Then you take all these variables as earlier we have done. So we are take here let us say cholesterol, CRP protein and the blood pressure as a dependent variable. The group, which group of activity he was coming that and weight is my covariate.

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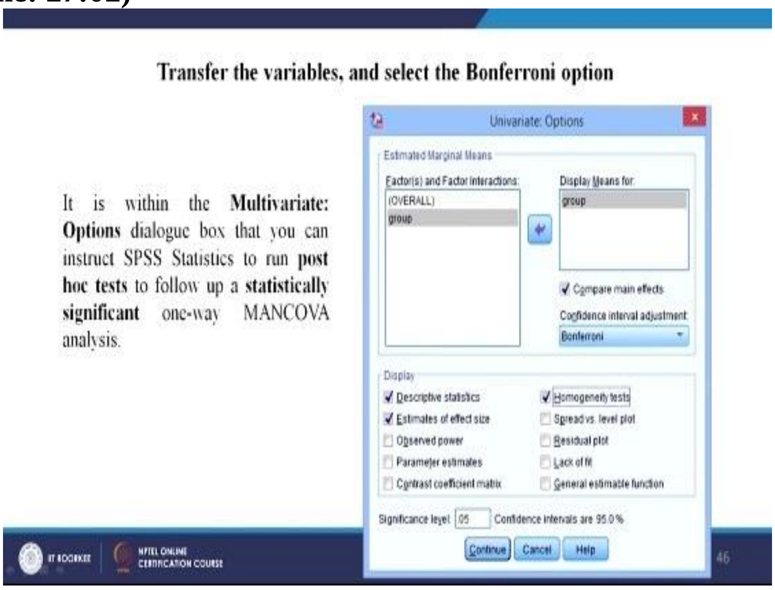

Now you can similarly I am just showing you then I will show you is a real case so the same case on the SPSS. So group we will take the group the intensity of the exercise into the, this side to check the display that means. It is within the multivariate options dialogue box that you can instruct ok this is. Now take this and finally compare the main effects and be check for these three things effect size, description statistics, and the homogeneity.

So we want the mean median, standard division and all those things mean standard division the variance equality and the Eta squared of effect size, you can also take the observed power to see how stronger test is, how powerful test is.

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- Click on the **continue button**. This will return you to the **Multivariate** dialogue box.
- Click on the **Ok button** to generate the results for the one-way MANCOVA.

So as I said if you remembered during ANOCA if you have a good covariate it reduces the mean sum of square within the test. So that is why if you have a good covariate it reduces the MS within and that increase the F-ratio so thereby what happens is your power effect test the beta. The beta reduces the beta is the type to reduces and your power effect test statistically significantly improve ok. Now click on the continue button and get the results, so how to interpret the result in the let us try to do it on the SPSS. So I have a MANCOVA.

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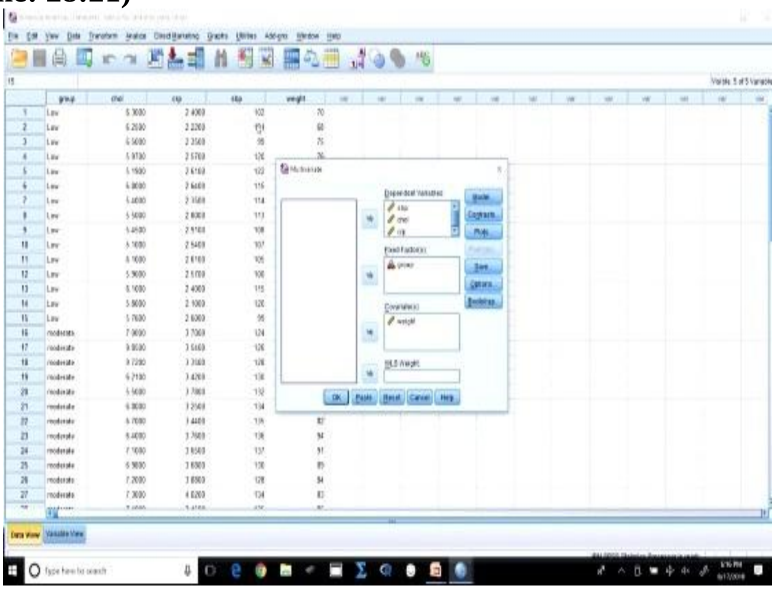

So we go to the general linear model univariate, so I have done it. We can reset so I will take all the, 3 group as my fixed factor, cholesterol, CRP, SBP blood pressure and this has my covariate. Now I will go to straightway I will go to the full factorial model it is by default; now let us go to or sorry not save I do not want to save anything in fact so I want to see the group means right group means and compare the main effects.

So you can Bonferroni you can if you keep LSD does not make much of difference because sample sizes are not large that is why we are bonferroni actually takes care of that small sample size it adjust for the differences ok, so but if sample size is good enough then you can take go for even Cedac or LSD and we want do this right even observed power is want if you can take so this is all; now run, let us run.

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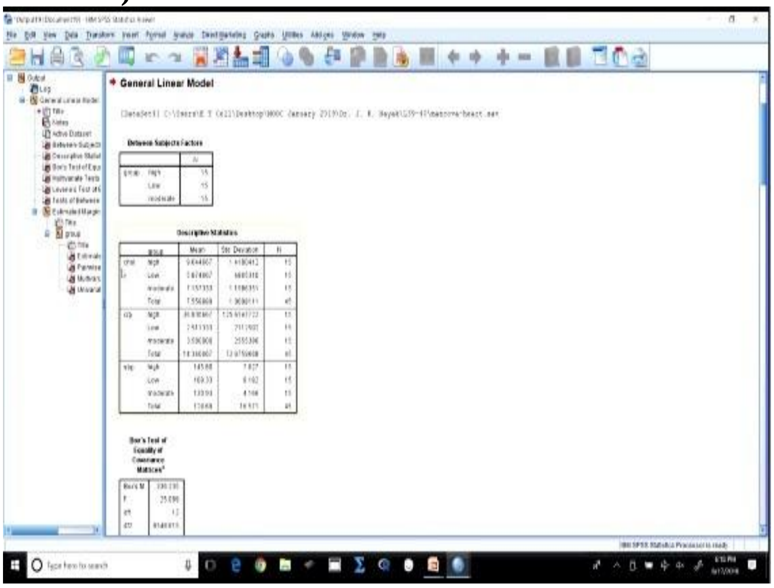

So if you go to output now so let us look at it. so what is the my dependent variable so dependent variable cholesterol, CRP and SBP and three groups whether High, Low moderate exercise for all the same and look at the mean and standard deviation. So if you see the cholesterol for the overall cholesterol was 7.5, CRP 14.34, SBP 128. The highest cholesterol was for the people who were doing you know high exercise. But here remember we do not know particularly well because the covariate also is 1 that has to be taken.

People with the low-exercise is the mean cholesterol level is 5.87 and 7.15 this is CRP similarly 36, 2.5 higher the protein risk of you know heart disease may be high I do not know high or low may be I am not a doctor anyway we will only go through numbers ok, now coming down so in fact this box's M tests, we test the null hypothesis that the observed covariance matrices of the dependent variables are equal across groups

But in this case our data is not showing a good sign it should not come significant actually please note it down when you write because of you write in the research paper, we should actually be more than because 5% level significant, we should have come at least above .05 but our cases coming .000 which show that it is significant that is actually should not come because I am not treated my data so I have brought as it is. So, whatever is coming it is shown here.

So, you should ensure that it is the above .05 there is not then we have to may be go to the data set again and check and may be collect more data my sample size also less here.

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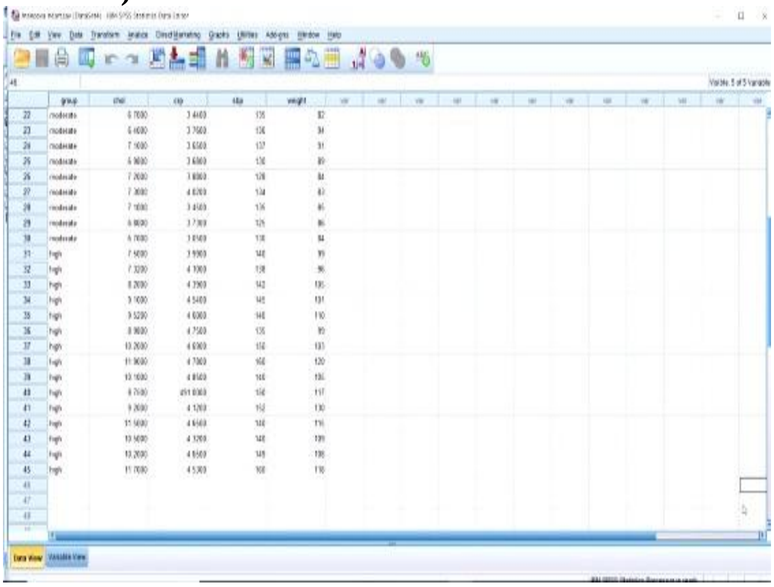

So, because if you see my sample size how much it is? It is much less because we expected 120 in the group but we have only 45 I believe. So you do not expect the same result right anyway just understand it, now will go to the Multivariate test. Now if you want to see the effect of the weight so first since it is remember, when it is non-significant you should there are two options, here basically we go for if it is significant then we should go for the Pillai's, if it is significant we go for the Wilks'Lambda, if it is not significant then will go for the Pillai's Trace.

So here will go for the Wilks'Lambda and here we say, we see it is significant, so weight has the significant effect right and the effect size is .387 which is as I said it is close to the similar to the regression in the R squared in the regression right and observe power is .986, this is the effect of weight the covariate, now the effect of the group that means the exercise.

How much is it? Is it significant? Yes, it is significant and but if you see the earlier weight of the person has got a larger effect on the final dependent variable then the type of exercise and observed power is 952 here. So this is Levene's test should have come actually this none of them are coming significant but it should have actually for a right MANCOVA test or ANCOVA test, the Levene's test should be above .05 or above a significant level, which is not coming here.

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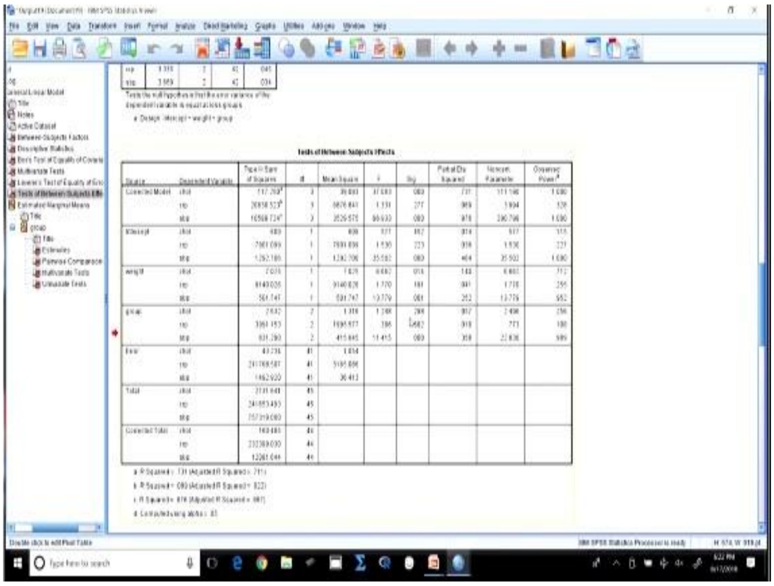

Now coming to the test of between subjects effects now let us look at it we have again see weight we have seen, it is significant? Yes, cholesterol at a particular by controlling the covariate weight ok. Is cholesterol significant? Yes, is CRP significant? No, CRP is not coming significant. Is the blood pressure coming significant? Yes so when I am controlling for the weight so my cholesterol is coming significant my blood pressure is coming significant but my CRP is not necessarily coming significant.

When you look at the group so when I look at the group I will see so group is it significant cholesterol? No, is my CRP significant? No. Is my blood pressure is Significant? Yes that means the type of exercise is having a effect on these three. So, obviously my Eta squared if you see my power effect test will also fall down drastically but how ever would have been higher would have been more happier, now you can see the pair wise comparisons this is the Post hoc test, when I am looking at cholesterol.

I am comparing cholesterol high and the group and what I am comparing it against the high cholesterol and I am compare the low and moderate exercise, so cholesterol low high moderate, cholesterol moderate high and low. So, when I am taking this dependent variables and I am comparing so I can find out the mean difference from here and I can run the; check the significance so where then I can say which is having a significant effect which is not having a significant effect, so but ultimately this is what is the final. So let us go back to the interpreting the results, now the result values might not be the same here this is only for writing.

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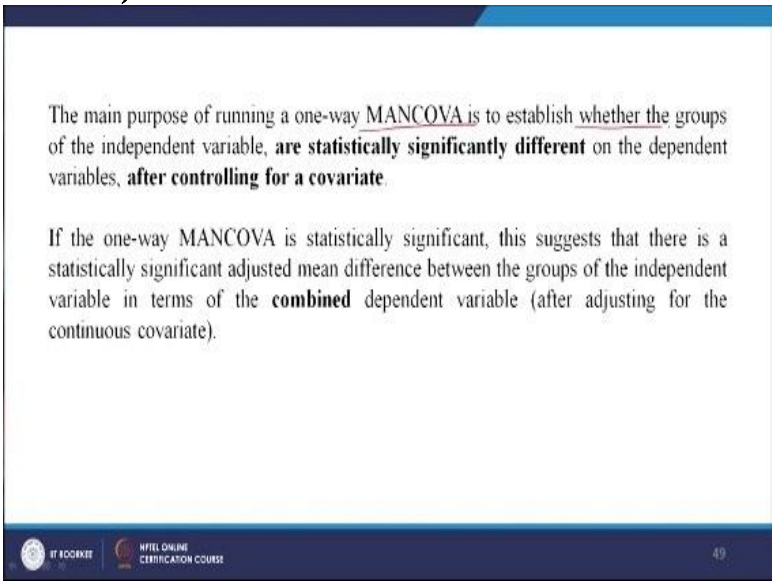

So the main purpose of running a one-way MANCOVA is to establish whether the groups of the independent variable are statistically different on the dependent variables, after controlling for a covariate, if the one-way MANCOVA is statistically significant, this suggests that there is a statistical significant adjusted mean difference between the groups of the independent variable in terms of the combined dependent variable so this is what we saw the last slide.

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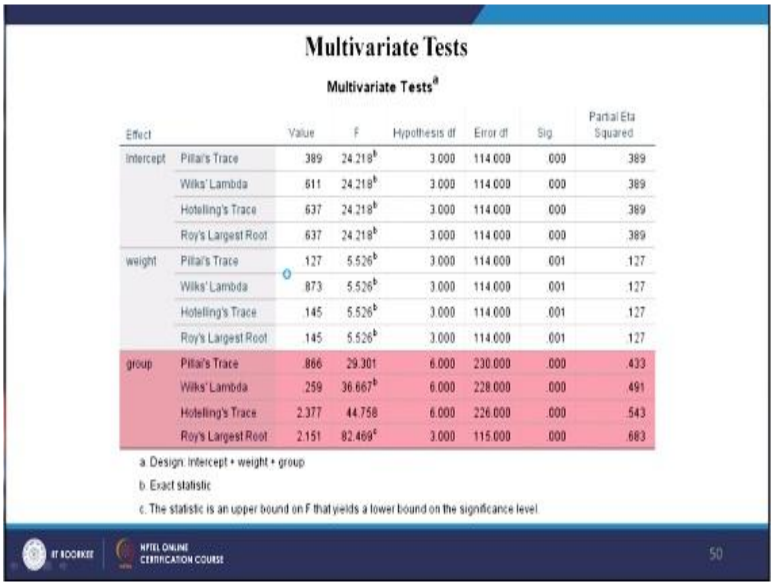

Multivariate Tests

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Intercept	Pillai's Trace	389	24.218[b]	3.000	114.000	000	389
	Wilks' Lambda	611	24.218[b]	3.000	114.000	000	389
	Hotelling's Trace	637	24.218[b]	3.000	114.000	000	389
	Roy's Largest Root	637	24.218[b]	3.000	114.000	000	389
weight	Pillai's Trace	127	5.526[b]	3.000	114.000	001	127
	Wilks' Lambda	873	5.526[b]	3.000	114.000	.001	.127
	Hotelling's Trace	.145	5.526[b]	3.000	114.000	.001	.127
	Roy's Largest Root	.145	5.526[b]	3.000	114.000	.001	.127
group	Pillai's Trace	.866	29.301	6.000	230.000	.000	.433
	Wilks' Lambda	.259	36.667[b]	6.000	228.000	.000	.491
	Hotelling's Trace	2.377	44.758	6.000	226.000	.000	.543
	Roy's Largest Root	2.151	82.469[c]	3.000	115.000	.000	.683

a. Design: Intercept + weight + group

b. Exact statistic

c. The statistic is an upper bound on F that yields a lower bound on the significance level.

So this table I am taking about ok and look at this so this is the weight and the group now we will see this group effect for example we have only interested in the effect of the group so if you look at it is it significant look at it yes it is significant, so that is what you report and this is my Eta the effect size.

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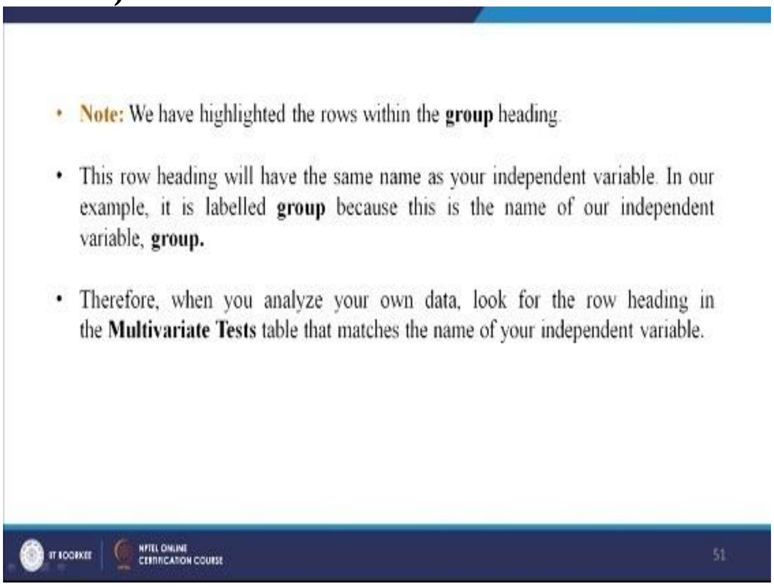

Note: we have highlighted the rows within the group heading as you saw. The row heading will have the same name as your independent variable. In our example it is labelled group because this is the name of our independent variable. So exercise are whatever you want to here, when you analyze your own data, look for the row heading in the multivariate tests that matches the name of independent variable.

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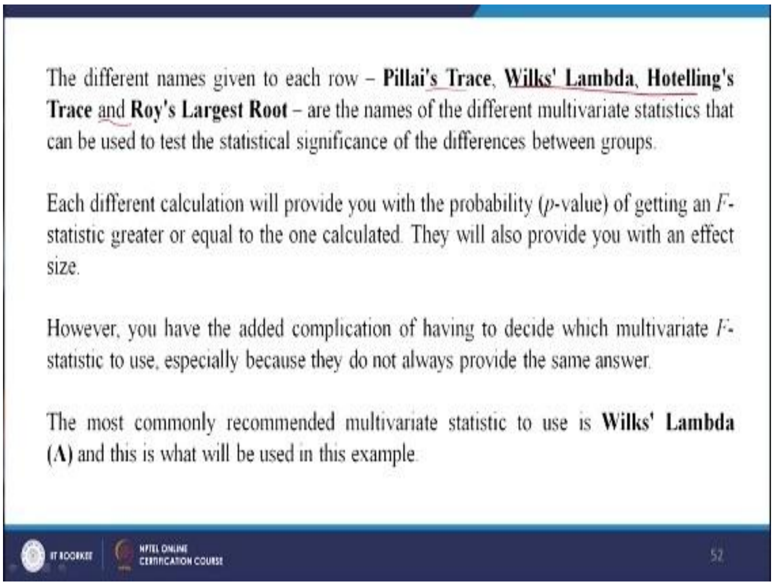

The different names given to each row Pillai’s Trace, Wilks’Lambda, Hotelling’s and Roy’s are then names of the multivariate statistics that can be used to test the statistical significance of the differences between groups. But generally we use the Wilks’Lambda, Roy’s Largest Root is also used but it is a highly you know sensitive to the normality assumption. Each different calculation will provide with the probability of getting F statistics of greater or equal to one the calculated then we want to compare with the calculated and the table value, it also provides together the effect size.

The Eta squared so which is analysed, however you added the complication of having to decide which multivariate F- statistics to use. The most commonly recommended is the Wilks’Lambda so this is I would have set it I kept it in the power point show that you can later on read it and understand it. Therefore, the results for the one-way MANOVA is found along the Wilks’Lambda, so go across this line so what is it saying, is it significant? Yes the Eta squared is this much ok.

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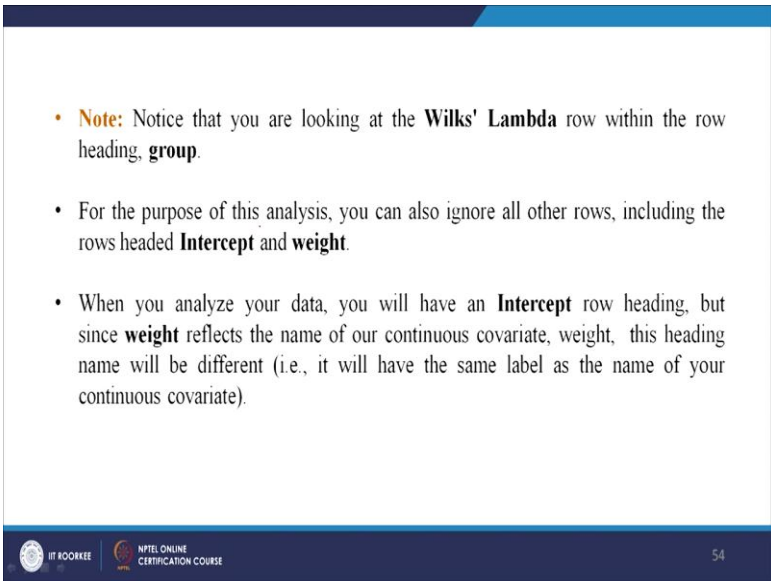

So, when you look at the Wilks'Lambda that you ignore all the other things. So when you analyze your data, you will have an intercept row heading, so these things but since weight reflects the name of our continuous covariate, weight, this heading name will be different it will have the same as the name of your continuous covariate. So forget this part this is what we require. If the one way MANCOVA is statistically significant so what you found, you will have a p-value less than .05.

However if p is greater than .05 the one-way MANCOVA is not statically significant. In our example there is a statistically significant difference between physical activity groups in terms of the combined health variables, after controlling for weight alternatively, if p is greater than 0.05 this is not a statistically significant difference, so between the physical activity groups in terms of the combined health variables, after controlling for weight .As such, you need to consult the significance column and along the Wilks'Lambda row.

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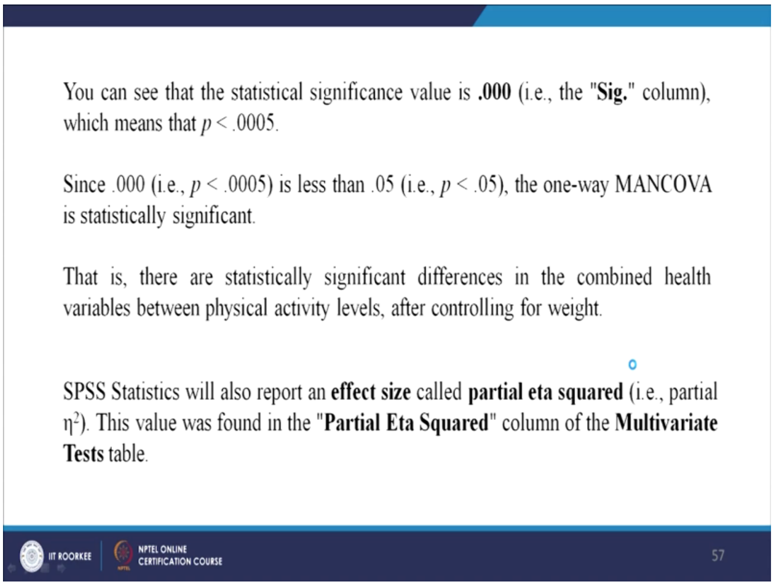

So this is what we have shown earlier also, so this is written so that is there are statistically significant differences in the combined health variables between physical activity levels, after controlling for weight. SPSS statistics will also report an effect size called the Partial Eta Squared, ok.

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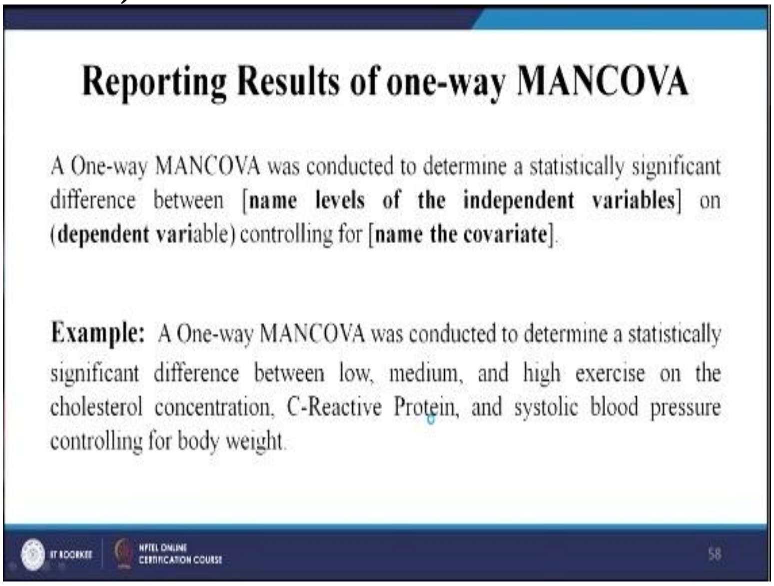

So this is also I have shown, now how do you finally write so you write like this A One-way MANCOVA was conducted to determine a statistically significant difference between you have to write the original the name the between here for the example what is the our independent variable the type of exercise.

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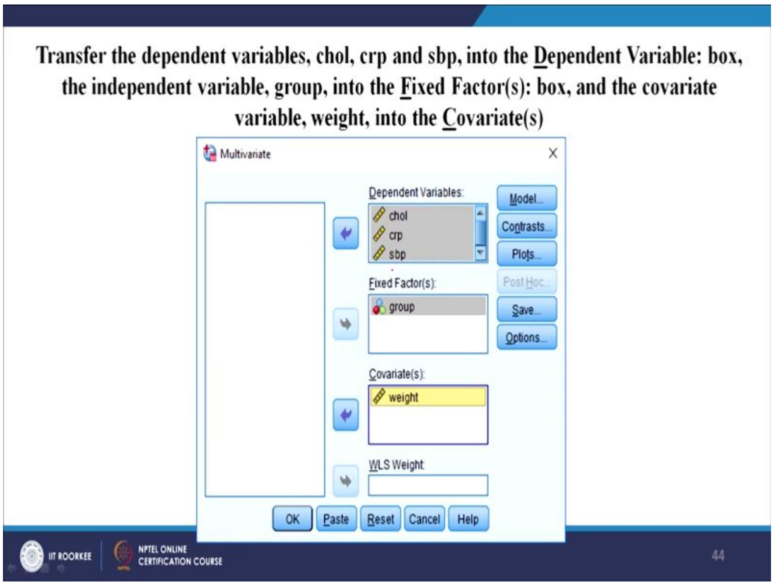

On the cholesterol, CRP and SBP, so these are my dependent variables. So you write the levels of the dependent variable cholesterol, CRP and whatever third one BP blood pressure controlling for what? the weight write so this is have you write. A One-way MANCOVA was conducted to determine a statistically significant difference between low, medium, and high exercise on the cholesterol concentration, C-reactive protein, and systolic blood pressure controlling for body weight.

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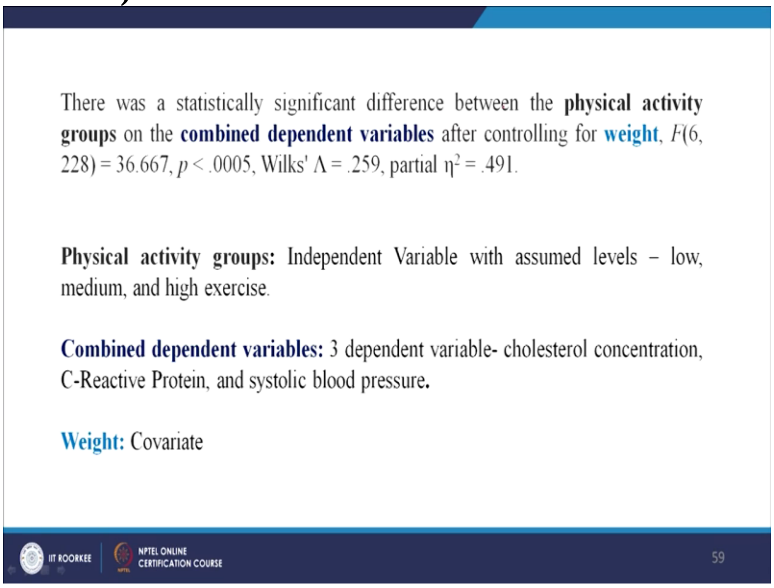

There was a statistically significant difference between the physical activity groups on the combined dependent variables after controlling for weight. Now this is how you report F(6228) or my numerator, denominator the degrees of freedom And my F value is this much, p is this much, Wilks'Lambda is this much, eta squared is this much, so physical activity groups:

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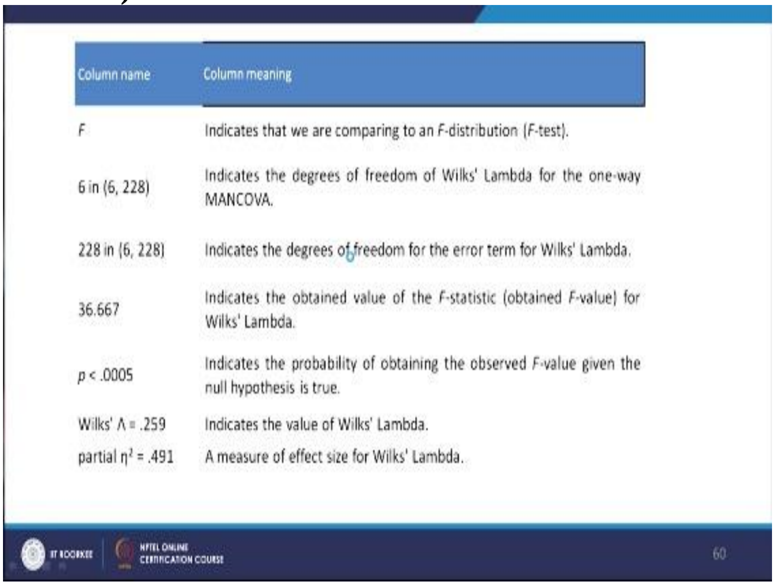

Column name	Column meaning
F	Indicates that we are comparing to an *F*-distribution (*F*-test).
6 in (6, 228)	Indicates the degrees of freedom of Wilks' Lambda for the one-way MANCOVA.
228 in (6, 228)	Indicates the degrees of freedom for the error term for Wilks' Lambda.
36.667	Indicates the obtained value of the *F*-statistic (obtained *F*-value) for Wilks' Lambda.
$p < .0005$	Indicates the probability of obtaining the observed *F*-value given the null hypothesis is true.
Wilks' $\Lambda = .259$	Indicates the value of Wilks' Lambda.
partial $\eta^2 = .491$	A measure of effect size for Wilks' Lambda.

So, this is the already explain so this is how finally you see this table.

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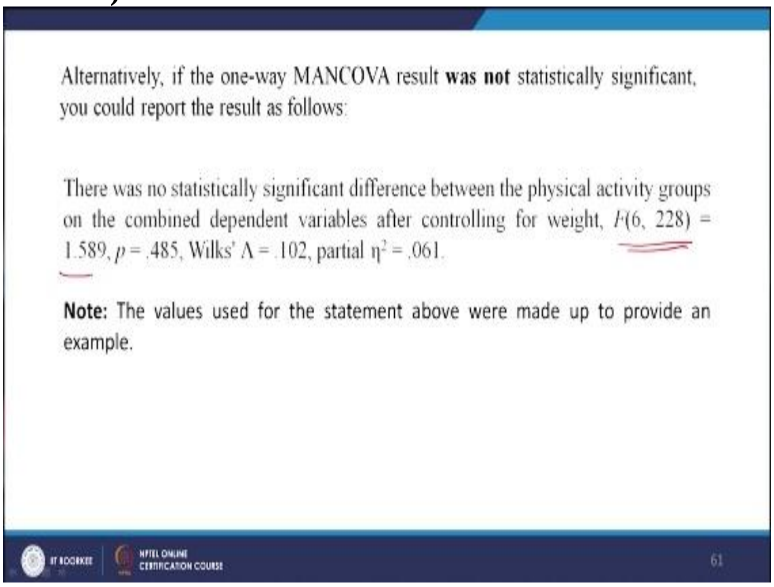

If alternatively the one-way MANCOVA was not significant you could report the result as follows, suppose sometimes is not significant so what is your mistake so it is written there was no statistically significant difference between the physical activity groups on the combined dependent variables after controlling for weight, this is same write is equal to this much, p is this much, Wilks'Lambda is this much and eta squared.

So you have got that you remember so this is my final if you so just one you can go back of also and check the table value, so individually for the groups we had seen we should go to the output table, now if you go to the output little up also you can it here, so this does this group was the group effect significant let us say Wilks'Lambda will see is it significant? Yes, so we can see here and then from here from this you can compare the test of between subject effects, so now will stop here I am sure you must have got the some insight at least into the details of ANCOVA and MANCOVA.

Which is nothing but similar to the extension of ANOVA and MANOVA, MANOVA is sometimes called as the mirror image of the discriminated analysis that is the separate story , I will explain sometime, but I hope it is clear to you if it is there is some doubt in your mind you can question me and I will try to help you out but remember it is the very very important technique, very important techniques and the very useful and you can really do wonderful research work if you can understand this statistical tools, I hope this is all for the day, thank You very much.