

TRAINING OF PREGNANT WOMEN WITH DIABETES MELLITUS USING A LOW-COST SIMULATOR

CAPACITAÇÃO DE GESTANTES: DIABETES MELLITUS E SIMULADOR DE BAIXO CUSTO

CAPACITACIÓN DE GESTANTES CON DIABETES MELLITUS MEDIANTE UN SIMULADOR DE BAJO COSTO

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ABSTRACT

Objective: This study assessed the use of a low-cost simulator to train pregnant women with diabetes *mellitus* in insulin administration, evaluating its effectiveness in improving knowledge and autonomy. **Methods:** A mixed-method experimental study was conducted with 50 pregnant women hospitalized for glycemic control. Questionnaires were applied before and after the training, alongside an informational leaflet. **Results:** After training, 98% of participants identified insulin types and appropriate actions during hypoglycemia. Average correct answers increased from 54% to 82%. Fear was significantly reduced, with 94% reporting they had overcome their fears, and 100% felt capable of self-administering insulin. **Conclusion:** The low-cost simulator proved to be an effective and accessible tool for educating diabetic pregnant women, enhancing their confidence, knowledge, and self-care skills. This strategy contributed to better glycemic control and potentially improved maternal-fetal outcomes, supporting the systematic implementation of similar educational interventions in obstetric care settings.

Keywords: *Diabetes mellitus; Pregnant women; Simulator; Training.*

RESUMO

Objetivo: Este estudo investigou a utilização de um simulador de baixo custo para capacitação de gestantes com diabetes *mellitus* na aplicação de insulina, avaliando a eficácia dessa estratégia na melhoria do conhecimento e autonomia das gestantes diabéticas em insulinoterapia. **Métodos:** Estudo experimental de abordagem qualiquantitativa com 50 gestantes diabéticas internadas para controle glicêmico. Foram aplicados questionários antes e depois da capacitação, além do uso de folder informativo como material complementar. **Resultados:** Após a capacitação, 98% das participantes reconheceram os tipos de insulina e como agir em situações de hipoglicemia. A média de acertos aumentou de 54% para 82%. Houve redução expressiva do medo, com 94% relatando superação dos receios, e 100% se sentindo aptas à autoadministração. **Considerações finais:** A pesquisa concluiu que o simulador de baixo custo é uma ferramenta eficaz e acessível para capacitação de gestantes diabéticas, contribuindo para um melhor controle glicêmico e desfechos mais favoráveis.

Descritores: *Diabetes mellitus; Gestantes; Simulador; Capacitação.*

RESUMEN

Objetivo: Este estudio evaluó el uso de un simulador de bajo costo para capacitar a gestantes con diabetes *mellitus* en la administración de insulina, analizando su eficacia en mejorar el conocimiento y la autonomía. **Métodos:** Estudio experimental con enfoque cuali-cuantitativo realizado con 50 gestantes hospitalizadas por control glucémico. Se aplicaron cuestionarios antes y después de la capacitación, junto con folleto informativo. **Resultados:** Tras la capacitación, el 98% identificó los tipos de insulina y cómo actuar ante hipoglucemia. El promedio de aciertos aumentó del 54% al 82%. El miedo disminuyó significativamente: el 94% reportó haberlo superado y el 100% se sintió capaz de autoadministrarse la insulina. **Conclusión:** El simulador de bajo costo demostró ser una herramienta eficaz y accesible para capacitar a gestantes diabéticas, promoviendo conocimiento, confianza y autocuidado. Esta estrategia favoreció un mejor control glucémico y posibles mejoras en los desenlaces materno-fetales, recomendando su implementación sistemática en la atención obstétrica.

Descriptorios: *Diabetes mellitus; Gestantes; Simulador; Capacitación.*

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INTRODUCTION

Gestational diabetes *mellitus* (GDM) is defined as a carbohydrate intolerance of varying severity. Hyperglycemia, when detected at any time during pregnancy, should be categorized and differentiated into diabetes *mellitus* (DM) diagnosed in pregnancy (*overt diabetes*) or GDM. Therefore, gestational diabetes mellitus can be defined as pregnant women with hyperglycemia detected for the first-time during pregnancy, with blood glucose levels that do not meet the diagnostic criteria for DM; and diabetes mellitus diagnosed during pregnancy (*overt diabetes*) in pregnant women without a previous diagnosis of DM, with hyperglycemia detected during pregnancy, and with blood glucose levels that meet the WHO criteria for DM in non-pregnant women¹.

The training of pregnant women with diabetes *mellitus* for the application of insulin is an educational challenge in health and demands the development of viable and accessible actions. It is important to emphasize that health teams spend little time improving the technique of self-administration of insulin with these pregnant women, since the focus of prenatal care is usually directed to adjustments in the dose of the medication in view of laboratory findings and analysis of the glycemic curve. The incorrect application technique can result in several errors and complications, such as hypoglycemia, hyperglycemia, absence of rotation of the application area, application in an inappropriate area, and use of inappropriate materials².

To reduce these possibilities, it is necessary to adopt strategies aimed at training these pregnant women. One model that has already shown great advances and benefits is clinical simulation through patient simulators. Clinical simulation can be defined as an experience in which the peculiarities of a given real situation are reproduced, aiming at its better understanding and realization³. However, clinical simulation still encounters obstacles ranging from the knowledge of professionals to onerous costs and the difficulty of accessing simulators. Low cost, realism, and clinical relevance are desirable characteristics for a patient training simulator⁴.

The importance of this study lies in its ability to offer an innovative and affordable solution for better control of a common health problem in pregnant women: gestational diabetes mellitus. Adequate training of these pregnant women to apply insulin is essential for glycemic control and to avoid complications for both mother and baby. The use of a low-cost simulator and an information folder can be an effective strategy to improve the glycemic control of these pregnant women and, consequently, reduce the risk of maternal-fetal complications.

The objective of this study was to evaluate the effect of a low-cost simulator and an information folder on the training of diabetic pregnant women using insulin therapy. The specific objectives were: to identify the level of knowledge of pregnant women before and after the use of the simulator and the folder; implement a folder in the training of diabetic pregnant women using insulin therapy; To apply a low-cost simulator in the training of diabetic pregnant women using insulin therapy.

METHODOLOGY

This research is an experimental study with a mixed approach (quantitative/qualitative). The study was carried out at the Northern Regional Hospital

of Sobral, at the Women's Reproductive Health Support Center (CASRM), during the months of January and February 2025. The study was carried out in accordance with resolutions No. 466/2012 and 510/2016 of the National Health Council, after approval by the Research Ethics Committee (CEP) of the Institute of Health and Hospital Management (ISGH).

The research was organized in three phases: Phase 1 – restoration of an existing low-cost simulator in a tertiary hospital (Hospital Regional Norte/HRN - Sobral, CE) for use in the training of diabetic pregnant women in insulin therapy; Phase 2 – use of the simulator with pregnant women hospitalized in the service, associated with a questionnaire that assessed their knowledge in relation to insulin treatment; Phase 3 – evaluation of the satisfaction of these pregnant women in relation to the training.

Initially, pregnant women hospitalized at the Women's Reproductive Health Support Center (CASRM-HRN) who were using insulin therapy were recruited. The sample estimate for the study was 50 diabetic pregnant women who used insulin therapy and were hospitalized at the Northern Regional Hospital. Then, these patients were allocated to the digital island of Obstetric Clinic 1. Before starting the training, the Informed Consent Form (ICF) was applied.

After signing the term, the participants answered the pre-training questionnaire and received informative folders. The pre-training questionnaire had 12 multiple-choice questions, addressing the pregnant women's previous knowledge about the types of insulin, storage, application sites, glycemic goals, and application rotations.

The training began with guidance from the nursing team on the correct use of insulin, followed by explanations by the resident physician in Gynecology and Obstetrics, responsible for the project, who addressed the side effects of an incorrect application, the goals of glycemic control and the rotation of application sites. Subsequently, the practical simulation was carried out with the active participation of the pregnant women, followed by a moment to clarify doubts. Finally, the pregnant women answered the post-training questionnaire (with 13 questions) to assess the impact of the intervention, especially in relation to the patient's safety to perform self-administration of home insulin. Once this stage was completed, each participant was sent back to their ward.

Data analysis was carried out in a mixed manner (qualitative/quantitative), through statistical analysis of the data, conducted using the *RStudio* software (version 2023.03.0). The data were organized in tables and expressed in absolute and relative frequency to describe the participants' answers to the questionnaires applied before and after the training.

RESULTS

FIRST PHASE

The first phase involved the restoration of a low-cost simulator, aiming to ensure the adequate adaptation of the areas recommended for insulin application. For this, a mannequin previously used in training was renovated. This mannequin, made of rigid plastic with a hollow structure and iron support on the feet, underwent modifications to simulate the subcutaneous tissue, using laminated foam seven centimeters thick and

density 20. The skin was represented by an extra-thin rubber strip of 0.45 mm thick. The restoration of the simulator was carried out by the hospital's maintenance team and by the resident physician in Gynecology and Obstetrics responsible for the project, without labor costs.

The manikin was sent from Obstetric Clinic 1 to the maintenance team, where the recommended areas for insulin application were cut, following the guidelines of the Brazilian Diabetes Society⁶. The cutouts were made with a hand saw blade, and the resulting edges were sanded. The internal plastic bases were fixed approximately seven centimeters from the surface with metal rods and screws, avoiding the decoupling of the phantom during the skin fold. In the arms, due to the reduced dimensions, only foam was used for support. The skin was fixed to the mannequin with instant glue; and the total cost of the renovation was R\$ 105.00.

SECOND PHASE – QUESTIONNAIRE PRIOR TO TRAINING

The results of the questionnaire prior to the training describe the characteristics and knowledge of the 50 participants about diabetes management and insulin use. Regarding the type of diabetes, almost half of the participants (48%) had Gestational Diabetes *Mellitus* (GDM), while 42% had type 2 diabetes *mellitus* (DM2) and only 10% had a diagnosis of type 1 diabetes *mellitus* (DM1). This profile reinforces the need for educational approaches that meet the particularities of these conditions.

Half of the participants reported using oral medications, such as metformin, before starting insulin treatment. However, knowledge about the use and application of insulin was varied. A portion of 18% of the participants said they had no knowledge about the subject, and the majority (44%) reported knowing little. Another 26% rated their knowledge as moderate, while only 12% consider themselves well-informed. These data highlight the importance of expanding access to clear and practical information on insulin management.

Knowledge about the sites of insulin delivery was adequate for 84% of the participants, who correctly identified the abdomen, thighs, arms and buttocks as appropriate areas. On the other hand, only 54% reported being aware of the importance of alternating application sites, which can increase the risk of complications such as lipodystrophies.

Regarding the knowledge and practices of pregnant women in relation to insulin therapy, when asked if they knew the types of insulin in use, 66% answered affirmatively, while 34% stated they did not know. The majority (82%) knew how and where to store insulin properly. Regarding the performance of the glycemic curve at home, 90% of the pregnant women stated that they performed it, demonstrating good adherence to this control.

However, only 40% reported knowing the glycemic control goals, indicating an important gap in this regard. Regarding the importance of application rotations, 54% said they had this knowledge, while 46% did not know. The same percentage (54%) reported having some fear in the use of insulin. When asked about what hypoglycemia is and how to act in the face of it, 48% said they knew, while 52% said they did not have this knowledge. Finally, 54% had already self-administered insulin.

THIRD PHASE – QUESTIONNAIRE AFTER TRAINING

After the training, the results of the questionnaire indicate a significant improvement in the knowledge, confidence, and skills of the 50 participants about insulin management and glycemic control (see Table 1). All participants (100%) considered the training important, reinforcing the positive impact of the intervention. With regard to technical knowledge, 98% of the participants stated that they understand the differentiation of the types of insulin they are using and the desired dosages for glycemic control and recognize the types of insulin they are using.

Table 1 – Questionnaire after training

Features	N = 50 ¹	
	Yes	No
1. Do you think the proposed training was important?	50 (100%)	0 (0%)
2. Do you know the desired dosages for better glycemic control?	49 (98%)	1 (2%)
3. Is it possible to differentiate the types of insulin you are using?	49 (98%)	1 (2%)
4. Do you know how and where to store insulin properly?	50 (100%)	0 (0%)
5. Do you feel that you are able to properly perform the glycemic curve at home?	50 (100%)	0 (0%)
6. In case of hypoglycemia, do you know what to do?	49 (98%)	1 (2%)
7. Do you have any questions about the places where insulin should be applied?	0 (0%)	50 (100%)
8. Do you understand the importance of insulin application rotations, that is, not always applying insulin in the same places?	50 (100%)	0 (0%)
9. Do you still have any fears about using insulin?	2 (4%)	48 (96%)
10. Do you believe that after the training it will be easier to self-administer insulin?	49 (98%)	1 (2%)
11. Would you apply it yourself?	49 (98%)	1 (2%)
12. Do you think it is important for each person to know and know how to make their own application, if necessary?	50 (100%)	0 (0%)
13. Regarding what was learned about the application of insulin, was it supplied with training?	47 (94%)	3 (6%)

¹ⁿ (%)

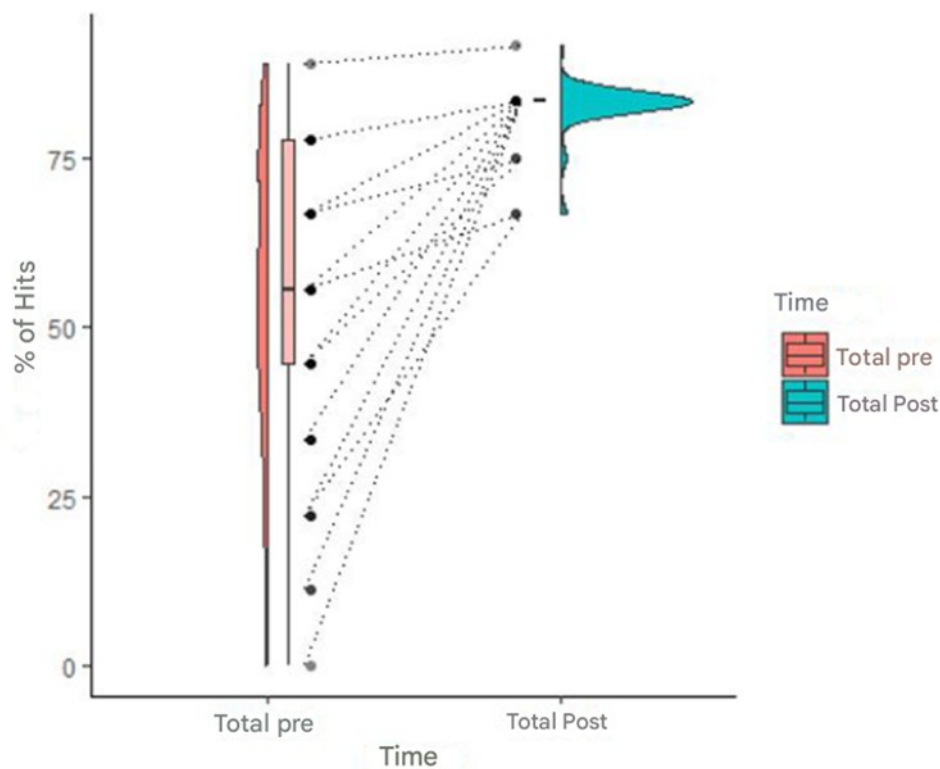
Source: Prepared by the authors.

In addition, all participants (100%) demonstrated that they knew how and where to store insulin properly and felt able to perform the glycemic curve at home. In situations of hypoglycemia, 98% stated that they knew how to act, evidencing a significant advance in this critical aspect of self-care. The training was also effective in answering questions and improving safety in insulin management. None of the participants reported doubts about the appropriate regions for insulin application, and all of them understood the importance of alternating the application sites to avoid complications.

Regarding fears about the use of insulin, only 4% of the participants still showed some insecurity, 98% believe that it will be easier to carry out the applications after the training and stated that they will do it on their own. All participants (100%) recognized the importance of learning how to self-administer insulin rather than relying on others and 94% reported having completely overcome their fears after the empowerment.

The statistical comparison between the pre- and post-training scores (Graph 1) showed a significant increase in the percentage of correct answers, with an initial mean of 54% (± 21) and a subsequent increase to 82% (± 4) ($p < 0.001$), demonstrating that the training was effective in improving the participants' understanding and management of insulin.

Graph 1 – Statistical comparison between the pre- and post-training scores



Source: Prepared by the authors.

These results demonstrate the positive impact of this study on the training of participants. With expanded knowledge, greater autonomy and confidence, it is possible to expect more effective adherence to treatment and an overall improvement in diabetes management. In addition, the importance of implementing this type of training and approach in a systematic way is highlighted, especially for patients diagnosed with GDM who require insulin therapy. The continuous realization of these training sessions contributes to clarifying critical points about the use of insulin, reinforcing safety in the application and minimizing any fears of pregnant women, promoting safer and more effective care.

DISCUSSION

The results obtained from the questionnaires applied before and after the training demonstrate significant advances in the training of diabetic pregnant women using insulin therapy. The positive impact of the intervention, consisting of the use of a low-cost simulator and an information folder, is evident when comparing the participants' levels of knowledge and confidence before and after the training.

The discussion of the results of this study, comparing them with the findings of Santos et al.,⁵ Rodrigues⁶ and Silva et al.,⁷ allows an in-depth analysis of the impact of the use of low-cost simulators and information folders on the training of diabetic pregnant women using insulin therapy. The results demonstrate a significant improvement in the knowledge, confidence, and skills of pregnant women after training, corroborating the evidence presented by the aforementioned authors.

The results show that, after the training, 100% of the pregnant women considered the intervention important, and there was a significant increase in knowledge about insulin dosages (98%), types of insulin (98%), adequate storage (100%) and performing the glycemic curve at home (100%). These findings are in line with the studies by Santos et al.⁵ and Silva et al.,⁷ who highlight that the use of low-cost simulators provides a safe environment for the practice of insulin application techniques, reducing anxiety and increasing the confidence of pregnant women. In addition, the study reinforces the idea that simulation allows practice in a controlled environment, in which errors can be corrected without health risks⁵.

The use of low-cost simulators in the present study proved to be a viable and inclusive strategy, allowing pregnant women in different economic conditions to have access to the necessary training. This finding is in line with the studies by Rodrigues⁶ and Silva et al.⁷, which highlight the importance of accessible educational strategies adapted to the sociocultural context of pregnant women. The proposal of the low-cost simulator fills a significant gap, especially in regions where access to original devices and specialized training is limited, as highlighted by Silva et al.⁷. The research reinforces the idea that the use of simulators and information folders does not replace but complements the medical and nutritional monitoring of pregnant women. This integrated approach is in line with the recommendations of Santos et al.⁵, which highlight the importance of combining educational interventions with ongoing clinical support to ensure treatment success⁷.

FINAL CONSIDERATIONS

The objectives of the research were achieved. The implementation of the low-cost simulator, combined with the distribution of informative material, allowed for effective and accessible learning, contributing to greater adherence to treatment and better glycemic control. The evaluation of the questionnaires applied before and after the training confirmed the effectiveness of the proposal, showing a significant increase in the participants' knowledge and a reduction in fears related to the application of insulin.

Despite the positive results, some limits must be considered. The study was conducted in a single hospital and with a restricted sample of participants, which may

limit the generalization of the findings to other regions or populations with different socioeconomic profiles. In addition, the follow-up of the pregnant women was carried out only during the hospitalization period, without long-term monitoring to assess the permanence of learning and its influence on treatment adherence after hospital discharge.

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