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Examining Statistical and Practical Differences among Life Expectancy Tables: Implications for Vocational Rehabilitation

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Life expectancy tables represent a valuable tool for the vocational counselor, enabling a counselor to plan for assistive living needs, predict caregiver longevity, and, furthermore, offer a framework to compare and contrast both worklife and life expectancy. In the present study, projected life expectancies were examined in the context of their respective life expectancy tables, with a goal to determine not only whether differences exist between selected tables (statistical differences), but also evaluate whether the inconsistencies resulted in variances related to projected lost wages across a lifespan (practical significance). While there was not a statistical difference across tables, using Analysis of Variance to compare means, there was a statistical difference when comparing individual ages, utilizing paired-samples *t*-tests. This suggests that while differences do not fluctuate across tables *in globo*, differences do exist for individual ages. Moreover, differences across tables vary significantly according to age, with dissimilarities varying more than a few months across tables for older individuals and several years for younger individuals. Differences are further examined in the context of three scenarios, depicting projected financial differences among the examined life expectancy tables. Depending on both wages and length of time that a worker with a disability may be restricted from working, various tables may be biased towards prospectively under or over-projecting specified wages. Further practical applications of the present research are further discussed.

Keywords: life, expectancy, life expectancy, tables

Life expectancy embodies the number of years that a person may most probably expect to live (Olshansky, et al., 2005), affecting not only quality of life (Kaplan & Bush, 1982), but also years remaining to critically calculate remedy or compensation in litigation, such as planning for life-continuation services, including home health, medication, or assistive living needs (Krause, 2002). Assessment of life expectancy is difficult (Carnes & Olshansky, 2007; Fries, 1980; Havrilesky, 1993), not only in consideration of both governable and uncontrollable factors, but also bearing in mind the variety of charts that potentially guide valuation of life expectancy. As such, the purpose of the present article is to examine differences between multiple charts designating life expectancy. The imposed questions will address dissimilarities between charts as summary tables, and variances associated with individual ages. Furthermore, inconsistencies pertaining to actual wage losses, linked with three case studies (comparing case studies with identified disabilities, wage earning capacity, and loss of employability), will also be scrutinized.

It is proposed that life expectancy tables represent a vital instrument or tool for the vocational rehabilitation counselor, life care planner, rehabilitation nurse, or forensic economist working in either private or public employment settings. Although life expectancy as a construct has been debated extensively in the literature, the literature has consistently suggested that an understanding of a person's life expectancy remains a vital component of both short and long term rehabilitation planning (see Katz, 2003; Strauss, Vachon, &

Shavelle, 2005 for a discussion pertaining to life expectancy estimates for chronic conditions). Alternatively, in public rehabilitation settings, an appreciation of life expectancy enables a vocational counselor to assist the family, and even the person with a disability themselves, to plan for caregiver longevity, housing, or a combination of both assistive living and economic necessities (Thornton & Slesnick, 1997). Indeed, a general comprehension of life expectancy, coupled with a command of worklife expectancy, may serve as valuable tools for the vocational rehabilitation counselor.

An essential process towards grasping the concept of life expectancy is utilization of life expectancy tables. Most, if not all, life expectancy tables are relatively easy to use. Based on a variety of personal demographic features, (present age, sex, and race) cross-references are available with the projected number of years remaining in a person's lifetime, typically represented in demarcations of both years and months remaining. A variety of tables are available for the vocational rehabilitation counselor to utilize. Undeniably, the literature has exhaustively critiqued the value and credibility of multiple tables (Silcocks, Jenner, & Reza, 2001; Wallace & Prevost, 2006).

While life expectancy tables may serve as valuable tools, it is important to note that not all life expectancy tables are the same. More specifically, different tables offer alternative projections related to life expectancy. Psychometrically, one may state that different tables have variable levels of alternative form reliability, or statistically one may otherwise propose that life expectancy tables have error or variability. Differences between life expectancy tables most probably are due to both theoretical foundations for creating the tables, as well as procedural processes for completing calculations. Procedurally, life expectancy tables are the result of mathematical formulas. Similarly, formulas are dependent on imputations with different numbers, obviously affecting the end result. Taking into consideration both theoretical foundations and imputation processes, multiple life expectancy tables have summarized data enabling ready-access to project life expectancy.

Future life expectancies across tables vary from a few months to several years, depending on both the table and the original age. As such, many important questions may be presented pertaining to these differences. First, are there statistical differences *between* the tables? Statistical differences may be compared by analyzing both variances between and within the tables, enabling completion of a simple Analysis of Variance (ANOVA). However, a simple ANOVA does not fully account for differences between ages, leading into a second empirical question. Second, are there statistical differences between the *individual* ages? Vocational rehabilitation counselors most often are not interested in the entirety of a table, but rather differences equated for an individual client or individual with a disability. Paired-samples *t*-tests allow an examination of not only differences associated with mean differences, but also these differences in the context of population distribution, or sampling error of the mean. Third, how much do these differences translate to projected *wage losses for actual clients*? Vocational counselors, particularly when considering wage losses and loss of wage earning capacity, most often are interested in the monetary differences projected by one table in comparison to another table. As such, the present article has examined practical differences, as demonstrated by three case studies in addition to statistical differences.

Method

Defining Constructs

Numerous constructs must be defined in the scope of the present methodology: *life*, *expectancy*, and *life expectancy*. In order to define life expectancy it is necessary to define the individual constructs. According to *Black's Law Dictionary* (1979) "life" is a state in which an organized being can function naturally. This source also claims that "expectancy" is that which is expected or desired (1979). The term "life expectancy," or "expectancy of life" is "the share or number of years of life which a person of a given age may, upon an equality of chance, expect to enjoy" (Black, 1979, p. 517). (It is important to note that life expectancy is defined in the context of "expected to enjoy." Oftentimes, life expectancy may be evaluated in the context of quality of live versus number of years remaining. While these discussions are beyond the scope of the present article, these discussions should be further examined in future studies.)

Identification of Hypotheses

Utilizing the framework of the null hypothesis, it is posited that the predicted life expectancy will not vary across each life expectancy table, or H_O: $\mu_1=\mu_2=\mu_3$. As an alternative hypothesis, it is projected that differences will exist across the life expectancy tables, or $H_A=\mu_1\ \mu_2\ \mu_3$. This would suggest that life expectancy does vary across the tables, considering both within and between subject variances.

Another assumption would be that the specific predicted life expectancy per each age will vary in regards to each life expectancy table. As individual paired-sample *t*-tests will be completed several projections are presented. Again using the framework of the null hypothesis several results could be proposed, including (1) H_O: $x_1= x_2$, (2) H_O: $x_1 = x_3$, (3) H_O: $x_2 = x_3$. As an alternative hypothesis, it is projected that differ-

ences will exist across the life expectancy tables, or (1) H_0: x1 ≠ x2, (2) H_0: x1 ≠ x3, (3) H_0: x2 ≠ x3. This would suggest that there is a significant difference between predictions among each life expectancy table.

Selection of Tables

Multiple tables are available for the vocational counselor to assist in making projections. Three tables were reviewed or analyzed in the present study. First, the *Future Damage Calculator* (FDC) was utilized. It derived its information from numerous sources such as the U.S. Dicennial Life Tables, various actuarial tables, and data from the U.S. Census Bureau (Lawyers and Judges Publishing Company, 2012-2013). This specified table imparts its information in the form of a chart that allows the user to pick a specified age, along with race and sex, for a plaintiff then consequently identify the projected data for the number of years remaining in that subject's life. Second, the *Expectation of Life and Expected Deaths by Race, Sex, and Age: 2008* (Census Bureau, 2008) was examined. It uses a blending of vital statistics, including death rates and modeled probabilities of death, resulting in a table accessible by cross-referencing a specific age and deriving the projected number of years remaining (U.S. Census Bureau, 2008). This model derived from the U.S. National Center for Health Statistics (2008) measures the death rates for ages under 66 and modeled probabilities of death for the age range of 66 through 100. Third, the *Expectation of Life and Expected Deaths by Race, Sex, and Age: 2004* (U.S. Census Bureau, 2004) table was also examined, due to its contiguous relationship with the aforementioned table from 2008 (U.S. Census Bureau, 2004). It is important to note that the Census Bureau tables are updated approximately every four years. Considering a federal or state case may take several years to come to trial, a question must be presented whether utilization of a "2004" chart will necessarily statistically vary from a "2008" chart, leaving an important question whether using the same tables with different distribution dates may result in difference in calculation of life expectancy years.

Statistical Analyses

ANOVA analyzes the variance within each sample of data and between samples of data, while in regards to life expectancy tables and the projected number of years of life remaining, the function was used to measure the difference between the table means. The relationship between individual age and projected number of years of life remaining is analyzed through the paired sample *t*-tests to measure the difference between the numbers of years remaining across tables.

Selection of Age Ranges

Selection of age ranges was based on random sampling of ages, ranging from 25 to 60. As opposed to using all ages (i.e., 25, 26, 27 . . . 58, 59, 60), random samples were utilized to depict a more expected, or probable range of clients in a legal setting. That is, it would be unreasonable to expect that 50 clients would all be incrementally one year apart. As such, a random number generator was utilized to select 50 age demarcations, as opposed to simply using 50 consecutive incremental ages.

Results

ANOVA was completed to assess the mean difference of life expectancy years across three different tables. There was not a significant main effect for type of table on life expectancy years, $F(2, 147) = .593$, $p = .554$. This suggests that there is not a statistical difference in the life expectancy means between the tables when comparing both between and within subject variances.

Planned *t*-test analyses suggest that there are differences between individual ages, when referencing different tables. Three repeated measures *t*-tests were completed to compare means of individual ages across tables. There was a significant difference when comparing FDC and Census Bureau 2004 tables, $t(49)=21.62$, $p < .001$. There was a significant difference when comparing the Census Bureau 2004 and Census Bureau 2008 tables, $t(49)=52.81$, $p<.001$. There was a significant difference when comparing the FDC and Census Bureau 2008 tables, $t(49)=74.27$, $p<.001$. It is recognize that p values must be partitioned, as it is too easy to obtain either Type I or Type II errors, by completing multiple comparisons. Due to the attained p-levels, it is assessed that corrections for multiple comparisons is not needed or warranted, considering guidelines offered by Saville (1990).

Case Studies

Development of Case Studies

Three case studies were developed based on past work activity, or cases worked by the first author. The cases were identified wherein the workers varied by wages and ages, but did not vary by sex or race. As discussed previously, a variety of both controllable and pre-determined factors contribute to life expectancy, in which all factors could not be equated across all of the following case studies. While the case studies were developed by the first author, the economic cost projections were developed by the third author, an Economist. In the pending cost projections, a 5% discount value was utilized.

Case Study One

Thomas T. is a male, age 26, with brain trauma, related to a motor vehicle accident. Thomas T. was a shuttle driver for the City of New Orleans, as he was responsible for transporting festival goers and musicians during the New Orleans Jazz and Heritage Festival. He was not married, but he did have one child, age 3, named Joseph. Thomas was "t-boned" by an 18-wheeler transporting equipment for a reggae band that was playing at the festival. Based on trauma, Irma will not return to the workforce due to a combination of physical and cognitive disabilities. At the time of the accident, Irma was earning $24,300 annually. Based on pending settlement, wage losses would be compensable to death.

Case Study Two

Eric C. is a male, age 47, with an above-elbow amputation, related to infection following surgical intervention. Eric C. was a mechanic for the City of New Orleans and was responsible for maintaining the city busses. He was married; he had three children, ages 12, 8, and 6. Eric will be able to return-to-work, albeit at a reduced capacity. At the time of accident, he was earning $42,300; now, considering that he is working part time, is capable of earning $27,300, resulting in a $15,000 annual wage loss. Based on pending settlement, wage losses would be compensable to death.

Case Study Three

John M. is a male, age 67, with respiratory problems, related to inhalation of fumes, while working as an airplane fuel technician, a position he held until he was not able to maintain needed physical conditioning to sustain employment. John M. was married; he had two children, ages, 37, and 42. At the time of accident, he was earning $47,900; now, considering a summation of physical conditions, he is not able to return-to-work in any capacity. Based on pending settlement, wage losses would be compensable to death.

Table 1
Case 1: Loss of Future Earnings Using Different Life Tables: Thomas T.

Lawyers and Judges Life Expectancy	$ 903,756
NVSR 2004 Life Expectancy	$ 902,548
NVSR 2008 Life Expectancy	$ 904,965

Table 2
Case 2: Loss of Future Earnings Using Different Life Tables: Eric C.

Lawyers and Judges Life Expectancy	$ 391,027
NVSR 2004 Life Expectancy	$ 390,072
NVSR 2008 Life Expectancy	$ 391,991

Discussion

Typically, results are compared against a specific theoretical construct or proposal. In this study, the results may be considered in context of classical test theory (See Gregory, 2011 for a review) , wherein, results must be considered not only within the framework of "raw" scores, but also in consideration of "error," with error resulting in altered projected ages across different tables. The results are consistent with the proposal that life expectancy tables do not differ from one another, considering the composite tables; however, when comparing the individual ages, there are differences in projected ages, reflecting both statistical and practical differences. Unfortunately, it is not possible to compare the present results with other studies that have either directly or indirectly addressed these empirical questions. That is, prior research has not examined test-retest, split half, or alternate form reliabilities of life expectancy tables, resulting in lack of comparison to similar or parallel studies.

Statistical differences were not found between tables using ANOVA. As such, anecdotally, if one asks the question whether selected tables in general differ from each other, based on the present study, the response would be negative. Statistically, while sample means within tables may vary (reflective of individual ages), the mean between table variances is not sufficiently different, wherein non-statistical difference was found in the present study. As such, differences must be examined not across entire tables, but rather at a more specified level, or individual ages.

In the present study, statistics differences were found across all *t*-tests performed. First, there were differences between the FDC table and both the Census Bureau 2004 and Census Bureau 2008 tables, with the mean year difference varying greater with the Census Bureau 2008 table (M=.41, SD=.13) than the Census Bureau 2004 table (M=1.85, SD=.18). However, one must also consider the direction of these differences.

Table 3
Case 3: Loss of Future Earnings Using Different Life Tables: John M.

Lawyers and Judges Life Expectancy	$ 758,555
NVSR 2004 Life Expectancy	$ 754,920
NVSR 2008 Life Expectancy	$ 748,753

In reference to the FDC table, the Census Bureau 2004 table tends to offer lower life expectancies, while the Census Bureau 2008 offers greater life expectancies. When comparing both of the Census Bureau tables, a statistical difference was also found, again with the Census Bureau 2008 table offering the greater expectancy of remaining life years. This suggests that the vocational rehabilitation counselor must carefully consider updates, or updated tables, even when using tables from the same publisher. A listing of age projections, along with derived differences across tables is depicted in Table 1.

Undeniably, life expectancy varies, considering a variety of factors, including age (Everitt & Le Coteur, 2011), gender (Conti et al., 2003), socioeconomic contributors (Perenboom, Van Herten, Boshuizen, Van Den Bos, 2005), cohort effects (Rajpathak et al., 2011), geographic region (Conti et al., 2003), among others. One must also recognize that life expectancy tables are dynamic, not static documents, due to the fact that mortality is dynamic, or not certain in regards to age.

One must also consider potential outliers, particularly among those that have demonstrated the ability to live beyond expected life expectancy. Rosero-Bixby (2008) used birth-registration ledgers and census data to compare Costa Rican farmers to those in 13 high-income countries, and found that on average mortality rates for the Costa Ricans was 14% lower. A comparison with the United States and Sweden found that the Costa Rican nonagenarians have a reduced incidence of cardiovascular diseases and obesity, but notes that frailty effects must be accounted for. According to the *Social Characteristics and Health Status of Exceptionally Long-Lived Americans in the Health and Retirement Study*, which sought to characterize the different health of "exceptional survivors", those who remained independent for the longest amount of time were those who lived to a greater age (Ailshire, Beltran-Sanchez, & Crimmins, 2011). Life expectancy is increasing, but life expectancy tables remain the same. Oeppen and Vaupel (2002) made the controversial claim that there is no limit to life expectancy, as has long been assumed. From their research, they have concluded that while life expectancy continues to rise in a linear fashion with no maximum in sight, women are also surpassing men even more than before (previously 2 years, now 6 years).

Although variability has been found across life expectancy tables, it is not proposed that the use of said tables, moreover examining life expectancy as an important construct, should be abandoned. The practical use of life expectancy encompasses many environments. Everitt and Coeaur (2011) examined the increase in life expectancy over a fifty year period in Australia, and concluded that the progress of medical life expectancy research on ageing has advanced the understanding of ageing in a positive manner, thus promoting practices to better the ageing process. Hasegawa et al. (2011) explored the relationship between "lifestyle", "socioeconomic factors", "health and disease", and "social health", and life expectancy. After performing the cross-sectional study, it was determined that "socioeconomic factors" were the most important factors in influencing survival. Van Wieren, Roberts, Arellano, Feller, and Diaz (2011) study sought to explore the relationship between acculturation and cardiovascular behaviors among different Latino nationalities, and found that Latinos have overall better health outcomes than non-Latino whites despite their typically low socioeconomic status. Wong et al. (2005) explored the differences in cause-specific mortality between Latino and white adults in the United States, and found that Latinos had higher mortality rates when affected by diabetes, homicide, HIV, and liver disease, but whites had higher mortality rates when affected by lung cancer. Result from all of these studies has serious implications for public health policy.

The present study offers a glimpse into the need for additional research. There are several directions that future research needs to pursue, in which three directions will be discussed. First, it must be recognized that three tables were reviewed in the present study, leaving question related to the reliability between tables and subsequent cross-table differences among the tables not addressed in the present study. Perhaps, additional articles may seek not only to identify the complete number of life expectancy tables, but also offer descriptors for each table. Second, discussion must begin whether single tables offer the best predictor, considering the variety of available tables. Perhaps, two or multiple tables may be utilized and a mean taken across tables to offer a sampling mean across tables. In the context of the present paper, the practice of forensics was the empirical and theoretical focus. However, it is important to recognize that evaluation of life expectancy has significance beyond forensics, encompassing such areas as hospital planning, life care planning, insurance projections related to health annuities, human resources and worklife expectancy, and elderly care. Moreover, these represent a miniscule representation of future directions for this research.

Conclusion

The purpose of this research was to examine the statistical and practical differences between life expectancy tables. Statistical differences referred to whether means between tables would occur by chance or due to differences in the independent variable—represented by different tables. Statistical differences suggested that *in globo* there were no differences between tables when considering only mean squares between and within; however, paired samples

t-tests indicated different results. When considering paired samples t-tests the mean difference was not 0, but rather greater than 0, reflecting statistical differences when considering the means across individual ages. Second, we examined practical differences, or how the derived results may have ecologically-valid significance. Basically, if the question is presented "do the tables vary, generally?" it will require a negative response, as across all ages there was not a statistical difference. However, a positive response would be required if asked the question "is there a difference in age projections for someone 32 years of age?" Moreover, results indicated that there are greater age differences for younger individuals, perhaps 26 years age, than older ages, conceivably 72 years of age. Lastly, the present article has heuristic value. That is, attorneys and the legal communities must critically examine which tables are utilized for life expectancy projections, as differences may not only be reflected in anticipated years, but also settlement and remedy based on derived years from differing tables.

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