Analysis of student biomechanics in videos of delivery simulation practice*

Prática simulada: análise de filmes sobre a biomecânica dos estudantes na realização do parto

Práctica simulada: análisis de películas acerca de la biomecánica de los estudiantes en la realización del parto

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ABSTRACT

Objective: Analyze the posture of students from the master's degree program in Maternal Health and Obstetrical Nursing; understand how intervention during delivery influences posture; and identify strategies for the prevention of work-related musculoskeletal injuries. **Method:** Qualitative descriptive study, which recorded and analyzed videos in a learning situation using high-fidelity simulation practice. **Results:** Thirteen students participated in the study. The results show the adopted body movement does not take into account coordination of the musculoskeletal system to keep body balance, posture and alignment when changing the delivery position. **Conclusion:** Obstetric nurses have a high prevalence of musculoskeletal injuries, and the specificity of professional activity makes it difficult to assess and prevent risks. Training favors the acquisition of knowledge and reflection of behaviors. Investments should be made in training to students and professionals in work contexts.

DESCRIPTORS

Students, Nursing; Obstetric Nursing; Musculoskeletal Diseases; High Fidelity Simulation Training; Labor, Obstetric.

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INTRODUCTION

Musculoskeletal disorders are a major health issue worldwide and one of the most alarming in Europe[1], tending to become a pandemic. Excessive tension in muscle tissue and joints are harmful and cause problems of disability and work absenteeism. High prevalence of injuries and associated symptomatology increase treatment costs and reduce productivity at work[2].

Nursing is a profession with a high incidence and prevalence of work-related injuries, as reported in some studies[1,3-5]. Nursing training is a moment for the acquisition of knowledge and reflection on some student behaviors within health education. Prevention of work-related musculoskeletal disorders (WMSDs) as a strategy for nursing intervention aims to ensure individual well-being and compliance with current health policies.

Although studies have been conducted on musculoskeletal injuries among nurses, in nursing education few studies have been developed with a focus on this topic[6-7]. The prevalence of spinal column pain during the nursing course, and specifically during and/or after clinical teaching periods, has raised a concern and interest in identifying causal factors. Although a specific reason cannot be identified due to multiple dimensions involved, more frequent clinical practices seem to be related to the complaints of back pain of students, such as the practices of patient lifting and mobilization, where personal characteristics, such as the level of anxiety and the locus of control, are significant and aggravating elements[6-7].

Considering the students from the second stage of higher education, nurses attending the master's degree program in Maternal Health and Obstetrical Nursing (In Portuguese: *Curso de Mestrado em Enfermagem de Saúde Materna e Obstétrica* (CMESMO)), musculoskeletal injuries present double importance. On the one hand, as nurses, WMSDs have a strong impact on their professional life, and on the other hand, as students, in this specific area of nursing, there is an additional risk of new tasks and interventions they will perform. In a prior study[8], nurses with a degree in Maternal Health and Obstetrical Nursing (In Portuguese: *Enfermagem de Saúde Materna e Obstétrica* (EEESMO)) recognized mobilizations, mother care, newborn care, and teamwork as interventions involving risk of injury. The complexity of nursing care in the specific situation of labor[9] leads to constant biomechanical adjustments to static or dynamic position, causing inappropriate posture of nurses with a degree in Maternal Health and Obstetrical Nursing. The concern to ensure safe nursing practice of CMESMO students in terms of quality of patient care and quality of their productivity originated this study which aims to analyze their posture during classes of high-fidelity simulation practice before starting the clinical teaching period[1,9].

The use of simulated practice, a teaching strategy currently used in the training of health professionals, allows controlled representations of reality and, consequently, learning through practice in which students do not have to handle real risks from the context of care[10]. Nursing simulation laboratories are equipped with devices and reproduce situations that are similar to those in the clinic context, which allow student learning.

The technology used in high-fidelity manikin-based simulation, besides contributing to the development of psychomotor skills, allows the development of clinical judgment[11]. For this reason, nursing education often uses demonstration of procedures before the beginning of clinical teaching[12] for student preparation and training on the acquisition of skills for the context of care[10]. Review of concepts and application of knowledge allow students to practice and receive immediate feedback of their performance, and the identification of students at risk, maximizing learning with targeted guidance.

The small number of studies and scientific evidence and the concern about the health and training of CMESMO students and future nurses in Maternal Health and Obstetrical Nursing suggest a public health problem that has to be addressed[7]. Then, the possibility of teaching, training and monitoring content related to WMSDs in the master's degree program in Maternal Health and Obstetrical Nursing originated this study.

This study has the following objectives: analyze the posture of CMESMO students in laboratory classes of birth delivery during the expulsive stage, using High-Fidelity Simulation Practice (HFSP); understand how nursing interventions during labor influence the posture of CMESMO students; and identify WMSD prevention strategies in future nurses with a degree in Maternal Health and Obstetrical Nursing.

METHOD

STUDY DESIGN

This is a qualitative descriptive study that uses video analysis.

POPULATION

Thirteen students from the master's degree program in Maternal Health and Obstetrical Nursing of a Portuguese nursing school participated in this study.

INCLUSION CRITERIA

To participate in this study, students had to fulfill the following criteria: have at least 3 years of professional activity, attend the second year of the master's degree program, have not performed birth procedure in the context of clinical practice, fill out an informed consent form, and authorize recording of practice simulation.

DATA COLLECTION

Recording vaginal deliveries in clinical situations in HFSP enabled direct and detailed observation and the analysis of student postures and determinants of the principles of biomechanics. This method of recording delivery videos allowed the formulation of explanatory hypotheses

for the phenomenon analyzed in this study: How does the progress of labor force the adoption of postures by nursing specialists in Maternal Health and Obstetrical Nursing? Many studies developed in this field use quantitative approaches and determine risk factors, but do not establish a relationship between the practices and behaviors of professionals regarding the principles of biomechanics, the phases of labor and the motivations for making biomechanical decisions, not allowing a comprehensive understanding of the phenomenon.

Filming also allows emotional detachment for reflexive analysis of the material, the possibility of repeatedly watching or freezing images[13], and allows to capture elements other than the verbal ones. "Communication is only 7% verbal and 93% non-verbal, that is, with body movements"[13], among other types of expression.

Without specific interpretation methods for image analysis for systematization of all procedures[14], careful planning was developed, taking into account the time available for the study, costs, experience of researchers, the skills of the filming technician, ethical and legal issues of image rights[14], among other elements.

The planning also considered challenges related to study development, including the installation of cameras to cover all areas and actions of professionals and avoid 'dead' spaces, enhancing the video quality and creating a similar environment to that of the clinic, reproducing the real context of a delivery room. Previous alignment with audiovisual technicians and two EEESMO students was essential for the final quality of the videos, ensuring a suitable environment for the phenomenon analyzed in this study.

Participants attended the HFSP laboratory for one week using a birth simulator, which allowed them to become familiar with the real context of a clinic. Before filming, they received information about the study objectives and methodology. Prior to the simulation, the purpose of the scenario and the simulation practice were explained to participants, referring to a woman in labor, allowing a theoretical preparation of the students for the clinical activity to be developed: perform a vaginal delivery.

The professors who participated in the HFSP sessions were Maternal Health and Obstetrical Nursing specialists with experience in labor and specific training for this scenario simulation sessions. A protocol was set to standardize the inputs provided to students, ensuring as similar simulation as possible, in order to analyze the postures in predefined moments: organization of the physical space and preparation of materials and equipment, preparation of the woman in labor, and expulsive stage.

The inputs provided by the professors were previously defined to produce changes in the scenario that would imply moving from a static to a dynamic position, accelerating the expulsive stage, increasing the speed of movements and force control, and enhancing the complexity of the situation by placing the professional under the simultaneous interference of multiple variables.

The room where the simulation practice took place has a fixed camera, which was adjusted to cover all the area. Filming was controlled by one of the professors/researchers who was present in the room to avoid strange people in the delivery room, making the situation as real as possible. Filming was performed on February 22-26, 2016.

DATA ANALYSIS AND TREATMENT

The researchers watched the videos in pairs. Researchers and professors with a degree in maternal and obstetric health watched all videos produced, which covered the four stages of labor, and selected only the videos where they participated, selecting frames from the expulsive stage. The videos were watched without concern to categorize them, but to identify the postures showing increased risk of musculoskeletal injury, associated with changes in the support base, dorsiflexion, lateralization and torsion of the cervical region and dorsolumbar region, misuse of leverage for force, and misuse of the palmar grasp to help in the newborn expulsive stage. The videos also helped identify postural changes whenever the nurses had to perform simultaneous activities that interfered in the posture, for example, provide breathing support to the laboring woman in this stage while observing the perineum for birth progress.

In the second time the researchers watched the videos, they compared the content with the theoretical reference, re-viewing the videos several times and defined categories according to the principles of biomechanics: 1) body movement; 2) body alignment; 3) balance; 4) mechanical force; 5) friction. Group meetings were held for proper selection of images and consensus on the sample of audiovisual material that would be subject to the qualitative analysis. A consensus was reached after an inter-judges discussion and double evaluation of selected video excerpts. After that, video excerpts were coded. Video coding, categorization and interpretation were performed directly on the videos[15].

In a third moment, the researchers watched the videos to identify different screenshots and perform content analysis. Besides the analysis of all 13 videos, 182 screenshots were extracted from the audiovisual material. This investigation intended to evaluate the aspects related to decision making for the maintenance of biomechanical safety of nurses while performing a specific activity, so during this process, the researchers had the context in mind, from image production through coding and their ability to "mean"[16].

In image treatment, a color coding was assigned for easy coding and definition of categories, in a structured and interconnected way, ensuring representativeness, completeness, homogeneity, and pertinence to images. To increase the reliability of the analysis, two investigators performed image coding, which was later verified by the other researchers. Image interpretation was performed by all four researchers, who assigned a meaning to every image.

ETHICAL ASPECTS

To conduct the study, authorization was obtained from the Ethics Committee of the Escola Superior de Enfermagem de Lisboa (Process no. 02/2017/CE).

The participants signed an informed consent form, ensuring participant anonymity and confidentiality of the videos, considering that, when using the frames to promote the investigation, the faces of participants would be covered to prevent their identification.

RESULTS

All 13 participants were female nurses with a degree in nursing and who attended, for the first time, the second year of CMESMO program in the academic year 2015/2016.

All participants were students who worked, on average, 35 hours a week plus 25 hours a week of clinical practice for the master's degree program.

Regarding the study objectives, the only risk factors identified were those associated with the nature of this professional activity. Individual, physical and/or psycho--organizational risk factors were not measured.

The analysis of videos produced in a learning situation in a controlled HFSP environment allowed an assessment of the principles of biomechanics adopted during the second stage of labor (expulsive stage) and understanding the principles of biomechanics adopted by students. The analysis of all materials defined subcategories and the units of record (Table 1).

Table 1 – Corpus of content analysis – Lisbon, Portugal, 2017.

Category	Subcategory	Units of analysis
Body movements	Static position	26
	Dynamic position	39
	Subtotal	65
Body alignment	Body stability	13
	Posture	42
	Motor coordination	42
	Subtotal	97
Balance	Support base	13
	Center of gravity	21
	Orientation of movement	42
	Subtotal	76
Mechanical force	Use of leverage	17
	Hand grasp	26
	Articular mobility	24
	Subtotal	67
Friction	Equipment organization	7
	Positioning of laboring woman	18
	Subtotal	25
	Total	**330**

Body movement refers to the movement trajectory in relation to velocity, time and space[17].

A deep analysis of the HFSP videos showed the body of the Maternal Health and Obstetrical Nursing students remained in a static position for long periods, with dorso-lumbar spine misalignment for the evaluation of the dilation of the cervix and quick switch from a static to a dynamic position in the expulsive stage. In both situations, they use major muscle groups and joints to keep body stabilization in a position without movement, allow it to perform a movement, and return it to stabilization after that.

When comparing these two positions, the static position may be less tiresome because it does not involve application of force, and since some moments of dynamic posture require the application of force for the baby to come out, aggravated by alternating the weight between the sides of the body of the lower limbs, keeping the center of gravity off the support base, and misuse of the leverage to apply force and movements performed in an unbalanced condition. A detailed analysis of the mobility patterns of participants during the expulsive stage shows that the body movement does not take into account the coordination of the musculoskeletal and nervous systems to keep body balance, posture and alignment when changing the movement direction and orientation.

Video analysis shows that, in movements not requiring changes in the direction, but in orientation, the body is not positioned in the direction of the movement.

Regarding body alignment, it represents the organization of all body segments, promoting balance and maximum function of the body at rest or in any activity[17]. This relationship between two parts of the body in a vertical or horizontal line is provided by the coordination of movements and depends on muscle tone, neuromuscular reflex and coordinated movements of opposing muscle groups (antagonists, synergists, antigravity muscles). Correct body alignment decreases distension of joints, tendons, ligaments and muscles, is associated with muscle tone and balance[17] and contributes to body stability.

Video analysis identified the following subcategories: body stability, posture and motor coordination.

During the expulsive stage, nurses presented body misalignment with uneven shoulders, tilting of the head to the side of shoulder depression. Also, anterior position in relation to trunk and arms was observed, which reduces stability and stimulates anterior inclination of the body and flexion of the arms and forearms (Figure 1).

Figure 1 – Position of EESMO nurse during the expulsive stage – Lisbon, Portugal, 2017.

Keeping the lower limbs in adduction or with a minimum distance of the feet (less than 10 cm) determines a small base of support, with the center of gravity frequently off this base and increased body imbalance, especially when moving from static to dynamic position.

The pain felt in this position is aggravated by the type of activity performed, with uneven shoulder at the reception of the baby's head, which is an important moment for the final result of the birth process, and when attention, concern, and anticipation of possible complications require decisions to be made by the nurse, as observed in the speeches of nurses during the simulation practice.

It should be noted that in these movements, the nurse does not change the posture nor shows to be concerned about body alignment, without adjustments to the support base (for example, distance between the lower limbs) or the center of gravity, which remains high (no movement is observed to flex the hip and knee joints to keep the spine aligned).

Video analysis shows that, at the reception of the baby's head and body release, the nurses perform dorsiflexion of the vertebral column along with a flexion of the neck and they bend the trunk forwards. The dorsolumbar column is in flexion, not keeping the three physiological curvatures (cervical, dorsal and lumbar). The upper limbs are not supported by the body, nor present a 90º angle. The shoulders are down and not aligned with the rest of the body.

Body balance represents the state of firm position, maximizing the performance, with minimum muscular effort, which involves stability of opposing forces[17]. This category has the subcategories: base of support, center of gravity, and orientation for the movement.

The analysis of videos and frames of screenshots shows that the lower limbs are mostly extended, and the feet are not aligned with the iliac crests and shoulders, not allowing an even distribution of the body weight, by the support base. A narrow support base causes the center of gravity to easily be off the base, with some movements performed by the nurse in an unbalanced position. A high center of gravity without flexion of the hip and knees reduces body balance and favors dorsiflexion and body misalignment.

Regarding the category of mechanical force, the use of leverage, hand grasp and articular mobility was analyzed. The mechanical force refers to the use of a leverage (a solid or firm structure) supported on a fulcrum or axis, a fixed point on which the lever moves) to move a load (weight of an object or person, usually called resistance) more easily through the application of force (effort exerted)[17].

During labor, the leverages are not used to support the baby's weight, and the fulcrum is not supported, which requires increased dorsiflexion to observe the perineum. Force is often applied in the opposite direction of movement to support the baby's weight and control the mother's movements.

Finally, the friction category has the subcategories of equipment organization and positioning of the laboring woman. Friction results from the rubbing effect or resistance that a body finds on the surface on which it moves; the larger the surface area of the object, the greater the friction[17]. Despite the elevation of the procedure bed, the professionals did not adjust the height of the support table, leading to a gap between the two work surfaces and increased friction, which promotes non-adoption of the principles of biomechanics.

DISCUSSION

The prevalence of WMSDs is high among health professionals, reaching up to 65.4%[18]. In a study developed in Brazil, 79% of nurses reported pain in the spine, especially in the cervical and lumbar region[9]. Musculoskeletal pain and discomfort are recurrent complaints among professionals who work in the birth unit, causing absenteeism and representing 56% of the causes of temporary absence from work[18].

The results of this study corroborate the results of other studies that used a qualitative approach to analyze this phenomenon[19] and concluded that nursing professionals have an increased risk of musculoskeletal injuries, since they use incorrect postures for long periods. The work of these professionals tends to place body out of alignment, as they remain in the standing position, with accentuated flexion of the neck and dorsolumbar region, and dorsiflexion when handling loads, while performing repetitive movements, with application of force and upper members raised above 90º[19].

The professional activity of delivery performed by obstetrical nurses, especially in the expulsive stage, involves specific risks associated with the nature of the task, such as sudden pronation/supination movements, performed with the hands raised above shoulders. With the arms raised in tension, the baby is removed exactly when in this position (already painful in itself)[20].

In movements involving fast changes from static to dynamic position, eccentric muscle contractions[21-22] also increase the risk of injury. Although this study was developed in a controlled simulation environment, increased muscle contraction[22] is clearly observed in nurses' posture and speeches during moments of greater stress (baby's head out and body rotation). The fast development of labor process makes it difficult to plan body movement and posture, so the principles of biomechanics are disregarded when the change from static to dynamic position is fast and almost instinctive. Body movement of nurses during delivery did not take into account the coordination of the musculoskeletal system when changing the orientation of movement to keep body balance, posture and alignment. Other studies highlight that nursing professionals perform their practices with vicious and inadequate postures, resulting in musculoskeletal symptoms that change their quality of life[9].

The physical space of the simulation room and lack of equipment organization in the room and non-adjustment of the table height are obstacles to body movements[22] and require dorsiflexion, trunk lateralization with uneven

shoulder and bending of the cervical and dorsolumbar spine. This study warns that human and material resources, which are often scarce and not adapted to the anthropometric characteristics of the professionals, and the lack of organization in the workplace increase the risk of WMSDs[23]. The students did not adjust the height of the different equipment, causing a gap between the work surfaces, implying increased friction and not observing the principles of biomechanics.

Video analysis allows a deep understanding of the adoption of the principles of biomechanics while performing professional activities, supporting the proposal of strategies for the correct use of leverages and adjusted application of force during the expulsive stage. In addition, resources can be proposed, such as a large base of support to ensure different movements and transition from static to dynamic position are performed with stability, maintaining the center of gravity in the body support base, among other things. Challenges in observing the principles of biomechanics are increased due to inadequate work spaces and damaged equipment[8].

As a strategy for WMSD prevention among nurses in Maternal Health and Obstetrical Nursing, this content should be addressed in the master's degree program for maternal health and obstetrical nursing, and training on the prevention of WMSD in HFSP. HFSP, with the development of suitable scenarios, may favor innovative, stimulating classes that facilitate the use of simulation practice by the teacher in the process of "teaching in an efficient and objective way, and may even guide teachers and researchers in the area of clinical simulation"[24].

Partnerships with health institutions are essential to ensure better adoption of postural practices of professionals.

This study has limitations associated with the design and sample type and size. A visual analysis of the findings is complex and cannot be detached from the context, and the fact that the participants knew they were filmed may have changed their "usual biomechanical behavior". The limited number and the intentional selection of participants do not allow generalization of the findings.

CONCLUSION

High-fidelity Simulation Practice is critical for the development of CMESMO competences, as the technology used in this practice allows safe training in a controlled environment through visualization and reflection about the care provided in computerized manikins. In the program theory, contents are taught about labor and the technical, scientific and relational procedures are exemplified for

performing/supporting a vaginal delivery, according to the position chosen by the laboring woman. In HFSP, students have to make decisions according to the clinical situation. Providing specific training on WMSD prevention, inserted in the program curriculum and complemented with videos so that each student becomes aware of the postures, will definitely help correct inadequate postures in clinical practice and prevent WMSDs.

In this study, the students of the master's degree in Maternal Health and Obstetrical Nursing did not use the principles of biomechanics in their clinical HFSP for WMSD prevention. Systematic observation of previously selected video screenshots confirmed that during most HFSP activity, body misalignment is evidenced by flexion of the spine, anterior tilting of the head, upper limbs in anterior position in relation to the trunk, and a small base of support. A greater fragility of the students' posture was observed while alternating from static to dynamic positions in nursing care during labor.

In the expulsive stage, the nurse's concern about the baby's head out, body rotation, release of shoulders and body involves alternated body postures of the professional when it is necessary to keep body balance and concentrate force due to the fast decision, according to the progress of the birth process.

The results also allow recommendations regarding the work organization, taking into account the environmental risk factors, including adequacy of spaces and equipment in the laboratory and in clinical contexts with adjustable support tables, surgical tables, among others.

HFSP can be considered an important training methodology for WMSD prevention among professionals in their intervention/work contexts. It is important to evaluate the posture of nurses in order to guide and correct the posture through preventive attitudes. Research projects conducted in partnership with health institutions is one of the strategies that can help prevent WMSDs among nurses specialized in Maternal Health and Obstetrical Nursing.

Further investigations should analyze all risk factors for WMSDs, including individual factors such as height, weight, and body mass index. Also, the impact of HFSP on the adoption of the principles of biomechanics in a clinical context should be analyzed.

Video recording is an important technique in investigations of qualitative approach. The quality of life of professionals is critical both in individual and institutional terms and, consequently, a contribution to the economy and health policies.

RESUMO

Objetivo: Analisar as posturas dos estudantes do Curso de Mestrado em Enfermagem de Saúde Materna e Obstetrícia; compreender como a intervenção durante o trabalho de parto influencia as posturas; e identificar as estratégias de prevenção das lesões musculoesqueléticas ligadas ao trabalho. **Método:** Estudo qualitativo e descritivo, que recorreu à gravação e análise fílmica em situação de aprendizagem em Prática Simulada de Alta-Fidelidade. **Resultados:** Participaram do estudo 13 estudantes. Os resultados evidenciam que o movimento corporal adotado não tem em conta a coordenação do sistema musculoesquelético para manter o equilíbrio, a postura e o alinhamento corporal nas alterações de posição na realização do parto. **Conclusão:** Os enfermeiros obstetras apresentam elevada prevalência de lesões musculoesqueléticas, e a especificidade da atividade profissional dificulta a avaliação do

risco e a sua prevenção. A formação favorece a aquisição de conhecimentos e reflexão de comportamentos. É fundamental investir na formação dos estudantes e dos profissionais nos contextos de trabalho.

DESCRITORES

Estudantes de Enfermagem; Enfermagem Obstétrica; Doenças Musculoesqueléticas; Treinamento com Simulação de Alta Fidelidade; Trabalho de Parto.

RESUMEN

Objetivo: Analizar las posturas de los estudiantes del Curso de Máster en Enfermería de Salud Materna y Obstetricia; comprender cómo la intervención durante el trabajo de parto influencia las posturas; e identificar las estrategias de prevención de las lesiones musculoesqueléticas vinculadas al trabajo. **Método:** Estudio cualitativo y descriptivo, que recurrió a la grabación y análisis fílmico en situación de aprendizaje en Práctica Simulada de Alta Fidelidad. **Resultados:** Participaron en el estudio 13 estudiantes. Los resultados evidencian que el movimiento corporal adoptado no tiene en cuenta la coordinación del sistema musculoesquelético para mantener el equilibrio, la postura y la alineación corporal en las alteraciones de posición en la realización del parto. **Conclusión:** Los enfermeros obstetras presentan elevada prevalencia de lesiones musculoesqueléticas, y la especificidad de la actividad profesional dificulta la evaluación del riesgo y su prevención. La formación favorece la adquisición de conocimientos y reflexión de comportamientos. Es fundamental invertir en la formación de los estudiantes y los profesionales en los contextos de trabajo.

DESCRIPTORES

Estudiantes de Enfermería; Enfermería Obstétrica; Enfermedades Musculoesqueléticas; Enseñanza Mediante Simulación de Alta Fidelidad; Trabajo de Parto.

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