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DR. NABEEL TAHIR

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EDITORIAL PREFACE

This is the Second Issue of Volume Four of International Journal of Ergonomics (IJEG). The Journal is published bi-monthly, with papers being peer reviewed to high international standards. The International Journal of Ergonomics is not limited to a specific aspect of Ergonomics but it is devoted to the publication of high quality papers on all division of engineering in general. IJEG intends to disseminate knowledge in the various disciplines of the Computer Science field from theoretical, practical and analytical research to physical implications and theoretical or quantitative discussion intended for academic and industrial progress. In order to position IJEG as one of the good journal on Computer Sciences, a group of highly valuable scholars are serving on the editorial board. The International Editorial Board ensures that significant developments in Ergonomics from around the world are reflected in the Journal. Some important topics covers by journal are architectures, middleware, tools designs, Experiments, Evaluation, etc.

The initial efforts helped to shape the editorial policy and to sharpen the focus of the journal. Started with Volume 4, 2014, IJEG appears with more focused issues. Besides normal publications, IJEG intend to organized special issues on more focused topics. Each special issue will have a designated editor (editors) – either member of the editorial board or another recognized specialist in the respective field.

The coverage of the journal includes all new theoretical and experimental findings in the fields of engineering which enhance the knowledge of scientist, industrials, researchers and all those persons who are coupled with engineering field. IJEG objective is to publish articles that are not only technically proficient but also contains information and ideas of fresh interest for International readership. IJEG aims to handle submissions courteously and promptly. IJEG objectives are to promote and extend the use of all methods in the principal disciplines of Computing.

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To build its international reputation, we are disseminating the publication information through Google Books, Google Scholar, Directory of Open Access Journals (DOAJ), Open J Gate, ScientificCommons, Docstoc and many more. Our International Editors are working on establishing ISI listing and a good impact factor for IJEG. We would like to remind you that the success of our journal depends directly on the number of quality articles submitted for review. Accordingly, we would like to request your participation by submitting quality manuscripts for review and encouraging your colleagues to submit quality manuscripts for review. One of the great benefits we can provide to our prospective authors is the mentoring nature of our review process. IJEG provides authors with high quality, helpful reviews that are shaped to assist authors in improving their manuscripts.

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Erlinda Muslim *erlinda@eng.ui.ac.id*
Department of Industrial Engineering
Universitas Indonesia
Depok, Indonesia - 16424

Boy Nurtjahyo Moch. *boymoch@eng.ui.ac.id*
Department of Industrial Engineering
Universitas Indonesia
Depok, Indonesia – 16424

Nauli Dwi Fileinti *nauli_tiui09@yahoo.com*
Department of Industrial Engineering
Universitas Indonesia
Depok, Indonesia – 16424

Maya Arlini Puspasari *maya@ie.ui.ac.id*
Department of Industrial Engineering
Universitas Indonesia
Depok, Indonesia – 16424

Triasni M. L. Sibarani *triasni_ti2011@yahoo.com*
Department of Industrial Engineering
Universitas Indonesia
Depok, Indonesia – 16424

Deo G. N. Laksana *deo_ti2011@yahoo.com*
Department of Industrial Engineering
Universitas Indonesia
Depok, Indonesia – 16424

Abstract

In order to increase the market share of garment products in local market, the Ministry of Industry pointed out the need to provide added value to the garment products. One of the options is to implement standard sizing system for clothes. Standard sizing system is substantial especially for children, since there seem to be unique anthropometric differences among each child. This study aims to develop a standard size of clothes for Indonesian boys based on anthropometric data, which is expected to be a national standard and a recommendation for the design of SNI. The anthropometric data are gathered from 155 boys aged 7-12 years old using 3D Body Scanner. Factor analysis and two stage cluster analysis were performed in this study and 8 groups of size for boys' clothes were established with a coverage rate of 95.48%.

Keywords: Standard Size for Clothes, Garment Industry, Anthropometry, Indonesian Children, Factor Analysis, Two Stage Cluster Analysis.

1. INTRODUCTION

Garment industry is one of the most important industries in Indonesia. Currently, garment industry is rapidly growing. Together with textile and other textile products, the Ministry of Industry considered garment industry as one of the most contributing sector to national's income. Based on the data from Ministry of Industry, the export rate of garment from Indonesia is significantly increasing each year, and reached US$13.2 billion in 2011.

Contradictory to the export rate, the market share of local garment in Indonesia is still low. Asep Setiaharja as one of the staff of Asosiasi Petekstilan Indonesia (API) said that in 2013, the market share of garment in local market was only about 50%. Therefore, the Ministry of Industry considered the need to increase added value in local garment product in order to compete with imported products. One of the efforts that could be done to increase added value is by implementing standard sizing system to local product, which means that the product will be designed based on the anthropometric data of consumers.

The important thing to be noticed while developing the standard sizing system is that there has been an anthropometric difference among people caused by ethnic/race, age, gender, and the dimension of time. The anthropometric difference caused by ethnic/race has been studied in several researches. T.K. Chuan et al conducted one of them in 2010 that successfully showed the anthropometric differences between Singaporean and Indonesian people in several body dimensions. Whereas anthropometric differences caused by age are significant if we compare the anthropometry of adult and children. Children are considered to be people who are still growing, both mentally and physically. Each child will be experiencing rapid growth until the age of 18, causing anthropometric differences between children from different group of ages and even among children in the same group of age. Therefore, 50% of children are not able to wear clothing size based on ages (Otieno, 2008). Gender and the dimension of time also contribute in anthropometric differences. Several researchers have found that the anthropometry of children in England and America are growing in the past three decades. This change has proved that the anthropometry of children is changing from time to time. Therefore, the anthropometric database should always be updated.

In Indonesia, several SNI have been formulated by Badan Standardisasi Nasional (BSN) in order to standardize the sizing system for clothes, such as SNI 08- 4985-1999 which contains about the characteristic of anthropometry for designing clothes, and other SNI which contains the standard for specific type of clothes, such as SNI 08-0555-1995 about standard size of shirts for Indonesian boys. However, SNI 08-0555-1995 has been abolished by BSN since it no longer fits with the anthropometry of children nowadays.

Based on the introduction explained above, the statement of problem in this research is the need of the development of standard size of clothes for Indonesian boys based on the updated database of anthropometry. Therefore, the objective of this research is to develop a standard size of clothes for Indonesian boys that could be used as a reference to formulate RSNI 0555:2013 to revise SNI 08-0555-1995. In addition to that, this research is conducted to add more variety in anthropometric researches in Indonesia, especially about the anthropometry of children, since until now the researches of anthropometry in Indonesia are focused on the anthropometry of adult.

2. METHOD

This section explains about the material and method used in this research.

Subject of Research

The subject of this research are Indonesian boys aged 7-12 years old, with the race of Southeast Asiatic, since the objective of this research is to develop a standard size of clothes for Indonesian boys, especially for shirts. Boys of age 7-12 were chosen as the subject of this research because several researchers have found that there has been some different type of growth between the children under 13 years old and children above 13 years old. Both male and female children have rapid changes in both vertical and horizontal dimensions. The total of subject in this research is 155 boys.

Tools Used in Research

The main tool used in this research is 3D Body Scanner or Anthroscan. By using Anthroscan, 151 variables of body dimension can be accurately determined in 10-15 seconds. Thus, this tool is the appropriate tool to gather anthropometric data.

Basic Rules for Collecting Research Data

One of the contributing factors that affect the successfulness of using Anthroscan is the type of clothes that the subjects of the research wear. The clothes used for the scanning should be tight enough and shows the real body shape of the subject. The clothes should also be in light colors, since Anthroscan could not identify dark colors. The other important factor is the body posture of the subject. The subject should stand straight with eyes straight to the front and remain with the same posture as the scanning process goes on.

Collecting Anthropometric Data

3D Body Scanner or Anthroscan can be used in several steps that are quite simple. The steps of using Anthroscan are:

- Calibrate the Anthroscan
- Set the laser
- Prepare the subject of the research
- Scan the subject using Anthroscan

Variables Used in Research

The result of scanning using Anthroscan provides 151 variables of body dimensions from head to toe. However, based on the objective of the research, only 28 dimensions of upper body are used in this research. Those 28 variables are listed in Table 1 as follows:

No.	Variables
1	Body height
2	Mid neck girth
3	Neck at base girth
4	Cross shoulder
5	Shoulder width left
6	Shoulder width right
7	Across front width
8	Bust/chest girth
9	Across back width
10	Waist girth
11	Buttock girth
12	Hip girth
13	Maximum belly circumference
14	Arm length left

15	Arm length right
16	Upper arm length left
17	Upper arm length right
18	Forearm length left
19	Forearm length right
20	Upper arm girth left
21	Upper arm girth right
22	Elbow girth left
23	Elbow girth right
24	Forearm girth left
25	Forearm girth right
26	Wrist girth left
27	Wrist girth right
28	Weight

TABLE 1: Variables Used in Research.

3. RESULTS AND DISCUSSIONS

This section will discuss about steps of processing the data, establishing the standards size of clothes, and also analyzing of the end result.

Factor Analysis

The main requirement in using factor analysis is each variable has to be correlated to each other. The correlation between each variable can be tested using Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and Bartlett's test of sphericity. The higher the KMO obtained from the research, shows the higher level of correlation among each variable. Bartlett's test of sphericity is used to test the hypothesis that all of the variables do not have correlations among each other in the population. The Table 2 below shows KMO and Bartlett's test obtained in this research:

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.887
Bartlett's Test of Sphericity	Approx. Chi-Square	6737.217
	Df	378
	Sig.	.000

TABLE 2: KMO and Bartlett's Test.

Based on the KMO and Bartlett's test, we can conclude that each variable has a strong correlation to each other. Thus, factor analysis can be used in this research. The next step is to determine the amount of factors extracted in this research, based on eigen value greater than 1. In this research, 6 factors are extracted based on eigen value. Each factor has its own members based on the correlation among variables. The members of each factor are shown in the rotated component matrix in **Table 3** as follows:

	Component					
Variables	1	2	3	4	5	6
Forearm girth right	**0,917**	0,268	-0,04	0,12	0,022	0,156
Forearm girth left	**0,908**	0,292	-0,06	0,129	0,016	0,155
Elbow girth left	**0,907**	0,33	-0,04	0,101	0,021	0,148
Elbow girth right	**0,893**	0,36	-0,04	0,104	0,044	0,12
Upper arm girth right	**0,766**	0,532	-0,01	0,162	0,086	0,157
Upper arm girth left	**0,755**	0,564	-0,01	0,135	0,088	0,147
Across back width	**0,514**	0,239	0,21	0,085	0,38	-0,352
Max belly circumference	0,293	**0,881**	0,059	0,132	0,095	0,13
Across front width	0,239	**0,854**	-0,05	-0,043	0,079	0,169
Waist girth	0,338	**0,837**	0,108	0,195	0,171	0,131
Hip girth	0,368	**0,823**	0,195	0,088	0,102	0,181
Buttock girth	0,336	**0,807**	0,269	0,108	0,098	0,161
Cross shoulder	0,386	**0,741**	0,034	0,004	0,277	-0,123
Bust/chest girth (horizontal)	0,519	**0,704**	0,17	0,23	0,199	0,126
Weight	0,038	**0,696**	0,314	0,343	0,089	0,043
Arm length left	0,038	0,158	**0,931**	-0,034	0,06	-0,009
Arm length right	-0,09	0,121	**0,907**	0,038	-0,009	0,048
Forearm length left	-0,27	-0,06	**0,86**	0,067	0,077	-0,109
Body height	0,359	0,177	**0,846**	0,026	0,164	0,055
Forearm length right	-0,37	-0,07	**0,836**	0,044	0,02	-0,082
Upper arm length right	0,287	0,247	**0,745**	-0,053	0,169	0,036
Upper arm length left	0,604	0,12	**0,627**	-0,038	0,054	0,064
Neck at base girth	0,249	0,192	-0,12	**0,804**	-0,061	0,014
Mid neck girth	0,117	0,196	0,155	**0,784**	0,285	0,131
Shoulder width left	-0,09	0,232	0,263	0,065	**0,749**	-0,011
Shoulder width right	0,156	0,158	0,019	0,086	**0,733**	0,181
Wrist girth right	0,408	0,387	-0,03	0,128	0,157	**0,73**
Wrist girth left	0,389	0,426	0,016	0,122	0,161	**0,726**

TABLE 3: Rotated Component Matrix.

Considering the factor loadings in each factor, the name of each factor can be identified. Thus, factor 1 was named as arm girth factor. Similarly, factor 2 was named as body girth factor, factor 3 was named as arm length factor, factor 4 was named as neck girth factor, factor 5 was named as shoulder width factor, and factor 6 was named as wrist girth factor.

Two-Stage Cluster Analysis

The next step in this research is conducted using two-stage cluster analysis. The variables used in this method are 6 body dimensions that represent the 6 factors that have been formed before. Those 6 variables are upper arm girth right, maximum belly circumference, arm length left, neck at base girth, shoulder width left, and wrist girth right.

Hierarchical cluster analysis provides several alternative solutions in terms of forming the clusters. Based on the level of homogeneity among the members in one cluster, the level of heterogeneity between members from different clusters, and also the characteristics of cluster members, the optimal solution obtained from hierarchical cluster analysis is three clusters solution. After obtaining the optimal amount of cluster solution, non-hierarchical cluster analysis is used in order to find the final cluster centers for each variable in each cluster that later will be the main basis in establishing standard size. In this research, K-Means is used to form the final cluster. The **Table 4** below is the final result obtained from non- hierarchical cluster analysis:

Variable	Cluster		
	1	2	3
Neck at base girth	41.07	38.64	35.68
Shoulder width left	11.64	10.84	10.35
Max belly circumference	95.64	71.51	58.59
Arm length left	44.24	43.04	41.29
Upper arm girth right	29.50	25.28	20.05
Wristh girth right	18.05	15.45	13.38

TABLE 4 Final Cluster Center.

Establishing Standard Size of Clothes for Indonesian Boys

The final result obtained from two- stage cluster analysis cannot be directly used as a standard sizing system, since there appears to be some size intervals problem. In general, the optimal size interval for girth dimensions is 4 to 6 cm (Eberle and Kilgus, 1996; Chung et al, 2007). Based on the standardized size intervals and also final cluster centers, the standard size of clothes for Indonesian boys is shown in **Table 5** below:

Body Dimension	S			M	L			
	1	2	3	1	1	2	3	4
Neck at base girth	26	30	34	38	42	46	50	54
Shoulder width	8	9	10	11	12	13	14	15
Belly circumference	54	60	66	72	78	84	90	96
Arm length:								
Long	37	39	41	43	45	47	49	51
Short	22	23	24	25	26	27	28	29
Upper arm girth	13	17	21	25	29	33	37	41
Wrist girth	10	12	13	15	17	19	21	23

TABLE 5: Establishment of Standard Size of Clothes for Indonesian Boys.

Analysis

The establishment of standard size of clothes for Indonesian boys in this research shows that the control dimensions used are neck at base girth, shoulder width, maximum belly circumference, arm length, upper arm girth, and wrist girth. Whereas, the size interval used in this research is based on literature review and also the standardized intervals that are written in ISO/TR 10652 and has been implemented in SNI 08-0555-1995. Moreover, the size interval used in this research is constant from one size to another, in order to make the production system more efficient and also make the consumers easier to find the appropriate size.

The cover factor obtained in this research is 95.48% which means that the standard sizing system obtained from this research is able to accommodate 95,48% of population. The cover factor should typically range 65-80%, meaning that the sizing system is able to accommodate 65-80% of the sample population with the size given (Zakaria, 2011). Hence, the result of this research shows a valid cover factor since it is able to accommodate more than 80% of the population.

The result of this research shows some significance differences compared to ISO 3636:1977 and also SNI 08-0555-1995 in terms of size interval and control dimension. It is clearly written in ISO 3636:1977 that the control dimensions for sizing system for boys are body height, chest girth, and hip girth. These differences are actually normal, since ISO is a global standard that does not consider a specific anthropometric data of a certain country. In addition to that, ISO does not consider the anthropometric differences caused by different ethnic and race. Another reason for the differences is that ISO 3636 is formulated in 1977, and obviously anthropometric data of people have been significantly changing since then.

The differences between the result of this research and SNI 08-0555-1995 are mostly caused by the dimension of time. Not only that, the anthropometric tools used to conduct the research is different than the tools used to formulate SNI, since this research used a 3D Body Scanner to collect all of the anthropometric data. The differences also could also be affected by the amount and characteristics of respondents used in this research.

4. CONCLUSION

This research has been able to prove that there are some anthropometric differences between children from different groups of age and also among children in the same group of age. Moreover, this research also proved that there are some anthropometric differences caused by the dimension of time. Hence, anthropometric database should always be updated from time to time especially if the database is used for product design.

The result of this research shows 8 groups of size for Indonesian boys that have the advantage of high coverage rate of 95.48%. The result of this research also shows significance differences compared to ISO 3636:1977 and SNI 08-0555-1995 in terms of size interval and control dimension. The differences of size interval and control dimension obtained from this research compared to SNI 08-0555-1995 show that SNI needs to be updated from time to time. Whereas the differences compared to ISO 3636:1977 show that ISO could not be directly adopted in terms of designing a certain product in a specific country.

For the future research, authors suggest to add more respondents in the study and compare the study to another standard of clothing.

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Decree of Safe Postures in Manual Lifting Tasks among Some Groups of Construction Workers in Southwestern Nigeria

H.O. Adeyemi *ahacoy@yahoo.com*
Department of Mechanical Engineering
Federal University of Agriculture
P.M.B., 2240, Abeokuta, Ogun State, Nigeria

S.B. Adejuyigbe *samueladejuyigbe@yahoo.com*
Department of Mechanical Engineering
Federal University of Agriculture
P.M.B., 2240, Abeokuta, Ogun State, Nigeria

O. G. Akanbi engrakanbi@yahoo.com
Department of Industrial Engineering Department,
University of Ibadan, Oyo State, Nigeria

S. O. Ismaila *ismailasalami@yahoo.com*
Department of Mechanical Engineering
Federal University of Agriculture
P.M.B., 2240, Abeokuta, Ogun State, Nigeria

A. F. Adekoya *Lanlenge@gmail.com*
Department of Computer Science
Federal University of Agriculture
P.M.B., 2240, Abeokuta, Ogun State, Nigeria

Abstract

This study appraised working postures adopted by two groups of construction workers in Southwestern Nigeria. The objective was to measure and compare the level of safe postures in manual lifting tasks among the workers. Using Ovako Working Postures Analyzing System (OWAS), 844 working postures involving 250 healthy Bricklayers (BL) and Bricklayers' Assistants (BA), were analyzed. 36% of the total postures observed were classified as Action Group 1 (AG-1) - not harmful, while the rest postures call for ergonomics interventions. AG-3 and AG-4 (harmful) occupied more than 49% of the total recorded postures. The higher percentage among the safe postures (58%) was recorded in lifting task performed by BA. The study revealed that the degree of safe postures among the groups of workers is comparatively low. Necessary ergonomics measure is required to improve on AG-1 postures among the workers. Such control will reduce the unsafe conditions characterizing manual lifting activities in construction tasks.

Keywords: Safe, Harmful Working Postures, Construction, OWAS.

1. INTRODUCTION

Safe posture is paramount for good ergonomics. Good postures at work involves training body to stand in positions where the least strain is placed on supporting muscles and ligaments during weight bearing activities. It is the position in which body is held upright against gravity [1]. Lifting and transfer operations typically entail some risk factors that cannot be totally eliminated. In fact no manual handling activity is completely safe [2]. Construction workers however often lift, hold or carry heavy objects, putting them at risk for strains, sprains and soft tissues injuries [3]. To help prevent manual injuries in the workplace, manual lifting should be avoided as much as possible for use of mechanical lifting devices (like a fork lift, hoist, crane, or block and tackle). Where it is not possible, redesigning of work methods leading to adopting proper posture in construction tasks as stated by [4] becomes a necessity. Good postures during lifting tasks can prevents strain or overuse problems, backache and muscle pains [5].

Keeping arms fully extended when lifting heavy load will strain the forearm muscles at their attachment to the elbow and holding objects at arms length can increase the load on the lower spine by 15 times the original weight. It is therefore safer to hold the object as close to body as possible to reduce the strain on arms and back [6]. In like manner, lifting above shoulder is hard on arms and back. Improper shoulder posture can put unwanted strain on neck and back, causing chronic pain. Lifting from floor level or above shoulder height, especially heavy loads should be avoided and the amount of weight being lifted reduced. For a long lift such as floor to shoulder height, using ladder to get closer to the target area Instead of lifting above shoulders can be considered [7].

Although human spine is quite strong and flexible, it may get damaged when pressure is exerted on it in a wrong way especially when heavy objects are lifted. Therefore all site material lifting needs to be planned before the job starts as proper lifting and handling help protect against injury and make job easier [8]. Body should be positioned properly, with the back in straight position maintaining its natural curve. Material to be lifted should be properly stored where there is space to lift them safely and without reaching or twisting [9]. The arms and elbow should be closed to body to prevent too much of the weight being placed on shoulders. To reduce the strain on arms and back, objects carrying should be closed to body as much as possible [6]. As stated by OSHA [10], If a material to be lifted looks like more than can be handled, it is better to get help from another person. However if a heavy load must be lifted, the back should be kept straight [11]. Figure 1 demonstrates the areas around the body within which loads may be lifted without risk for 95% of the male and 95% of the female population as reported by Manual Handling Operation Regulation [12]. It was mentioned that figures up to twice the levels stated may be acceptable with some control measures. However weight to be lifted may be reduced below the guideline values if it involves twisting or bending.

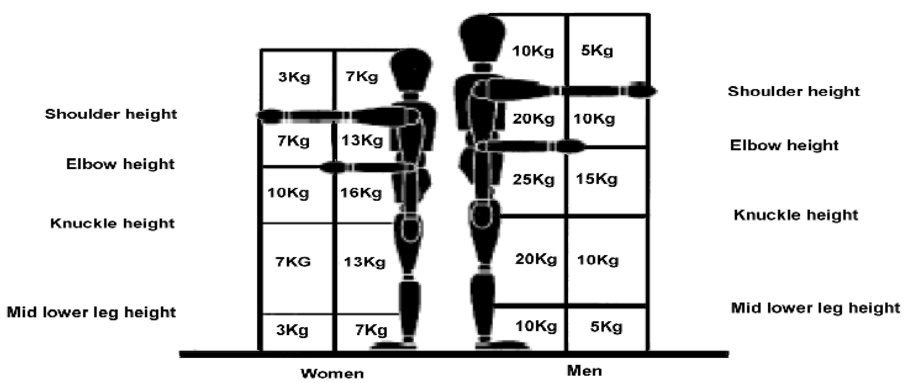


FIGURE 1: Demonstrating the areas around the body within which loads may be lifted (12).

There are several posture based ergonomics tools developed for posture analysis, such as Posturegram, Ovako Working Posture Analyzing System (OWAS), Rapid Entire Body Assessment (REBA) to evaluate whole body postural Musculoskeletal Disorders (MSDs) and risk associated with job tasks, Posture Targeting and Quick Exposure Check for Work-related MSDs (WMSDs) risks (QEC). Some special tools are equally designed for specific parts of the human body. Rapid Upper Limb Assessment (RULA) is designed for assessing the severity of postural loading for the upper extremity. The similar systems include HAMA (Hand-Arm-Movement

Analysis), PLIBEL (method for the identification of musculoskeletal stress factors that may have injurious effects) and (MFA) for muscle fatigue analysis (13).

REBA was used by (14) in the Study and Justification of body postures of workers working in small scale industry, evaluation of postures gives a Very High Risk level and showed that there is need for corrective action. Trevelyen and Haslam (15) investigated MSDs in a handmade brick factory. Posture and force analysis found poor standing posture and undesirable wrist positions. Variety of different handling techniques within 131 employees in one brick manufacturing plant was observed by (16) of which some of the techniques were considered potentially harmful, necessitating frequent bending and twisting. In the survey of some occupations reported as an annex to “WMSDs– Facts and figures”, construction industry was reported as having the highest percentage shares of workers working in awkward positions and the highest exposure rates (17). In the construction tasks analysis conducted in Southwestern Nigeria by [18], result obtained indicated that most of the stresses related complaints in construction works are engineered by poor work methods. The involvement of ergonomics in the jobs is very low with a wide gaps in information related to the prevention of construction site injuries and illnesses.

A good posture however should keep the body free from pain, allow it stay flexible and provide the strength and motion necessary to perform task without undue stress on any component of the body [19]. It takes training and practice to do it right [8]. Workers need exposures to training on the proper techniques for lifting, bending and carrying. It is also advised that stretching and strengthening exercise before lifting heavy objects with hands could be helpful [20]. Employers need look at the risk of the task and put sensible health and safety measures in place to prevent and avoid related injury [1, 12]. A lifting plan/safe working method should be in place with regular material handling and lifting inspections. This according to [21], should be included in the project health and safety plans.

Most of the available studies reported various harmful postures among workers. This present work aims at evaluating the extent of safe working postures obtainable in manual lifting tasks among two groups of construction workers. The objective is to ascertain the contribution of working postures to the level of safety in manual material lifting task.

2. MATERIALS AND METHODS

Two hundred and fifty (250) healthy male workers drawn from five different construction sites in the Southwestern Nigeria participated in this study. An urgent observation of how the workers perform their jobs and the working postures maintained at the various lifting task were made with video recordings which were played indoors and observed by some ergonomics experts drawn from academics. The data was analyzed with the use of WinOWAS software. OWAS method is based on a simple and systematic classification of work postures combined with observations of work tasks. The observation, as used in this study, is expressed in 4 number code (****), where the first number is the back posture, second number is the arms posture, third number is the legs posture and fourth number is the load. The observation interval was within 30 seconds at the workers’ agreed time during working period.

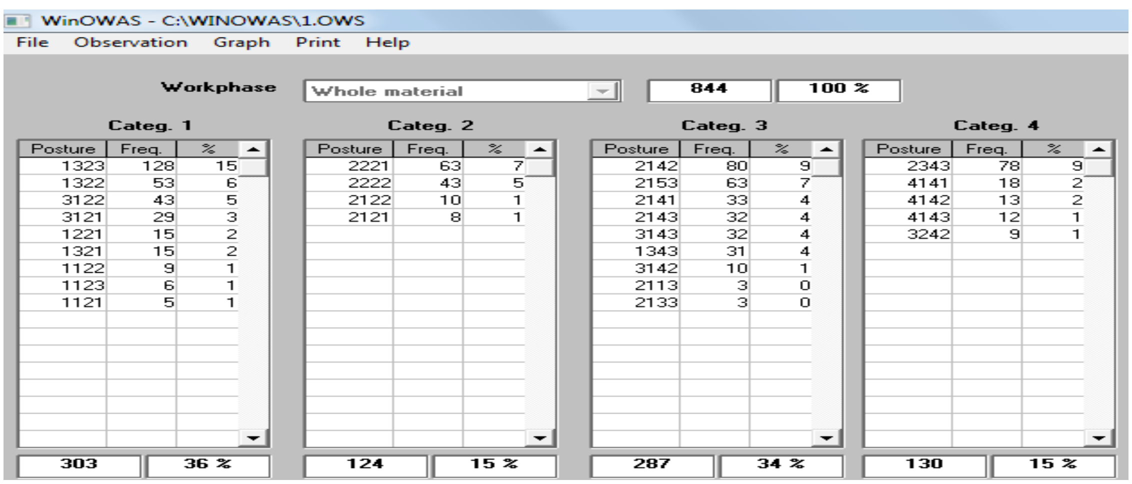
Eight hundred and forty-four (844) working postures were recorded and analyzed. Four hundred and twenty two (422) working postures were recorded during Bricklayers’ jobs performance and the rest recorded in Bricklayers Assistants’ tasks. As adopted in this study, Action Group 1 (AG-1) are grouped postures that required no actions (safe postures). Action Group 2 (AG-2) are grouped postures that required actions in the nearest future (not completely safe), Action Group 3 (AG-3) are grouped postures that required remedial actions very soon (not safe), and Action Group 4 (AG-4) are grouped postures that required immediate remedial actions (not safe).

Back	Arms	Legs	Load/Use of Force
1 = straight 2 = bent forward or backward 3 = twisted or bent sideways 4 = bent and twisted or bent forward and sideways	1= both arms below shoulder level 2= one arm at or above shoulder level 3 = both arms at or above shoulder level.	1 = Sitting 2 = Standing on two legs 3 = Standing on one leg 4 = Standing on two bent knees 5 = Standing on one bent knee 6=Kneeling 7=Walking	1= weight needed is 10kg or less 2=weight needed exceeds 10kg but is less than 20kg 3 = weight needed exceeds 20kg.

Percentages of postures considered to be safe among the analysed postures were compared with the other groups of postures considered not safe in the manual lifting tasks.

3. RESULTS AND DISCUSSIONS

Table 1 shows the total 844 different postures recorded during manual material lifting task for the two studied groups of workers as presented in OWAS software. The highest frequency (303) of postures was recorded for Category 1 (AG-1) while the least (124) were recorded for Category 2 (AG-2). The OWAS reported 36%, 15%, 34% and 15% for AG-1, AG-2, AG-3 and AG-4 respectively (Figure 2).



Categ. 1

Posture	Freq.	%
1323	128	15
1322	53	6
3122	43	5
3121	29	3
1221	15	2
1321	15	2
1122	9	1
1123	6	1
1121	5	1
303	36 %	

Categ. 2

Posture	Freq.	%
2221	63	7
2222	43	5
2122	10	1
2121	8	1
124	15 %	

Categ. 3

Posture	Freq.	%
2142	80	9
2153	63	7
2141	33	4
2143	32	4
3143	32	4
1343	31	4
3142	10	1
2113	3	0
2133	3	0
287	34 %	

Categ. 4

Posture	Freq.	%
2343	78	9
4141	18	2
4142	13	2
4143	12	1
3242	9	1
130	15 %	

TABLE 2: Showing OWAS description of all categories, frequency and percentages of recorded postures.

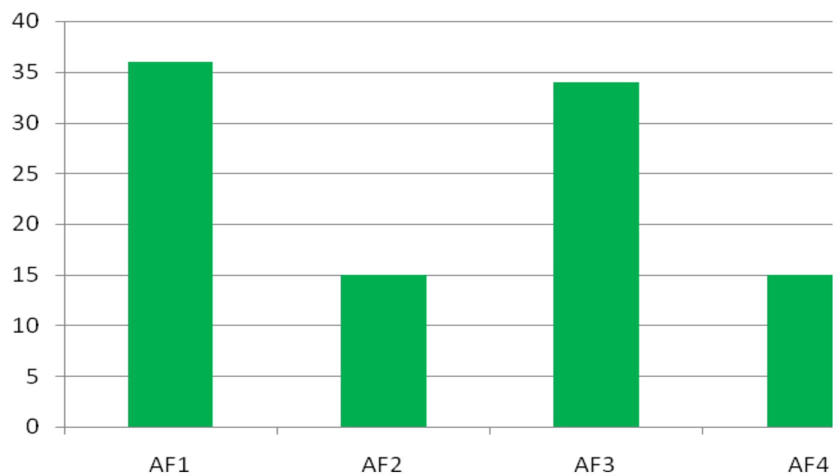


FIGURE 2: Percentages of AF1, AF2, AF3 and AF4 categories of all recorded postures for the group of workers.

Figure 3 shows the OWAS recommendations for actions for all the postures recorded. The length of the bar in the graph shows the action group. Only 31% of all back positions during the lifting task were recorded as 'straight' which could be described as safe back position as stated by Scott [11]. The remaining 69% were either bent, twisted or both of which could contribute to back injuries. It is also recorded that 48% of all Arms position were found below shoulder level. A level within which heavy loads may be lifted without risk for 95% of the workers [12]. The remaining 52% were above the shoulder level. In the category of weight of material lifted by the workers, only 22% of the total load are reported to be less than 10kg, while more than 46% of the load are reported having some membership with heavy load and which is capable of contributing to body pains and other lifting related injuries [14].

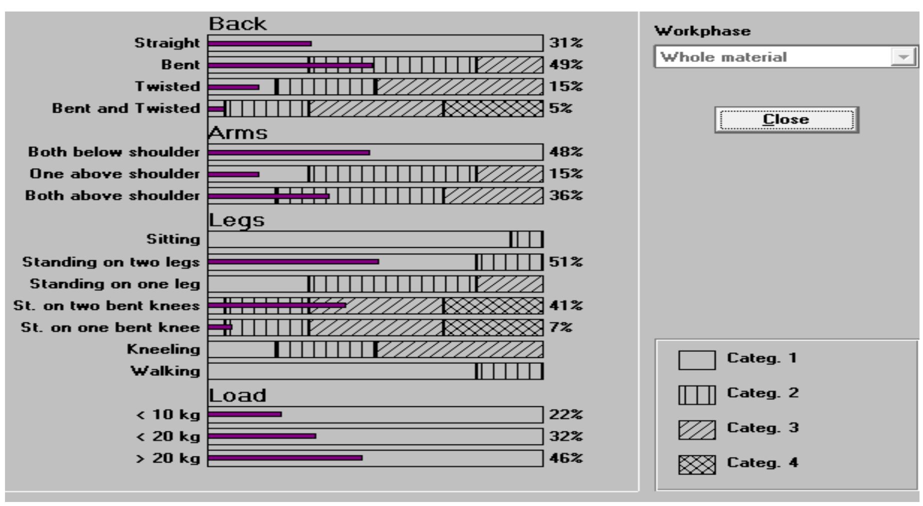


FIGURE 3: Showing the OWAS' Recommendations for Action.

In OWAS definition AG-1 are grouped postures that do not require ergonomics action and while AG-2 are those that required actions in the nearest future. Table 3 shows the recorded postures for these two categories. Only 35.9% of the total postures recorded fall into category AG-1 which included 15.2% of BL total postures and 20.7% of BA total postures. For AG-2, 14.7% of the total postures are recorded for this category. This included 9.6% of BL total postures and 5.1% of BA total postures.

Four hundred and twenty two (422) different postures were recorded for each category of the workers. 128 postures, representing 30.3% in the BL group fall into AG-1 family while 19.2% fall into AG-2 family. In the group of BA, 175 postures, representing 41.5% of the postures fall into AG-1 family and 43 postures, representing 10.2% in AG-2 family (Figure 4). Within the group of BL, 209 different postures representing 49.5% of the total postures fall into AG-1 and AG-2 while in the BA category 218 postures representing 51.7% of the total recorded postures within the group fall into AG-1 and AG-2 (Figure 4).

AG-1 POSTURES				AG-2 POSTURES			
BRICKLAYERS		BRICKLAYER ASSISTANTS		BRICKLAYERS		BRICKLAYER ASSISTANTS	
CODE	FREQ.	CODE	FREQ.	CODE	FREQ.	CODE	FREQ.
3122	43	1322	43	2122	10	2222	43
3121	29	1221	9	2121	8		
1321	15	1323	108	2221	63		
1323	20	1123	4				
1221	6	1122	7				
1322	10	1121	4				
1123	2						
1122	2						
1121	1						
TOTAL	128		175		81		43

TABLE 3: Showing OWAS Report for AG-1 and AG-2 Postures.

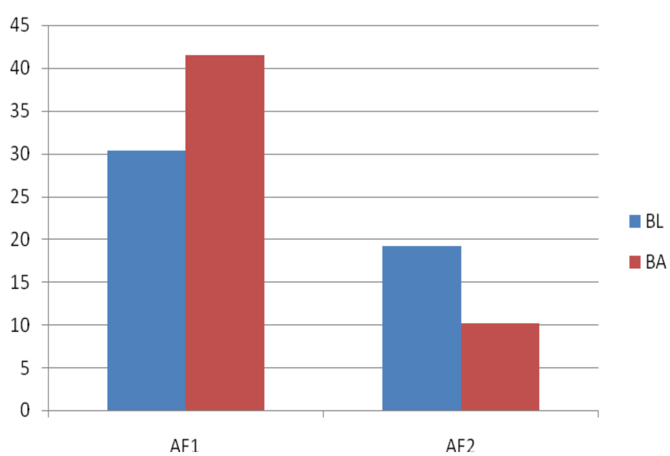


FIGURE 4: Percentages of AF1 and AF2 categories within each group of the workers' postures.

Considering safe postures scenario that requires no ergonomics action now (AG-1), 128 postures (15.2%) and 175 postures (20.7%) in the category of BL and BA respectively were observed (Figure 5).

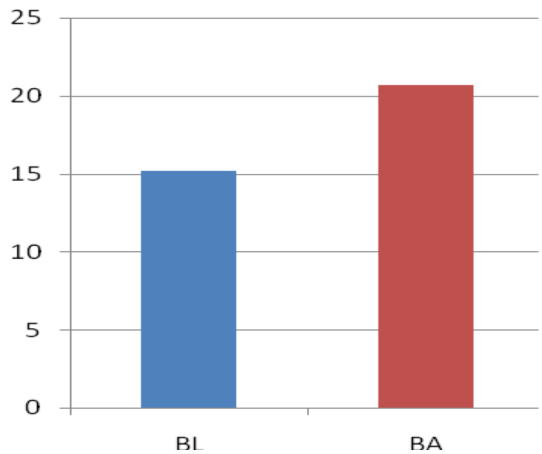


FIGURE 5: Overall percentages of Safe Postures recorded for each category of workers

It was reported that most workers performing manual lifting job in construction trade will be at an increased risk of a work-related injury [4]. As observed in this study, AG-1 postures are considered safe since AG-2 postures will still required ergonomics action latter, it is not completely safe. The degree of AG-1 among all the postures recorded is comparatively low (36%) to the unsafe postures, most especially to AG-3 and AG-4, which take more than 49% of the total recorded postures. Bricklayer Assistants however has the highest of about 21% among the safe postures. The AG-2 postures are closed to safe category if the gaps of information relating to ergonomics methods of lifting among the workers are closed.

4. CONCLUSION

The degree of safe postures (AG-1) recorded during manual material lifting tasks in the construction sites studied is very low (36%) compared with the harmful postures. AG-3 and AG-4 take more than 49% of the total recorded postures. Among the group of workers studied, the highest safe postures were recorded among Bricklayer Assistances.

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