An Ergonomic Design of Birthing Chair for Public Maternity Hospitals in the Philippines

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Abstract

This study aims to design an ergonomic birthing chair for public maternity hospitals in the Philippines in order to provide comfort for patients and maternity healthcare workers. Previous studies prove that for normal delivery, patients giving birth in sitting position provides 30% more ease compared to lateral position. In addition, healthcare workers are also exposed to less risk for musculoskeletal disorders if they are in sitting position when assisting patients compared to standing position. In this regard, the researchers intend to design an ergonomic birthing chair for patients with an adjustable chair for healthcare workers by applying the principles of anthropometry that is fit for Filipino users. Ergonomic assessment tools such as CMDQ and RULA were used in order to determine the risks of workers for MSD due to the current design of birthing bed for normal delivery. Statistical tools such as analysis of variance (ANOVA) and correlation analysis were also used in order to determine significant factors that contribute to the MSDs of healthcare workers in maternity hospitals. The result of CMDQ and RULA indicated that musculoskeletal disorders are evident in the following: (a) obstetricians: wrist (95.2%), thighs (86.9%), shoulders (69.05%), forearms (60.7%) and lower back (52.4%); (b) midwives: knees (81.5%), wrists (78.8%), lower back (72.4%) and shoulders (72%). Statistical analysis proved that task factors such as positioning, supporting baby's head as it emerges, supporting baby's neck using both hands, delivering placenta and final positioning significantly contributes to the MSD experienced by workers. Thus, the new design of birthing chair proves significant reduction of MSDs for healthcare workers and provides more comfort for patients.

Keywords
Maternity hospital, birthing chair, ergonomic design, musculoskeletal disorder

1. Introduction

Birthing chair is a device that is shaped to assist women in the physiological upright posture during childbirth. It is intended to provide balance and support for patients when delivering babies. In a study by Yap (1996) states that the posture adopted by the mother during labor is considered to be the most important factor for the safe passage of fetus through birth canal. Based on studies, the natural and most effective posture in giving birth is upright position – sitting, squatting, kneeling or standing. The supine position for this delivery facilitates the management of labor and provides physiological advantages for mothers and fetuses compared to lateral position. The advantages of upright position for labor includes: gravitational forces to promote fetal descent; preventing compression of aorta; inferior umbilical cord; increased size of pelvic inlet; promoting more effective bearing down-effort and promoting more efficient contraction. In terms of physiological responses, laboring in the seated position has been found to promote active participation, control and emotional satisfaction (Yap, 1996).

The problems affecting childbirth could be most appropriately studied within the confines of human-machine environment system, or the Ergonomics approach. The International Ergonomic Association (IEA) defined ergonomics as the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theoretical principles, data and methods to the design in order to optimize human well-being and overall system performance. Ergonomists contribute to the design and evaluation of tasks, jobs, products, environments and system in order to make them compatible with the needs, abilities and limitation of people (Karwowski, 2000).

The application of ergonomics in maternity hospital allows the human-machine, and the human-environmental interface problems, involving psychological, physiological and biometrical factors to be analyzed, optimized, designed and evaluated more scientifically, according to evidence-based principles that is why ergonomic design for childbirth facility is highly important because childbirth is a critical and highly complex physiological process involving the safety and well-being of mothers and babies (Yap, 1996).

Similarly, the needs and concerns of healthcare workers in the maternity hospitals are also a concern. Previous studies proved that healthcare workers such as obstetricians, midwives, nurses and nursing aids are exposed to risk of musculoskeletal disorders when performing tasks in assisting mother during labor. Workers in maternity hospitals are subjected to awkward postures and use of muscular force due to the inadequate work environment and demands of the work tasks (Nowotny, 2011).

There are numerous studies for ergonomic design of birthing chair to provide comfort for healthcare workers and patients during delivery. However, in the Philippines, it is not a current practice to use birthing chair in delivering babies since most of patients especially in public hospitals use lateral posture in giving birth that is why birthing beds are commonly use. Thus, this study aims to design an adjustable birthing chair for patients to be used in public hospitals in the Philippines.

2. Methodology

In order to design a birthing chair, the researchers gathered data among 84 obstetricians and 184 midwives in 3 largest public hospitals in the Philippines. Initially, the researchers identified musculoskeletal disorders experienced by obstetricians and midwives in assisting patients during labor and delivery using ergonomic tools such as CMDQ and RULA. Cornell Musculoskeletal Disorder Questionnaire (CMDQ) were used in order to identify the specific body parts of the subjects experiencing pain and discomfort. And in order to determine task postures contributing to musculoskeletal disorders experienced by subjects, Rapid Upper Limb Assessment (RULA) tool is used.

Afterwards, risk factors affecting MSDs of workers are recognized using statistical tools such as analysis of variance and correlation analysis. Analysis of Variance (ANOVA) is utilized in order to determine significant difference among the MSDs experienced by obstetricians and midwives as well as significant difference in task postures among the subjects of the study. In addition, correlation analysis is also used in order to identify significant factors that contribute to the MSDs of the subjects in terms of task postures.

Finally, using the principles of anthropometry based on Philippine populations are considered in order to design an ergonomic birthing chair for Filipino users. The anthropometric measurements were able to help the researcher to solve the awkward posture of the subjects which reduced presence of MSDs in the task. AutoCAD software had been utilized for the drawing of prototype design. To control and to lessen the risk of potential failures in the design, FMEA analysis was conducted. Cost and Benefit Analysis was applied to determine the advantages and benefits of the proposed design against the current design. For final testing, the design was evaluated through the use of Minitab software.

3. Results and Discussion

In order to identify musculoskeletal disorders experience by healthcare workers due to the current design of birthing facility in the public hospitals, CMDQ was used. The results of the survey are shown in the tables below.

Table 1. CMDQ Result for Obstetricians
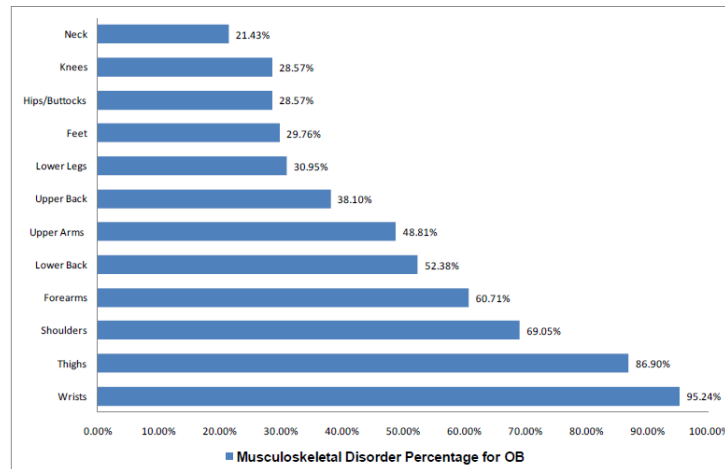
Based on the result of CMDQ, obstetricians experience pain and discomfort in the following: wrist (95.2%), thighs (86.9%), shoulders (69.05%), forearms (60.7%) and lower back (52.4%).

Table 2. CMDQ Result for Midwives
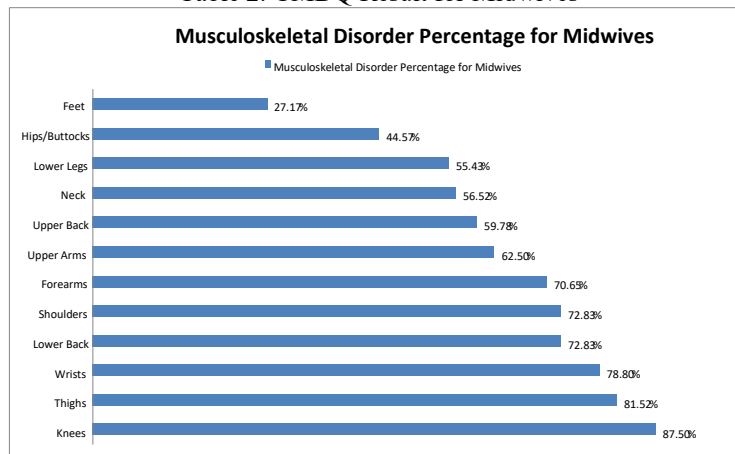
Based on the result of CMDQ, midwives experience pain and discomfort in the following: knees (81.5%), wrists (78.8%), lower back (72.4%) and shoulders (72%).

In order to analyze the cause of musculoskeletal disorders among obstetricians and midwives, task posture analysis was done using Rapid Upper Limb Assessment (RULA). RULA is a tools to identify the risks of workers for upper limb disorders due to current working posture based on the design of device and facility being used by the subjects. The result of the analysis is shown in the table below.

Table 3. Summary of Tasks for Obstetricians and Midwives
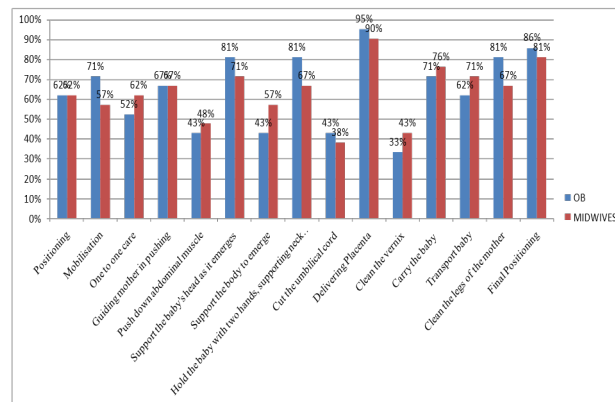
The result of task analysis indicated that majority of the time the subjects spent during task are delivering placenta, final positioning, cleaning the legs of patients, supporting the baby's head as it emerges and supporting the baby's neck as it emerges using both hands.

In order to further evaluate and analyze the data, the researchers evaluated the tasks of the subjects using RULA in order to determine which among the tasks pose risks for musculoskeletal disorders. The result of the analysis is shown in the table below.

Table 4. Summary of RULA Score

RULA Score for Obstetricians and Midwives					
Tasks	Hospital A	Hospital B	Hospital C	Average	Remarks
Positioning	6	6	6	6	medium risk
Mobilization	5	6	7	6	medium risk
One to one care	3	6	5	5	medium risk
Guiding patient in pushing	5	4	4	4	low risk
Push down abdominal muscle	4	3	3	3	low risk
Support baby's head as it emerge	7	4	6	6	medium risk
Support baby's body as it emerge	4	4	4	4	low risk
Supporting baby's neck using both hands	6	4	5	5	medium risk
Cutting the umbilical cord	3	3	3	3	low risk
Delivering placenta	7	7	7	7	high risk
Cleaning the vernix	4	3	4	4	low risk
Carrying the baby	7	5	6	6	medium risk
Transporting the baby	6	5	6	6	medium risk
Cleaning the legs of the mother	7	4	4	5	medium risk
Final positioning	7	7	6	7	high risk

The RULA revealed that tasks that pose high risk for upper limb disorders are delivering placenta and final positioning, while tasks that pose medium risk for upper limb disorders are positioning, mobilization, one to one care, supporting baby's head as it emerges, supporting baby's neck as it emerges, carrying the baby, transporting the baby and cleaning the legs of the mother. These tasks will be the focus of the researchers in the design of birthing chairs.

In order to determine which among the tasks contribute significantly to the musculoskeletal disorders experienced by the obstetricians and midwives in assisting patients during labor and delivery, regression analysis was used. The result of the analysis is shown in the equation below.

Y (CMDQ) = 31.2 + 2.312 Positioning task + 5.324 Supporting baby's head task + 4.003 Supporting baby's neck task + 6.988 Delivering placenta task + 7.312 Final positioning task

The result of the regression analysis proved that for every 1 value increase in RULA score for the positioning task, there will be 2.312 value increase in the CMDQ scores of the subjects, 1 value increase in RULA score for supporting baby's neck head task will give 5.32 value increase in CMDQ scores, 1 value increase in RULA score will give 4.003 value increase in the CMDQ score, 1 value increase in RULA will give 6.988 increase in CMDQ score and 1 value increase will give 7.312 value increase in CMDQ scores. The task factors indicated in the equation are all significant contributors to the musculoskeletal disorders of the subjects due to the awkard postures and use of muscular force of the obstetricians and midwives in performing tasks as supported by the result of the RULA analysis.

Hence, the researchers were able to come up with an ergonomic design of birthing chair focusing on the tasks that contribute to the MSD of the subjects of the study. The researchers gathered anthropometric data for both obstetricians and midwives to be used as reference for ergonomic design. The results of the data are shown in the tables below.

Table 5. Summary of Anthropometric Measurement

Anthropometric Measurements of Obstetricians and Midwives								
	Height	Shoulder Height	Upper Arm Length	Lower Arm Length	Elbow Height	Waist Height	Knee Height	Overhead Reach	Forward Reach
Mean	158.09	129.33	29.74	48.3	99.6	83.79	45.06	198.89	69.56
5th %	145.02	118.64	27.28	44.31	91.36	76.86	41.33	182.45	63.81
50th %	158.09	129.33	29.74	48.3	99.6	83.79	45.06	198.89	69.56
95th %	171.16	140.03	32.2	52.3	107.83	90.72	48.78	215.34	75.31
Std. Dev	7.95	6.5	1.49	2.43	5.01	4.21	2.26	10	3.5

Using the anthropometric measurements gathered from the subjects, the researchers were able to come up with the design of birthing chair using AutoCad software. The design prototype is shown in the figures below.
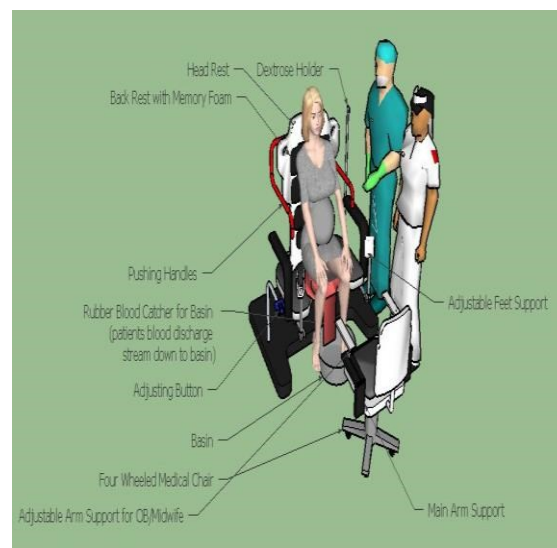

Figure 1. Overall Design of Birthing Chair

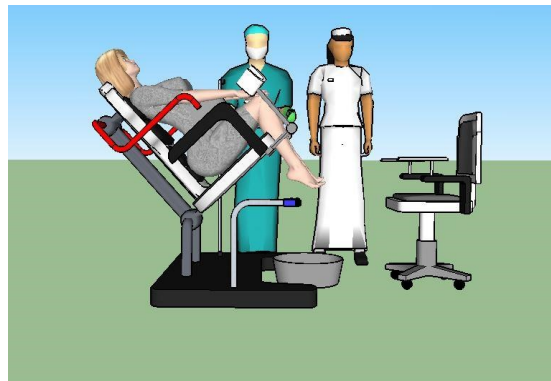Figure 2. Isometric View of Birthing Chair (Upright Position)

Figure 3. Isometric View of Birthing Chair (Slanting Position)

The design of the birthing chair includes an adjustable opening angle of the pushing handles that provide variation in use during the pushing phase based on the height and preferences of the patient. The arm supports offer an opportunity to relax in the opening phase of the delivery process. The seat opening offers space for the midwife and obstetricians to assist with the childbirth. Two wheels that turn make steering the birthing support possible. The birthing support can be equipped with an adjustable infusion stand, pushing straps to enhance the leverage force of the mother and a safety harness. Features of the birthing chair also includes a combined headrest, pushing handles, adjustable seat, arm support, inclined backrest, and backrest side handles.

4. Conclusion

Based on the result of the analysis, the following conclusions were drawn. First, the result of CMDQ revealed that obstetricians and midwives experienced musculoskeletal disorders due to current design of birthing facility in the public hospitals in the Philippines. The RULA analysis proved that the subjects were exposed to awkward postures and use of muscular force, hence, are exposed to risks for upper limb disorders. The result of the regression analysis showed that the following tasks significantly contribute to the musculoskeletal disorders of the subjects: positioning, supporting baby's head as it emerges, supporting baby's neck using both hands, delivering placenta and final positioning. With that, the researchers were able to come up with an ergonomic design of birthing chair focusing on the tasks that contribute to the musculoskeletal disorders of the subjects. The design is based on the anthropometric measurements gathered from the subjects of the study and using AutoCad software, the researchers made a mock-up design prototype.

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