

The OntoWoH Ontology - a Women's Health Reference Ontology Detailing the Fragment of Climacteric and Menopause

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Abstract

The reference ontology named Ontology for Women's Health (OntoWoH) is a representation of the complex and extensive domain of women's health, directed to climacteric and menopause aspects in its first version, based on the STRAW criteria. Women's health has repercussions in the cultural-social-legal-economic scenario, and it is the study object of several researches, with different approaches, due to its relevance. Considering the increase in women's life expectancy, the importance of these studies aimed at the phases of a woman's life from the climacteric onwards, extending to post-menopause, which need greater attention in public health systems, is highlighted. Thus, the goal of this work was to develop OntoWoH using the Systematic Approach for Building Ontologies (SABiO) methodology and based on the Unified Foundational Ontology (UFO) guidelines, with emphasis on ontology formalization activities and knowledge acquisition tasks. Among its contributions, this work shows the integration of Computer Science and Health Science areas, aiming to assist in the construction of a future quality information system in the field of Health Care, due to the increase of this type of information system in Brazil, mainly in the Unified Health System (SUS) (public healthcare assistance in Brazil), of which women are main users. In addition, OntoWoH was created to help understanding and communication in the stages of a woman's life, especially after the climacteric, with the intention of identifying a terminology (which may become standard) and paving the way for semantic interoperability in the domain. As next steps, OntoWoH should invest in reuse and integration activities, and can evolve into an operational ontology, initiating the mapping to a computational tool.

Keywords

UFO, SABiO, Reference Ontology, Women's Health, Climacteric, Menopause

1. Introduction

A conceptual model intends to improve understanding and communication of aspects in the physical and social world through a formal description [1]. Conceptual models bring numerous benefits to the representation of a domain and can be useful in several areas, such as Computer Science and the area of the domain (such as, Health Care or Law). One of the ways to build quality conceptual models is through Ontology-Driven Conceptual Modeling (ODCM).

On the other hand, the Health Care area applies Health Care Information Systems (HCIS) to obtain, manage and use information to improve health care tasks, increase the performance of services and facilitate their administration [2].

At same time, the demand for health information grows, and the challenges inherent to its use grow, such as knowledge sharing and data integration (including among different HCIS), which is essential for improving the quality of healthcare services [2, 3].

Proceedings of the International Conference on Biomedical Ontologies 2023, August 28th-September 1st, 2023, Brasilia, Brazil
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CEUR Workshop Proceedings (CEUR-WS.org)

The construction of ontologies to represent a domain is one of the techniques to solve these problems [2]. The increase in the use of ontologies is justified by the fact that they provide a common conceptual framework that enables the development of shareable and reusable knowledge bases, which facilitates interoperability and the fusion of information, enabling the construction of powerful and more intelligent computational applications [4].

Once the benefits of ODCM have been established, it is necessary to identify the domain over which the model will be established. Keeping this in mind we chose to explore women's health.

Women have greater longevity than men, but their disability-free life expectancy has been lower, due to the increase in the occurrence of diseases such as depression, dementia and functional dependence (inability to maintain the physical and mental skills necessary for an independent and autonomous life), as well as cardiovascular [5, 6] and autoimmune [7] diseases. Considering the increase in woman's life expectancy, there is a need for research and solutions focused on the phases of a woman's life, especially the climacteric and post-menopause, which also require greater attention in public health systems [8].

Climacteric and menopause occur in the lives of any woman, often triggering a series of symptoms that can cause suffering and misunderstanding of their families and other people, other than the affected woman herself. Despite advances in studies of Women's Health, there is still a significant lack of knowledge about the climacteric and menopause as a natural phenomenon in women's lives, which requires special care of health care professionals, with systematized and individualized guidance for women and close people [9].

Thus, this work aimed to understand the domain of Women's Health, focusing on the Climacteric and Menopause stage in its first version. Such understanding enabled the development of a consistent representation of the domain, which can be used by Health Care specialists, Computer Science specialists and other stakeholders, as an object of communication, deep understanding of the domain and, also, as income for Decision Support Information Systems, both for Women's Health specifically and for Health Care in general.

This paper is organized as follows. The first section contains the Introduction, which describes the context of the work, as well as the work itself. The second section contains the necessary theoretical foundation to understand the work and the main methodological aspects adopted in the development of OntoWoH. Then, section 3 presents the reference domain ontology. Concluding the paper, the last section describes our final considerations.

2. Theoretical Foundation and Methodological Aspects

2.1. The Domain of Women's Health - Climacteric and Menopause Stage

In Brazil, Women's Health was incorporated into National Health Care policies in the first decades of the 20th century, focusing on demands related to pregnancy and childbirth. Mother-infant programs, developed in the 30s, 50s and 70s, demonstrated a restricted view of women, taking into account their biological specificity and their social role as mothers and housewives, responsible for raising, educating and caring for their health of her children and other family members [10]. That is, demands for a comprehensive approach to women's health do not encompass all of their life stages, as strategies aimed at the female population occur mostly for women of reproductive age [11]. It is noteworthy that with the decline in birth rates and increased life expectancy, women in the climacteric phase may become the majority in health care assistance compared to pregnant women [12].

At present moment, there are still several gaps in relation to women's health care, such as: gynecological complaints; infertility and assisted reproduction; women's health in adolescence; chronic degenerative diseases; occupational health; mental health; infectious diseases and care during the climacteric/menopause [10].

Each phase of a woman's life has peculiarities. In addition to the phases of life common to any person (childhood, adolescence, adulthood and advanced age), it is observed that for women there may exist particularly feminine events: the menstrual cycle, pregnancy, the breastfeeding period and the climacteric stages (which includes menopause).

The terms menopause and climacteric, although used as synonyms, have different meanings [9]. According to the World Health Organization (WHO), climacteric is a biological phase of a woman's life, and not a pathological process, comprising the transition between a woman's reproductive and non-

reproductive period. Menopause is a milestone of this phase and corresponds to the last menstrual cycle, being recognized after 12 months of its occurrence.

There is no predetermined age for menopause begins. Usually, it occurs around age 48 to 50 years [13], but it can start at 40 without being a problem [9]. When it occurs before the age of 45 (40 years for some authors), menopause is considered premature and can be caused by some chromosomal abnormalities, autoimmune disorders or even by some unknown cause. Also, it can be induced as a consequence of bilateral or iatrogenic surgical oophorectomy at any age. Late menopause occurs after the age of 55 years [14].

To better understand the menopause and climacteric stage, it is necessary to observe the previous phase of a woman's life. The menstrual cycle occurs during the female reproductive period, with two subcycles simultaneously - the ovarian, which occurs in the ovary, and the uterine, which occurs in the endometrium. The menstrual cycle occurs due to the function of the hypothalamic-pituitary-ovarian (HHO) axis. The hypothalamus stimulates the pituitary gland, which releases gonadotropins (follicle-stimulating hormone (FSH) and luteinizing hormone (LH)), which stimulate the ovaries. In contrast, hormones (estrogen and progesterone) produced by follicles in the ovaries regulate the hypothalamus, completing the cycle [15]. Menopause happens because, over time, there is a decrease in the number of follicles, a progressive drop in the concentrations of estrogen estradiol (E2) and progesterone, and the ovaries begin to respond less to the stimulus of the FSH and LH hormones. At first, women have more spaced menstrual cycles, then they stop ovulating and menstruation becomes irregular until they reach menopause [16].

Before the 2000s there was ambiguity in the use of the term pre-menopause by researchers: either it corresponded to the one or two years immediately preceding menopause; or comprising the entire reproductive period until the occurrence of menopause, which is the term recommended by WHO. Postmenopause corresponds to the period after menopause. Perimenopause corresponds to the period immediately prior to the occurrence of menopause, characterized by the onset of endocrine, biological and clinical changes that indicate the approach of menopause and extends to the first year after menopause; and the menopausal transition, which corresponds to the period of time before menopause, characterized by increased variation in the menstrual cycle. As the term climacteric was previously used interchangeably with perimenopause, to avoid confusion it was recommended that its use be dropped, but considering its popularity and dominance of the term climacteric, The Council of Affiliated Menopause Societies (CAMS) reinstated its use in 1999, determining it as a period that marks the transition from the reproductive to the non-reproductive period and that incorporates perimenopause, extending over a longer variable period, both before and after perimenopause [17, 18].

Despite the existence of an established nomenclature that facilitated a scientific consensus to describe female reproductive aging, there was still a lack of clear and objective criteria to describe the stages of female reproductive aging, which led to the realization of the Stages of Reproductive Aging Workshop (STRAW) in 2001 [16].

The STRAW, organized by the North American Menopause Society (NAMS), aims to standardize the nomenclature of the stages of female reproductive life, and proposed the division of the climacteric into stages [19, 8]. The STRAW criteria divided the phases of female reproductive aging into seven distinct stages, focusing particularly on healthy women who were in natural menopause, considering menstrual cycles, endocrine/biochemical factors, signs/symptoms in other organ systems and anatomy for this definition. uterine/ovarian [18].

The STRAW suggested that the terms perimenopause and climacteric should be synonymous, with use restricted to patients or the general public, but not in scientific articles, as recommended by the WHO. The term climacteric is not used directly in the proposed classifications, but the application of the term is maintained due to its daily use, both by health care professionals and society.

Established in 2011, the Stages of Reproductive Aging Workshop: STRAW + 10 (Figure 1), proposed a new classification, to improve the definitions applied and communication in the field. This proposal considers the female reproductive life since menarche, highlighting three main categories: Reproductive (early, peak, and late), Menopausal Transition (early and late) and Post-Menopause (early and late). Ten stages are considered (-5, -4, -3b, -3a, -2, -1, +1a, +1b, +1c, +2), six of which (-5, -4, -3b, -3a, -2, -1) before the end of the menstrual period (FMP) and four (+1a, +1b, +1c, +2) after the end of the menstrual period. Their classification is made according to a Main Criterion and Supporting Criteria. The variability of the menstrual cycle is considered the Main Criterion for the diagnosis and

classification of reproductive stages. Supporting Criteria (laboratory) are anti-Mullerian hormone (AMH) levels, inhibin B and FSH, and antral follicle count. Vasomotor symptoms and urogenital atrophy are also considered. Diagnosis and classification for healthy women is done by the Main Criterion. The symptomatology and the supporting criteria are used in the diagnosis and classification of women with polycystic ovary syndrome and primary ovarian insufficiency or who have undergone specific surgical procedures (endometrial ablation, unilateral oophorectomy or hysterectomy), which alter the menstrual cycle without determining the total depletion of ovarian hormones, as the underlying disease may be the explanation for changes in the menstrual cycle [20].

The STRAW criteria were an advance in understanding women's health and are considered the current gold standard for defining terms related to female reproductive aging [18], thus representing the core of OntoWoH.

Stage	-5	-4	-3b	-3a	-2	-1	+1 a	+1b	+1c	+2
Terminology	REPRODUCTIVE				MENOPAUSAL TRANSITION		POSTMENOPAUSE			
	Early	Peak	Late		Early	Late	Perimenopause		Early	Late
Duration	variable				variable	1-3 years	2 years (1+1)	3-6 years	Remaining lifespan	
PRINCIPAL CRITERIA										
Menstrual Cycle	Variable to regular	Regular	Regular	Subtle changes in Flow/Length	Variable Length Persistent ≥7- day difference in length of consecutive cycles	Interval of amenorrhea of ≥60 days				
SUPPORTIVE CRITERIA										
Endocrine FSH AMH Inhibin B			Low Low	Variable* Low Low	↑ Variable* Low Low	↑ >25 IU/L** Low Low	↑ Variable Low Low	Stabilizes Very Low Very Low		
Antral Follicle Count			Low	Low	Low	Low	Very Low	Very Low		
DESCRIPTIVE CHARACTERISTICS										
Symptoms						Vasomotor symptoms <i>Likely</i>	Vasomotor symptoms <i>Most Likely</i>			Increasing symptoms of urogenital atrophy

* Blood draw on cycle days 2-5 ↑ = elevated
 **Approximate expected level based on assays using current international pituitary standard⁶⁷⁻⁶⁹

Figure 1: Stages of Reproductive Aging Workshop: STRAW + 10 [20]

2.1.1. Symptomatology and Treatment

Many women go through the climacteric without complaints or medication, while others have symptoms that vary in diversity and intensity. In both cases, it is essential that the woman receives follow-up, to promote her health, obtaining an early diagnosis, immediate treatment of injuries and prevention of possible damage. In 2008, data showed that the increase in women's symptoms and problems in this period are not just endocrine events of the climacteric and menopause, but are also a reflection of social and personal circumstances, such as the personal (psychological state), marital, family and professional situation, and the decrease of endogenous estrogen, are the main factors that influence the symptoms intensity and clinical signs [13].

To define the symptoms and signs resulting from the interaction between sociocultural, psychological and endocrine factors that manifest themselves in aging women, the term Climacteric Syndrome is applied [21], whose diagnosis is based on detailed anamnesis complemented with a thorough physical examination [22, 23].

Among the most common climacteric symptoms, we mention physical and psychological discomfort, such as hot flashes in the upper part of the body, insomnia, vaginal dryness, palpitations, headaches, increased irritability, difficulty concentrating, memory failures, anxiety and depression. In the long term, there may be repercussions on the bone, cardiovascular and urinary systems [9].

The first step in the Climacteric Syndrome treatment should be to encourage healthy habits, such as physical exercise, maintaining a balanced diet and avoiding smoking, to alleviate symptoms [24].

The need for treatment for Climacteric Syndrome is based on the intensity of short-term symptoms and the risk for long-term conditions such as Osteoporosis and Cardiovascular Disease. Different therapies are used to reduce, mainly, vasomotor symptoms, without using hormones. Such therapies can be divided into non-pharmacological or behavioral therapies, pharmacological therapies (for example, antidepressants) and alternative pharmacological therapies (such as herbal medicines) [25].

Hormone therapy is considered the most effective treatment for dealing with vasomotor symptoms and Genitourinary Syndrome of Menopause and it has been prevented bone loss and fractures [26]. It should be noted that there is an opportunity window for the use of hormone therapy, which covers the first ten years from the date of the woman's last menstruation, or age between 50 and 60 years. The closer to menopause the start of hormone therapy, the greater the benefits and the lower the risks. Even within the opportunity window, it is essential that a careful and judicious analysis of a patient be carried out before the prescription of hormone therapy [27].

2.2. Methodological Aspects and Development of OntoWoH

An ontology is a formal representation of relevant concepts and relationships of a system, which allows sharing and reuse of acquired and represented knowledge [28]. They can be classified into foundational ontologies (serve as basis for the construction of other ontologies, as they describe more abstract concepts), domain (represent concepts and relations associated to a specific domain, such as Medicine), task (represent concepts and relations of tasks or generic activities that contribute to the solution of problems independent of the domain) and of application (depend on a particular domain and a specific task at the same time) [29].

For the construction of OntoWoH, classified as a domain ontology, the guidelines of the Unified Foundational Ontology (UFO) [30] were adopted, which enables a consistent integration with the methodology chosen for the development of OntoWoH (SABiO).

To deal with the different aspects of reality, UFO is divided into three categories: UFO-A (ontology of *endurants or continuants*), focused on objects related to the domain to be modeled; UFO-B (ontology of *perdurants or occurrents*), focused on events and processes, that is, on the actions existing between the domain objects, and UFO-C (ontology of social aspects), which aims to define concepts of social scope [30, 31]. The development of OntoWoH required constructs from UFO-A and UFO-B.

OntoWoH was developed applying the Systematic Approach for Building Ontologies (SABiO) methodology [32]. SABiO has two groups of processes: The Development Process and the Support Process. The activities of the Development Process give rise to the artifacts: Reference Ontology, a conceptual model centered on the expressiveness of the domain, and Operational Ontology, which is a machine-processable artifact mapped from the corresponding reference ontology. Initially, the Purpose Identification and Requirements Definition and Knowledge Acquisition activities were developed to elaborate OntoWoH. Knowledge Acquisition was carried out mainly through bibliographical research, supported by domain specialists during the activity.

Figure 2 presents the SABiO flow adopted in the construction of OntoWoH, highlighting the results obtained in some activities (for example, during the evaluation, quality control was obtained through verification and validation tasks).

During the Knowledge Acquisition, it was identified that, despite some differences, there is a convergence of viewpoints and terminologies in the area of Women's Health, which contributed to the consistent choice of which concepts would be used in the project. Regarding the term Climacteric, the WHO definition was chosen, followed by STRAW conceptualization, from which the terms related to the staging of female reproductive aging were adopted.

A pending activity to be performed is Reuse. A brief simplified search showed that there was no ontology like OntoWoH, but further research is needed to confirm this statement.

The Visual Paradigm editor was chosen for modeling the ontology, due to its robustness, offering free access in its community version and for enabling integration with the OntoUML Plugin for Visual Paradigm, which provides the use of UFO stereotypes and meta-properties natively in the editor [33].

Quality control tasks has taken two manner: (1) Verification, which has been the result of tasks such as carefully reviewing graphical issues of diagrams (such as visual arrangement of symbols to aid diagram legibility and cardinality definition in proper relationships), to check the nomenclature of the

represented terms (according to the domain and standard nomenclature usually adopted in conceptual models), to check that all types of entities and relationships are characterized via a UFO stereotype; (2) validation, which was the result of domain understanding tasks and checking whether such understanding was reflected in the ontology, which basically occurred through periodic discussions between the team of specialists, and was also reflected in the competence questions (CQ) elaborated (during the requirements elicitation activity) and that later had a response characterized from the navigation in the diagrams.

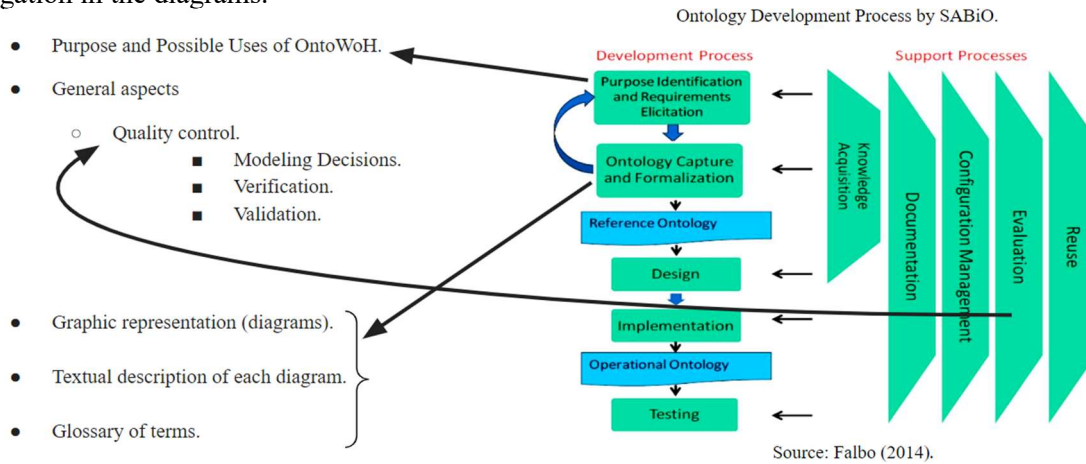


Figure 2: Application of the SABiO in the construction of OntoWoH.

Next, some CQ are presented, which helped in understanding the domain, and the traceability of these CQ in the ontology, through the reasoning adopted to answer the question from the concepts of OntoWoH.

- CQ 1: What are the particularly feminine events and at what stages of a woman's life can such events occur?
 Answer: In addition to the phases of a Person²'s life, during her life a Woman can go through particularly feminine events, which are the Menstrual Cycle, Pregnancy, Breastfeeding and the Climacteric phases, which are the Early and Late Menopausal Transitions and the first part of the Early Post-Menopause. The Menstrual Cycle results in Pregnancy or Menstruation, in which Menarche (first Menstruation, which usually occurs in adolescence) and Menopause (last Menstruation, which usually occurs in adulthood) stand out. The Menarche marks the beginning, and Menopause marks the end, of Menacme. During Menacme, which goes from adolescence to adulthood, Pregnancy and Breastfeeding may occur. The Climacteric phases (the Early and Late Menopausal Transition, the first part of the Early Post-Menopause) that occur before the Menopause, occur in adulthood.
- CQ 2: Which stages of women's reproductive aging are considered in STRAW + 10?
 Answer: The Female Reproductive Aging Staging System considers different phases of a woman's life, defined between the occurrence of Menarche and Menopause (central milestone). The phases are: Pre-Menopause (subdivided into Reproductive Period and Menopausal Transition), Perimenopause and Post-Menopause (subdivided into Early Post-Menopause and Late Post-Menopause). Such phases are equivalent to Stages, within which women are diagnosed and classified according to Criteria for Diagnosis and Classification (which is explained in a separate diagram) established by the Female Reproductive Aging Staging System.

² To facilitate the identification of the ontology concepts used in the text, the cited terms are highlighted with a different font than that used in the rest of the text.

3. Reference Ontology for Women's Health (OntoWoH)

The purpose of the Reference Ontology for Women's Health - OntoWoH - is to consistently represent the domain of Women's Health, with emphasis on the climacteric and menopause in its first version, highlighting the most susceptible symptoms in this period, possible treatments for the identified symptoms, the phases of reproductive aging, as well as essentially female characteristics and events. As for use, it is expected to be used by domain experts, technical specialists and other stakeholders as an object for communication and understanding of the domain, facilitating the dissemination of information in different segments and in addition to being used as a teaching and learning instrument for health professionals. Also, it can serve as income for Decision Support Information Systems in the area of Women's Health.

OntoWoH is a case study of the joint use of different technologies/methodologies, namely: the SABiO methodology, the UFO foundational ontology, the Visual Paradigm editor with the OntoUML plugin, the intense bibliographic research and the interaction with domain and technical experts.

Figure 3 presents an overview of the OntoWoH architecture, showing the packages and the links between them. OntoWoH has been organized into packages to facilitate its representation, understanding and use. With regard to the use of colors to highlight some property of the model, the colors defined by the VP tool for the different UFO stereotypes were preserved. To facilitate the identification of the modules and each concept of the ontology, we adopted the nomenclature in which each word (simple or compound) starts with the first letter in capital letters.

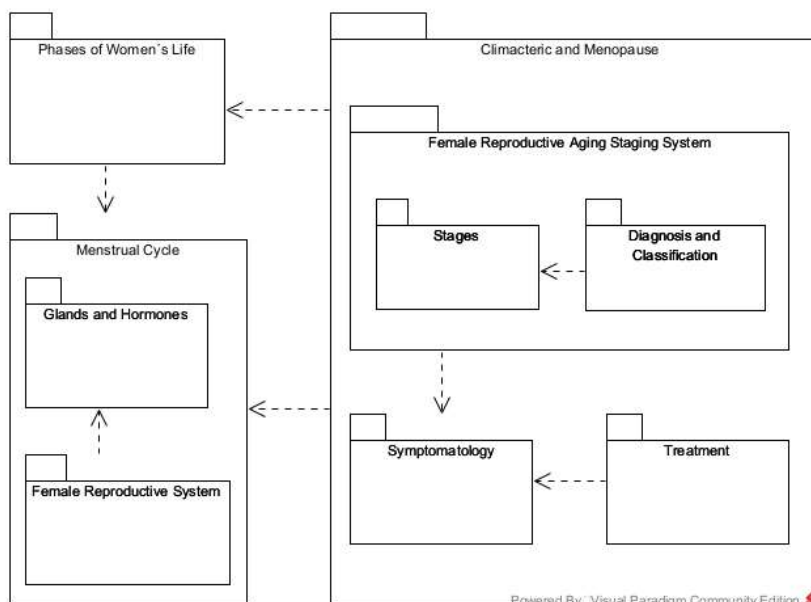


Figure 3: OntoWoH Architecture Overview

The Menstrual Cycle module presents particularities of the Menstrual Cycle, such as its components and symptoms of the Menstrual Syndrome and involves both the glands and hormones, as well as the female reproductive system. Its sub-modules are: (i) The Glands and Hormones, that presents types of glands, types of hormones and the main hormones relevant to the female universe; (ii) The Female Reproductive System presents the human body systems and particularities of the female reproductive system, mainly internal organs.

The Climacteric and Menopause module refers to the staging of Female Reproductive Aging, which involves the diagnosis and classification of women's situation, as well as symptomatology and treatment approaches for the climacteric phase and menopause. Its sub-modules are: (i) The Symptomatology sub-module presents early and late manifestations, transient and non-transient, resulting from female reproductive aging, associated with menopause; (ii) The Treatment sub-module presents the types of approaches for treating women who suffer from the Climacteric Syndrome; (iii) The Female Reproductive Aging Staging System sub-module presents the female reproductive aging staging system according to the STRAW + 10 criteria, which is in turn divided into: (iii.1) The Diagnosis and

Classification sub-module presents the criteria diagnosis and classification of women according to the STRAW + 10; (iii.2) The Stages sub-module presents the stages that make up the STRAW + 10.

Finally, the Phases of a Woman's Life module presents the phases of a woman's life and the main events in the female universe, under the aspects of her reproductive aging, focusing on menopause.

The OntoWoH 1.0 modules have nine diagrams (its graphical representation), a complementary descriptions and a glossary of terms for the applied concepts. In this paper some of these diagrams are presented, offering an overview of the main concepts adopted. An example of how the glossary of terms is organized³: Concept: Menstruation. Definition: Menstruation is the shedding of the lining of the uterus (endometrium) accompanied by bleeding. It occurs in approximately monthly cycles throughout a woman's reproductive life, except during pregnancy. Menstruation starts during puberty (at menarche) and stops permanently at menopause. Source: <https://www.msmanuals.com/pt-br/casa/problemas-de-sa%C3%BAde-feminina/biologia-do-sistema-reprodutor-feminino/ciclo-menstrual> (original definition in Portuguese). Diagram(s): Phases of a Woman's Life Module, Menstrual Cycle Diagram.

We can observe in the presented diagrams the use of several UFO stereotypes, which served as guidelines for some modeling decisions that occurred throughout the construction of OntoWoH. Among the UFO stereotypes applied, we mention kind, which encompasses individuals who have the principle of identity and are existentially independent - as is the example of `Person` (each person is unique and does not depend on the existence of another concept to exist) and `phase` (as in woman's life phases), whose instantiation is determined by an inherent property of the individual, and the change between phases occurs due to changes in values in the intrinsic properties of the instances (for example, John instantiates the `Child` phase if his age is less than 12 years old). A property is called quality when it has a measurable value in its quality dimensions (for example, a person's weight or age) and is called a mode if it cannot be represented by a measurement system (for example, a person's headache) [30]⁴.

In the phases of a Woman's Life diagram (Figure 4) we visualize female events according to the phases in which they occur, culminating in Menopause, which occurs due to Ovarian Failure and can happen naturally or unnaturally.

During her life, a Woman usually goes through a reproductive period, a non-reproductive period and a transition period from the reproductive to the non-reproductive period, which is represented in the diagram of the Female Reproductive Aging Staging System (Figure 5) - the core of OntoWoH, which considers different phases of a woman's life, defined from the occurrence of Menarche and Menopause (central milestone).

The usual phases of woman's life are Pre-Menopause (divided into the Reproductive Period and Menopausal Transition), Perimenopause and Post-Menopause (specialized in Early Post-Menopause and Late Post-Menopause). Such phases are equivalent to Stages, within which women are diagnosed and classified according to Criteria for Diagnosis and Classification established by the Female Reproductive Aging Staging System.

Menarche and Menopause are Milestones in a Woman's life. Menarche marks the beginning and Menopause (which occurs in Perimenopause) marks the end of the Reproductive Period (classified into Early Reproductive Period, Early Reproductive Period and Late Reproductive Period, which marks the moment when fertility begins to decline and during which the woman begins to notice changes in her menstrual cycles). The Menopausal Transition, which corresponds to the period of time characterized by the onset of endocrine, biological and clinical changes that indicate the approach of Menopause, is subdivided into Early Menopausal Transition (marked by increased variability in the duration of the menstrual cycle) and Late Menopausal Transition, marked by the occurrence of amenorrhea for 60 days or more.

³ For access to the complete glossary of terms, as well as the complete ontology specification, please contact the authors of the research.

⁴ For more details on the UFO foundation, please consult publications that discuss such artifact specifically, as in [30] and [31].

4. Final Considerations

The benefits of integrating the areas of Computer Science and Health Care are varied, which justifies the growing number of HCIS's that aim to improve the quality of Health Care. Ontologies, such as OntoWoH, are tools used to overcome some HCIS challenges (such as the integration of large volumes of data and knowledge sharing), which allows Health Care professionals to perform more accurate analyzes, to have greater access to knowledge and means to offer better service to the population, whose portion directly benefited with OntoWoH are women. In these cases, the ontology is an initial artifact for the development of a technological framework. On the other hand, an ontology is also a final artifact, when applied as a tool for teaching, learning and communication between stakeholders in the domain.

The research carried out showed the complexity and richness of information in the specific domain of Climacteric and Menopause. Using STRAW and domain specialists as main source of information, OntoWoH can be considered as an artifact to clarify and establish a terminology and to help in the semantic interoperability of the domain. We tried to represent it in a clear and reliable manner, but there are many possibilities for future work concerning the domain. Among these possibilities, we cite specific causes of Amenorrhea, adverse effects of therapeutic approaches, and complementary exams indicated for climacteric women.

Also, regarding STRAW + 10, there are some issues that are not included in version 1.0 of OntoWoH, but will be considered in the future: the need for operationalization and transparent reporting of pre-menopause, which is currently not explicitly stated; to establish, as minimum requirement, that regular menstruation be defined as the number of menstrual cycles in a time interval of at least three months and the need to consider the usefulness of introducing normative age ranges as a supplementary criterion for defining the stages of female reproductive aging [18].

OntoWoH was conceived with the aim of arousing greater interest and knowledge for the stage of a woman's life that is menopause, in different environments and groups, as well as facilitating the dissemination of information. We highlight among the purposes and possible uses of OntoWoH, the need to develop a HCIS with its database based on OntoWoH, whose users would be Health Care professionals, mainly.

To prepare OntoWoH for the next step, according to SABiO, one (or more than one) operational ontology must be developed. It is in our plans to continue the process, mapping the OntoWoH reference ontology (based on UFO) to, for example, an operational ontology developed in the OWL language. This mapping will open up a series of possibilities, mainly to explore reuse and integration with existing ontologies, such as those available in OBO Foundry. It is expected that a step like this will cause the revision of the reference ontology itself, to better explore reuse situations.

As lessons learned from the project, the importance of involving domain experts in the ontology development activities is highlighted, in order to obtain results that better reflect the reality and, at the same time, make them defenders of the use of ontologies [34].

OntoWoH is open to improvement and expansion, as well as reuse, including an integration to OntoSau de [35] – what has already been started, and application as basis to a technological tool. An initial quality control was carried out by both technical experts (through technical reviews) and its likely future users (through domain experts with whom the model was discussed), and so its first version was considered ready to be released⁵. New activities, such as empirical studies, are desired to ensure the quality of OntoWoH. In summary, the soap opera OntoWoH has begun, but there are still many chapters to go, maybe even some spin-off.

5. References

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⁵ At this moment, the ontology and associated documentation are not available for download on the Internet. However, for possible interested parties, the authors are open to contact and to send the material developed.

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