Ergonomic Assessment of School Furniture in Primary Schools in Nigeria

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Abstract

This work considered the micro ergonomics of some facilities used in sampled primary schools with particular focus on how they impact on the pupils. About (24) twenty-four various body characteristics were measured with standard equipment. Characterization of the classroom chairs and tables were also carried out. The data collected from the pupil's body characteristics were analyzed using percentile statistics the extremes (5th and 95th percentile). A fitness check was conducted to establish the match between the furniture and the users. Some features of the furniture were observed to pose ergonomics issues were by the comfort survey and particular sample case of mismatch between popliteal height sitting body measurement and chair height is noticed at p = 0.05 which rendered the chair uncomfortable for use of the pupils. Ergonomic intervention using participatory ergonomic intervention approach is suggested to mitigate the prevalence of musculoskeletal disorder experienced by the pupil.

Keywords: Comfort survey, Developing countries, Risk factors, School furniture.

1. Introduction

Greater part of production, education, transport, administration and relaxation activities takes place in a sitting position. Teenagers, youths and adult students were expected to remain in sitting position for extended period of time within a workplace while carrying out some activities such as receiving lectures, engaging in tutorials and other classroom activities. Sitting posture which is perceived to be relatively comfortable for several educational, official and manual operations in workplaces has the capacity to pose musculoskeletal challenges as a result of poor seat design, extended period of sitting in a fixed position and other identifiable workplace risk factors. Students in the primary school in developing countries particularly form a large population of soft targets of work related musculoskeletal disorder (WMSD). There is a general nonchalant attitude and ignoramus on the part of key players in education industry to pupils' opinion about classroom furniture and fittings influenced by cultural dysfunction. The expressed and unexpressed quandary of school children on their classroom experience usually force the kids to be fitted to school facilities such as chair, table chuck board wash-hand basin, toilet fittings most of which failed to consider their physical capability and limitations and to which pupils have been culturally interdicted to criticize (Healy *et al* 1997, and Myhr and von Wendt 1990).

Sitting position is found to be more relaxing and comfortable than standing posture and it provides better support surface and allow reduction of the muscles in the legs (Howe and Oldham, 2001). Poor postures are often induced by the poorly designed seat, work table and adverse environmental factors. It has been observed that while resting or attending to the teacher, students adopt backward position leaning against the back rest. This awkward posture was forced on the children by the badly constructed seat as they seek to achieve a comfortable and stress free sitting condition. The design of suitable school furniture is therefore a complicated task which aims at enhancing safety, comfort and effective performance at school children workstation. As a result, chair and other seating furniture thereby have become most important tools for children, youths and adult's population. Unfortunately, the number of people with back injuries is greatly increasing (Hastings 2000).

Strangely enough in spite of this development educationists, government and doctors have paid little attention to the shaping of this important tool, and have left this to haphazard design fashion. The painful experience and other damaging effects resulting from uncomfortable posture during learning, writing and painting at school has been the focus of ergonomists.

The familiar low back scourge did not exclude children from the infant to teenage categories. However, there is dearth of research effort in this area. Children with sitting challenges are exposed to worse condition with the use of inappropriate furniture which litters the classrooms of primary schools and junior secondary school pupils. The complexity of seat system development for all ages suggests the need for conscious and continuous research in the field of ergonomics of educational furniture and tools. Appropriate postural management using the right seat can act as effective therapeutic modality to enhance functional ability (Wandel, 2000 and Geldhof *et al* 2007).

1.1 Postural development in Children

Human body have been conveniently divided into segments which include head and neck, upper arm, fore arm, hand, thoracolumbar, thigh, foreleg and foot which are connected together by linkages at different joints (Phillips. 2000, Pope, 2002, and Onawumi, 2013) Much of the damages in posture are done at the childhood age with poor attitude to interventions expected in the process of seat systems development, seat component design and fabrication and monitoring of sitting children posture. The contributions of house and school furniture to musculoskeletal development for both adult and children cannot be over-emphasized (Farley *et al*. 2003. Magnuson and Dilabio 2003). Postural management has severally been proposed as form of intervention to reduce the challenges of musculoskeletal disorders issues with posture become very important as it is found to have influence on vast range of daily functions and other internal processes such as temperature regulation, vision, digestion circulation, breathing etc. (Green, and Nelham 1991, Clarke and Redden 1992 Healy *et al*. 1997, and Myhr and von Wendt 1990).

Seating systems are aimed at providing a fitting level of postural support as well as offering comfort, skin protection, and stability to enable daily functional activities such as sitting and movement to be carried out at home and at school (Johnson Taylor, 1993; Cutter, 1997; Perr, 1998; Hastings, 2000; Pain, 2000; Rappl, 2000; Buck, 2001; Paleg, 2006). In addition, the introduction of seating systems at an appropriate age is considered to facilitate psychosocial and cognitive development (Dworak, 2005). Human posture was defined in the work of Ham *et al* (1998) as "the position of one or many body segments in relation to one another and their orientation in space" Posture therefore synchronizes the effect of function, stability and comfort on human musculoskeletal system. A number of interconnecting factors were identified to have significant influence on human posture include muscle tone, body shape and size, gravity, nature of floor surface, task in hand, posture enduring time and health status (Howe and Oldham 2001, Kangas 2002, Buck *2003,* Van der Heide *et al* 2003 and Pope 2002).

The results of poor postural management have been well identified to include increased dependency, tissue trauma, contractures and spasticity, poor systemic function, such as respiratory, cardiovascular and digestive functions, immobility, increased pain and discomfort, and muscular fatigue (Turner, 2001, Gilinsky, 2006, McClinton, 2007 Cutter, 1997). According to Hong (2002), the inability to control posture has a significant impact on function. A seating system that does not match the user's requirements would likely fail to provide adequate postural support and may therefore limit function rather than promote it (Di Marco *et al*, 2003).

1.2 Anthropometric of School Pupils

A number of anthropometric studies of school children related to educational environment were carried out in the 1960s (Wilson 1990). Since the 1970s efforts of researches focused on school seating and seat design have continued to receive incentive for publications (Knight and Noye, 1999, Mandal, 1984). While ideal design of school furniture continues to be debated, attempt to make improvements has been launched. Researchers have identified a surprisingly high prevalence of back pain among school children and adolescent. (Watson *et al*, 2002). Many authors have tried to establish the extent of mismatch between school furniture and American students' anthropometric characteristics of 11-13years age limit and reported that only 18.9% of students could have appropriate match (Gouvali and Boudolos, 2006). Studies of back are education have been conducted in Europe (Cardon *et al* 2004) but the inclusion of this subject in school is not universal, many have shown concern with the load that student carry in book bag and back pains (Chow *et al* 2011). The awareness of the significant contribution of ergonomic data into standards or design in low cost ergonomically designed furniture is yet to receive wider policy support in nations especially in developing countries. Consequently, the need for anthropometric databank of schoolchildren in the country cannot be over-emphasized.

Such data is required to develop reliable equations that could be used in the design and construction of comfortable and user-friendly school furniture. This work is concerned anthropometric survey together with investigating the degree of fitness of school furniture used in public schools in Nigeria.

1.3 Ergonomics in Education

Educational Ergonomics is concerned with the interdependence of Education performance and design of educational facilities. Educational ergonomics has the capacity to enhance the performance of students and educational systems to a substantial degree. Ergonomic interventions directed at design improvement therefore can benefit education scientifically. The field is concerned with, how and why design characteristics of the educational process and system influence variability in performance of participants in the system The design of education process refers to physical designs of instructional materials, environments, and technologies (e.g. classroom implements and equipment, text books, audio visual material and system, computer), as well as design of different skills, tasks, classes of knowledge and curriculum targeted to learning in school/classroom setting and the systems design of participants interrelationship. This also involves the design, management and administration of jobs, supervisory relationship, organizations, policies, and programs of educational systems, as well as to the designs of communities in which education occurs. The report of National bureau of statistics indicates that the population of school age range of 5-19 years is slightly above one-third of Nigerian population (NBS 2010).

This ergonomic study is an effort in the direction of secondary intervention that is aimed at recognizing the risk factors associated with poor selected classroom furniture in some primary schools in Nigeria and to suggest mitigating response capable of enhancing performance and increase productivity of primary school educational system in Nigeria. The engineering-based intervention resulting in anthropometric modeling and ergonomic seat development was proposed in this work. Participatory approach was used to achieve this laudable objective.

2. Materials and Methods

A total of fifteen primary schools were selected at random in the study area. During the visit five pupils per classroom were randomly picked for purpose of interview and administration of questionnaire. Ninety classrooms and one staff offices per school were covered which provided access to seventy-five teachers and staff and Four hundred and fifty pupils. The objectives of this study were achieved by following three major steps which include firstly ergonomic study of the physical facilities, secondly anthropometric survey of primary school pupils and thirdly Evaluation of the physical facilities as it affects the comfort, safety, effectiveness and efficient performance of student in classroom settings.

The equipment used for the collection of the body dimensions includes stadiometer, long and short anthropometry, weight scale, adjustable chair and measuring tape. The first three were designed and fabricated while the remaining were bought for convenience and to reduce calibration error to the barest minimum. Structured questionnaire was used to address related ergonomic issues.

2.1 Ergonomic study of the physical facilities

This study made use of participatory intervention ergonomic approach in which the informed enumerators took time to educate stakeholders in the system on the study and the potential benefit that the product of it can offer. Structured questionnaire was designed to enable the identified respondents find it interesting to fill. The questionnaire addressed demographics of the respondent such as Names (optional), Age, sex and Nationality. Also the assessment of chairs, table and chalkboard in the classes, and classroom structural dimension were investigated through physical measurement of ergonomically characterized features of the items and their relative position to the pupils in the classroom.

2.2 Primary School Pupils' Body Dimension

Anthropometry gives a systematic measurement of body dimension using specialized equipment. The body characteristics in some selected will be measured within Ogbomoso town. The anthropometry survey is exclusively for the purpose of collection of anthropometric data of school pupils. This will assist in the development of the designing of the pupil's facilities and to correct the existing mismatch between facilities provided.

2.3 General Procedure for Body measurement

For each group three enumerators, having been properly trained on the use of the tools for participatory ergonomic intervention approach made available as well education on attitudinal issues work together with the following rules and procedures guiding their activities:

i. Do not attempt to weigh or measure the child if the subject refuses
ii. When there is more than one child or respondent, complete and record all the measurements for one child before moving on to the next child.
iii. It is necessary to touch and handle children during the weighing and measuring process.
iv. If a pupil becomes very upset, give the pupil back to the teacher and wait a few minute.
v. Write all results in pencil. If you make a mistake, erase the error and write the correct results.
vi. Place the measuring board on a hard, flat surface and against a wall or a table. Make sure the measuring board is stable.
vii. Take off the shoe and unbraid any hair that would interfere with the height measurement.
viii. Put the questionnaire and pencil on the ground.
ix. Place the subject's feet flat together in the centre of the board. Put your right hand on the child shins and your left on the child knee.
x. Ask the child's leg are straight ahead. Make sure the child's line of sight is parallel to the ground.
xi. Check the position of the child. When the child position is correct, lower the headpiece to the top of the child's head; read the measurement to the nearest 0.1cm and call out the result.
xii. Write the result on the questionnaire and show it to confirmation.

2.4 Analysis of Anthropometric Data

Percentile statistics and analysis of variance (ANOVA) were used to study the differences between the user's bodily demands and the variable of furniture n the classroom. Descriptive statistics were also used to present the data from the structured questionnaire administered Appropriate percentile for assessment were identified and used for instance a common practice is the use of 95th percentile use in designing facilities such as door clearance. Maxi percentile example includes door handle.

3. Result and Discussion

The table shown below presents the result of the desk and chair that were measured during the cause of this work. Multiple designs were common the study area as no known standard or specification is in existence. Some private schools do recommend that parents and wards should pay between N5000:00 and N15000:00 per piece of chair and table which they use to procure ready-made furniture for students but little or no consideration of individual peculiar anthropometric dimension. This practice point to the lack of quality control of school facilities by school inspectors, the poor attitude of school administrators to pupils' comfort and lack of knowhow of the furniture makers and parent ignorance of the risk factors that their children are exposed to. Many cases of postural damages start from the primary school experience of the children as they were forced adapt their musculoskeletal system to unfit seat system. Also observed was the unsafe and disused state of eighty-five percent of the classroom furniture in the study area. The result of this include frequent cases of turned uniform, body injury from lacerations caused by sharp edges, exposed nail tips and weak joints of the chair or table.

3.1 Classroom Furniture Characteristics

Table 1 shows the measurement of the different types of chairs found in the classrooms one to six of all schools visited. The measurements of the furniture show significant variations with seat breath (30.84 ± 20.62) and backrest length (81,96 ± 20.9) of the seat in the class one. The seat pan shows consistent reduction in SD which span between 0.92 and 1.49 for class two to six. The exceptional case of class one is consistent with variations of the dimension of other seat characteristics. The backrest length ($27.02 \leq \mu \leq 30.84$, $1.31 \leq sd \leq 7.05$) and backrest height ($8.84 \leq \mu \leq 12{,}42$, $0.33 \leq sd \leq 0.99$) are reflective of possible mix of different design of furniture in each classroom. The case of arrangement of the different designs of seats as observed in the classrooms was a show of chaos and risk prone setting. About forty-five percent of the chairs are double seat type with ninety-three percent of the same having no arm-rest. Single seat type had both writing top and arm–rest which feature provide some level of comfort provided that its dimensions fit adequately the relevant body measurement of the users.

It was observed that none of the seat used by pupils in all the school in the study area have room for adjustment. This limits the seat system of the primary schools to specific pupils whose body dimensions fit the design feature of the chairs. It is therefore expected that furniture makers should measure relevant student's body measurement before fabrication of the same.

Table 2 shows the descriptive statistics of the writing table used by students at the schools sampled for this survey. Desk length has the highest variability (SD = 25.29) due to the use of multiple designs of the table. This suggests the possibility of musculoskeletal disorder challenges which is capable of impairing the safety and performance of the pupil especially as they are being newly introduced into the classroom system.

The table which was primarily for writing were fabricated with the chair or reduced to just a writing flap top (Figure 2). Limitations imposed by these divergent characteristics have capacity of creating distractions and unsafe classroom settings. A unified classroom seat system designed with school pupils' anthropometric variables is suggested as solution to postural damage, health challenges and other musculoskeletal disorders among school children. The age range of the pupils is indicative of the primary school education system in practice with mean age of 9 years which inform that students are major in their preteen age. The age that is faced with limiting problems due to localized cultural believes.

The anthropometric measurement of some body part of school pupil presents a characterization which can be of significant benefit to school facility and wears (Table 3). It is important to note that the measurement presented was for both male and female students in all school visited. An example of the misfit between body measurement and chair feature is noticed with the maximum mean values in all classes surveyed ($\mu_{min} = 33.00$, $\mu_{max} = 41.06$) is significantly lower ($p = 0.05$) than the popliteal height sitting (95th percentile = 42.38) which rendered the chair uncomfortable for use of the pupils. Another salient point is the fact that girls have larger

Table 1: Data Collected from Chair Measurement

Class	Descriptive Statistics (N=430)	Seat Pan	Seat Breadth	Chair Height	Backrest Length	Backrest Height	Acromion Height
Class One	x_{min}	25.60	45.20	30.40	44.60	11.30	37.20
	x_{max}	45.00	92.40	39.00	92.40	14.00	45.50
	μ	30.84	82.06	33.00	81.96	12.42	39.80
	SD	7.98	20.62	3.44	20.90	0.99	3.28
Class Two	x_{min}	25.00	90.10	29.80	90.40	9.00	34.00
	x_{max}	29.00	106.20	42.80	106.50	10.90	37.40
	μ	27.02	96.38	38.40	96.44	10.04	35.72
	SD	1.49	6.95	5.09	7.05	0.81	1.37
Class Three	x_{min}	25.90	100.20	39.40	100.20	8.40	34.30
	x_{max}	28.60	106.60	42.40	106.40	9.30	36.70
	μ	27.68	103.72	41.06	103.82	8.84	35.76
	SD	1.13	3.14	1.33	2.96	0.33	0.93
Class Four	x_{min}	26.00	98.40	38.30	99.30	9.30	33.80
	x_{max}	30.80	106.00	42.90	106.00	10.50	39.90
	μ	28.54	102.42	40.56	102.52	9.72	36.56
	SD	2.08	3.13	1.70	2.88	0.47	2.64
lass Five	x_{min}	28.70	100.60	34.80	100.80	9.10	30.50
	x_{max}	30.30	106.50	42.20	105.50	10.30	36.40
	μ	29.44	102.12	37.64	102.06	9.68	34.48
	SD	0.65	2.48	3.23	1.99	0.51	2.44
Class Six	x_{min}	28.20	100.60	38.60	100.60	9.30	33.10
	x_{max}	30.30	106.10	41.80	106.90	10.50	36.10
	μ	29.30	103.12	40.82	103.28	10.02	35.02
	SD	0.92	2.45	1.31	2.73	0.49	1.21

All dimension is in meters (m), μ = Mean, SD = Standard deviation,

a b c

d e f

g h i

a. Isometric view of Single Unit with writing top Wooden Seat with writing Top
b. Front view of Single Unit with writing top Wooden Seat
c. Chaotic Arrangement of Single Unit Seat with writing top in a Classroom Setting
d. Double Seat Wooden Chair
e. Isometric View of Double Seat Wooden Chair and Table
f. Front View of Double Seat Wooden Chair and Table
g. Isometric View of Iron Framed Combined Chair and Table
h. Side and Top Viewed Iron Framed Combined Chair and Table.
i. Back of Iron Framed Combined Chair and Table

Figure 1: Dimensionally Multivariate Classroom Furniture

Sizes in all age group than their male counterpart. The reason for this is that some girls enter their adolescence age much earlier than boys. This is in conformity with Leon's anthropometric study of school children (2001). Close observation of the furniture found at the schools visited purported a chaotic and unsafe situation unexpected of learning environment. The seats were observed to be dimensionally different and do not represent a match with the functional anthropometric measurement of the pupils. The school authorities do not help the prevailing alarming state the classroom arrangement as 87 % of the staff and teachers claim they had neither the knowledge of ergonomic nor anthropometric dimension of the pupils.

No directive on the expected design of the chairs and table. On the average each student confined to sitting posture for lecture for 35 minute per lecture and sometimes may extend 80 and 110 minutes for two and three periods of lectures respectively. About 90 % of local furniture makers also known as carpenters were either uneducated or semi-illiterates. This explains the reasons for lack of respect for or any appreciation of users' comfort and wellbeing. The limitation and capability of the school children that are expected to reflect in dimensions of the furniture were flagrantly abused. Cultural challenge which create restriction complex in pupils in the primary school prevents the teenagers from expressing their displeasure on actions of elderly ones, the same which possibly is responsible to the cold feet and disregards to the conduct of discomfort survey among the school children. Children rarely had the privilege of making contribution to thing provided or made for them. This is evidentially seen in the rate of child abuse in Africa and Nigeria in particular.

Table 2: Data Collected from Table Measurement

Class	Descriptive Statistics (N= 430)	Table Height	Height from the Ground to the Bottom of Book Pack	Desk Breadth	Desk Length	Book Pack Height	Distance between Table and Chair
One	x_{min}	56.90	43.40	22.80	44.70	9.70	30.80
	x_{max}	61.90	54.30	29.30	102.50	10.90	32.40
	μ	59.74	46.46	27.12	89.92	10.10	31.28
	SD	1.85	4.46	2.51	25.29	0.49	0.64
Two	x_{min}	62.50	45.30	27.00	98.30	9.70	22.60
	x_{max}	75.00	60.70	36.00	106.30	12.40	41.80
	μ	65.76	49.56	30.86	101.54	10.86	29.90
	SD	5.20	6.31	3.27	3.23	1.03	7.63
Three	x_{min}	62.70	47.40	26.40	101.10	9.30	25.70
	x_{max}	75.90	61.90	40.00	106.40	12.70	35.20
	μ	70.30	55.70	32.24	104.30	10.52	29.96
	SD	6.30	7.11	6.31	2.18	1.39	4.73
Four	x_{min}	61.80	42.70	26.40	101.40	9.90	24.50
	x_{max}	74.70	59.30	39.70	107.80	14.30	27.40
	μ	67.26	50.76	34.16	104.28	12.46	25.74
	SD	6.16	7.64	6.75	2.37	2.17	1.28
Five	x_{min}	64.30	47.00	28.00	103.60	9.60	26.70
	x_{max}	75.80	60.30	40.30	106.30	12.00	30.40
	μ	69.52	51.16	31.72	105.56	10.72	29.20
	SD	4.36	5.29	5.26	1.13	1.03	1.57
Class Six	x_{min}	43.50	43.50	27.30	102.70	10.30	29.60
	x_{max}	74.30	61.50	34.50	105.80	11.80	38.80
	μ	54.52	51.88	29.90	104.32	10.96	32.52
	SD	13.09	8.70	2.80	1.34	0.57	3.63

All dimension is in meters (m), μ = Mean, SD = Standard deviation,

Table 3: Anthropometric Characteristic of Pupils in Primary School

DISCIPTIVE STATISTICS (N=434)		Age (yr)	Weight (kg)	Stature	Sitting Height	Eye Height Standing	Eye Height Sitting	Shoulder Breath
Mean		8.97	26.68	128.39	60.63	116.76	52.07	29.07
Median		9.00	23.00	126.15	60.65	115.20	52.40	29.20
Mode		8.00	22.00	128.00	63.50	113.00	52.40(a)	30.20
Std. Deviation		2.48	8.43	11.55	7.12	16.18	5.98	3.70
Range		11.00	46.00	61.60	47.70	112.20	37.70	26.50
Minimum		5.00	15.00	101.50	32.30	41.60	34.90	13.10
Maximum		16.00	61.00	163.10	80.00	153.80	72.60	39.60
	5	5.00	18.00	112.00	49.20	98.18	41.68	23.40
	50	9.00	23.00	126.15	60.65	115.20	52.40	29.20
Percentiles	95	13.00	44.93	151.33	73.30	145.23	63.35	35.76
DISCIPTIVE STATISTICS (N=434)		Chest Breath	Hip Breath	Hip Breath Sitting	Acromium Height	Shoulder Elbow Length	Elbow-Hand Length	Maximum Horizontal Reach
Mean		15.65	21.83	24.14	39.46	27.41	21.42	50.48
Median		15.30	21.30	23.50	39.20	26.80	21.50	51.90
Mode		14.00	22.90	22.90	37.60	26.40	21.20	50.10(a)
Std. Deviation		2.04	3.06	3.83	3.94	3.31	5.40	8.40
Range		32.20	16.10	37.90	19.00	41.60	55.30	45.90
Minimum		12.90	16.20	18.30	30.90	20.70	11.90	22.00
Maximum		45.10	32.30	56.20	49.90	62.30	67.20	67.90
	5	13.70	18.05	19.98	33.38	23.00	14.13	38.95
Percentiles	50	15.30	21.30	23.50	39.20	26.80	21.50	51.90
	95	18.40	30.03	32.50	47.83	33.00	26.30	63.35
DISCIPTIVE STATISTICS (N=434)		Elbow Rest Height	Buttock Knee Length	Buttock Popliteal Length	Foot Length	Popliteal Height Sitting	Elbow-Centre of hand	Thigh Clearance Length
Mean		19.92	35.13	35.34	24.66	39.13	31.36	34.08
Median		14.60	38.20	32.90	21.65	38.70	32.35	34.50
Mode		11.90	38.00(a)	30.30	20.10	38.40	30.00(a)	34.30
Std. Deviation		10.02	9.78	22.18	6.70	5.39	8.31	5.58
Range		39.70	44.70	461.80	29.40	36.60	73.50	41.80
Minimum		9.80	11.70	19.20	17.40	24.70	2.70	13.00
Maximum		49.50	56.40	481.00	46.80	61.30	76.20	54.80
	5	20.20	27.88	19.00	31.50	12.78	19.63	38.95
Percentiles	50	38.20	32.90	21.65	38.70	32.35	34.50	51.90
	95	48.15	44.23	38.78	49.05	42.38	43.95	63.35

a Multiple modes exist. The smallest value is shown All dimension is in meters except Age (yr) and weight (kg)

4. Conclusion

The examination of match between school furniture dimensions and pupil's anthropometry data collected in primary schools in Ogbomoso revealed a varying measurement recorded in their body characteristics due to age difference which cut across primary one to primary six. This was so because the pupils were in the primary phase of growth, which is associated with increase in body sizes. This work suggests that postural build-up of school children were compromised by the unfit work system that they were subjected to with no stern effort to correct the resulting musculoskeletal disorder early enough before they become issue for medical attention and possibly leading to some form of physical disability. Also it is evident that the existing facilities needs to be modified in order to enhance the comfort ability of the pupil while doing their work through the conduct participatory ergonomic intervention program which include collection and analysis of medical information, discomfort survey and accident investigation and auditing among school children.

5. Recommendation

In the course of this study a lot of measurement was made and observations were recorded. It is based on this that a recommendation is made for future design of school pupil's furniture. The design of chair should be made with armrest to support the weight of the upper arm (shoulder). Due to longer period that the pupil spent in school, plastic chair should be made available for pupils. The size of backrest should be from the shoulder to bottom of the scapular to support the weight of the trunk. The desk and chair should not be fixed (separated) so that different user's can adjust it to suit their various sitting position. The seat depth should be made on 95th percentile to accommodate the length from buttock to popliteal. The desk surface should slant at an angle between $10^0 - 17^0$ to prevent forward leaning while writing. There should be provision for book pack space in the desk.

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