Modelling the Effect of Shoe-size and Neck-size on Human Weight Model

Ogwumu, O.D.[1*], Ogofotha M. O.[2], Amakoromo G.I.[3], Kyaga T.Y.[4], Ezeh A.T.[5] and Elugah J.I.[6]
[1,2,3,4,5,6] *Department of Mathematics and Statistics, Federal University Wukari, Nigeria*
**Corresponding Author*

Abstract:- **The research is concerned with the development of a mathematical model for estimating the body weight of human beings in relation to some of human body parameters such as; height, waist size, neck size, and shoe size. The model was validated to see whether the model conforms to reality or not. However, the optimization result showed that there is no specific body weight that could be called a maximum or minimum. Emphasis was laid mainly on a particular proportion of Nigerians from the north-east geopolitical zone (as a case study) in order to be able to make generalizations about the entire country and beyond. Hence, the population sample for the research was the Taraba state of Nigeria's community. Moreover, several recommendations were made at the end of the model analysis, each when adhered to would bring about some medical breakthroughs to the entire human populace.**

Key words: **Effect of Shoe-size, Neck-size, Human, Weight Model, Model Validation**

I. INTRODUCTION

Noting and estimating the key parameters that affect human weight measurement is very paramount in every country today. Thus, the knowledge of weight helps in the development of a nation through identifying and reducing critical health issues associated with human body weight, as the knowledge of one's weight will lead to determining solution to such health casualty. Hence, these anthropometric parameters/measures are essential to calculate human weight. Anthropometric measure is the single most universally applicable inexpensive and non-invasive method available for the assessment of size, Proportion and composition of the human body [1].

This work is an extension to the wok of Ogwumu *et al*. (2015).Therefore, it would be important to discuss in the course of this work various mathematical approaches for estimating weight as already used in Ogwumu et al (2015) since both of the work follows similar trend. Hence, a mathematical look at this anthropometric measurement in particular is essential. This model is developed basically, to solve problems associated to weight such as; underweight, overweight and obesity.

People who are obese, compared to those with normal or healthy weight, are at increased risk for many serious diseases and health conditions, such as; high blood pressure, stroke, diabetes, heart disease, high cholesterol levels, cancer, infertility, back pain, skin infection, ulcers, gall stone among many others [2,3]. Overweight is defined as Body Mass Index (BMI) of 25 or higher, obesity is defined as a BMI of 30 or higher [4].

Obesity rates as a percentage of total population in Organisation for Economic Co-operation and Development (OECD) member countries in the years 1996 - 2003(According to BMI) [5] for thousands of years obesity was rarely seen [6]. In 2014,a lancet study estimated that the number of overweight adults in the world was 2.1 billion in 2013, compared with 857 million in 1980 [7]. The rate of obesity also increases with age at least up to 50 or 60 years old [8].

Meanwhile, we need to employ the knowledge of mathematical modelling for this task in our hands because mathematical modelling is the aspect of mathematics that connects the learning of its principles, concepts and procedures to the real world phenomena. According to [9] mathematical models are useful experimental tools for building and testing theories, accessing quantitative conjectures, answering specific questions, determining sensitivities to changes in parameter values and estimating key parameters from data, but advised that the closer mathematical model assumptions are to reality of dynamics, the more difficult the mathematical analysis, hence the need to simplify assumptions without losing track of the situation or dynamics at hand.

Thus, the need for this research and the choice of using mathematical modelling approach cannot be over emphasized. Moreover, this work is an extension of the work of Ogwumu *et al.* (2014).

1.1 Relevance of the Study

The study of weight of human beings is important to enable one know when he/she is underweight, normal weight, overweight and obese in order to take all necessary dietary and regular exercise precautions. It is useful for identifying if a person's weight corresponds to his/her height.

This model is of utmost relevance in many remote interior places in the both developed and undeveloped countries in the world as the model developed can be used to estimate human weight where the weight scale is not available due to financial constraints, but with the help of a measuring tape which is less expensive is of course a vital tool instead.

1.2 Relevance of the Study over Others

The study is peculiar to certain vegetation zone in Nigeria and can be adopted for use in other areas with same or similar unique characteristics of human.

As an addendum, without weight scale (which maybe expensive to afford) either in the hospital or at home, if an individual could identify his height, waist size, neck size and foot size, he or she will be able to estimate him/her body weight using the model developed kin this work.

II. METHODOLOGY

Under this section, we shall consider subheadings such as; Formulation of the model itself, Basic assumptions needed to give us a model that conforms to reality, establish a relationship between the model parameters, and evaluate the resulting model equations' constants.

2.1 Formulation of the Model

In similar manner, this section will also address a few subtopics as they unfold.

2.1.1 Basic assumptions

2.1.1.1 Weight (W) versus Height (H)

A very tall person must have long bones, and it is remarkable that the length of the bones accounts for the possible weight of the bones. Hence, an increase in the height (*H)* of a person gives the corresponding increase in his body weight (*W*). Hence it is the suffices to remark that the body weight of a person is directly proportional to its height since an increase in one leads to corresponding increase in the other. Hence, mathematically,

$$W \propto H$$

$$\Rightarrow W = k_1 H \tag{2.1}$$

2.1.1.2 Weight (W) versus Waist size (W_s)

A man, who uses his waist belt calibrated at a certain 36inch mark, has a weight W_1 measured. After a short while some natural and physiological factors like (illness, hunger, dehydration etc.) came upon him, and his belt calibrated at the 36inch mark could no longer size him. Hence for a perfect comfort and fitness in his dressing and his waist size (W_S), he reduced his belt calibration to yet another 32inch mark in order for his belt to fit/size him. But when his waist size (W_S) got reduced, he went and take a new measurement of his weight (*W*) and discovered that his body weight has likewise reduced in kg. Thus it can be postulated that, the weight (*W*) of a person is directly proportional to his waist size (W_S) since a decrease in one leads to a corresponding decrease in the other; and verse versa. Hence mathematically;

$$W \propto W_S$$

$$\Rightarrow W = k_2 W_S \tag{2.2}$$

2.1.1.3 Weight (W_S) versus Shoe size (S_S)

A boy still growing rapidly has a shoe size of 6.5inch and weight measure W_1. After some months/year (time) while some natural factors, such as feeding on balance nutritional diet, his growth increase, thus the shoe size 6.5inch could not size him/her and when the person measured his/her weight again, he/she discovered there an increase in him/her weight (*W*). Thus it can be postulated that the weight of a person is directly proportional to him/her shoe size.

$$W \propto Ss$$

$$\Rightarrow W = k_3 Ss \tag{2.3}$$

2.1.1.4 Weight (W) versus Neck size (Ns)

A person growing normally as a result of feeding on good nutritional diet has the neck size in a calibrated tape size is either the same or increases slightly as the weight increases. Hence it can be postulated that, the weight of a person is directly proportional to neck size (*Ns*) since an increase in one do not lead to a decrease of the other.

$$W \propto Ns$$

$$\Rightarrow W = k_4 Ns$$

2.1.2 First establishment of model parameter relationship

From our respective postulations above, adding equation (2.1), (2.2), (2.3) and (2.4) gives

$$4W = k_1H + k_2Ws + k_3Ss + k_4Nsss$$

$$\therefore W = AH + BWs + CSs + DNs \tag{2.5}$$

Where H = Height of an individual human being

W_S = Waist size of an individual human being

S_S = Shoe size of an individual human being

N_S = Neck size of an individual human being

W = Weight of an individual human being

And A, B, C and D are the model constants.

2.1.3 Nature of equation's basic assumption

Under this heading, the nature of the equation view was given to the relationship that existed between the variables of the model. Hence, a relationship graph was plotted for weight, height, waist size, shoe size and neck size and considering equation (2.1), (2.2), (2.3) and (2.4). It can be observed also that:

- The relationship between the human weight and height is a linear equation relationship

W = ah + C_1 (where C_1 is a constant) (2.6)

- The relationship between the human weight and waist size is linear equation relationship

  W = bW_S + C_2 (where C_2 is a constant) (2.7)

- The relationship between the human weight and shoe size is a linear equation relationship

  W = cS_S + C_3 (where C_3 is a constant) (2.8)

- The relationship between weight and neck size is a linear equation relationship

  W = dN_S+ C_4 (where C_4 is a constant) (2.9)

2.1.4 Second establishment of the model parameter relationship

From our respective equation above, if we add equation (2.6), (2.7), (2.8) and (2.9) gives,

W = a'H + b'Ws + c'Ss + d'Ns + c (2.10)

(where c is a constant, a' = $\frac{1}{4}$ a, b'= $\frac{1}{4}$ b, c' = $\frac{1}{4}$ c, d' = $\frac{1}{4}$ d, C = C_1 + C_2 + C_3 + C_4)

2.1.5 General establishment of the model parameter relationship

From our respective postulations above, if we add equation (2.5) and (2.10) in a similar way, we have;

4W = (A + a')H + (B + b')Ws + (C + c')Ss + (D + d')Ns

$$\therefore\ W = \alpha H + \gamma\, Ws + \beta\, Ss + \lambda\, Ns + \mu \quad (2.11)$$

Where: H = Height of an individual human being

Ws = Waist size of an individual human being
Ss = Shoe size of an individual human being
Ns = Neck size of an individual human being
W = Weight of an individual human being and a, b, c, d and e are the model constants.

2.2 Analysing the Model to Evaluate Its Equation Constants

To evaluate the constants in the model above, equation (2.11) is going to be differentiated partially with respect to a, b c, d and e. To do this, we minimize the model using least square method as follows: From (2.11) we let,

$$I_{min} = \min \sum_{i=1}^{10} \left(W_i - \alpha H_i - \gamma\, Ws_i - \beta\, Ss_i - \lambda\, Ns_i - \mu \right)^2 \quad (2.12)$$

$$\frac{\partial I}{\partial \alpha} = -2 \sum_{i=1}^{10} (\mathrm{Wi} - \alpha \mathrm{H_i} - \gamma\, \mathrm{W_i} - \beta\, \mathrm{S_{si}} - \lambda \mathrm{N_{si}} - \mu)\, \mathrm{H_i} = 0 \quad (2.13)$$

$$\frac{\partial I}{\partial \gamma} = -2 \sum_{i=1}^{10} (\mathrm{Wi} - \alpha \mathrm{H_i} - \gamma\, \mathrm{W_i} - \beta\, \mathrm{S_{si}} - \lambda \mathrm{N_{si}} - \mu)\, \mathrm{W_{si}} = 0 \quad (2.14)$$

$$\frac{\partial I}{\partial \beta} = -2 \sum_{i=1}^{10} (\mathrm{Wi} - \alpha \mathrm{H_i} - \gamma\, \mathrm{W_i} - \beta\, \mathrm{S_{si}} - \lambda \mathrm{N_{si}} - \mu)\, \mathrm{S_{si}} = 0 \quad (2.15)$$

$$\frac{\partial I}{\partial \lambda} = -2 \sum_{i=1}^{10} (\mathrm{Wi} - \alpha \mathrm{H_i} - \gamma\, \mathrm{W_i} - \beta\, \mathrm{S_{si}} - \lambda \mathrm{N_{si}} - \mu)\, \mathrm{N_{si}} = 0 \quad (2.15)$$

$$\frac{\partial I}{\partial \mu} = -2 \sum_{i=1}^{10} (\mathrm{Wi} - \alpha \mathrm{H_i} - \gamma\, \mathrm{W_i} - \beta\, \mathrm{S_{si}} - \lambda \mathrm{N_{si}} - \mu) = 0 \quad (2.16)$$

Hence from equation (2.13),

$$\sum_{i=0}^{10} (W_i - \alpha H_i - \gamma\, W_i - \beta\, S_{Si} - \lambda N_{Si} - \mu) H_i = 0 \quad (2.17)$$

$$\left.\begin{aligned} &\alpha \sum_{i=1}^{10} H^2 + \gamma \sum W_{Si} H_i + \beta \sum S_{Si} W_{Si} + \gamma \sum N_{Si} H_i \\ &+ \gamma \sum_{i=1}^{10} W_{Si} H_i + \beta \sum_{i=1}^{10} S_{Si} W_{Si} + \lambda \sum_{i=1}^{10} N_{Si} H_i + \mu \sum_{i=1}^{10} H_i \end{aligned} = \sum_{i=1}^{10} W_i H_i \right\} \quad (2.18)$$

Likewise from (2.14)

$$\sum_{i=0}^{10} (W_i - \alpha H_i - \gamma\, W_i - \beta\, S_{Si} - \lambda N_{Si} - \mu) W_{Si} = 0 \quad (2.19)$$

$$\alpha\sum_{i=1}^{10} H_{si}Ws_i + \gamma\sum_{i=1}^{10} Ws_i2 + \beta\sum_{i=1}^{10} S_{si}Ws_i + \lambda \sum_{i=1}^{10} Ns_iWs_i + \mu\sum_{i=1}^{10} Wsi_i = \sum_{i=1}^{10} W_iWs_i \qquad (2.20)$$

From

$$-2(W_i - \alpha H_i - \gamma W_i - \beta Ss_i - \lambda Ns_i - \mu)Ss_i = 0 \qquad (2.21)$$

$$\alpha\sum_{i=1}^{10} H_iSs_i + \gamma\sum_{i=1}^{10} W_{si}Ss_i + \beta\sum_{i=1}^{10} Ss_i^2 + \lambda \sum_{i=1}^{10} Ns_iSs_i + \mu\sum_{i=1}^{10} Ssi_i = \sum_{i=1}^{10} W_iSs_i \qquad (2.22)$$

From

$$-2(W_i - \alpha H_i - \gamma W_i - \beta Ss_i - \lambda Ns_i - \mu)Ns_i = 0 \qquad (2.23)$$

$$\alpha\sum_{i=1}^{10} H_iNs_i + \gamma\sum_{i=1}^{10} W_{si}Ns_i + \beta\sum_{i=1}^{10} S_{si}Ns_i + \lambda \sum_{i=1}^{10} Ns^2_iN_i + \mu\sum_{i=1}^{10} Ns_i = \sum_{i=1}^{10} W_iNs_i \qquad (2.24)$$

From

$$-2(W_i - \alpha H_i - \gamma W_i - \beta Ss_i - \lambda Ns_i - \mu)1 = 0 \qquad (2.25)$$

$$\alpha\sum_{i=1}^{10} H_i + \gamma\sum_{i=1}^{10} Ws_i + \beta\sum_{i=1}^{10} Ss_i + \lambda\sum_{i=1}^{10} Ns + \mu\sum_{i=1}^{10} 1 = \sum_{i=1}^{10} W_i \qquad (2.26)$$

i = 1,2,3, …, n. But for this research n=10.

Meanwhile Equations (2.18), (2.20), (2.22), (2.24) and (2.26) are to be solved simultaneously for values of α, γ, β, λ, and μ respectively.

2.2.1 Research Instrument Used

The research instrument used is known is random sampling technique. This is a situation where a certain sample of the Federal University Wukari and Firm Foundation Academy (Nursery, Primary and Secondary) School, Wukari members, which was randomly made to represent to entire population of the two communities in the research. However, during the study, only the set of persons that are not deprived by nature leading to obesity, dwarfism, and the likes were considered. Such natural situation(s) stated above may affect the authenticity of our research model and may not allow the model result to conform to reality. Also, the data collected were appropriate as they were directly from the university clinic, and the biology laboratory which has functional height measuring and weight measuring scales respectively. After all possible and positive screening of the data, 10 data were finally considered for the research.

Table 1. Measured data gathered from Federal University Wukari and Firm Foundation Academy, Wukari communities of Nigeria.

Weight(kg)	height(m)	Shoe size(inch)	Waist size(inch)	Neck size(inch)
59.1	1.75	11	30	14.5
61.3	1.725	11	33	15.5
57.9	1.615	9.2	32	15
57.9	1.6	9.6	30	15
65.4	1.72	10.5	32	16
15.8	1.075	6.5	20.5	9.5
16.3	1.065	7	21	10
15.8	1.075	6.5	20	10
16.3	1.06	7	22	10
16.3	1.1	7.5	21.5	10

Evaluation of the Equation Constants Using the Questionnaire Data in Table 1

Solving equation (2.18), (2.20), (2.22), (2.24) and (2.26) in the section above simultaneously, where from the table 1 above

Table 2.Multiplication values of the figures in table 1 above

W_i(m)	H_i(m)	S_s(inch)	W_s (inch)	N_s (inch)	H^2	S_s^2	W_s^2	N_s^2	W*H	H*S_s
59.1	1.75	11	30	14.5	3.0625	121	900	210.25	103.425	19.25
61.3	1.725	11	33	15.5	2.975625	121	1089	240.25	105.7425	18.975
57.9	1.615	9.2	32	15	2.608225	84.64	1024	225	93.5085	14.858
57.9	1.6	9.6	30	15	2.56	92.16	900	225	92.64	15.36
65.4	1.72	10.5	32	16	2.9584	110.25	1024	256	112.488	18.06
15.8	1.075	6.5	20.5	9.5	1.155625	42.25	420.25	90.25	16.985	6.9875
16.3	1.065	7	21	10	1.134225	49	441	100	17.3595	7.455
15.8	1.075	6.5	20	10	1.155625	42.25	400	100	16.985	6.9875
16.3	1.06	7	22	10	1.155625	49	484	100	17.278	7.42
16.3	1.1	7.5	21.5	10	1.1236	56.25	462.25	100	17.93	8.25
382.1	13.785	85.8	262	125.5	19.88945	767.8	7144.5	1646.75	594.3415	123.603

Ws*H	**H*N_s**	**W*S_s**	**Ws*Ss**	**Ns*Ss**	**Ns*Ws**	**W*N_s**	**W*W_s**
52.5	25.375	650.1	330	159.5	435	856.95	1773
56.925	26.7375	674.3	363	170.5	511.5	950.15	2022.9
51.68	24.225	532.68	294.4	138	480	868.5	1852.8
48	24	555.84	288	144	450	868.5	1737
55.04	27.52	686.7	336	168	512	1046.4	2092.8
22.0375	10.2125	102.7	133.25	61.75	194.75	150.1	323.9
22.365	10.65	114.1	147	70	210	163	342.3
21.5	10.75	102.7	130	65	200	158	316
23.32	10.6	114.1	154	70	220	163	358.6
23.65	11	122.25	161.25	75	215	163	350.45
$\sum_{i=1}^{10} = 377.0175$	$\sum_{i=1}^{10} = 181.07$	$\sum_{i=1}^{10} = 3655.47$	$\sum_{i=1}^{10} = 2336.9$	$\sum_{i=1}^{10} = 1121.75$	$\sum_{i=1}^{10} = 3428.25$	$\sum_{i=1}^{10} = 5387.6$	$\sum_{i=1}^{10} = 11169.75$

Using the data collected for equation (2.18), (2.20), (2.22), (2.24) and (2.26) as evaluated in table 2, we have:

$$\sum_{i=1}^{10} {}_iW_i = 382.1 \quad \sum_{i=1}^{10} H_i = 13.785 \quad \sum_{i=1}^{10} S_{Si} = 85.8$$

$$\sum_{i=1}^{10} W_{Si} = 262 \quad \sum_{i=1}^{10} N_S = 125 \quad \sum_{i=1}^{10} H_i^2 = 19.88945$$

$$\sum_{i=1}^{10} S_{Si}^2 = 767.8 \quad \sum_{i=1}^{10} W_{Si}^2 = 7144.5$$

$$\sum_{i=1}^{10} N_{Si}^2 = 1646.75 \sum_{i=1}^{10} WH_i = 594.3415$$

$$\sum_{i=1}^{10} HS_{Si} = 123.603 \sum_{i=1}^{10} W_{Si}H_i = 377.0175$$

$$\sum_{i=1}^{10} HN_{Si} = 181.07 \sum_{i=1}^{10} WS_{Si} = 3655.47$$

$$\sum_{i=1}^{10} W_{Si}S_{Si} = 2336.9$$

$$12.58004\alpha + 247.365\gamma + 82.0125\beta + 116.054\lambda + 11.25\mu = 202.182 \qquad (2.27)$$

$$247.365\alpha + 4831.25\gamma + 1600.25\beta + 2265.5\lambda + 219.5\mu = 3946.15 \qquad (2.28)$$

$$82.0125\alpha + 1600.25\gamma + 530.77\beta + 750.65\lambda + 72.7\mu = 1308.2 \qquad (2.29)$$

$$116.054\alpha + 2265.5\gamma + 750.65\beta + 1063.5\lambda + 103\mu = 1851.55 \qquad (2.30)$$

$11.25\alpha + 219.5\gamma + 72.7\beta + 103\lambda + 10\mu = 178.9$ (2.31)

Hence, solving (2.27), (2.28), (2.29), (2.30) and (2.31) above gives

$\alpha = -1.81735$

$\gamma = 0.50494$

$\beta = 0.94624$

$\lambda = 1.96980$

$\mu = -18.29630$

Also, putting the values of α, γ, β λ and μ in the equation (2.11) yields

$W = -12.92246H - 0.05664W_S + 2.71222S_S + 8.12128N_S - 67.68534$; $W \geq 0$ or $W \in [0,1)$ (2.32)

Thus, equation (2.32) is the developed model for estimating weight of human beings (Nigeria specifically).

III. RESULTS AND DISCUSSION

In the concluding part of the previous chapter, data were collected in order to be able to evaluate our emerging model equation constants. Thus, our new model equation now as in equation

$$\therefore W = -12.92246H - 0.05664Ws + 2.7122Ss + 8.12128Ns - 67.68534;\ W \geq 0 \text{ or } W \in [0,1)$$

It means W has no information derivable about its extreme values or it has no local *extremum* or has no specific optimal value (that is, there is no specific minimum or maximum value for weight of human beings in the range of values $W \geq 0$ $or\, W \in [0,1)$.

3.1 Validation of Our Model

After the model became ready, the researchers conducted a pilot test using some people living in Taraba state community, to see whether or not the model conforms to reality. The test confirms that the model is suitable for the people since the absolute difference between the model data generated and the actual measurement done for the people is approximately less than five unit (as in the table below).This little difference in measurement however, is due to the fact that, the parameters considered by the researchers are not the whole parameters associated with the study of weight of a human being. This confirms the view of [10] that, model parameter are inexact. The reason being that, the solution is dependent on the parameters decided to be considered by the modellers. In the same vein, the model is developed and validated in Nigeria, if considered logical could be used to make a universal generalization about the weight of every other person in the world.

Moreover, the table below gives a validation of the questionnaire data to see whether the model really measures what it claims to measure in order to be able to conclude if the model conforms to reality or not.

Table 4 Table for validation of our model

Questionnaires/measured data on weight(kg)	Model data on weight(kg)	Absolute difference/ Error
59.1	55.594	Less than 4 unit(s)
61.3	63.869	Less than 3 unit(s)
57.9	56.404	Less than 2 unit(s)
57.9	57.790	Less than 1 unit(s)
65.4	66.694	Less than 2 unit(s)
15.8	12.043	Less than 4 unit(s)
16.3	17.561	Less than 2 unit(s)
15.8	16.132	Less than 2 unit(s)
16.3	17.569	Less than 1 unit(s)
16.6	15.111	Less than 2 unit(s)

3.2 Discussion of Results

From the model validation process in section 3.3 above, it could be observed that the model data correlate closely with the real life data/ measured data collected. This is due to the fact that the absolute difference in value between our model data and the questionnaire gathered data is approximately less or equal to 4 units. Hence, we can remark here that the model could measure what it claims to be able to measure. Additionally, it gives rise to simplicity of measures and can be utilized in remote areas in the absence of physically produced weight scales if tape rule for measuring height, waist sizes etc could be made available. The study could also be said to be relevant in checkmating cases of false report of data from the available weight machines.

IV. CONCLUSION

In view of the fact that immunity/resistance to health conditions and ailments varies from generation to generation and geographical location to geographical location, then this research recommends that new ,repeated and consistent researches be made be made about respective community's members' weight, body mass index(BMI),weight loss ,reactions to treatment/illness/conditions and other body to overhaul reasons behind why so many persistent medical conditions possess solitary characteristics that need to be treated alike.

Finally, the weight model developed in this research work possesses a higher level of correlations deducted from the result obtained in the model validation section above. Hence the model could be recommended as one of the standard measure for determining the weight of Nigerians and other human beings alike.

REFERENCES

[1] WHO (World Health Organisation) (1995), Physical status: the use and interpretation of anthropometry, available from: http//www.who.int/childgrowth/publications/physical status/en/index.html

[2] American Heart Association, National Institutes of Health and the centres for disease control and prevention. Medi-Weightloss a national physician –supervised weight loss centre

[3] NHLBI-2013. Managing overweight and obesity in adult: systematic evidence Review from the obesity Expert panel.http: //www.nhlbi.nih.gov/sites/ Available:www.nhbi-nih.gov/files/obesity.evidence-review.pdf.

[4] Clinical guidelines on the identification, evaluation and treatment of overweight and obesity in adult Available: http://www.nhibi.nih.gov/files/docs/guidelines /ob-gdlns.pdf.

[5] Anon (2005) OECD factbook; Economic, Environment and Social Statistics. Organization for Economics Co-operation and Development. ISBN 92-64-01869-7

[6] Haslam D (March 2007) obesity: a medical history " Obs.Rev.8.Suppl1:31-6 do.101111/ j.1467.789*2007.00314.PMID 17316298

[7] Benyah F. Introduction to epidemiological modelling, 10th regional college work on modelling. Stimulation and optimization , university of Cape Coast ,Ghana. 2008 ;23-51.

[8] Ogwumu O.D., Amoo, S.A., Eguda F.Y., Adeyefa E.O., and Abubakar S. (2015),

[9] A Mathematical Model for Estimating the Weight of Human Beings Using Some Anthropometric Parameters (A case Study of Taraba State Nigeria's Community). *British Journal of Mathematics and Computer Science 8*(2): 147-158, ISSN: 2231-0851. Retrieved on 6th April, 2016, from http://sciencedomain.org/issue/1031

[10] Ogwumu O.D. (2015).MTH328- Introduction to Mathematical Modelling,

[11] A lecture note (unpublished) of the Department of Mathematics and Statistics, Federal University Wukari, Nigeria