A STATISTICAL ANALYSIS OF THE GENESIS LIFE-SPANS

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An extensive statistical analysis of the life-spans of the patriarchs, as given in Genesis Chapters 5 and 11, shows that statistically the life-span can be considered constant before the Flood, while after the Flood the data can be fitted by an asymptotic exponential decay curve. Also, it is concluded that as for the life-spans reported in Genesis Chapter 11, the data in the Masoretic text are the authentic ones; those in the Septuagint have been tampered with. Moreover, it is statistically unlikely that there are gaps in the genealogies in Genesis Chapter 11.

In his recent book, *The Waters Above: Earth's Pre-Flood Vapor Canopy,* Joseph Dillow has noted that for almost 75 years different theories about a water canopy have been proliferated in creationist (and other) literature.[1] This pre-Flood vapor canopy has been proposed to be the only scientific and Biblical explanation for the greatly extended lifespans of the post-Flood patriarchs. It has been contended by Morris and Whitcomb and others since that this vapor canopy shielded the pre-Flood patriarchs from radiation bombardment; and that with the collapse of the canopy increased radiation levels would result in decreased longevity.[2] On the other hand, Donald Patten has suggested that after the Flood there was a progressive decline in carbon dioxide (affecting the skin and the brain) resulting in a decline in oxygenation of brain cells, which is considered the cause of accelerated aging.[3] However, it is not the intention of this author to debate what caused the decline in lifespans, but to analyze the decline both statistically and Biblically.

Graphic analysis of the life-spans delineated in Genesis 11 seems to indicate an exponential decay function after the Flood. Both Patten[4] and Armstrong[5] have investigated this functional possibility. Later, Strickling, using the data from the Septuagint and Masoretic texts, generated exponential decay functions for expressing the post-Flood life-spans for the purpose of establishing a correction factor for the Carbon 14 dating process.[6] More recently, Dillow has used linear regression to derive the equation

$$y = 652e^{-.1355x} \qquad (1)$$

where y = the age at death for the patriarch and x = the number of generations from Noah, with $x = 0$ at Noah's generation.[7] Because there was a high correlation of .95 (perfect correlation is +1 or −1 and in no correlation the correlation coefficient $r = 0$) between the life-spans and the generations, Dillow concluded that the exponential decay curve was statistically valid.[8] His model is a building stone and a step in the right direction; but is still not quite Biblically and statistically correct. A proper statistical analysis of the longevity data, using recently developed statistical model building reasoning, and the scriptures shall confirm another model to have the best fit. Furthermore, statistical analysis of the Genesis 5 and 11 age data shall confirm two recent conclusions: (a) one by Niessen that there was a deliberate and systematic tampering of hte Septuagint ages[9] (b) and another by Dillow that for there to be gaps in the genealogy "the gaps would have to be systematic and specific, not random."[10]

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Statistical Model Concepts

To develop a statistical model, whether by linear or nonlinear regression methods, the purpose of the model must be carefully considered. Statistical models can be used solely for data description as Dillow, Patten, and Armstrong have done, for parameter estimation, and for prediction and estimation as illustrated by Strickling in his analysis of the Genesis 11 data. The appropriate model for the post-Flood patriarch life-spans should not only be descriptive of the Genesis 11 data but beyond. Also, the parameters of the equation should have some meaning, and the predictions or estimates for later generations should be sensible. In addition, assumptions about the error terms ϵ_i for a simple linear model (if it were appropriate for the Genesis 11 life-spans)

$$Y_i = \beta_0 + \beta_1 X_i + \epsilon_i. \qquad (2)$$

may be very important depending upon the use of the model.

The models that could be used in analyzing the Genesis longevity data are either linear or nonlinear. The statement that a model is linear or nonlinear refers to linearity or nonlinearity in the parameters, β_0, β_1, β_2, etc. Y being the response variable and X representing the predictor variables. A linear model would be as follows:

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_p X_p + \epsilon_i \qquad (3)$$

On the other hand, the nonlinear model

$$y = \beta_0 \exp(-\beta_1 x + \epsilon) \qquad (4)$$

used by Dillow can be transformed to a linear model by taking logarithms to the base e as shown below:

$$\ln y = \ln \beta_0 - \beta_1 x + \epsilon \qquad (5)$$

However, sometimes a nonlinear model cannot be converted into a linear form.

If a linear model is chosen, say $Y = \beta_0 + \beta_1 X$, the unknown parameters (β_0, β_1) for this simple linear model must be estimated, $\hat{y}_i = b_0 + b_1 x_1$, where b_0 = the y intercept and b_1 = the slope of the line. For linear regression, the method of least squares is to minimize the function,

$$Q = \sum_{i=1}^{n}(y_i - \hat{y}_i)^2 = \sum_{i=1}^{n}(y_i - b_0 - b_1 x_i)^2, \qquad (6)$$

with respect to each estimated coefficient where y_i = the actual observation value and $\hat{y}_i$ = the fitted or predicted value corresponding to the associated x_i. The solution is unique.[11] For nonlinear regression, an iterative technique for obtaining the parameter estimates is necessary. There are three iterative methods: (1) the Taylor series or Gauss-Newton method, (2) the gradient or steepest descent method, and (3) the Marguardt compromise which is basically an interpolation between the other two methods so that the size and direction of the step of convergence can be determined simultaneously. A mathematical summary of these three methods is presented by Draper and Smith.[12] The Marguardt compromise is the nonlinear method used for the nonlinear regression model in this paper. It should be mentioned that all three iterative nonlinear estimation procedures require initial starting values for the parameters, and all available prior information should be used to make these starting values as reliable as possible. Poor starting values can lead to poor convergence or a wrong estimation. However, there is certain Biblical information that can be utilized to establish good starting values for the nonlinear model for the post-Flood data.

Once a feasible model is found that describes the data and estimates the parameters, the next phase of the model building is checking the adequacy of the model. Various questions on model adequacy are asked. Is the model reasonable for present and future observations? Do certain data points not fit the equation? Why do these unusual observations not conform? Must the original model be modified? These kinds of questions in building a statistical model, whether linear or nonlinear, lead to a repetitive process which goes from data to model, model to data, data to model, etc., until final adoption of a totally adequate model.

An easy way to check for adequacy is to compare the observed data values (y_i) to the fitted values of the model ($\hat{y}_i$). These differences between data and model fit, $y_i - \hat{y}_i$, are called residuals:

$$e_i = y_i - \hat{y}_i \qquad (7)$$

There is a residual, e_i, for each data point. An extremely large residual might suggest that either model is inadequate as to fit or that the observation in question is suspicious. Unusual observations that are not due to an incorrect specification of the model are called outliers. For instance, with a one-dimensional or univariate data set, an outlier would be an observation that sticks out unusually far on the end of the data set. There are numerous outlier diagnostics for linear regression that have appeared in the last ten years: standardized residuals, studentized residuals, Cook's index, the elements of the hat matrix, changes in the model coefficients or the model fit as a result of omitting an observation, and others.[13] Some of these outlier detecting methods can be extended to nonlinear regression. However, it is best only to mention the outlier diagnostics as they occur and their value for the situation at hand.

Pre-Flood Analysis

The Biblical evidence strongly supports the fact that there are no gaps in the Genesis 5 genealogy. As noted by Dillow, there is an absence of gaps in Genesis 4:25, 26 between Adam, Seth, and Enosh where a father-son, not a father-descendant, relationship is attested to by the first three generations.[14] In addition, Jude 14 confirms that Enoch was the seventh generation from Adam. Thus, the implications of these two passages are that there are no gaps between the remaining three generations. Niessen's recent work on a tight chronology for Genesis 5 and 11 exegetically and logically supports the belief that there are no gaps in the genealogies.[15]

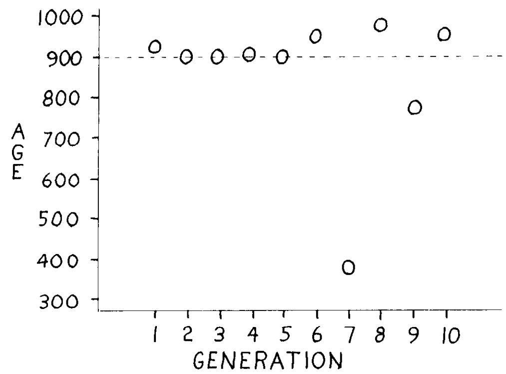

Figure 1. Pre-Flood data. "O" shows the observed, i.e. recorded, age of the patriarchs. The broken line shows the predictive equation for the median regression model.

Figure 1 gives a pictorial presentation of the prediluvian ages from Adam to Noah. Noah's inclusion in the Genesis 5 chronology even though he lived in the pre-Flood patriarchs is because of three reasons. First, as far as longevity, Noah is more like the pre-Flood patriarchs. Secondly, there is symmetry in the genealogies of Genesis 5 and 11 (ten generations in each) if Noah is included with the prediluvian patriarchs. And finally, if Noah is included in the post-Flood age, he is a statistical outlier that does not conform to the post-Flood model.

Examination of the data in Figure 1 suggests, to the statistician, that three models or model variations could fit the data of Genesis 5: a simple linear regression model, a median regression or robust regression model, or some arithmetic mean model. Using x for the number of generations away from Adam (with $x = 1$ at Adam) and y for the age-span, the following linear regression model can be fitted:

$$\hat{y} = 924.60 - 12.20x \qquad (8)$$
$$(t = 7.19) \; (t = -.59)$$

The slope, −12.20, suggests that ages declined 12.20 years for every generation prior to the Flood. However, a statistical test for the significance of this slope as being different from zero gives a t value of −.59, which means probability wise that there is about a 72 percent chance of finding a more significant slope. Furthermore, examination of the predicted values for this model and of the residuals in Table 1 shows that this model is inappropriate. The predicted values of the linear regression model are only relatively close to the actual age-spans for the first five generations. From Jared on, the residuals are large. Using the studentized residual (the residual divided by its unique standard deviation) or the studentized residual which examines the fit of the model on the remaining $n - 1$ data points when the i^{th} data point is omitted, it is obvious visually from Table 1 that Enoch is a statistical outlier. Statistical tests based upon the maximum studentized residual or the studentized residuals with

Table 1. Pre-Flood Analysis: Simple Linear Regression.

Name	Birth After Creation	Death After Creation	x Generation	y Age	y Predicted Age	e_i Residuals	Studentized Residuals	Studentized Residuals with i^{th} Point Deleted
Adam	0	930	1	930	912.4	17.6	.12	.11
Seth	130	1042	2	905	900.2	11.8	.07	.07
Enosh	235	1140	3	905	888.0	17.0	.10	.09
Kenan	325	1235	4	910	875.8	34.2	.20	.18
Mahalalel	395	1290	5	895	863.8	31.4	.18	.17
Jared	460	1422	6	962	851.4	110.6	.62	.60
Enoch	622	987	7	365	839.2	−474.2	−2.70	−8.39
Methuselah	687	1656	8	969	827.0	142.0	.83	.81
Lamech	874	1651	9	777	814.8	−37.8	−.23	−.22
Noah	1056	2006	10	950	802.6	147.8	.97	.96
Flood	1656							

the i^{th} point deleted would show Enoch an outlier at a 1 percent or a 0.1 percent level of significance or smaller, respectively.[16] For this model no other observation would statistically be proven an outlier. However, Lamech, who only lived 777 years and who died about 5 years before the flood, should have been a possible outlier, but the linear regression model casts more doubt on Methuselah and Noah than on Lamech. Thus, the outlier analysis of the residuals suggests that this regression model is inadequate.

A second model possibility for the Genesis 5 data is a robust regression model, such as median regression, which tends to be insensitive to outliers.[17] Using a simple median regression model explained by Velleman and Hoaglin, the model is as follows:[18]

$$\hat{y}_i = 895.3752 + 4.75x_i \qquad (9)$$

Table 2 shows that the predicted values for the ages are more in line with the actual values except for Enoch and Lamech, which is what we would expect Biblically. Enoch is definitely an outlier with a residual of −563.6 years away from an expected life span of 928.6 years. Genesis 5:22-24 and Hebrews 11:5 also confirm that he is an outlier because he pleased God with his walk. Thus, this median regression model provides a better statistical and Biblical fit to the Genesis 5 age-spans.

Since Enoch and possibly even Lamech may be statistical outliers, an accurate measurement of the association between generation and age can be analyzed with a nonparametric correlation, called the Spearman rank correlation coefficient, r_s.[19] This correlation coefficient is insensitive to outliers since it uses the rank of the variables instead of the actual values. If $d_i = rank(x_i) - rank(y_i)$ or $d_i = rank(generation) - rank(age)$, then

$$r_s = 1 - \frac{6\Sigma d_i^2}{n^3 - n} \quad \text{where n = sample size.}$$

Spearman's correlation coefficient for the pre-Flood data is .03 (remember that the minimum is zero and the maximum is +1 or −1), and the probability of finding a larger correlation value is 93 percent. The statistical conclusion of the pre-Flood analysis is that there is no relationship between generation and ages. The implication of this conclusion is that the best descriptive and predictive model for the pre-Flood age is a line parallel to the x axis, such as $\hat{y} = \bar{y}$ the arithmetic mean (857.5 years) or better yet $\hat{y}$ = the median age (911 years). The scientific conclusion of this pre-Flood analysis is that there were extremely stable conditions, likely atmospheric, prior to the Flood; but this analysis itself does not say what caused the stability or the longevity of the pre-Flood patriarchs.

Table 2. Pre-Flood Analysis: Median Regression.

Name	x Generation	y Age	y_i Predicted Age	e_i Residual
Adam	1	930	900.1	29.9
Seth	2	912	904.9	7.1
Enosh	3	905	909.6	−4.6
Kenan	4	910	914.4	−4.4
Mahalalel	5	895	919.1	−24.1
Jared	6	962	923.9	38.1
Enoch	7	365	928.6	−563.6
Methuselah	8	969	933.4	35.6
Lamech	9	777	938.1	−161.1
Noah	10	950	942.9	7.1

Post-Flood Analysis — Masoretic Text

As noted earlier, the Biblical evidence for a tight chronology for Genesis 5 with no gaps is difficult to refute. On the other hand, there is no such obvious Biblical support for no gaps in the Genesis 11 genealogy, except for the important hermeneutical concept of first reference whereby if there are no gaps in Genesis 5 it is expected that there are no gaps in Genesis 11. Niessen presented some excellent Biblical thinking on the question of no gaps in the Genesis 11 genealogy; but once the proper statistical model is chosen, the statistical evidence will also confirm that for gaps to exist there would have to be a systematic, mathematical, nonrandom spacing of these ages, which is extremely unlikely. Using the ages from the Hebrew Masoretic text, the proper biblical statistical model will be developed in this section.

Dillow's model for the post-Flood age considered the patriarchs from Noah to Jacob, and then Moses' contemporaries, according to Psalm 90:10. His original model did not include Joseph who lived to be 110 (Gen. 50:26).[20] Redoing Dillow's model with Joseph included, the model obtained through linear regression methods is little different:

Table 3. Post-Flood Linear Regression Models.

Patriarch	Generation*	Age	Dillow Model** Predicted Age	Residual	Modified Dillow Model*** Predicted Age	Residual	Studentized Residuals****
Noah		950	652.4	297.6			
Shem	0	600	569.7	30.0	517.2	82.8	.93
Arpachshad	1	438	497.5	−59.5	456.3	−18.3	−.25
Shelah	2	433	434.4	−1.4	402.5	30.5	.43
Eber	3	464	379.4	84.6	355.1	108.9	1.56
Peleg	4	239	331.3	−92.3	313.3	−74.3	−1.56
Reu	5	239	289.3	−50.3	276.4	−37.4	−.83
Serug	6	230	252.6	−22.6	243.8	−13.8	−.33
Nahor	7	148	220.6	−72.6	215.1	−67.1	−2.12
Terah	8	205	192.7	12.3	189.8	15.2	.44
Abraham	9	175	168.2	6.8	167.4	7.6	.25
Isaac	10	180	146.9	33.1	147.7	32.3	1.15
Jacob	11	147	128.3	18.7	130.3	16.7	.71
Joseph	12	110	112.0	−2.0	115.0	−5.0	−.27
Moses' Contemporaries	16	70	65.2	4.8	69.6	.4	.04
Selected Generation Away From Shem	19		43.4		47.8		
	29		11.2		13.7		
	39		2.9		3.9		
	99		0.0		0.0		

*For the original Dillow model where x = 0 starting with Noah, all of the values for generation would be increased by one.
**The mean square, the variance about the regression line for the transformed model $\ln y = \ln b_0 - b_1x$, is .048529.
***The mean square is only .033478 for the modified Dillow model.
****The studentized residuals were computed from the model, $\ln y = \ln b_0 - b_1x$.

$$\hat{y} = 653e^{-.1358x} \quad (10)$$

The predicted values and residuals for Dillow's exponential decay model are shown in Table 3. The model completely misses Noah by 297.7 years. He is definitely a statistical outlier for the post-Flood data but not the pre-Flood data. There are also large residuals for Peleg, Eber, and Nahor. Omitting Noah and letting Shem be the first semi-true post-Flood observation ($x = 0$ for his generation), the linear regression model is

$$\hat{y} = 517e^{-.1253x} \quad (11)$$

As seen in Table 3 for the modified Dillow model, Eber and Shem have the largest residuals, 108.9 and 82.8 respectively. However, using the maximum studentized residual whereby each residual is divided by its own standard deviation thus putting all the residuals on an equal footing, only Nahor is suspect; but he is not an outlier at a 10 percent level of significance.[21] For the studentized residual with the i^{th} observation omitted, Nahor would again be flagged as suspicious; but other outlier tests confirm that he is a valid observation.[22] While both Dillow's original model and the modified model yield a Spearman rank correlation coefficient of −.9549 between age and generation, the modified model has a lower mean square (variance about the regression line) and almost exactly predicts the age of 70 for Moses' contemporaries according to Psalm 90:12. However, if predictions are made for successive generations after Moses as done in Table 3, both of the models fall apart. For instance, 29 generations after Shem, the predicted ages are 11.2 years for the Dillow model and 13.7 years for the modified Dillow model. While the modified model is better, it is only good for descriptive purposes.

The models presented in Table 3 were derived with linear regression methods after the natural logarithum transformation was applied to the age. These models provide only a close approximation of the nonlinear model. If nonlinear regression with the Marquardt compromise is used to construct the exponential decay curve, the model is slightly different:

$$\hat{y} = 563e^{-.1416x} \quad (12)$$

The sum of squares (the sum of the square of the differences between the actual observations and the predicted values, $SS = \Sigma(y_i - \hat{y}_i)^2$) for the modified Dillow model is 33228 while it is considerably less for the exponential decay, nonlinear model at 28728.[23] Thus, the nonlinear form of the exponential decay curve fits the data better. Table 4 reveals that, by this model, Eber has the largest residual and the largest studentized residual but is not a likely outlier.[24] The predicted value for Moses' contemporaries is 58.5 years, and for 29 generations away from Shem it is 9.3 years. So again, while this form of the exponential decay model provides an even better description of the patriarch life-spans than the modified Dillow model, it still fails in prediction beyond the scope of the data. As visually evidenced in Figure 2, this descriptive model is still declining after Moses.

Using the Biblical information from Psalm 90:12 that man should live to be 70 or 80 years old if strong, the best model should incorporate this information along with the exponentially declining ages. The nonlinear model, an asymptotic exponential decay model, utilizes this information and would be of the following form:

$$y = \beta_0 + \beta_1 e^{-\beta_2 x} \quad (13)$$

Using 70 as a starting value for β_0, the nonlinear re-

Table 4. Nonlinear Models.

Patriarch	Generation	Age	Exponential Decay Model* Predicted Age	Exponential Decay Model* Residual	Exponential Decay Model* Studentized Residual	Asymptotic Exponential Decay Model** Predicted Age	Asymptotic Exponential Decay Model** Residual	Asymptotic Exponential Decay Model** Studentized Residual
Shem	0	600	563.6	36.4	1.03	583.1	16.9	.59
Arpachshad	1	438	489.2	−51.2	−1.22	492.9	−54.9	−1.31
Shelah	2	433	424.6	8.4	.19	418.5	14.5	.33
Eber	3	464	368.5	95.5	2.07	357.2	106.8	2.40
Peleg	4	239	319.8	−80.8	−1.74	306.5	−67.5	−1.52
Reu	5	239	277.6	−38.6	−.83	264.8	25.8	−.58
Serug	6	230	240.9	−10.9	−.24	230.4	−.4	−.01
Nahor	7	148	209.1	−61.1	−1.32	202.0	−54.0	−1.18
Terah	8	205	181.5	23.5	.51	178.6	26.4	.57
Abraham	9	175	157.5	17.5	.38	159.2	15.8	.34
Isaac	10	180	136.7	43.3	.94	143.3	36.7	.80
Jacob	11	147	118.7	28.3	.61	130.2	16.8	.38
Joseph	12	110	103.0	7.0	.15	119.3	−9.3	−.21
Moses' Contemporaries	16	70	58.5	11.5	.24	91.9	−21.9	−.60
Selected Generations Away From Shem	19		38.2			81.6		
	29		9.3			70.3		
	39		2.3			68.6		
	99		0.0			68.3		

*y = 563 exp (−0.1416x).
**y = 68.34 + 514.8 exp (−0.1927x).

gression model that fits the post-Flood data is as follows:

$$\hat{y} = 68.34 + 514.8e^{-.1927x} \qquad (14)$$

This model has a smaller sum of squares, 26213 versus 28728, for the exponential decay model in equation (12); but the standard deviations about the regression lines are about the same, 2394 and 2383 respectively. However, the asymptotic exponential decay model not only describes the data well, but it also accurately predicts for future generations. Table 4 shows that the predictions for 19, 29, 39, and 99 future generations away from Shem are very close to what Psalm 90:12 says, 81.6, 70.3, 68.6, and 68.3 years old. Thus, there is a converging of the estimate of life-span to 68.3 years, which is very close to the male expectation of life at birth in 1980 at 69.8 years.[25] A graph of this model and the data is shown in Figure 3.

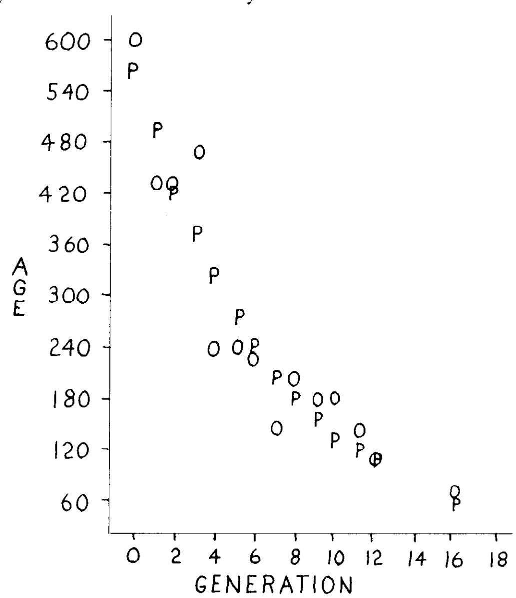

Figure 2. Post-Flood data: nonlinear exponential decay curve. "O" shows the observed age of the patriarchs, "P" the predicted age. A connection of the predicted points P would give the predictive curve.

Examination of the residuals for the AED model shows that Eber again has the largest residual and largest studentized residual. At a 10 percent significance level, Eber would not be an outlier by the maximum studentized residual criterion.[26] Using the studentized residual with the i^{th} observation deleted from the model, Eber is very suspect at a 1 percent level of significance. Other outlier diagnostics discussed by Hoaglin and Welsch suggest that Shem and Moses' contemporaries could be outliers, but close examination of the changes in the coefficients with the i^{th} observation deleted and the change in overall model fit with the i^{th} observation deleted show these two observations to be consistent with the model and the rest of the data.[27] Thus, only Eber, whose life-span increased over his father's, rather than decreasing, is still possibly an outlier. It has recently been suggested by Peterson that Eber was a prophet who had been informed by God that the earth was going to be divided during his son's lifetime (since Peleg, Eber's son, means division in Hebrew) with the division of the people due to the confusion of tongues at the Tower of Babel and with the division of the land masses with water.[28] If Eber was such a prophet, then the extended life-span for him may have been an extension of his ministry during some difficult days. As a result then, Eber Biblically is a valid observation but with different circumstances surrounding his lifetime.

To evaluate the special impact that Eber has on the AED model, a nonlinear jackknife procedure was used whereby each observation was deleted from the post-Flood data set and the Marguardt nonlinear algorithm was rerun using the original least squares estimates as

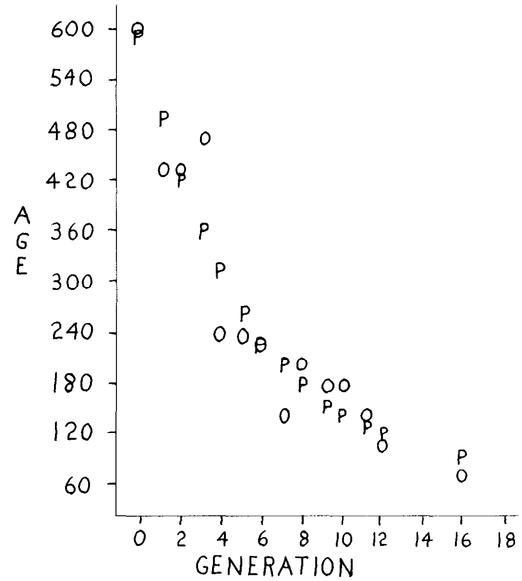

Figure 3. Post-Flood data: asymptotic exponential decay curve. "O" indicates the observed age of the patriarchs, "P" the predicted age. A connection of the predicted points P would give the predictive curve.

starting points.[29] These nonlinear least squares estimates of the AED model parameters are shown in Table 5. Only the coefficient estimates with Eber omitted are widely different from the other estimates. In fact, the average of these nonlinear estimates with a patriarch omitted is very close to the preferred AED model ($b_0 = 68.34$, $b_1 = 514.8$, $b_2 = .1927$). While this author has assumed consecutive generations for Genesis 11, even the omission of a generation, one at a time, does not change the equation of the model significantly.

In developing a jackknife estimate of the nonlinear coefficients which was distribution-free and rather insensitive to an outlier, Duncan and Fox have suggested the use of pseudo-values, which are

$$P_i = nb - (n - 1)b_{-i} \qquad (15)$$

the difference between the nonlinear least squares estimates and the nonlinear estimate with the i^{th} data point deleted.[30] The average of these pseudo-values for each estimated parameter will give a jackknife estimate. These jackknife estimates are given in Table 5, and again they are little different from the original AED model except for b_0, which is now estimated at 78.09 years instead of 68.34 years. An important aspect of these pseudo-values is their analogy to residuals in which case the pseudo-values for Eber are the most extreme.

In the final analysis, the AED fits the post-Flood data better than any other model, even with the one patriarch generation omitted. Secondly, even the fact that Eber lived longer than might have been expected during his day and so tended to be a statistical outlier (but not a Biblical outlier) did not invalidate the AED model. Thirdly, the fact that the original AED model converges to 68.3 years or the jackknife AED model converges to 78.1 years is further confirmation that this model is in line with what the Bible says. It is interesting to note that the 1980 preliminary expectation of life at birth was 73.6 for all residents of the United States, 69.8 for all male, and 77.5 for all females.[31] The highest life expectancy according to the 1982 World Almanac and Book of Facts was 79.2 years for all females in Iceland.[32] Thus, time and statistics again confirm the validity of the Bible, and the AED model fits the Genesis 11 data of the past plus the present day situation.

Post-Flood Analysis — Septuagint Text

The Septuagint (LXX) for Genesis 11 not only contains an extra name, Cainan, that does not appear in the Hebrew Masoretic text, but also an entirely different set of numbers for "begetting" ages and lifespans. The net result is that Genesis 11 contains an additional 880 years between the Flood and Abraham. Niessen concludes from historical evidence that the Septuagint records of Genesis 5 and 11 were tampered, that the second Cainan in Genesis 11 is spurious, and that the second Cainan was accidently added to later copies of Luke.[33] Even a statistical analysis of the Septuagint lifespans versus generation leads to some suspicious

Table 5. Post-Flood Jackknife Analysis.

Patriarch	Nonlinear Coefficient Estimates With Patriarch Omitted			Pseudo-Values		
	b_0	b_1	b_2	P_0	P_1	P_2
Shem	49.57	502.36	.1164	312.35	676.50	.5346
Arpachshad	69.61	541.30	.2009	51.78	170.25	.0856
Shelah	71.24	508.90	.1954	30.67	591.50	.1568
Eber	99.69	481.46	.2424	−339.20	948.26	−.4543
Peleg	44.38	536.58	.1662	379.83	231.66	.5367
Reu	60.65	520.07	.1820	168.38	446.35	.3308
Serug	68.27	514.83	.1925	69.29	514.39	.1944
Nahor	61.92	515.34	.1785	151.86	507.83	.3774
Terah	67.77	517.62	.1964	75.81	478.17	.1447
Abraham	66.27	517.80	.1931	95.21	475.86	.1867
Isaac	59.24	524.94	.1896	186.62	382.95	.2331
Jacob	62.00	521.01	.1891	150.17	434.10	.2385
Joseph	73.10	510.51	.1960	6.43	570.62	.1497
Moses' Contemporaries	92.56	496.02	.2153	−246.55	759.01	−.1019
Average	67.59	514.91	.1931	78.09	513.39	.1867*

*$y = 78.09 + 513.39 \exp(-0.1867x)$ is the jackknife model.

results. The Septuagint data listed in Table 6 and plotted in Figure 4 reveals a directly inverse relationship between age and lifespan. The simple linear regression model

$$\hat{y} = 542.76 - 32.25x \qquad (16)$$

fits the data very well. Both model coefficients are extremely statistically significant at a level of significance of 0.0001. The largest residuals and studentized residuals (shown in Table 6) are for the end points of the data set, Shem and Moses' contemporaries. Using the maximum studentized residual, the 70 year-old for Moses' contemporaries is a statistical outlier at a 10 percent level of significance.[34]

However, using the studentized residual with the i^{th} observation deleted plus scaled measures of change in each parameter estimate with the i^{th} patriarch deleted, the lifespans of Shem and Moses' contemporaries are statistical outliers.[35] This is very surprising in light of the fact that the Pearson correlation coefficient is −.976 between age and generation while the Spearman correlation coefficient is −.995. If the observation for Moses' contemporaries is dropped from the post-Flood data set, the Pearson correlation coefficient jumps up to −.986 and there are no statistical outliers for this reduced data set. The high correlation with the full Septuagint data set with outliers and a higher correlation with the reduced data set with no outliers (and yet still having poor predictability for Moses' contemporaries) suggest that something is wrong either with the model or the data. The simple linear model does not fit the scientific expectation of a decay curve for the post-Flood era, and according to Dillow,

> Such a decay is a common curve whenever a system in equilibrium is suddenly acted on in a way that results in pressure toward a new equilibrium. It can be seen in the discharge of a capacitor in the laboratory and in many other scientific experiments.[36]

In particular, an AED curve would be the expectation. There is no doubt that Shem at 600 years and Moses'

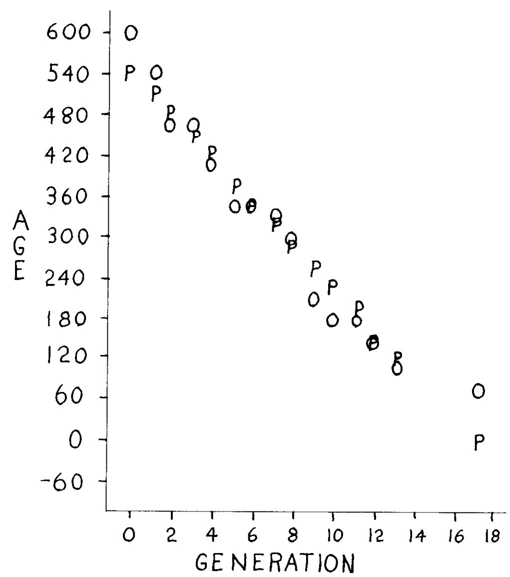

Figure 4. Post-Flood data as given in the Septuagint: simple linear regression model. "O" shows the observed (i.e., stated in the Septuagint) age of the patriarchs, "P" the predicted age. A connection of the predicted points P would give the predictive curve.

contemporaries at 70 years are valid Biblical points. Thus, the end points being valid and the simple linear model fitting the data but missing the end points and not being scientifically appropriate, there must have been a tampering with the Genesis 11 lifespans in the making of the Septuagint, as suggested by Niessen.[37] In fact, statistically it is very likely that the lifespans were adjusted up to force the data to fit a straightedge or simple linear model.

Even a nonlinear model of the AED form was fitted to the Septuagint Genesis 11 data; but it had poor predictability and the estimated coefficients were Biblically meaningless. Thus, the statistical analysis of the Septuagint post-Flood data reveals that the Septuagint data are invalid.

Table 6. Post-Flood: Simple Linear Regression Model with the Septuagint Data.

Patriarch	Generation	Age	Predicted Age	Residual	Studentized Residual	Studentized Residuals With i^{th} Point Deleted
Shem	0	600	542.8	57.2	1.78	1.97
Arpachshad	1	535	510.5	24.5	.74	.73
Cainan	2	460	478.3	−18.3	−.54	−.53
Shelah	3	460	446.0	14.0	.41	.40
Eber	4	404	413.7	−9.7	.28	−.27
Peleg	5	339	381.5	−42.5	−1.22	−1.24
Reu	6	339	349.2	−10.2	−.29	−.28
Serug	7	330	317.0	13.0	.37	.36
Nahor	8	304	284.7	19.3	.55	.53
Terah	9	205	252.5	−47.5	−1.36	−1.40
Abraham	10	175	220.2	−45.2	−1.30	−1.34
Isaac	11	180	188.0	−8.0	−.23	−.22
Jacob	12	147	155.7	−8.7	−.26	−.25
Joseph	13	110	123.5	−13.5	−.41	−.39
Moses' Contemporaries	17	70	−5.6	75.6	2.59	3.56

Conclusions

On the basis of the statistical analysis of the lifespans in Genesis 5 and 11, using linear and nonlinear models, some important conclusions need to be repeated. First off, for the genealogies in Genesis 5 for which the Biblical evidence indicates no gaps, the statistical model that best fits those lifespans is either a median or robust regression model with practically a zero slope. Such a model, which is not affected by the outlier Enoch, indicates that there were extremely stable conditions of life prior to the Flood, interpreted by many as stable atmospheric conditions. Secondly, the basic exponential decay curve is inadequate for the post-Flood era, but the asymptotic exponential decay curve on the Masoretic text lifespans provides the best fit. The AED model is best as far as description of the relationship between ages and generations, as far as prediction of future lifespans, as far as explainability, and as far as agreement with the Bible (in particular Psalm 90:12). Thirdly, the fact that the AED model provides estimates of today's longevity which are in agreement with the Bible confirms again that "the grass withers, the flower fades, but the Word of our God abides forever" (Isa. 40:8). Fourthly, the statistical analysis of the Septuagint lifespans in Genesis 11 supports Niessen's recent conclusion that there was a deliberate tampering of the ages. And finally, if there were gaps in the Genesis 11 genealogy, which is not likely in light of the excellent Biblical and statistical fit of the AED model, then the gaps would have to be systematic, specific, nonrandom, and of the AED model form.

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14. Dillow, p. 162.
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16. The critical value at a 1 percent level of significance for the studentized residual is 2.55 according to Lund, pp. 473-476. Since any single studentized residual with the i^{th} data point omitted is distributed as a t distribution, the probability of a t of 8.39 with 7 degrees of freedom is considerably less than .0005. Hoaglin and Welsch, p. 20.
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22. The studentized residual with the i^{th} observation omitted is 2.57 for Nahor, but with only 12 degrees of freedom Nahor is only an outlier at a .025 level of significance and not at a .01 level of significance. Measures of change in overall model fit or in coefficients do not suggest that Nahor is an outlier. Hoaglin and Welsch, p. 20.
23. The smaller this sum of squares the better the fit of the model is to the actual data.
24. While Eber has the largest studentized residual of 2.07 which is not statistically significant at 10 percent and the largest studentized residual with the i^{th} patriarch omitted (2.47) which is significant at a 5 percent level of significance, the other outlier diagnostics such as Cook's index, change in overall fit, or change in coefficients with the i^{th} observation deleted reflect nothing unusual about Eber. In part, this last group of outlier diagnostics cast more doubt on Shem than Eber.
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36. Dillow, p. 164.