

## MOBILE APPLICATION FOR METABOLIC SYNDROME SCREENING IN CLIMACTERIC WOMEN: APPLIED METHODOLOGICAL STUDY

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**Highlights:** (1) ClimatMed can contribute to improving care for climacteric women. (2) Mobile application for monitoring climacteric women in PHC. (3) Early identification of MS as a means of preventing chronic cardiovascular diseases.

PRE-PROOF

(as accepted)

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### **ABSTRACT**

The objective of this work was to present the development of an application to track metabolic syndrome in climacteric women. As for the methodology, it was an applied research developed from a study that evaluated the ability of anthropometric measures to discriminate metabolic syndrome in climacteric women. A database was created with extraction of logistic regression models and the application for smartphones was developed. Flutter, software development kit, created by Google, was used. As a result, the application called ClimatMed was developed, which is available for free in the Play Store and can be installed on smartphones with Android system. It is composed of home screen, screens for the definition of the climacteric period and adjusted variables. Measures for the calculation of the indices can be entered and the application provides the probability of development of metabolic syndrome. It is concluded that the inclusion of a computer technology in the assistance to climacteric women predisposed to develop metabolic syndrome brings positive repercussions, because it allows savings in a simple and accessible way. In addition, the identification of this population predisposed to develop metabolic syndrome helps in preventing chronic cardiovascular diseases.

**Keywords:** Climacteric; Metabolic Syndrome; Primary Health Care; Anthropometry.

### **INTRODUCTION**

The climacteric period is characterized by a gradual loss of ovarian function, which results in a decrease in estrogen and other hormone levels<sup>1</sup>. Among the repercussions caused by hypoestrogenism to women's health, there is the increase in the prevalence of metabolic syndrome (MS), a set of risk factors for cardiovascular diseases such as hypertension, diabetes and hypercholesterolemia, insulin resistance and central fat deposition<sup>2</sup>.

The menopausal transition is an independent risk factor for MS<sup>3</sup>, with a tendency to increase in relation to pre- and postmenopausal periods. It may occur in 40% of postmenopausal women and is largely influenced by overweight and obesity status, whose prevalence increases significantly in women at this stage of the life cycle<sup>5,6</sup>.

The early identification of climacteric women with predisposition to develop MS, through simple and low-cost anthropometric measures, would facilitate the development of programs to modify or prevent the installation and progression of the disease,<sup>7</sup> especially in

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populations with socio-economic vulnerability, such as those assisted by the Family Health Strategy (FHS), due to the financial cost involved in the diagnosis.

The evolution of computer technology has brought changes in work processes and globalization of information, influencing the health area, which has accompanied this advance, modernizing its way of assisting humans and their families<sup>8</sup>. Mobile applications are increasingly being used in the practice of medical assistance<sup>9</sup>, providing greater involvement, monitoring, outreach and delivery of health care to the patient<sup>10</sup>.

In essence, mobile applications provide a relatively cost-effective service delivery on a large scale,<sup>11</sup> with the potential to reduce access inequalities. In addition, digital health resources contribute to the strengthening and organization of health services and actions in Primary Health Care and the Unified Health System (UHS)<sup>12</sup>.

In this sense, this study aims to present the process of development of an application aimed at primary care physicians, designed to facilitate the identification of climacteric women predisposed to develop metabolic syndrome, from the calculation of appropriate anthropometric index.

### METHODS

This is an applied methodological research carried out by the Master's Program in Primary Health Care at the State University of Montes Claros (Unimontes), located in the city of Montes Claros, Minas Gerais, between 2014 and 2015. Methodological studies are based on database research using specific terms for research and allow the refinement of methods and the design of new forms of investigation<sup>13</sup>. The present study contemplated the following stages: planning, composed by the definition and modeling of the database, the development of the navigation interface, followed by programming, according to a study made by Santana *et al.*<sup>8</sup>

In the initial planning stage, the Body Roundness Index (BRI) and the Visceral Adiposity Index (VAI) were defined as the most suitable anthropometric measures to be used, from a study that evaluated the ability of anthropometric indices to discriminate metabolic syndrome in climacteric women. The BRI (Body Roundness Index) is a recent index developed by Thomas *et al.*<sup>14</sup> to discriminate body and visceral fat, which associates height and abdominal circumference and can be applied as a visual tool for health assessment. The VAI (Visceral

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Adiposity Index) was developed as a measure to individualize with respect to sex, based on abdominal circumference, BMI, triglycerides and HDL, to express indirectly the visceral fat<sup>15</sup>. The BRI and VAI were calculated using the following equations:

$$\text{BRI} = 364.2 - 365.5 \sqrt{1 - \left( \frac{\left( \frac{WC}{2\pi} \right)^2}{(0.5 \times \text{height})^2} \right)}$$

$$\text{VAI} = \left( \frac{CC}{36.58 + 1.89 \times \text{IMC}} \right) \times \left( \frac{\text{TG}}{0.81} \right) \times \left( \frac{1.52}{\text{HDL}} \right)$$

Source: Thomas *et al.* (2013) and Amato *et al.* (2010)

As a result of the study that supported the development of the mobile application, a database was compiled in which the predictive capacity of MS of the BRI and VAI indices was verified, considering premenopausal and postmenopausal. The predictive capacity was obtained by means of logistic regression models, reaching a value of 70% accuracy (curve under the Roc area) when used BRI and approximately 80% for the VAI index. Therefore, these results showed that the BRI presented the necessary characteristics for a screening test, since it achieved an accuracy value considered good, had high sensitivity and, mainly, because it was non-invasive and easy to apply<sup>6</sup>. The VAI was also inserted in the application because, despite being an invasive measure, it obtained a higher accuracy value.

After the experiments with regression models, the application architecture was elaborated, containing the navigation and interaction screens with the user, with a brief explanation about the objectives, besides the forms for selecting variables and inserting anthropometric measures necessary to calculate BRI and VAI. After defining the application architecture, we searched for the best tool to build it. Based on emerging technologies, it was decided to use a mobile application development kit created by Google, whose objective is to facilitate the creation of mobile applications for mobile devices and Internet-oriented, called Flutter, which used the programming language Dart, also created by Google.

The mobile application was tested in a pilot study with 20 women between 45 and 65 years old.

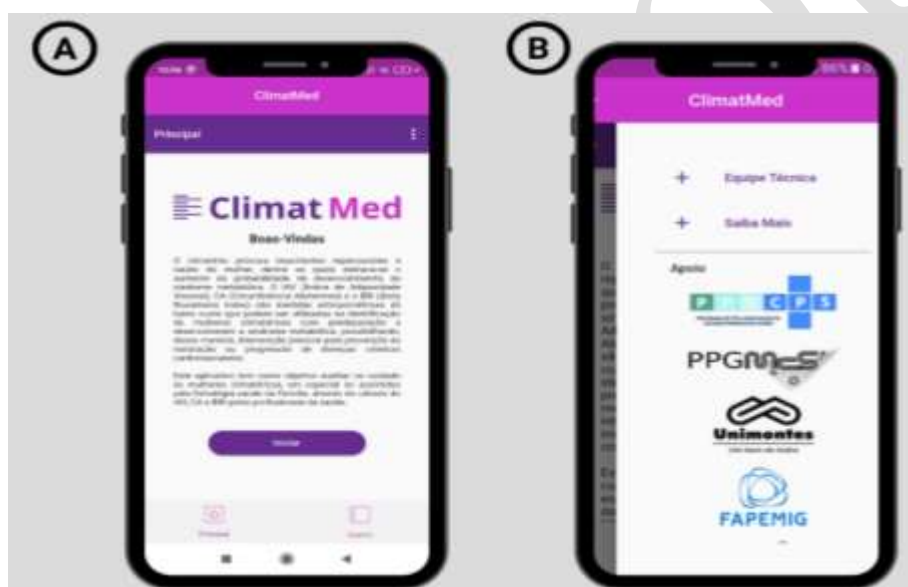
The research project was approved by the Research Ethics Committee of the Integrated Pythagorean Faculties of Montes Claros with opinion n. 817.666.

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## RESULTS

The project was named ClimatMed and is available for free on the Google Play Store platform, and can be installed on smartphones with Android system. The initial screens of the application contain a brief introduction, with justification of the theme addressed and objective of the application (Figures 1A and 1B), according to the architectural model previously defined and presents the partner institutions of this project.

Figure 1 (A-B) – Home pages presenting the application.



Source: Researchers' collection (2024)

The "know more" option allows the access to diagnostic criteria for MS considering the International Diabetes Federation (IDF), in addition to the concepts of anthropometric measures used (BRI and VAI). (Figures 2A and 2B). Figure 2C shows the technical team responsible for the design.

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Figure 2 (A-B-C) - Home pages with MS, BRI and VAI concepts and technical team.

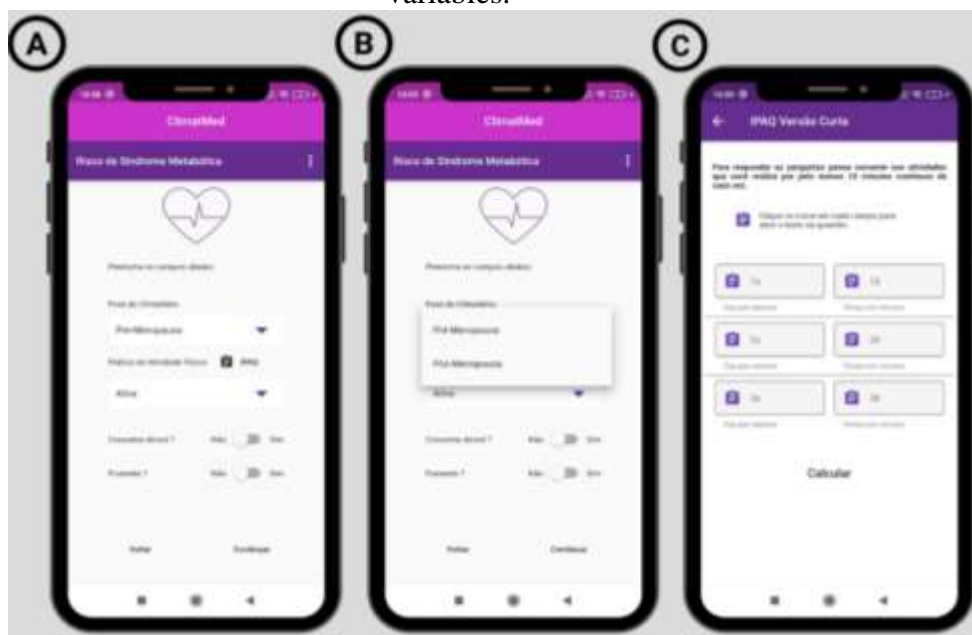


Source: Researchers' collection (2024)

On the home screen, by clicking on the "Start" button (Figure 1B), the application presents a screen for the definition of the climacteric period in which the woman is (pre or post-menopausal) and of the variables that were adjusted: level of physical activity, occurrence of alcoholism and smoking (Figure 3A and 3B). To evaluate the level of physical activity, the International Physical Activity Questionnaire (IPAQ), developed and validated by Craig *et al.*<sup>16</sup>, classified women as: very active/active, irregularly active and sedentary, through questions related to physical activity performed in the last week for at least 10 continuous minutes, prior to the application of the questionnaire (Figure 3C).

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Figure 3 (A-B-C) – Application pages for selecting the climacteric period and adjusted variables.

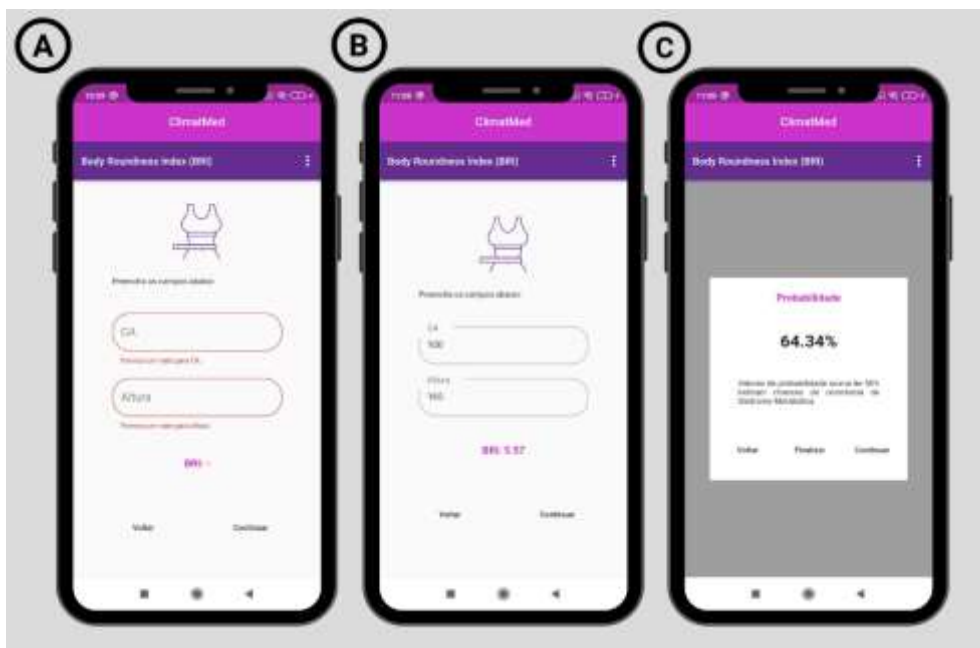


Source: Researchers' collection (2024)

In the sequence, the measures necessary to calculate BRI can be entered (abdominal circumference and height) and, as a response, the application provides the probability of development of MS (Figure 4). This probability is calculated by logistic regression models obtained from the created database.

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Figure 4 - Application pages for specific BRI calculation.



Source: Researchers' collection (2024)

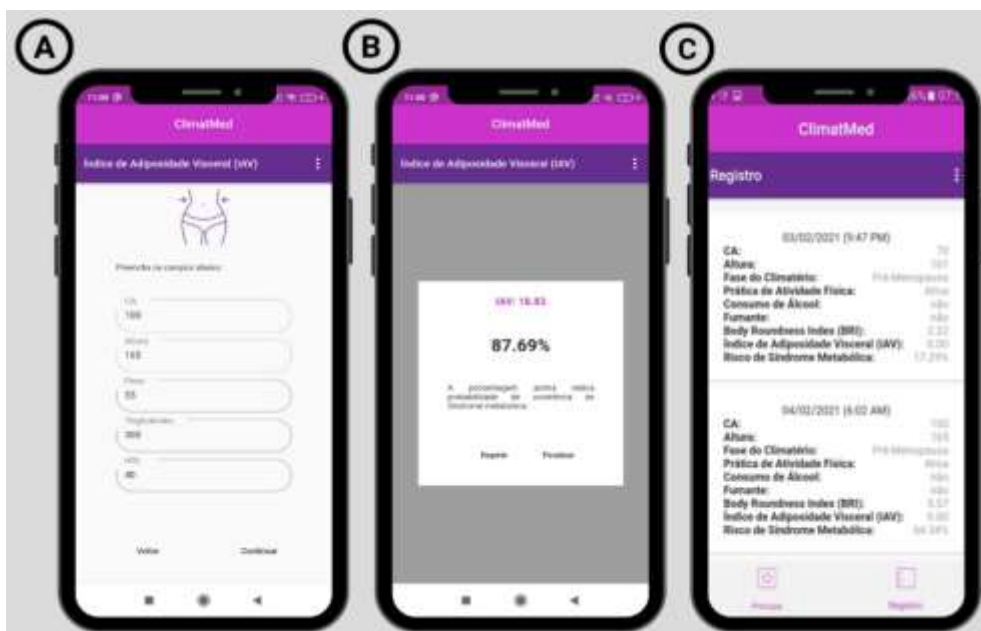
Once this is done, it is possible to complete the program or continue adding the anthropometric measures necessary for the calculation of the VAI, in addition to triglycerides and HDL, with automatic calculation of the index and the probability that the patient will develop MS (Figure 5). Probability values above 50% indicate the chances of developing MS, with progressive increase, as shown in Figure 4, item C and Figure 5, item B.

The application also allows storage of the history of the results of use, which facilitates monitoring and provides improvement of the system.



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Figure 5 - Application pages for calculating VAI and storing data.



Source: Researchers' collection (2023)

## DISCUSSION

The ClimatMed application is the first mobile application produced in Brazil aimed at climacteric women, enabling the improvement of assistance to this population group through a low-cost and easy application tool. Furthermore, the application was developed with the aim of offering primary care physicians an opportunity to track metabolic syndrome in the climacteric group assisted by FHS, in a simple and fast way, helping to identify women at higher risk of developing this important comorbidity and preventing the installation or progression of related cardiovascular diseases, such as diabetes *mellitus* type 2, non-alcoholic fatty liver disease, myocardial infarction and cerebrovascular accident<sup>17</sup>.

Primary health care is the population's gateway to public health services. In this sense, besides taking care of the needs of the community served, PHC should offer comprehensive and accessible care, seeking to promote the quality of life of the population throughout their lives, by means of techniques capable of assisting in the screening and diagnosis of possible diseases<sup>8,18</sup>.

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Considering this fact, health technologies are providing the modernization of medicine, with better reach, monitoring, involvement and improvement in patient healthcare delivery<sup>9</sup>. Mobile health is constantly developing due to technological advances and better understanding of the utility of this type of recursion<sup>9</sup>.

With the increased availability of mobile devices, doctors have access to a source of information at their fingertips through smartphones. Applications are programs developed to run on a computer or mobile device and currently there are mobile applications in the health area for various purposes, such as electronic prescription, diagnosis, medical calculators and guidelines that support the medical decision<sup>19</sup>.

Although the use of applications in the medical area provides many advantages, such as reducing health costs, and providing access to timely diagnosis<sup>20</sup>, it is understood that evaluation, rigorous validation and development of these tools are necessary to ensure quality and safety in their used<sup>19</sup>.

In Brazil, some studies have been developed in the health area for the construction of technologies that qualify care, as the development of a mobile application for the nursing consultation to hypertensive patients in FHS by Santana *et al.*<sup>8</sup> and a mobile application for the implementation of the nursing process focused on the renal patient<sup>21</sup>. Another study conducted in Porto Alegre developed and evaluated a mobile health application to support the shared decision regarding oral anticoagulation in atrial fibrillation<sup>22</sup>.

In the Brazilian public health scenario, specifically in primary care, represented by the FHS, the use of technologies has also increased in recent decades, presenting great potential to improve health care with a significant reduction in costs<sup>23</sup>. The use of applications aimed at Primary Health Care is an important ally to improve public health system assistance, with reduction in operating costs<sup>24</sup>.

Concatenating to this fact, an application developed for early identification of frail elderly, for example, registered in the FHS, has become an important digital instrument to enable access to health information, creation of health indicators, favoring the decision-making regarding care directed to this population<sup>25</sup>.

The study presents a limitation in the need for application evaluation to ensure product quality. Furthermore, although the woman herself can use the application, it still does not guide what should be done when the probability of developing MS is greater than 50%, that is, when

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indicating risk of metabolic syndrome. It is important to note that the application is a screening instrument and not diagnostic. However, despite these limitations, it is understood that ClimatMed can contribute to the improvement of the assistance to climacteric women in primary care through a simple and low-cost tool, able to identify early metabolic syndrome in this population group.

## **CONCLUSION**

The application called ClimatMed was developed to track MS in climacteric women. The inclusion of a computer technology to medical consultation for the climacteric woman assistance brings numerous contributions, especially to the public health system, because it allows savings, besides being simple and quite accessible to the professional. Additionally, the identification of this population predisposed to develop MS helps in the prevention of chronic cardiovascular diseases. The future project will include the evaluation of the application, an alert signal and a guidance for women to seek the reference FHS in case of probability greater than 50% and availability of ClimatMed for the IOS system and a version for Web browsers.

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