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ORIGINAL RESERACH REPORT

TITLE: Biomechanical Complications Associated with Handbags of various sizes amongst Females in Southeast Nigeria

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Running title: Biomechanical complications associated with handbags amongst females in Southeast Nigeria.
Anyachukwu et.al

Abstract: The women carry large/heavy handbags, which cause bad posture, musculoskeletal pain and limitation of movements. This cross-sectional study investigated the biomechanical complications associated with females using handbags in Enugu metropolis. 150 subjects (mean age, BMI: 26.41±7.75years, 35.00±23.32kg/m2) had their shoulder level, posture and basal gait parameters assessed respectively. 97(64.5%) carry handbags on right shoulder, and 53(35.5%) on the left shoulder. Post-handbag carriage test shows a significance difference ($p<0.05$) in shoulder height discrepancy as measured (*inter test*), greatest discrepancies occurred between heavy weight and normal handbag weight categories subjects *(mean difference = 3.32000).*There was a significant increase *($p<0.05$)* on the shoulder height discrepancy as the weight of the bag increases and at *intra and inter tests*. Ambulation of subjects at stride frequency (velotype 3**)** recorded significance difference ($p<0.05$) in stride length (pre-test and the post-test groups); and non-significance difference ($p>0.05$) in stride frequency, stride velocity and stride duration of normal stride (velotype 1). Healthy subjects group without any biomechanical complications (pre-test and post-tests) during walking with and without handbags reported non-significant difference *($p>0.307$, $r=0.352$ and 0.380*respectively). Conclusively, carrying handbags with weights showed (i) shoulder load carriage decreases transverse pelvic and thoracic rotation (ii) a mean relative phase between pelvic and thoracic rotations and (iii) an increase on hip excursion that limits normal gait pattern of most females with heavy handbags, suggesting that females should be wearing lighter handbags.
[Canice Chukwudi Anyachukwu, Emmanuella Chidinma Anyachukwu, Charles Ikechukwu Ezema, MJ Nwankwo, Ogochukwu Onyeso IK, Ejikeme T Ogbuebor. **ORIGINAL RESERACH REPORT TITLE: Biomechanical Complications Associated with Handbags of various sizes amongst Females in Southeast Nigeria.** Life Sci J 2023;20(10):23-31]. ISSN 1097-8135 (print); ISSN 2372-613X (online). http://www.lifesciencesite.com. 03. doi:10.7537/marslsj201023.03.

Keywords: Biomechanical complications, handbag, females, Nigerian

1. Introduction

The term "handbag" became a household terminology in the early 1900s. Initially, it was most often used to refer to men's hand luggage. With time, women's accessory increased and grew larger and more complex that the term was attached to be one, and even an important women's type. They come in all shapes, colours and sizes, and are quite literally indispensable for women (Gerval, 2009). In our society today, women prefer fashionable and stylish handbags with/without any consideration of its biomechanical complications associated with them. Some studies have shown that the average weight of a typical handbag has increased by 35 per cent over the last five years, with the average bag now tipping the scales at around 2.5 kilos-the equivalent of a standard sized house brick which has serious effects on the person's load-bearing capacity that leads to fatigue and postural problems (Haselgrove et al, 2008, Back pain Centre Sunderland 2011). This might be a deviation against the normal weight of a handbag which is supposed to be 10 per cent of every individual's total body mass (Illonis State Board of Education, 2006).

In the recent times some researchers have observed that most women may likely develop some biomechanical complications that can pose a serious health risk as a result of carrying a shoulder bag loads greater than their load-bearing capacity. These biomechanical problems could come in form of limited shoulder joint ROM, postural deformity that can lead to scoliosis, and leg length discrepancies (Luttman, 2003, Ravish, 2010). Also considering their sizes which is the major contributory factor on the weight of various handbags some studies equally show that heavy handbag, shoulder bag, or purse can injure ones back, neck, and shoulders (Lifemojo, 2011). Some researchers have also found that an average weight of a handbag has gone up to 3kgs in recent years. As a result an extraordinary amount of pressure is exerted on their backs and necks leading to pain and swelling. This is called the 'hand bag syndrome' (Ravish, 2010). In agreement, some studies equally states that when individuals carry a heavy bag on one side over a long period of time, the natural curve of the neck that evenly distributes pressures on the spine gets distorted, leading to chronic neck and shoulder and back pain, including headaches (Back Pain Centre Sunderland, 2011).

Recently, some physical medicine experts observed that handbags can be associated with poor posture by encouraging the carrier to lean to one side. This reduces their ability to maintain balance and restricts movement. Although most of this syndrome is seen in women, men are not spared from this problem, as they also carry briefcase or a laptop shoulder bag (Ravish, 2010).

The above scenario in recent times has been observed as a behavioural and health quality of life pattern among the females in the higher institutions within the Enugu metropolis. These females in higher institutions and those in the city always carry larger handbags. The handbags with different sizes and weight stuffed with books and other accessories of their daily needs. They range from make-up kits, cell phones, cameras, books, iPods, laptops and other accessories that were part of their daily needs.

However, these daily dressing pattern reflect down in the clinics in terms of several clinical presentations like shoulder, neck pains and other biomechanical complications for physiotherapy management coincidentally among the females in the higher institutions which may or may not be traced with their use of handbags. The report of Back Pain Centre Sunderland (2011) confirmed this syndrome by saying that women who haul heavy handbags are facing a future blighted by shoulder, neck and back pain, according to new warnings from a North East team of spinal experts.

This necessitated the search of empirical data on this situation, which lead to the conclusion that there seem to a dearth empirical data or study on the effects of load carriage on females' spine performance, or on the biomechanical complications associated with handbag carriage among the females residing in the southern Nigeria.

Therefore, it is pertinent to investigate the biomechanical complications associated with handbags of various sizes amongst females in Enugu metropolis. Scientifically, this study will bring will discreetly examine the relationship between the weight of various handbags carried by the individual's body weight with their health implications of fatigue and musculoskeletal symptoms, effects of load carriage on females' spine performance; the weight of load carriage, Centre of Gravity location of load carriage, the carrying method on spine curvature, and gait pattern due to the handbag carrying.

The objectives of the study include (a) Identify the relationship between age ranges and the weight of the handbags carried among the subjects (b) Find out the relationship between the Body Mass Index and subjects handbag weight carried (c) Determine the effects of bag weight on the line of gravity in relation to the body joints elbow, hip, knee and ankle (d) Investigate the side of the shoulder or hand dominance frequently used when carrying the handbags (e) Evaluate the shoulder height discrepancies with different weight categories of the handbag (f) Assess any significant difference in stride length, stride frequency, stride velocity, and stride duration during walking with handbags (g) Enumerate any significant difference in stride length, stride frequency, stride velocity, and stride duration during walking without handbags.

Nevertheless, the results of this study should (i) educate the public on the biomechanical complications that might occur among users. (ii) serve as a clinical cue to physiotherapists and other health professionals that always come in contact with patients in the hospitals diagnosed of shoulder, neck and back pains. Therefore, help to promote preventive measures. (iii) It will also add to the body of knowledge as many persons are ignorant of the health risks that is associated with improper use of handbags (iv) Equally assist women to be precautious in their choice of purchasing their handbags in shopping malls/markets and (v) This study will especially enable the government through legislation to regulate handbag manufacturers/importers to avoid flooding the malls/markets with non-ergonomic handbags. This may be achievable by involving health experts like the physiotherapists to monitor the handbags before been introduced to the public.

2. Materials and Methods

The cross sectional quasi-experimental research design study involved healthy volunteer females from 16-30 years, who reside within Enugu metropolis. This study involved selected healthy within the Enugu metropolis female volunteers between the ages of 16-30 years, who use weighted bag so that effects of weights can be determined on the individual by weighing them; but must be residing within the Enugu metropolis. Meanwhile, subjects were categorized into three groups (Group I-those who carry large handbags, Group 2-those who carry smaller handbags and Group 3-those that vary their handbags either large or sometimes use smaller handbags). This study was conducted in Enugu metropolis, a geographical location with three (3) local government areas that is within the capital city of Enugu state, South Eastern Nigeria. However, the target population comprises of women in the University of Nigeria Enugu campus, IMT, College Of Education Technical, Enugu and some Government secretariats all representing the three LGAs.

This study utilized a convenient sampling technique to select individuals from the three local governments only. This is considered suitable for the study because convenient sampling is more appropriate and practical when the population is widely and largely dispersed. But, prior to this time, the proportionate sampling method was utilized to ensure that 50 participants were equally and appropriately selected from each of the three (3) local government areas. It could be recalled that 150 sample size (n=150) was determined prior by the use of NCSS and PASS computer software computer Version 2000 to determine the power size as 150 samples.

The subjects that were selected to participate in this study were based on the following that: Only females within the age of 16-30 years, residing in Enugu metropolis and are willing to participate were involved in the study. Also, they were not having known musculoskeletal or biomechanical derangement or any deformity. Above all, they must be females who wear or will use a weighted bag so that effects of weights can be determined. Meanwhile, exclusion were based that the subjects were under the age of 16 years and above the age of 30 years, not residents in Enugu metropolis and were not willing to participate in the study. However, those having any known musculoskeletal or biomechanical derangement or any deformity were also excluded from the study. In addition, those females who do not wear or not willing to use a weighted bag for the research were allowed to participate in the study.

With the subjects in standing positions and barefooted on the platform with feet together, and the eyes looking forward as directed, the height of the subjects in centimeter (cm) was obtained using a stadiometer (Ravel Harpenden brand). The height measurement was taken from the platform of the stadiometer to the vertex of the head and thus read off and recorded to the nearest 1.0 centimeters and later converted to meters. Then weight measured to the nearest 0.1kilogram (kg) with Tefal electronic branded weighing device. Weighing scale was used to obtain the weight of the subject and their bag. The subject's weight is measured without handbag and then with a handbag to get the bag weight by subtracting the initial weight from the later.

A 0.5m×10m length wooden material was used to mark out a walking distance for the participants to do along at their normal speed and pace of walking. It is along this path that their necessary gait parameters were observed and recorded. Gait parameters such as step length, stride length, base width, number of steps and time taken were captured along this path, as well as other gait parameters necessary to measured in this study. Then, a mobile phone's digital stop watch reading in seconds was used. The SIM card was removed from the phone to avoid incoming calls and text messages disrupting the proceedings.

The stopwatch was used to record the time the subjects used in walking down the 10m pathway in seconds. Improvised postural grid chart: this is used to trace the shoulder level using the acromion as landmark while the subject is being instructed to stand in upright position. This was done when the subject is without a handbag and repeated with the handbag to check for a postural difference on standing.

Then, Plumb line was equally used in the study to determine the subjects' line of gravity (LOG). The camera was also used camera to observe the subjects' posture clearer. And the video was used to analyse the subject's gait pattern by ten meters 'walk on the flat surface.

The ethical approval and permission was sought and obtained from the Chairman, Human Research Committee, University of Nigeria Teaching Hospital Ituku-Ozalla, Enugu. This was based on the fact the informed consent of participants was obtained and that the procedures of the study were explained to the subjects. Meanwhile, it also means that participation was voluntary and that anyone of them is free to withdraw from the study at any stage.

Procedures/methods of the data collection

Step I The purpose, procedures and relevance of the study was explained to each participant on which basis their informed consent were requested and obtained. Hence the Subjects' informed consent was obtained prior to the study; the Subjects' privacy and confidentiality was equally maintained by secluding the assessment areas, using code numbers instead of names in data presentation, keeping the records confidential. The bio data information of the participants was recorded. These include their age, height and weight.

Step II The height and weight of each female subject was measured with portable height measurement scale equipment (standiometer) and weighing scale respectively. The body weight of each subject was measured using weighing scale and the handbag weight was equally obtained by reading the value when the subject was with the handbag to determine its weight. The subjects were uprightly positioned in between an improvised postural grid/chart and plumb line to measure their shoulder depression and postural deviation. Basal gait parameters were obtained through a 10 meter's walk where some gait parameters were carefully recorded and then compared with the subject's use of handbag. Therefore, only the data obtained from this study were presented and reported.

Data Analysis Prior to the data collection, PASS and NCSS computer software version 2000 was used to determine the sample size power (n=200). Further, D-Augustino normality test was done on the data collected to confirm if the sample was drawn from normal population. Then all data was descriptively and statistically done to obtain the mean ± and standard deviation (SD). The inferential analysis was done with the Independent t-test and Pearson correlation coefficient (ANOVA) at the alpha ($p<0.05$) significant level using the SPSS computer statistical software, version 17.0.

3. Results

The data generated from the study were analysed and results presented using the tables 1-6 represented the reports on the research questions and objectives of the study, involving a total of 150 volunteer subjects mean age and BMI (**26.41±7.75**years and **35.00±23.32kg/m^2)** respectively.

Objective One: To determine the effect of bag weight on the line of gravity in relation to some joints of the body such as the elbow, hip, knee and ankle joints. Table 1 shows the interaction of the body line of gravity in relation to some joints of the body. **148(98.7%), 14(9.3%),** and **99(66%)** out of the 150 subjects had an anterior LOG relation in respect to the elbow, hip, knee, and ankle joints respectively while **2(1.3%), 136(90.7%), 7(34%)** and **26(17.3%)** out of 150 subjects had posterior LOG relation as touching elbow, hip, knee, and ankle joints respectively.

Objective Two: To identify the side of the shoulder or hand dominance frequently used when carrying the handbags. Table 2 shows participants' distribution based on shoulder dominance on the use of Handbags among the subjects and of the 150 subjects, **97(64.7%)** were right handed while only **53(35.5)** subjects were left handed.

Objective Three: To identify shoulder height discrepancies with different weight categories of the handbag. Table 3 depicts the effect of handbag weight of different categories on shoulder height discrepancy. Further, there was a significant difference in shoulder height discrepancy compared among the three handbag weight categories. Results shows that there was a significant difference (between and within group), **$p<0.05$**. The post-handbag on carriage test shows that there is a significance difference in shoulder height discrepancy as measured between group with the greatest difference occurring between subjects in heavy weight and normal handbag weight categories**(**mean difference = 3.32000).

Objective Four: To identify shoulder height discrepancies with different weight categories of the handbag. The table shows the percentage body weight (BMI) to the weight of the handbag. **10(6.7%)** out of **92(61.3%)** out of 150 subjects were classified underweight and normal weight respectively while **36(24%)** and **12(8%)** were classified overweight and obese respectively (table 4).

Objective Five: To identify any significant difference in stride length, stride frequency, stride velocity, and stride duration during walking with handbags and without handbags. Table 5 shows the basal gait parameters on pre-test and post-test of subjects when with load and handbag of normal weight. The table shows a comparison of the temporospatial gait parameters between the pre-test and post-test groups in which the pre-test group represents the subjects when free of load while the post-test represents the subjects when loaded with the handbag of normal weight. Result of analysis shows that for velotype III, there is a significance difference in stride length between the pre-test and the post-test groups**($p<0.05$)** while there was no significance difference found in stride frequency, stride velocity and stride duration**($p>0.05$)** of the normal velotype between pre-test and post-test groups.

Discussion

The first objective of this study was to determine the effect of handbag weight on the LOG in relation to elbow, hip, knee and ankle joints. After the study, a comparison of the temporospatial gaits parameter between the pre-test and post- test groups where the pre-test group represents the subjects at load free phase while the post-test represents the subjects when loaded with the handbag of normal weight. Thus, this implies that there is a deviation of the LOG for which may be because of the handbag weight that would have likely altered the normal line of gravity across the hip joint but the LOG passed posteriorly at the knee joint and ankle joints, hence agreeing with O'Rahilly (2008) who stated that when a subject is in the easy standing position, few muscles of the back and lower limbs are active during the immobile periods.

The position of the line of gravity, which is determined by the distribution of body weight, is important in determining the degree of muscular activity involved in maintaining all phases of posture. The line of gravity extends superiorly through the junctions of the curves of the vertebral column and inferiorly in a line posterior to the hip joints but anterior to the knee and ankle joints.

The second objective that identified the percentage weight of the handbags to the bodyweight (BMI) of the subjects shows that out of 150 subjects that were classified underweight and normal weight respectively. The result shows that few subjects are either over weight and obese and the percentage of the handbag eight would have been nullified as a result of increase in their BMI when compared with subjects that have normal body weight. This implies that few persons in the populace were both overweight and obese which is of clinical importance in the management of patients that may come down with overweight and obese respectively.

The third objective which is to identify the side of the shoulder or hand dominance frequently used when carrying the handbags shows that most subjects carry their handbags on the right shoulder, compared to subjects that wear theirs on the left shoulder, elbow and both sides of the shoulder. This may imply that majority of the population among the females might experience shoulder pain on the right side.

The fourth objective is equally to identify shoulder height discrepancies with different weight categories of the handbag. Result of analysis shows that there was a significant difference in shoulder height discrepancy compared among the three handbag weight categories. The post-hoc test shows that there is a significance difference in shoulder height discrepancy as measured between group with the greatest difference occurring between subjects in heavy weight and normal handbag weight categories.

This may be as a result of the weight of the bag that tends to depress the shoulder as the subjects tries to compensate by tilting to the opposite side. This is implies that there may be postural deformity such as scoliosis among females with constant increase in handbag weight over time. This implies that shoulder height discrepancy as temporally measured could be cheaply precipitated by handbag weight of different sizes irrespective of the load value. This is in consonance to the findings of some works that were done by other researchers such as Pascoe et al (1997).

The fifth objective is to identify any significant difference in stride length, stride frequency, stride velocity, and stride duration during walking with handbags and without handbags. Result of analysis shows that for velotype three there is a significance difference in stride length between the pre-test and the post-test groups. While there was no significance difference found in stride frequency, stride velocity and stride duration of the normal velotype between pre-test and post-test groups. This may be as a result of no biomechanical complications as at the period this study was conducted.

Considering velotype III, there was a significance difference found in stride length, stride frequency, stride velocity and stride duration between the pre-test and the post-test groups, while in velotype II, significance difference was found only in stride frequency and stride duration while there was only a marginal difference in stride length and stride velocity all between the pre-test and post-test groups. It was earlier hypothesized by the researcher that compared to unloaded walking, load carriage decreases transverse pelvic and thoracic rotation, the mean relative phase between pelvic and thoracic rotations, and increases hip excursion.

In addition, it was hypothesized that these changes would coincide with a decreased stride length and increased stride frequency. The findings supported the hypotheses. Dimensionless analyses indicated that there was a significantly larger contribution of hip excursion and smaller contribution of transverse plane pelvic rotation to increases in stride length during load carriage. In addition, there was a significant effect of load carriage on the amplitudes of transverse pelvic and thoracic rotation and the relative phase of pelvic and thoracic rotation. It was concluded that the shorter stride length and higher stride frequency observed when carrying a backpack is the result of decreased pelvic rotation. During unloaded walking, increases in pelvic rotation contribute to increases in stride length with increasing walking speed.

The decreased pelvic rotation during load carriage requires an increased hip excursion to compensate. However, the increase in hip excursion is insufficient to fully compensate for the observed decrease in pelvis rotation, requiring an increase in stride frequency during load carriage to maintain a constant walking speed. Result of analysis shows that for velotype three there is a significance difference in stride length between the pre-test and the post-test groups**($p<0.05$)** while there was no significance difference found in stride frequency, stride velocity and stride duration of the normal velotype between pre-test and post-test groups.

This implies that there was loss of intrinsic interactions of temporo-spatial basal gait parameter as one suddenly transverse a certain distance changing one's status from unloaded to load all abruptly. The significance difference found between pre-test and post-test stride length could be attributed to the conservative nature of length perhaps as a standard unit of measurement and its inherent trait to be separately and definitely defined, thus, such a sudden/abrupt transposition of weight precipitated by handbag carriage perhaps of a strange load not accustomed to the subjects(the study limitation) could not significantly influence the stride frequency, stride velocity and stride duration of the normal velotype between pre-test and post-test groups while such hastily adjustment could significantly could significantly influence the stride length meaning that subjects stride length during the test fell within a certain extreme range but which in summary was not significantly different so as to influence the stride velocity as it ought to**(V=SF)**. This finding therefore is contrary to those of Lafindra et al (2002), who reported how do load carrying and walking speed influence trunk co-ordination and stride parameters. Also, Lafindra et al (2002) hypothesized that compared to unload walking, load carriage decreases transverse pelvic and thoracic rotation, the mean relative phase between pelvic and thoracic rotations, and increases hip excursion. In addition, they also hypothesized that these changes would coincide with a decreased stride length and increased stride frequency. The findings showed that a significant effect of load on stride parameters irrespective of the velotype though in a different fashions.

Considering velotype IV, there was a significance difference found in stride length, stride frequency, stride velocity and stride duration between the pre-test and the post-test groups while in velotype II, significance difference was found only in stride frequency and stride duration **($p<0.05$)** while there was only a marginal difference in stride length and stride velocity all between the pre-test and post-test groups **($p>0.05$)**.

This implies that subjects' stride length, stride frequency and stride velocity and stride duration were influenced by loading as touching velotype IV which precipitate greater acceleration. This could mean that the velotype IV was a more appropriate speed for this participant perhaps , because there are females with naturally greater walking steps or cadence per minutes; seeing that the temporospatial basal gait parameter rightly interacted with an overall decrease in stride length probably due to consequent decrease in pelvic tilt and rotation; and compensated increase in stride frequency supported by the compensating increase in stride frequency so as to modulate the efficiency of locomotion within a near normal range thus, it will be advisable then, for female who fondly travel via walking carrying their the perceived pet, the handbags of various sizes; to reduce their stride length while increasing their frequency amidst keeping an above normal walking speed(velotype IV).

However, there was no significant difference in stride length and stride velocity all between the pre-test and post-test groups**($p>0.05$)** while a significance difference was found only in stride frequency and stride duration **($p<0.05$)** as touching veltoype II. Such an interaction and response of the temporal basal gait parameter is similar to those observed at velotype indicating that velotypeII compensatory responses are closer to those of velotype IV than they are to Velotype III. This however is in contrary to the finding of this study therefore is contrary to those of Lafindra et al(2002), "How do load carrying and walking speed influence trunk co-ordination and stride parameters" . Lafindra et al (2002) hypothesized that compared to unload walking, load carriage decreases transverse pelvic and thoracic rotation, the mean relative phase between pelvic and thoracic rotations, and increases hip excursion.

In addition, they also hypothesized that these changes would coincide with a decreased stride length and increased stride frequency. In general it can be deduced from the findings of this study that loading a subject via the shoulder is capable of altering the temporo-spatial basal gait parameters probably due to imposed constraint to arm swing which will precipitate a constrained pelvic tilt and rotation and which in turn will no least bit impose restriction to the timing of the quadriceps and hamstring and their consequent hip and knee flexion respectively, precipitating a decreased stride length, increased stride frequency which itself is compensatory, and a near normal or decreased velocity of transition.

Conclusion:

The results of this study indicated that heavy handbags affect females' posture due to alteration to the line of gravity and the increase in the weight of bags causes shoulder height discrepancy. However, there is no observable effect of handbag weight to the subjects' BMI. But, when compared to unloaded walking, load carriage decreases transverse pelvic and thoracic rotation, the mean relative phase between pelvic and thoracic rotations, and increases hip excursion.

Clinical Implication of the Findings

The results of this study elicited results that necessitated the essence of examining the health significance of some possible susceptibility thus:

- Heavy handbags affect females' posture due to alteration to the line of gravity. About 98.7%, 9.3%, and 66% out of the 150 subjects had an anterior LOG relation with respect to their elbow, hip, knee, and ankle joints respectively while 1.3%, 90.7%, 34% and 17.3% subjects had posterior LOG relation as touching elbow, hip, knee, and ankle joints. These individuals who habitually use heavy handbags could always fall with small sliding incidents. However, due to unstable centre of gravity, continuous fall will result to fractures, subluxations, dislocations even head injuries death and other sequelas of head injuries and early osteoarthritis.

- Increase in the weight of bags causes shoulder height discrepancy. This is an important factor in the development of scoliosis and other deformities involving the thoracic region. This is not a figure for a woman. Biomechanically, it is bound to cause instability and compression and pressures to the organs of the integument.
- Above all, a loaded gait or walking carriage decreases transverse pelvic and thoracic rotation, the mean relative phase between pelvic and thoracic rotations, and increases hip excursion.

Finally, the gross effect on the population (if the trend persists continuous) is the unhealthy generation of the female gender, who will present among other conditions like scoliosis, neck and shoulder pain; and Thoracic Outlet Syndrome (TOS).

Acknowledgements

We appreciate the staff of the Departments of medical Rehabilitation, Faculty of health Sciences College of Medicine, UNEC and Physiotherapy, University of Nigeria teaching Hospital, Ituku-Ozalla, Enugu Nigeria and the research assistants who contributed in the collection of the data.

Conflict of Interest: Nil Source of financial support: Nil

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TABLES

Table 1: Line of gravity in relation to some joints of the body

Variables	**Some Joints of the body**			
LOG Relation	Elbow	Hip	Knee	Ankle
	N (%)	n (%)	n (%)	n(%)
Anterior	148(98.7)	14(9.3)	99(66)	124(82.7)
Posterior	2(1.3)	136(90.7)	7(34)	26(17.3)
Total	**150(100)**	**150(100)**	**150(100)**	**150(100)**

Table 2: Shoulder dominance when using bag

Variables	n	(%N)
Shoulder dominance		
Right	97	64.5
left	53	35.5
Total	**150**	**100**

Table 3: Comparison of Shoulder Height Discrepancy among the difference weight categories

Variables		Mean square	F-value	P-value
Shoulder Height Discrepancy				
Between group		413	304.980	0.000
POST-HOC		**Mean difference**	**SEM**	**P-value**
Normal wt	mild	-1.66000	0.1344	0.000
	Heavy	-3.32000	0.1344	0.000
Mild	normal	1.66000	0.1344	0.000
	Heavy	-1.66000	0.1344	0.000
Heavy	Normal	3.32000	0.1344	0.000
	Mild	1.66000	0.1344	0.000

Significant at **0.000**

Table 4: Subjects classification based on BMI

Variables		
BMI category	n	%N
Underweight	10	6.7
Normal	92	61.3
Overweight	36	24.0
Obese	12	8.0
Total	**150**	**100**

Table 5 Basal gait parameters on pre-test and post-test of subjects when with load and Handbag of normal weight

Variables	Pre-test group	Post-test group	t-value	p-value
Basal gait parameters				
VELOTYPE III				
Stride Length(SL)	31.97±3.68	30.54±3.79	3.325	0.001
Stride Freq.(SF)	0.92±0.30	0.88±0.28	1.023	0.307
Stride Vel(SV)	1.85±1.48	1.69±1.40	0.305	0.352
Stride duration	1.16±0.36	1.21±0.38	-0.976	0.380
VELOTYPE IV				
Stride Length(SL)	27.14±3.71	26.17±3.73	2.244	0.026
Stride Frequency(SF)	0.55±0.19	1.51±0.20	2.198	0.029
Stride Velocity(SV)	0.82±0.64	1.06±041	-3.089	0.002
Stride duration	2.01±0.69	2.26±0.86	-2.792	0.006
VELOTYPE II				
Stride Length(SL)	25.16±4.91	24.43±5.26	1.241	0.216
Stride Frequency(SF)	0.93±0.36	1.04±0.41	2.335	0.020
Stride Velocity(SV)	.26±0.95	1.35±1.06	-0.834	0.405
Stride duration	1.18±0.38	1.07±0.37	2.520	0.012

LETTER OF TRASNSMITTAL

1. We, the authors of this paper titled 'Biomechanical complications associated with handbags of various sizes amongst females in Southeast Nigeria' having read the criteria for submissions, thereby submit this paper or research work as an Original Article to the Editor.
2. However, all the authors mentioned in this work have contributed substantially to all of the following (a) the conception and design of the study, or acquisition of data, or analysis and interpretation of data, (b) drafting the article or revising it critically for important intellectual content, (c) final approval of the version to be submitted.
3. Also, each of the authors has read and concurs with the content in the manuscript.
4. That this paper has not been submitted and will not be submitted to any journal for publication
5. That the authors accept the '*Subscription'* choice of publication option which attracts no publication fee.
6. That we are having no conflicts of Interests with respect to this manuscript and no source of financial support for this manuscript except self efforts and sponsorship

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9/22/2023