An Introductory Excursion into Statistics

With refernce to a survey on birth weights

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Statistical analysis is probably the kind of research most suited to a spare time research worker. All that is actually needed for minor surveys is a reliable source of information, a fair amount of patience and more often than not, a calculating machine.

Most of our students graduate with little knowledge of statistical terms and methods and consequently, very little statistical work has been produced in these islands. This is, a great loss, especially when one considers how Malta, being a small island, would be an ideal site to carry out statistical surveys.

The purpose of this article is not to substitute such an introductory course on statistics, but to clarify a few basic terms commonly used in statistical work. Illustration of the various points shall be made by reference to a survey on birth weights which has been recently carried out in the department. The original goal of this survey was, to establish the mean birth weight of single live-born infants in Malta during 1965 and relating this to gestation time, maternal age and parity, social status and maternal blood pressure. As our sample we collected records of all births from St. Luke's Hospital, St. Catherines Hospital, King George V Hospital and the M.M.D.N.A. These institutions delivered 44% of the total births of 1965. Our sample should provide a fairly accurate representation of births in 1965, but one must point out that if it is intended to establish a national mean birth weight, this sample would be extremely restricted.

After collecting the sample, it was found that records of social status were very vaguely kept, and that the majority had no record of maternal blood pressure. As a result of this we decided to discard these two variables. Birth weights were recorded to the nearest oz. as only a very small number were found to have been recorded accurately to a fraction of an oz. Birth weights were converted to gms. to facilitate the work. Gestation time was recorded in weeks from the date of the last menstrual period. This measure of the duration of gestation is notorious for its inaccuracy, but, up to now it is the best guide we have for measuring the length of gestation and therefore all similar surveys have taken the data of the last menstrual period as the base line for measuring the duration of gestation. Data on maternal age and parity was straightforward. From the original sample all stillbirths, twin deliveries and births for which the complete data was not available were discarded. This reduced the sample to 42% of the total live births in Malta in 1965. ,Table 1.) This sample was then subdivided into male births and female births.

Table 1. Comparison of Sample to Total Birth Weights in Malta 1965

	Livebirths		Stillbirths	Unknown Sex
	Males	Females		
Total in Malta 1965	2922	2706	91	
Sample Reviewed	1276	1171	60	10
Final Sample	1232	1126		

The first step of a statistical survey is to construct a histogram in order that one may easily visualise the distribution of a sample. This was done by grouping the birth weights at 200 gm. intervals (Fig. 1.)

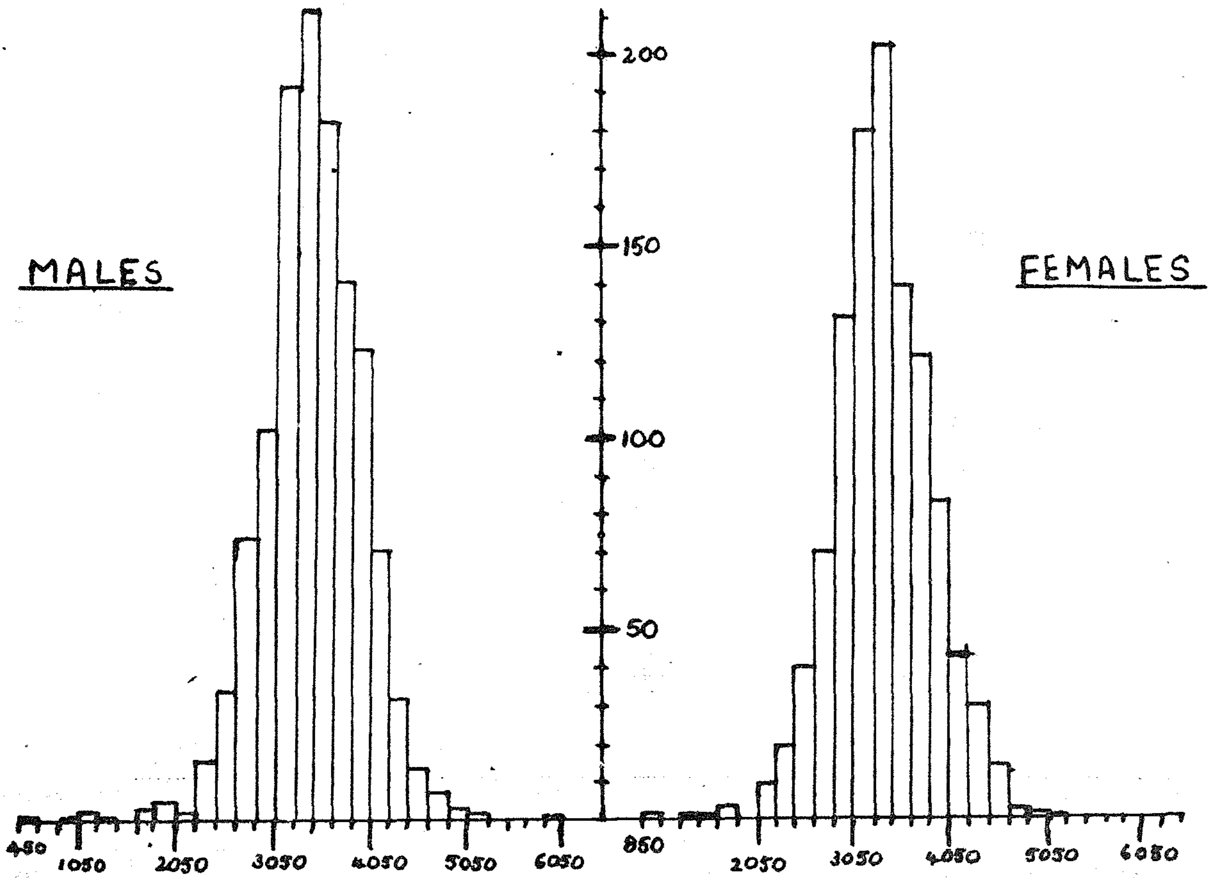

Fig. 1. Distribution of birth weights at 200 gm intervals.

A histogram represents a sample by surface area. The total area enclosed by the columns represents 100% of the sample and the percentage surface area of each column represents the percentage number of units in the particular interval, in relation to the number of units in the sample. In most cases the distribution of a sample will be normal. i.e. there is a regular rise to a peak on one side with a mirror image on the opposite side of the peak. If this pattern were to be transformed into a graph it will show up as a bell shaped curve. However, due to the size of the sample some irregularities are to be expected. Disregarding the peripheral parts of the histograms in fig. 1, it can be seen that there is a slight preponderance of male infants on the right hand side of the peak. However, the female birth weights are represented by a quasi-perfect bell-shaped curve. Small irregularities in the distribution are not very important and these histograms can be said to represent a normal distribution.

If we were dealing with the ideal sample the apex of a bell-shaped curve would be the mean of the ideal sample. However, as we are not dealing with an ideal sample we have to establish our mean, and then by the use of formulae establish the interval in which we would probably find the ideal mean if we could obtain an ideal sample.

The mean, as everybody knows, is found by adding up all the units in the sample and dividing by the number of units. The mean, however, conveys little information to the reader, as it provides no numerical information of how the sample is distributed around it, i.e. it conveys no information as to whether our sample is widely scattered around the mean or not. This information is represented graphically in the histogram but it can also be expressed as a number and is termed: the standard deviation of the mean.

The standard deviation is defined mathematically as the root-mean-square about the mean, or more simply as the square root of the mean, of the summation of the squared difference of each unit, from the mean of the sample. It would be extremely labourious if we had to find the squared difference from the mean for each unit, but by using special formulae the work is considerably reduced. Apart from the summation of the units, which we already have, all we need is the summation of the squares of the units. By using a calculating machine these two values can be obtained simultaneously. The standard deviation describes the distribution of the sample, because we know that the interval included by one standard deviation on either side of the mean contains about 68% of the sample etc. Thus the mean birth weight for males is 3446 gms and the standard deviation is †-535.4 gms. From this we know that 68% of our sample lies between 2910.6 gms. and 3981.4 gms.

Taking this a step further, we are able to find the standard error of the mean. Should a large number of similar surveys be carried out, the mean values of these samples should be normally distributed with the apex of the curve at the ideal mean. Now by providing the standard error of the mean the exact location of the ideal mean shall not be established, but, provided there are no gross anomalies in the sample, the 95% limits for the ideal mean are established. In other words odds arc 19 — 1 that the ideal mean lies somewhere within the interval of the standard error. The standard error for male birth weights is †-15.25 gms i.e. the true mean birth weight probably lies between 1430.75 gms. and 3461.25 gms. The usual way that these values are reproduced is:

Mean †- standard error of the mean (†- standard deviation).

Table 2 Mean Values for Birth Weight, Maternal Age, Parity and Gestation Time

	Birth Weight (gms.)			Mat. Age (yrs.)		Parity		Gestation Time (wks)	
	No.	**Mean**	†-535.4	27.88†-0.18	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**
M	1232	3446†-15.25	†-512.9	28.18†-0.19	†-6.29	2.12†-0.08	†-2.94	39.78†-0.052	†-1.84
F	1126	3358†-15.28	**S.D.**	**Mean**	†-6.34	2.19†-0.08	†-2.81	39.73†-0.051	†-1.72

In the sample, these values were established for all the four variables (Table 2). As is obvious there is considerable difference in the mean birth weight of male infants in relation to female infants, even at the limits of the standard error of the mean, the difference is almost 60 gms. Moreover, there is little difference in the means for material age, parity, and gestation time, as in these three variables the difference is less than the standard errors added together. From this data we can postulate, that maternal age, parity and gestation time being constant, a male infant should be born heavier than a female infant.

In a survey, where various variables are collected, it is pertinent to try and establish whether or not there is any association between the various groups of variables. E.g. Does gestation time decrease as parity increases, or does birth weight increase as maternal age increases etc? The index of the degree of association between two groups of variables is the correlation coefficient. This index is a value lying somewhere between —1 to +1. A negative coefficient means that as one variable increases the other decreases, while a positive coefficient means that if one variable increases the other increases as well. When the correlation coefficient is O there is absolutely no association between the two variables. As the index is increased the association is more pronounced until a correlation of 1 means that there is absolute dependence between the two variables, i.e. a change in one variable is always accompanied by a relative change in the other variable.

In Table 3 the various correlation coefficiants are listed. From this Table it can be seen that there is quite a good association between parity and maternal age and possibly some very slight correlation between birth weight and gestation time. However, it is possible, that due to the wide variations which can be found in such variables as birth weights, association can be found between two variables with a small correlation coefficient.

Table 3. Correlation Coefficients for Birth Weight, Maternal Age, Parity & Gestation Time.

	Males	Females
Birth weight to gestation time	.330	.356
Gestation time to parity	.003	—.059
Birth weight to parity	.132	.148
Birth weight to mat. age	.093	.135
Gestation time to mat. age	—.047	—.079
Parity to maternal age	.626	.675

The means by which these trends can be illustrated are tables and graphs. As an example let us take the mean birth weight and mean gestation time in relation to parity. These mean values are illustrated in Table 4. This table is constructed by finding the mean birth weight and mean gestation

Table 4. Mean Birth Weight and Mean Gestation time for given Parity.

Parity	Weight (gms)				Gestation time (wks)			
	Males		Females		Males		Females	
	No.	Mean	No.	Mean	No.	Mean	No.	Mean
0	431	3346.45	371	3255.58	431	39.85	371	39.86
1	278	3464.24	269	3371.90	278	39.72	269	39.74
2	164	3500.76	145	3403.26	164	39.77	145	39.86
3	111	1519.15	92	3374.55	111	39.68	992	39.45
4	66	3417.91	69	3393.56	66	39.53	69	39.65
5	39	3501.56	47	3406.40	39	39.85	47	39.43
6	37	3611.05	39	3524.26	37	39.62	39	40.05
7	26	3497.15	26	3414.23	26	39.81	26	38.88
8+9	41	3436.80	30	3580.87	41	39.80	30	39.83
10+	39	3792.94	38	3551.87	39	40.10	38	39.45
All	1232	3446.35	1126	3358.49	1232	39.78	1126	39.73

time for each parity. The major limitation of this table is that as the parity increases the number of units decrease so that we are left with very few births in the high parity groups. This could easily give rise to the question of whether the mean values at bottom of the table are truly representative. As a partial counter-measure to this, the higher parities have been grouped together, thus eliminating very small numbers. However, in this table we are still confronted with small groups and therefore great restraint must be exercised in drawing any conclusion. The most that can be said about this table is that despite very gross irregularities it shows a trend for mean weight to increase, as parity increases, while mean gestation time is constant throughout. To have a more reliable table one has to take a larger sample for the higher parities.

A simpler way of showing how two variables behave in relation to each other is by plotting a graph. Thus Table 4 is represented graphically in Fig. 2. The first thing which meets the eye is the irregularity of the graph. Such a graph is confusing and only fulfills its prime object of illustrating any trend, which is present, after careful study. However, by regrouping the various parities it is not only possible to clarify the graph, but also to make it more reliable by increasing the number of units which each mean represents. Fig. 3 is the same as fig. 2 but here the parities have been regrouped. The irregularities registered in fig. 2 have been eliminated and the graph shows that in this sample the mean birth weight tends to increase with parity.

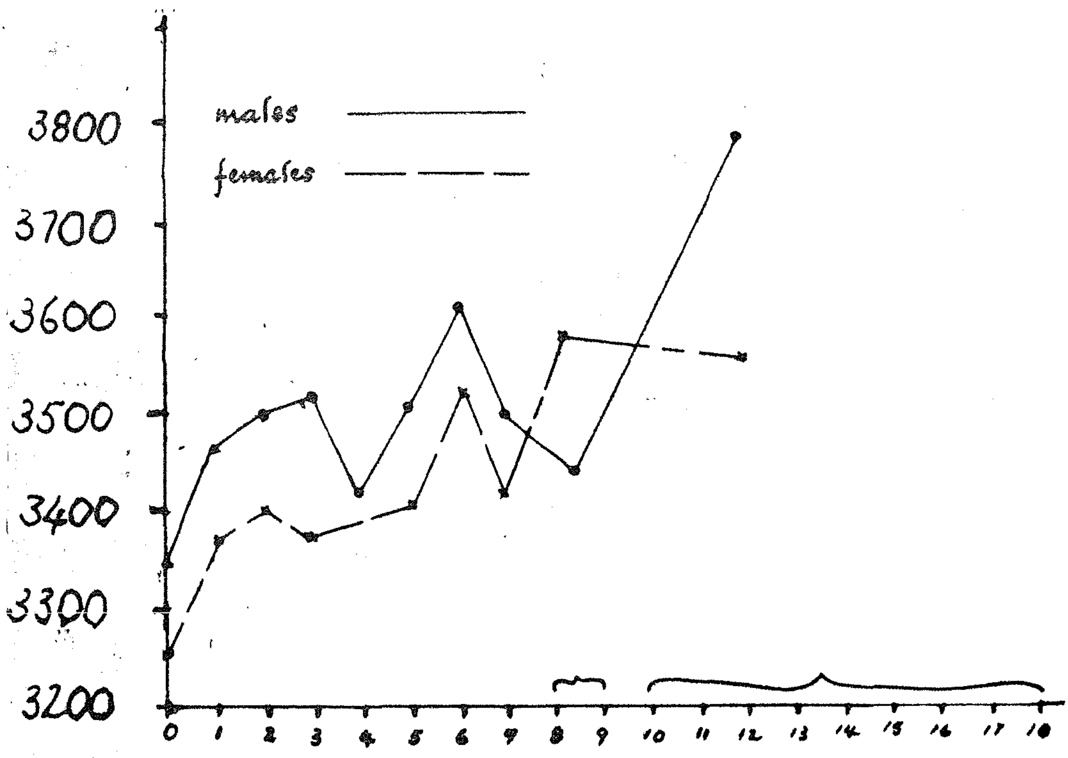

FIG. 2.

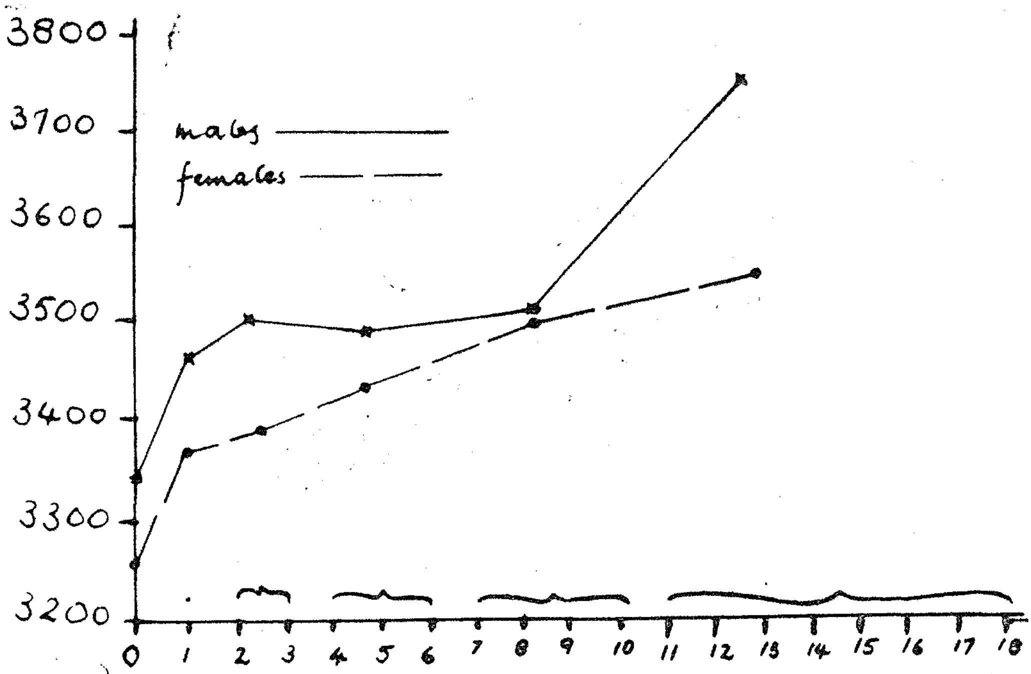

FIG. 3.

Up to now we have agreed with other authors who have published similar studies, but we do not agree in the trend for birth weight to increase in the higher parities. Fraccaro, in an almost identical study, states that it seems that mean birth weight increases with parity up to 8, but above this parity mean birth weight tends to decrease. However, Fraccaro's sample, although larger than this sample has smaller numbers of births above the 8th parity, and as he remarks, no definite conclusion can be based on such a small number of observations.

This controversial point demands further study. Definite evidence is now accumulating that large babies have an increased perinatal morbidity during labour. If by making a more extensive survey, on the relationship between birth weight and parity, it would be shown that the results of this sample are correct, it would partly explain the increased infant morbidity in grand-multiparas.