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Post Hoc Analysis of Life Expectancy in West Africa

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Abstract This paper investigates the effect of country, gender and the associated interaction term on life expectancy in West African countries. The empirical analysis revealed that country and gender have statistically significant effect on life expectancy in West Africa, while the associated interaction term has no significant effect on life expectancy. Thus the removal of the nuisance interaction term seems to improve the predictive task of the statistical model. The empirical findings in this paper revealed that Cape Verde has the highest average life expectancy among all the West African countries, which also ranks highest in the United Nations index of West Africa. The Tukey HSD tests provide statistically significant differences between countries with higher life expectancy and countries with lower life expectancy. This accounts for the variation in life expectancy between the West African countries. Contrary to the notion in some previous reports which believed that countries with higher GDP tend to have a higher life expectancy, and that the difference in life expectancy per difference in GDP per capita is higher for poorer than for richer countries; this paper reveals that most West African countries endowed with natural resources resulting to higher GDP tend to have lower life expectancy.

Keywords: *life expectancy, statistical model, interaction, main effects, Tukey HSD tests*

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1. Introduction

Life expectancy is an estimated statistical measure of a person's average lifespan. The United Nations defined life expectancy as a measure of the mean number of years of life remaining at a given age, assuming age-specific mortality rates remain at their most recently measured levels. Suffice it to say that every human is expected to live longer, based on the year of its birth, its current age and other demographic factors such as gender. Empirical literature have reported notable variations in life expectancy between different countries of the world, usually caused by differences in public health, medical care, health expenditure, poverty and diet. [1,2] identified some economic and environmental factors significantly influencing life expectancy. The economic factors include public health expenditure, per capita income, unemployment and primary school enrollment while carbon dioxide emission is typical environmental factor.

Following the classification by the European Public Health Commission, there are four determinants of life expectancy which includes genetics, lifestyles, environment and socioeconomics. Everyone expects to live longer and stay healthy. Thus, life expectancy is the most useful variable to determine a country's economic growth in this direction. The World Health Report revealed that health indicators differ dramatically between countries with similar income levels located in close proximity within the group of low-income countries in Sub-Saharan Africa, resulting to variations in life expectancy [3,4]. It is a huge government responsibility to provide the essential factors that can improve the well-being of the citizenry. Unfortunately, the reverse is the case in most West African countries. Rather than enhancing human capital development to improve welfare status of the citizenry, they deliberately inflict poverty on the masses in order to influence and dance behind them, especially buying of votes during election. Notwithstanding, there are West African countries that are working tirelessly round the clock to provide a breathe of fresh air to their citizenry and to promote life expectancy.

The Mauritius Child Health Project is a unique birth cohort that has contributed immensely to promote the well-being and life expectancy in the country [5]. Existing literature have shown that Mauritius has the highest life expectancy in Africa [6,7], and up to date. It is important to note that the level of government expenditure on health could determine the ultimate level of human capital development which eventually leads to better, more skillful, efficient and productive investment in other sectors of the economy. [8] suggests that smallness, landlockedness, tropical location, distance from world markets, racism, colonialism, corruption and other daunting challenges can be overcome through appropriate institutions, governance and good economic policies, using Botswana, Ghana, Mauritius and South Africa as a case study. According to the World Bank, health expenditure covers the provision of health services (preventive and curative), family planning activities, nutrition activities and emergency aid designated for

health. On the other hand, the World Health Organization defines health expenditure as a measure of final consumption of health goods and services plus capital investment in healthcare infrastructure. Thus, health is a critical tool for determining the living standard of a nation [9].

Life expectancy is declining abruptly in some West African countries that are endowed with sufficient resources to reflect a stable welfare status of the common man. For instance, Nigeria was the leading oil producer in Africa as of 2019 with production level of 101.4 million metric tons in the country, whereas the standard of living is worsening day-by-day. [10] shows that the socio-economic environment as constituted by government health expenditure, secondary school enrolment and per capita income have not exerted significantly on life expectancy in Nigeria. The huge health budget allocation and expenditure in the country failed to translate into better health status amongst her teeming population [11]. [12] added that food poverty is a negative factor reducing life expectancy in the country. The empirical analysis in [13] demonstrates the influence of financial development and globalization on life expectancy, indicating that they are both effective measures towards improving the physical health of the people in Sub-Saharan Africa. Unfavourable government decisions such as closure of borders, blocking forex and excessive utilization of political powers to oppress the citizenry have resulted to some negative economic implications and reducing life expectancy in the region. Lack of sanctions to country leaders or presidents by regional bodies such as the Economic Community of West African States (ECOWAS) and the African Union (AU) gave rise to recklessness in some member states. The main goal of ECOWAS is to promote economic cooperation among member states in order to raise living standards, to promote economic development, and to address some security issues by developing a peacekeeping force for conflicts in the region. Regretfully, the living standard of the citizenry in most member states is mortgaged for political negotiation.

The statement of the problem lies on the investigation of the effect and significant differences in gender and country on life expectancy. This paper is mainly concerned with the application of experimental design with post hoc tests to investigate the differences in life expectancy between West African countries and to make essential recommendations to government functionaries or public office holders. Thus, the output of this study shall enrich empirical literature with useful ideas to promote increase in life expectancy in West African region.

2. Materials and Methods

2.1. Dataset and Variables

The dataset used in this paper was derived from a secondary source published by the United Nations Organization, covering life expectancy for various countries with gender partitioning. The life expectancy for 16 West African countries based on their economies and gender with replications were extracted and used for the study. The West African countries include Benin (Be), Burkina Faso (Bu), Cape Verde (Ca), *Coˆte* D'Ivoire (Co), Gambia (Ga), Ghana (Gh), Guinea (Gu), Guinea-Bissau (Gb), Liberia (Li), Mali (Ma), Mauritania (Mu), Niger (Ni), Nigeria (Ng), Senegal (Se), Sierra Leone (Si) and Togo (To). In this study, the variables include *life expectancy*, *country* and *gender*. Thus, the argument is that *country's economy* and *gender* affect *life expectancy* without interaction; and there exists significant differences between countries economies on life expectancy in the region.

2.2. Statistical Model

The statistical model will take the form:

$$Y_{ijk} = \mu + \alpha_i + \beta_j + (\alpha\beta)_{ij} + \epsilon_{ijk}; \quad i = 1,...,I; \quad j = 1,...,J; \quad k = 1,...,K \tag{1}$$

where $\epsilon_{ijk} \sim iid\ N(0,\sigma^2)$ and

$$\sum_{i=1}^{I}\alpha_i = \sum_{j=1}^{J}\beta_j = \sum_{i,j=1}^{IJ}(\alpha\beta)_{ij} = 0;$$

μ is the grand mean, estimated by $\bar{Y}_{...}$;

α_i is the row effect, estimated by $\hat{\alpha}_i = \bar{Y}_{i..} - \bar{Y}_{...}$;

β_j is the column effect, estimated by $\hat{\beta}_j = \bar{Y}_{.j.} - \bar{Y}_{...}$;

$(\alpha\beta)_{ij}$ is the interaction effect, estimated by

$\widehat{(\alpha\beta)}_{ij} = \bar{Y}_{ij.} - \bar{Y}_{i..} - \bar{Y}_{.j.} + \bar{Y}_{...}$ [14,15]

The two-way analysis of variance (ANOVA) model with interaction is defined as follows:

$$Model: SS_T = SS_C + SS_G + SS_{C*G} + SS_E \tag{2}$$

where $SS_T = \sum_{i=1}^{I}\sum_{j=1}^{J}\sum_{k=1}^{K}(y_{ijk} - \bar{y}_{...})^2$ is the total sum of squares

$SS_C = JK\sum_{i=1}^{I}(\bar{Y}_{i..} - \bar{Y}_{...})^2$ is the sum of squares for factor C

$SS_G = IK\sum_{j=1}^{J}(\bar{Y}_{.j.} - \bar{Y}_{...})^2$ is the sum of squares for factor G

$SS_{C*G} = K\sum_{i=1}^{I}\sum_{j=1}^{J}(\bar{Y}_{ij.} - \bar{Y}_{i..} - \bar{Y}_{.j.} + \bar{Y}_{...})^2$ is the sum of squares for the interaction term (C*G)

$SS_E = SS_T - SS_C - SS_G - SS_{C*G}$ is the sum of squares for the error term.

We can distinguish three different test problems which are described by the following null versus alternative hypotheses:

I.

H_0^{C*G}: No interaction effect between country and gender versus

H_1^{C*G}: There is interaction effect between country and gender

II.

H_0^{C}: There is no effect of country on life expectancy versus

H_1^C : There is effect of country on life expectancy

III.

H_0^G : There is no effect of gender on life expectancy versus

H_1^G : There is effect of gender on life expectancy

The two-way analysis of variance (ANOVA) table is as follows [16,17].

2.3. Post Hoc Analysis

The post hoc analysis is used to compare differences between multiple group means while controlling the experiment-wise error rate [18]. In this study, the Tukey Honestly Significant Difference (Tukey HSD) tests was employed to investigate the significant differences between countries economies on life expectancy.

Table 1. Two-Way ANOVA

C	$I-1$	SS_C	$MS_C = \frac{SS_C}{(I-1)}$	$F_C = \frac{MS_C}{MS_E}$
G	$J-1$	SS_G	$MS_G = \frac{SS_G}{(J-1)}$	$F_G = \frac{MS_G}{MS_E}$
$C*G$	$(I-1)(J-1)$	SS_{C*G}	$MS_{C*G} = \frac{SS_G}{[(I-1)(J-1)]}$	$F_{C*G} = \frac{MS_{C*G}}{MS_E}$
Error	$N-IJ$		SS_E	$MS_E = \frac{SS_E}{(N-IJ)}$
Total	$N-1$	SS_T		

2.3.1. Tukey HSD Test

The Tukey method applies simultaneously to the set of all pairwise comparisons $\{\mu_r - \mu_s\}$, for $r \neq s$, and identifies any difference between two means that is greater than the estimated standard error.

The null versus alternative hypotheses can be stated as follows:

$$H_0 : \mu_r = \mu_s$$

versus

$$H_1 : \mu_r > \mu_s \text{ for } r \neq s$$

Thus the Tukey HSD can be tested as follows:

$$\text{Reject } H_0 \text{ if } \mu_r - \mu_s > q_{\alpha;v,N-v}\sqrt{\frac{MS_E}{n}}$$

where $q_{\alpha;v,N-v}$ is the studentised q critical value obtained from the the studentised range distribution table for α level of significance with v and $N-v$ degrees of freedom; v is the number of groups; n is the size of each group samples; N is the sample size; MS_E is the mean squared error [19,20].

For the interaction term, we can say that two interaction means $\mu_{r,s}$ and $\mu_{r',s'}$ are honestly significant if

$$\mu_{r,s} - \mu_{r',s'} > q_{\alpha;v,N-v}\sqrt{\frac{MS_E}{n}} \quad (4)$$

The Tukey confidence limits for all pairwise comparisons with confidence coefficient of at least $1-\alpha$ are:

$$\mu_r - \mu_s \pm \frac{q_{\alpha;v,N-v}}{\sqrt{2}}\hat{\sigma}_\epsilon\sqrt{\frac{2}{n}};\ r,s = 1,2,...,v \text{ for } r \neq s \quad (5)$$

where $\hat{\sigma}_\epsilon$ is the estimated standard deviation of the entire design.

Tukey HSD test is used when the following statistical assumptions are met.

- The observations to be tested are independent within and among the groups.
- The groups associated with each mean in the test are normally distributed.
- There is equal within-group variance across the groups associated with each mean in the test.

3. Data Analysis & Discussion

The life expectancy for 16 West African countries based on their economies and gender with 5 replications were analysed using R in this paper. Following the basic assumptons of the statistical model in the experimental design, the Shapiro-Wilk test confirmed that the data followed normal distribution. The empirical analysis reveals that the interaction term (i.e., Country*Gender) is statistically insignificant, hence the interaction between country economy and gender has no significant effect on life expectancy (see Table 2 and Figure 2). Following the rule of thumb in experimental design, the main effects can only be considered when the associated interaction term is insignificant, and the resulting model is additive. The analysis in Table 2 provide a strong statistically significant evident that country economy affect life expectancy, using a 1% significance level. Also, there is a strong statistically significant evident that gender affect life expectancy. Moving to the results of the additive model involving the main effects without the associated interaction term in Table 3, the analysis reveals an improvement in the test statistic (F value) for both country economy and gender. Thus the removal of the nuisance interaction factor seems to improve the predictive task of the statistical model. In each of the West African countries, the life expectancy of females is higher than the life expectancy of males, which corroborates the statistically

significant effect of gender on life expectancy in this study. Therefore, the females appeared to live longer than the males in this direction. This analysis agreed with the Global Observatory Health report in which women generally live longer than men with a marginal average of about 6 to 8 years.

Table 2. The Two-Way ANOVA With Interaction Term

Source	df	SS	MS	F	P-value
Country	15	3000.60	200.04	37.5343	$< 2.2e-16$
Gender	1	373.63	373.63	70.1049	$8.459e-14$
Country*Gender	15	42.31	2.82	0.5293	0.9205
Error	128	682.18	5.33		
Total	159	4098.72			

Table 3. The Two-Way ANOVA Without Interaction Term

Source	df	SS	MS	F	P-value
Country	15	3000.60	200.04	39.484	$< 2.2e-16$
Gender	1	373.63	373.63	73.746	$1.374e-14$
Error	143	724.49	5.07		
Total	159	4098.72			

According to the World Health Organisation report, the countries with the lowest life expectancy are Sierra Leone, the Central African Republic, the Democratic Republic of the Congo, Guinea-Bissau, Lesotho, Somalia, Eswatini, Angola, Chad, Mali, Burundi, Cameroon, and Mozambique. The analysis of this study concords with the World Health Organisation report in which the identifiable West African countries appeared also to be worst in this study. It is now evident that poor economy among West African countries greatly affect the life span of their citizenry. It is noticeable that countries with improved economy have higher life expectancy than the countries with poor economy. The empirical findings in this paper revealed that Cape Verde has the highest average life expectancy among all the West African countries (see Figure 1). Although Cape Verde is classified as a poor country, but the quality of life ranks highest in the United Nations index of West Africa. The economy in Cape Verde is service-oriented with commerce, transport and public services which accounts for about 70% of the GDP with annual population growth of about 2.5%. Manufacturing which includes sewing, ceramics, textiles, pharmaceuticals, and beverages seems to be the main industry in Cape Verde. In recent times, Agriculture employed about 21% of the active population and contributed over 15% to GDP. Suffice it to say that it is a huge government responsibility to provide essential activities and services to improve the welfare status and promote life expectancy for their citizenry.

Table 4(a). Tukey HSD Tests

Comparison	Difference	Lower Limit	Upper Limit	P-value	Decision
Bu-Be	-3.120	-7.4271824	1.1871824	0.4586483	Insignif.
Ca-Be	11.128	6.8208176	15.4351824	0.0000000	Signif.
Co-Be	-4.954	-9.2611824	-0.6468176	0.0090700	Signif.
Ga-Be	0.714	-3.5931824	5.0211824	0.9999998	Insignif.
Gb-Be	-5.242	-9.5491824	-0.9348176	0.0038818	Signif.
Gh-Be	2.637	-1.6701824	6.9441824	0.7392869	Insignif.
Gu-Be	-1.418	-5.7251824	2.8891824	0.9988049	Insignif.
Li-Be	0.240	-4.0671824	4.5471824	1.0000000	Insignif.
Ma-Be	-3.204	-7.5111824	1.1031824	0.4109206	Insignif.
Mu-Be	2.228	-2.0791824	6.5351824	0.9110051	Insignif.
Ng-Be	-6.436	-10.7431824	-2.1288176	0.0000721	Signif.
Ni-Be	-2.327	-6.6341824	1.9801824	0.8787661	Insignif.
Se-Be	3.921	-0.3861824	8.2281824	0.1189474	Insignif.
Si-Be	-6.064	-10.3711824	-1.7568176	0.0002683	Signif.
To-Be	-0.375	-4.6821824	3.9321824	1.0000000	Insignif.
Ca-Bu	14.248	9.9408176	18.5551824	0.0000000	Signif.
Co-Bu	-1.834	-6.1411824	2.4731824	0.9825954	Insignif.
Ga-Bu	3.834	-0.4731824	8.1411824	0.1420290	Insignif.
Gb-Bu	-2.122	-6.4291824	2.1851824	0.9386350	Insignif.
Gh-Bu	5.757	1.4498176	10.0641824	0.0007574	Signif.
Gu-Bu	1.702	-2.6051824	6.0091824	0.9915556	Insignif.
Li-Bu	3.360	-0.9471824	7.6671824	0.3282350	Insignif.
Ma-Bu	-0.084	-4.3911824	4.2231824	1.0000000	Insignif.
Mu-Bu	5.348	1.0408176	9.6551824	0.0028057	Signif.
Ng-Bu	-3.316	-7.6231824	0.9911824	0.3506450	Insignif.
Ni-Bu	0.793	-3.5141824	5.1001824	0.9999993	Insignif.
Se-Bu	7.041	2.7338176	11.3481824	0.0000075	Signif.
Si-Bu	-2.944	-7.2511824	1.3631824	0.5627261	Insignif.
To-Bu	2.745	-1.5621824	7.0521824	0.6797539	Insignif.

Table 4(b). Tukey HSD Tests

Comparison	Difference	Lower Limit	Upper Limit	P-value	Decision
Co-Ca	-16.082	-20.3891824	-11.7748176	0.0000000	Signif.
Ga-Ca	-10.414	-14.7211824	-6.1068176	0.0000000	Signif.
Gb-Ca	-16.370	-20.6771824	-12.0628176	0.0000000	Signif.
Gh-Ca	-8.491	-12.7981824	-4.1838176	0.0000000	Signif.
Gu-Ca	-12.546	-16.8531824	-8.2388176	0.0000000	Signif.
Li-Ca	-10.888	-15.1951824	-6.5808176	0.0000000	Signif.
Ma-Ca	-14.332	-18.6391824	-10.0248176	0.0000000	Signif.
Mu-Ca	-8.900	-13.2071824	-4.5928176	0.0000000	Signif.
Ng-Ca	-17.564	-21.8711824	-13.2568176	0.0000000	Signif.
Ni-Ca	-13.455	-17.7621824	-9.1478176	0.0000000	Signif.
Se-Ca	-7.207	-11.5141824	-2.8998176	0.0000040	Signif.
Si-Ca	-17.192	-21.4991824	-12.8848176	0.0000000	Signif.
To-Ca	-11.503	-15.8101824	-7.1958176	0.0000000	Signif.
Ga-Co	5.668	1.3608176	9.9751824	0.0010146	Signif.
Gb-Co	-0.288	-4.5951824	4.0191824	1.0000000	Insignif.
Gh-Co	7.591	3.2838176	11.8981824	0.0000009	Signif.
Gu-Co	3.536	-0.7711824	7.8431824	0.2469245	Insignif.
Li-Co	5.194	0.8868176	9.5011824	0.0044870	Signif.
Ma-Co	1.750	-2.5571824	6.0571824	0.9888828	Insignif.
Mu-Co	7.182	2.8748176	11.4891824	0.0000044	Signif.
Ng-Co	-1.482	-5.7891824	2.8251824	0.9980396	Insignif.
Ni-Co	2.627	-1.6801824	6.9341824	0.7445742	Insignif.
Se-Co	8.875	4.5678176	13.1821824	0.0000000	Signif.
Si-Co	-1.110	-5.4171824	3.1971824	0.9999376	Insignif.
To-Co	4.579	0.2718176	8.8861824	0.0252979	Signif.
Gb-Ga	-5.956	-10.2631824	-1.6488176	0.0003885	Signif.
Gh-Ga	1.923	-2.3841824	6.2301824	0.9731780	Insignif.
Gu-Ga	-2.132	-6.4391824	2.1751824	0.9363229	Insignif.
Li-Ga	-0.474	-4.7811824	3.8331824	1.0000000	Insignif.
Ma-Ga	-3.918	-8.2251824	0.3891824	0.1196908	Insignif.

Table 4(c). Tukey HSD Tests

Comparison	Difference	Lower Limit	Upper Limit	P-value	Decision
Mu-Ga	1.514	-2.7931824	5.8211824	0.9975209	Insignif.
Ng-Ga	-7.150	-11.4571824	-2.8428176	0.0000050	Signif.
Ni-Ga	-3.041	-7.3481824	1.2661824	0.5049268	Insignif.
Se-Ga	3.207	-1.1001824	7.5141824	0.4092518	Insignif.
Si-Ga	-6.778	-11.0851824	-2.4708176	0.0000205	Signif.
To-Ga	-1.089	-5.3961824	3.2181824	0.9999510	Insignif.
Gh-Gb	7.879	3.5718176	12.1861824	0.0000003	Signif.
Gu-Gb	3.824	-0.4831824	8.1311824	0.1448894	Insignif.
Li-Gb	5.482	1.1748176	9.7891824	0.0018448	Signif.
Ma-Gb	2.038	-2.2691824	6.3451824	0.9557687	Insignif.
Mu-Gb	7.470	3.1628176	11.7771824	0.0000014	Signif.
Ng-Gb	-1.194	-5.5011824	3.1131824	0.9998446	Insignif.
Ni-Gb	2.915	-1.3921824	7.2221824	0.5800536	Insignif.
Se-Gb	9.163	4.8558176	13.4701824	0.0000000	Signif.
Si-Gb	-0.822	-5.1291824	3.4851824	0.9999988	Insignif.
To-Gb	4.867	0.5598176	9.1741824	0.0116030	Signif.
Gu-Gh	-4.055	-8.3621824	0.2521824	0.0893243	Insignif.
Li-Gh	-2.397	-6.7041824	1.9101824	0.8521805	Insignif.
Ma-Gh	-5.841	-10.1481824	-1.5338176	0.0005727	Signif.
Mu-Gh	-0.409	-4.7161824	3.8981824	1.0000000	Insignif.
Ng-Gh	-9.073	-13.3801824	-4.7658176	0.0000000	Signif.
Ni-Gh	-4.964	-9.2711824	-0.6568176	0.0088141	Signif.
Se-Gh	1.284	-3.0231824	5.5911824	0.9996244	Insignif.
Si-Gh	-8.701	-13.0081824	-4.3938176	0.0000000	Signif.
To-Gh	-3.012	-7.3191824	1.2951824	0.5221390	Insignif.
Li-Gu	1.658	-2.6491824	5.9651824	0.9935208	Insignif.
Ma-Gu	-1.786	-6.0931824	2.5211824	0.9864608	Insignif.
Mu-Gu	3.646	-0.6611824	7.9531824	0.2033733	Insignif.
Ng-Gu	-5.018	-9.3251824	-0.7108176	0.0075438	Signif.
Ni-Gu	-0.909	-5.2161824	3.3981824	0.9999954	Insignif.

Table 4(d). Tukey HSD Tests

Comparison	Difference	Lower Limit	Upper Limit	P-value	Decision
Se-Gu	5.339	1.0318176	9.6461824	0.0028849	Signif.
Si-Gu	-4.646	-8.9531824	-0.3388176	0.0212100	Signif.
To-Gu	1.043	-3.2641824	5.3501824	0.9999719	Insignif.
Ma-Li	-3.444	-7.7511824	0.8631824	0.2876991	Insignif.
Mu-Li	1.988	-2.3191824	6.2951824	0.9641387	Insignif.
Ng-Li	-6.676	-10.9831824	-2.3688176	0.0000299	Signif.
Ni-Li	-2.567	-6.8741824	1.7401824	0.7753476	Insignif.
Se-Li	3.681	-0.6261824	7.9881824	0.1907155	Insignif.
Si-Li	-6.304	-10.6111824	-1.9968176	0.0001157	Signif.
To-Li	-0.615	-4.9221824	3.6921824	1.0000000	Insignif.
Mu-Ma	5.432	1.1248176	9.7391824	0.0021597	Signif.
Ng-Ma	-3.232	-7.5391824	1.0751824	0.3954532	Insignif.
Ni-Ma	0.877	-3.4301824	5.1841824	0.9999972	Insignif.
Se-Ma	7.125	2.8178176	11.4321824	0.0000055	Signif.
Si-Ma	-2.860	-7.1671824	1.4471824	0.6127850	Insignif.
To-Ma	2.829	-1.4781824	7.1361824	0.6310859	Insignif.
Ng-Mu	-8.664	-12.9711824	-4.3568176	0.0000000	Signif.
Ni-Mu	-4.555	-8.8621824	-0.2478176	0.0269255	Signif.
Se-Mu	1.693	-2.6141824	6.0001824	0.9919928	Insignif.
Si-Mu	-8.292	-12.5991824	-3.9848176	0.0000000	Signif.
To-Mu	-2.603	-6.9101824	1.7041824	0.7570845	Insignif.
Ni-Ng	4.109	-0.1981824	8.4161824	0.0792381	Insignif.
Se-Ng	10.357	6.0498176	14.6641824	0.0000000	Signif.
Si-Ng	0.372	-3.9351824	4.6791824	1.0000000	Insignif.
To-Ng	6.061	1.7538176	10.3681824	0.0002711	Signif.
Se-Ni	6.248	1.9408176	10.5551824	0.0001411	Signif.
Si-Ni	-3.737	-8.0441824	0.5701824	0.1716552	Insignif.
To-Ni	1.952	-2.3551824	6.2591824	0.9693893	Insignif.
Si-Se	-9.985	-14.2921824	-5.6778176	0.0000000	Signif.
To-Se	-4.296	-8.6031824	0.0111824	0.0513592	Insignif.
To-Si	5.689	1.3818176	9.9961824	0.0009473	Signif.

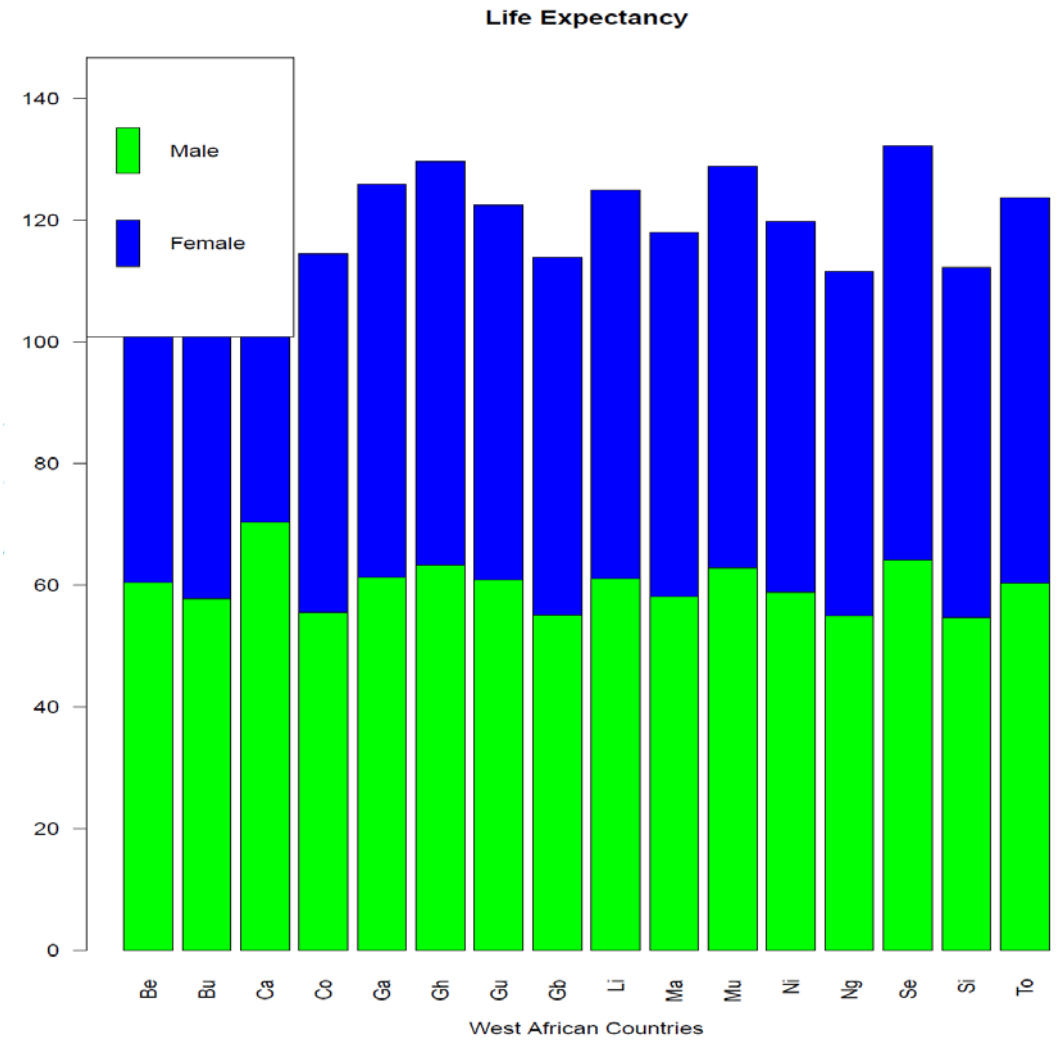

Figure 1. Stacked Bar Plot showing the Average Life Expectancy between Males and Females

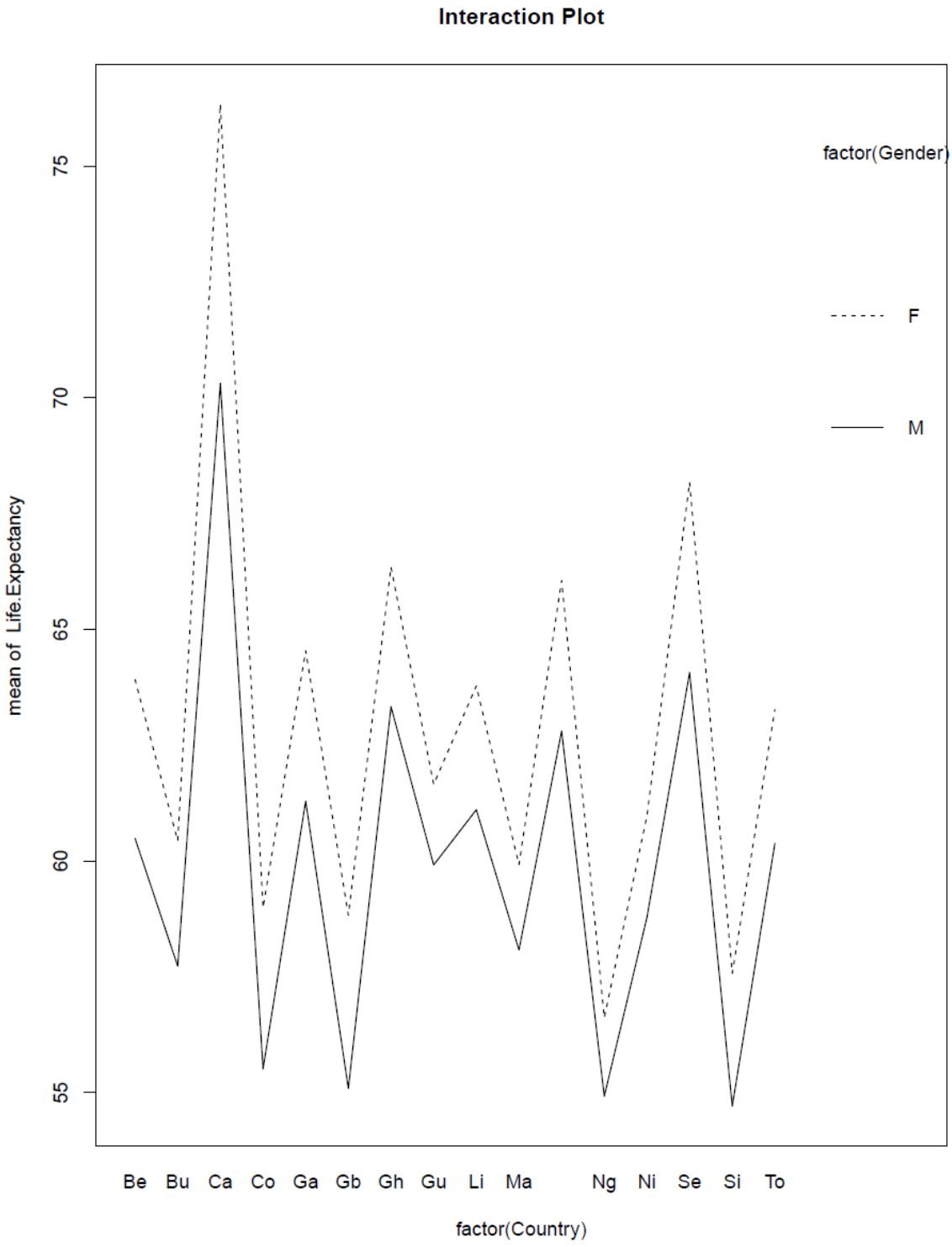

Figure 2. The Interaction Plot between Country and Gender on Life Expectancy

The Tukey HSD test results confirmed statistically significant differences between countries with higher life expectancy and countries with lower life expectancy (see Tables 4(a), 4(b), 4(c), 4(d) and Figure 3). This accounts for the variation in life expectancy between the West African countries. Contrary to the notion in some previous reports which believed that countries with higher GDP tend to have a higher life expectancy, and that the difference in life expectancy per difference in GDP per capita is higher for poorer than for richer countries; the empirical findings in this paper reveals that most West African countries endowed with natural or mineral resources resulting to higher GDP tend to have lower life expectancy, especially Nigeria. Majority of these West African countries are dwelling in darkness, no stable power supply, poor medical facilities, misappropriation or diversion of funds meant for public health expenditure, insurgency, criminal activities, brain-washing and corruption. It is a scenario in which the rich gets richer while the poor gets poorer, and the rich deliberately inflict poverty on the less-privileged in order to oppress, brain-wash and control them, and making the poor to dance behind them, and imposing support during periodic elections. These practices have accounted drastically to reduce the lifespan of the citizenry.

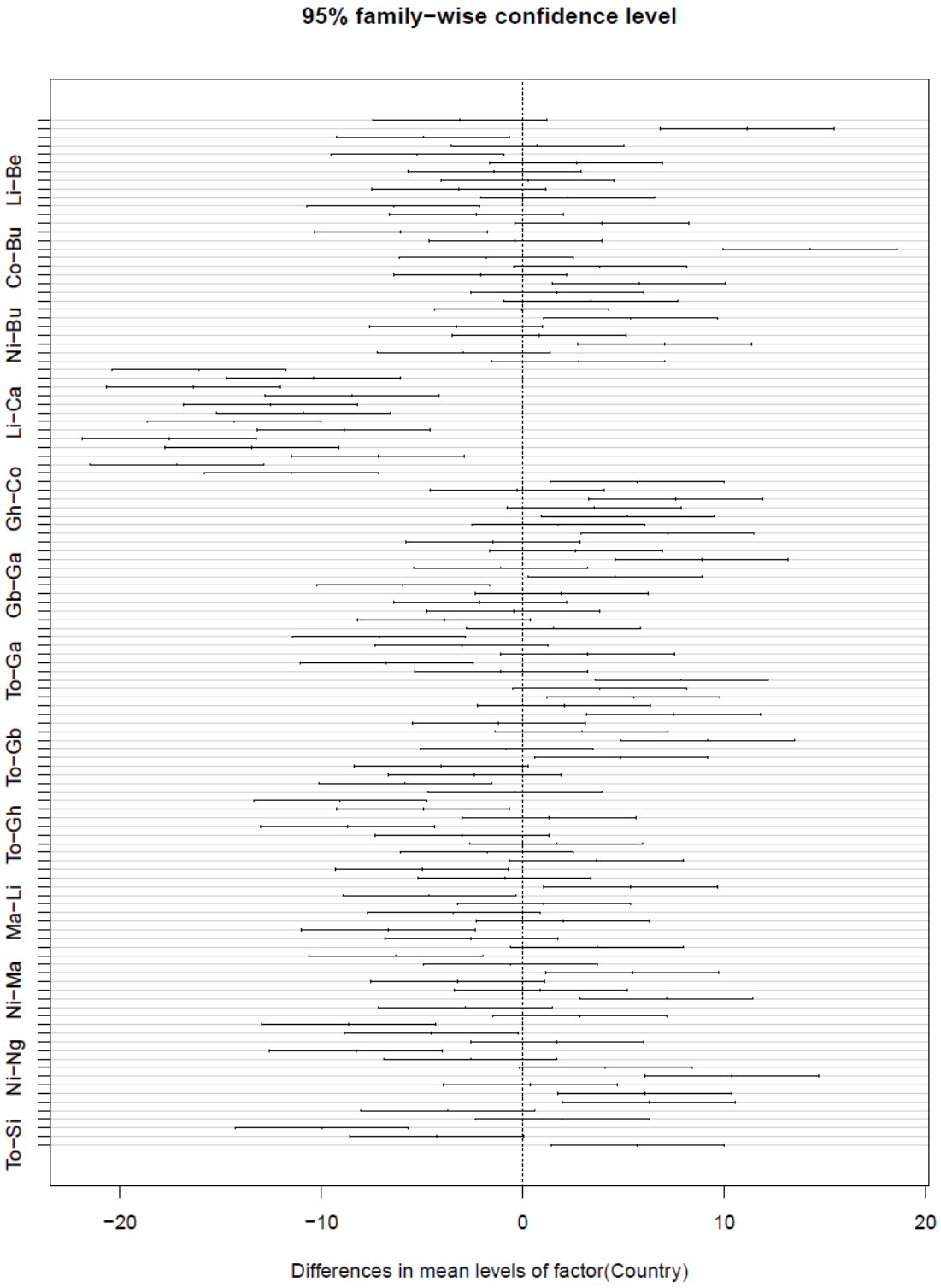

Figure 3. The Differences in Mean Levels of factor (Country)

4. Conclusion & Recommendations

The empirical findings in this paper revealed that country and gender have statistically significant effect on life expectancy in West Africa. Whereas the associated interaction term has no significant effect on life expectancy. Thus the removal of the nuisance interaction term seems to improve the predictive task of the statistical model. In each of the West African countries, the average life expectancy of females is higher than the average life expectancy of males, which corroborates the statistically significant effect of gender on life expectancy in this study. Indeed, this analysis agreed with the Global Observatory Health report in which women generally live longer than men with a marginal average of about 6 to 8 years.

Suffice it to say that poor economy among West African countries greatly affect the life span of their citizenry. It is noticeable that countries with improved economy have higher life expectancy than the countries with poor economy. The empirical findings in this paper

revealed that Cape Verde has the highest average life expectancy among all the West African countries. Although Cape Verde is classified as a poor country, but the quality of life ranks highest in the United Nations index of West Africa, which concords with the empirical analysis in this paper.

The Tukey HSD tests provide statistically significant differences between countries with higher life expectancy and countries with lower life expectancy. This accounts for the variation in life expectancy between the West African countries. Contrary to the notion in some previous reports which believed that countries with higher GDP tend to have a higher life expectancy, and that the difference in life expectancy per difference in GDP per capita is higher for poorer than for richer countries; the empirical findings in this paper reveals that most West African countries endowed with natural or mineral resources resulting to higher GDP tend to have lower life expectancy, especially Nigeria. It is a huge government responsibility to provide essential activities and services to improve the welfare status and promote life expectancy for their citizenry. Unfortunately, the reversed is the case in most West African countries. Thus the inability of government to keep to their responsibilities consequently leads to a reduction in lifespan of the citizenry in the respective West African countries.

The following recommendations will help to improve life expectancy in West African countries:

1. It is imperative for ECOWAS and the government of West African countries to place priority on sustainable economic development to reflect a high standard of living among thier citizenry.
2. As improved health promotes increase in life expectancy and longevity, the government of West African countries should provide well-equiped specialist hospitals and health centres or clinics, and keeps the healthcare delivery system functional.
3. The government of West African countries should constitute anticorruption agencies to probe and prosecute corrupt public office holders in order to avoid diversion or misappropriation of funds meant for public health expenditure.
4. As carbon monoxide from individual power generating plants is disastrous to life expectancy, the government of West African countries should provide stable power supply for their citizenry.
5. As women generally have a higher lifespan than men in the entire region, the government should apply discretion in legislation relating to labour force in order to enhance equilibrium in life expectancy by gender.
6. The government together with health professionals and information officers should embark on disseminating health and safety information to people living in the rural areas.

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