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Information Found In Biology Textbooks on Infectious and Parasitic Diseases That Have Caused the Most Hospitalizations in the State of Goiás: A Study Case

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Abstract

The objective of the present study was to analyze the information found in Biology textbooks regarding infectious and parasitic diseases that have caused the most hospitalizations in the State of Goiás in 2015 (dengue, gastroenteritis, leishmaniasis, septicemia and tuberculosis). For the analysis, it was taken into account the importance of textbooks as didactic resources in disseminating correct, consistent, and up-to-date information. The basis for the identification of the above-mentioned diseases was the Unified Health System databank (*Health Unic System*– DATASUS). The following aspects were taken into consideration when analyzing the textbooks: structure, adequacy of the information, theoretical contents related to pro-learning and graphic elements. The results showed that the content in most of the analyzed textbooks was treated superficially, with omission of important details, summarized in charts or in very simplified texts. The aspects prioritized by these textbooks are related to transmission forms, symptoms or clinical signs, control of the diseases and prophylaxis. The most neglected aspects were epidemiological characteristics and social and economic impacts related to the diseases. The weak points are content and illustrations, being more evident misconceptions, information gaps, misspelling, outdated theories and missing graphic scales in the images. We conclude that a thorough review of the analyzed textbooks is necessary, in order to better contribute to the learning process regarding such diseases. This study also shows that it is necessary that the teachers be aware of the contents of the textbooks that have been used in teaching.

Keywords: Dengue; Leishmaniasis; Tuberculosis; Textbooks; Quality of information

Introduction

In Brazil, as well as in other developing countries, sanitation, environmental and social characteristics, such as inadequate sanitation conditions, inadequate housing, deplorable health care programs, inadequate residue disposal, unequal distribution of income and low schooling level of the majority of the population, favor the dissemination of infirmities known as infectious and parasitic diseases (IPD) [1].

These diseases are characterized as neglected diseases, due to the low priority given to research incentives, development and access to new medication and lack of a comprehensive coverage of health services for their prevention and control [2,3]. The low investment related to these diseases in the ambit of health policies and services is the result of their low financial attractiveness when it comes to the major pharmaceutical companies, which do not envisage potential buyers of new medications to deal with these diseases, once they mostly reach marginalized, low-income populations [4,5].

At present, IPD are responsible for the high hospitalization indices and child mortality in Brazil, as well as in other developing countries in Africa, Asia and Americas [6-8]. Therefore, these diseases stand out as severe public health problems in tropical regions. In order to face these infirmities, the approach/discussion of themes related to health/disease/environment processes is essential by means of health education in the school.

Although the school is considered a proper educational and social environment to promote acquisition/construction of knowledge that can be very useful in preventing/controlling diseases, França et al. [9] highlight the fact that little attention is given to health education, when dealing with infirmities in Brazil. The few studies developed in Brazil that investigated the knowledge of the students from the basic education system on the dynamics of certain infirmities, such as intestinal parasitosis, reported that the understanding of such dynamics is quite limited [10,11]. This is a delicate issue, once the dissemination of many diseases is related to gaps in information and/or knowledge of the ways of prevention and treatment of these diseases, among other aspects [11].

When it comes to teaching Biology in the school, the textbook as a didactic resource is an important source of information and scientific knowledge for students and teachers, covering varied themes related to health issues. As discussed by França et al. [9], the Biology textbooks, when containing correct and up-to-date scientific information of quality, can contribute to the building or improvement of the students' knowledge on proper prevention measures against certain diseases.

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Despite the careful analysis of the textbooks that cover the varied subjects treated in the school, it is still possible to observe in different textbooks countless worrying aspects, such as scientific incorrectness (mostly conceptual), decontextualized language and information gaps, as well as the inclusion of images irrelevant for the understanding of the written texts. Such weak points compromise the teacher's work and are a disadvantage for the building of the student's knowledge [12].

Along the last years, many studies in the areas of Science/Biology teaching have analyzed the quality of didactic textbook contents (such as infectious and parasitic diseases), made available by the National High-School Textbook Program (National Book Program for High School– PNLEM). These studies have shown misconceptions in most part of the information available in these teaching resources, highlighting the necessity of greater rigidity regarding correctness and scientific updating in the preparation of the contents. The following studies can be cited as examples: França et al. [9] on leishmaniases; Assis et al. [13] on dengue; Batista et al. [14] on virology; Rosa and Mohr [15] on mycology; Succi et al. [16] on vaccination; Sandrin [17] on snakes and snakebites; Silva et al. [18] on arthropods; Santos [19] on phylum Mollusca, and Malafaia et al. [20] on environmental problems.

In view of the acknowledged importance of health education in high school and the ample use of didactic textbooks as a dissemination agent of health information for the benefit of students and even teachers, the objective of the present study was the analysis of the information found in Biology textbooks approved by PNLEM, concerning infectious and parasitic diseases that caused most hospitalizations in the State of Goiás in 2015. We assumed the hypothesis that, because of the role they play in the classroom, the didactic textbooks should contribute to the development of curriculum proposals and learning, when focusing on health themes such as IPD, so that they can promote preventive and eradication practices against these diseases.

Material and Methods

Selection of textbooks

The choice of textbooks for the present analysis took into account the Biology textbooks assessed and indicated by the PNLD Catalog for high-school students [21]. Seven of such textbooks indicated by PNLD for the 2015-2017 triennium were examined. Contents including the theme of this study were identified in six textbooks (Chart 1).

Data acquisition using the DATASUS databank

By means of the Unified Health System databank (*Health Unic System* – DATASUS), we identified the most prevalent infectious and parasitic diseases responsible for the most hospitalizations in the State of Goiás (from October 2014 to October 2015), which were the theme for the analysis of the didactic textbooks. The data were obtained by choosing the item concerning health information and the option "*morbidade hospitalar no SUS*" (hospital morbidity in SUS) and the item "*Geral, por local de residência*" (General, by place of residence). The research using the DATASUS databank was carried out in January 2016.

The results of such research showed that the infectious and parasitic diseases that have caused the highest number of hospitalizations in the State of Goiás in 2015 were dengue (122 cases), gastroenteritis (229 cases), leishmaniases (10 cases), septicemia (98 cases) and tuberculosis (25 cases).

Criteria and procedures of analysis

The analysis was performed book by book for each disease separately. An evaluation form was used, and the analysis criteria were adapted from items already considered in other studies, such as Mohr [22], Schall and Diniz [23], Vasconcelos and Souto [24], Santos et al. [19], Almeida et al. [25], Ferreira and Soares [26], and Batista et al. [14].

The items for analysis were divided in four evaluation blocks: (i) structure, (ii) language; (iii) theoretical contents related to pro-learning, and (iv) graphic elements (tables, figures, photographs, sketches, charts, etc.).

The first evaluation block mapped the presence or absence of a certain disease. The scope of the content was also analyzed, that is, whether they were presented superficially (only mentioning the subject) or satisfactorily (with explanations). It was also observed whether the subject was presented in exclusive chapters or inserted together with other subjects. The number of pages dedicated to the subject was also accounted for in this block.

The second block aimed to find in the text not only conceptual errors, fragmented concepts, and grammar errors, but also clear exemplifications and clear language. The third block was composed of questions that enabled the identification of important information on infectious and parasitic diseases, such as the etiological agents, modes of transmission, control/prophylaxis, symptoms or clinical signs and the mechanisms of action of the etiological agents.

While checking the presence of information concerning infectious and parasitic diseases, it was also verified whether the information provided in the text was adequate/correct. The information related to the theme in focus provided by the scientific literature was taken as a standard of adequate/correct information [27].

The fourth evaluation block consisted in the analysis of graphic elements related to the diseases, such as photos, illustrations, graphs, among others. The variables analyzed were mainly related to the consistency of such elements with the text, whether such graphic elements were mentioned in the text, the presence of self-explanatory legends/captions, whether the captions corresponded to the graphic elements, the presence of adequate scales (how much the image was enlarged), among others.

It is important to mention that the aim of our study, as Malafaia et al. [20] pointed out, was not to qualify or judge the quality of the

Didactic textbooksv[1]	Title	Authors	Publisher	Volume	Year
DT 1	*Biology: Unit and Diversity*	José Arnaldo Favaretto	Saraiva	2	2013
DT 2	*Biology in Context: the diversity of living things*	José Mariano Amabis e Gilberto Rodrigues Martho	Moderna	3	2013
DT 3	*Connections to Biology*	Rita helena Brockelmann	Moderna	2	2013
DT 4	*Connections to Biology*	Sergio Linhares e Fernando Gewandsznajder	Ática	2	2014
DT 5	*Bio*	Sônia Lopes e Sergio Rosso	Saraiva	3	2013
DT 6	*Biology: living things*	Vivian L. Mendonça	AJS	2	2013

[1] Code attributed to the didactic textbooks used in the analysis.

Chart 1: List of Biology didactic textbooks analyzed in the present study.

textbooks, nor recommend or make apologies for high school teachers not choosing the textbooks to be used in the classroom.

Results and Discussion

It was observed that all textbooks presented mistakes, gaps and limitations regarding some evaluation criterion. It was possible to observe that the analyzed textbooks did not present information regarding all the infectious and parasitic diseases selected for analysis, as shown in (Table 1).

None of the textbooks include information on gastroenteritis or septicemia. It is interesting to mention that it is not compulsory that the textbook, as an auxiliary resource to teaching, focus on all the contents recommended in the curriculum. In this sense, it is essential that teachers, in particular those of Sciences and Biology, search for other resources and sources of information, in order to complete and update their classes according to new scientific discoveries and innovations [13].

The DT2 book had the lowest number of diseases studied; only addressing leishmaniasis. Within the diseases selected for analysis, dengue was outnumbered, being leishmaniases dealt with in all the analyzed textbooks.

None of the selected diseases is dealt with in a separate chapter, but together with other subjects, in particular in chapters dedicated to viruses, bacteria and protozoa, inserted in volume 2 of all collections, except DT5, whose volume 3 is dedicated to diseases.

Some textbooks present the information in a succinct and poorly elaborated way, by means of charts (exemplifying diseases caused by microorganisms), which focus mainly on the name of the disease and the etiological agent, some transmission mechanisms and symptoms, e.g. DT1 on dengue and tuberculosis; DT3 and DT5 on tuberculosis.

Textbooks DT2, DT4 and DT6 cover the contents by using written text only. However, it is important to mention that some diseases cited in the textbooks are presented rather superficially, omitting/restricting important information that could contribute to the mitigation and control of such diseases. Some textbooks bring in a single paragraph information on the themes covered, abdicating the critical exploration on the diseases and valuing the memorization of the information, for example, DT4 on tuberculosis.

Regarding the theoretical contents related to pro-learning, which, according to Malafaia et al. [20], offer important key information for the satisfactory assimilation of the contents covered by the textbook, a survey on priority information presented in the theoretical contents was carried out, as summarized in (Figure 1).

The analysis of the written text showed that much key information is not totally contemplated in the contents presented by the textbooks (Figure 1). A high frequency of missing information on etiological agents and their mechanisms of action was observed. Regarding information on the modes of transmission/propagation, the symptoms or clinical signs and the disease control and prophylaxis, the frequency of "present" or "partially present" was satisfactorily higher. Regarding the disease epidemiological characteristics, a low frequency of information on the subject was observed. Another important factor is that none of the analyzed textbooks brings information on social and economic impacts caused by the diseases.

Dengue

Regarding dengue, the analyzed textbooks favor a descriptive approach of the control measures against the disease and its effects on health (symptomatology) in a poorly elucidative manner based on specialized literature. Moreover, the textbooks make no reference to the influence of social-economic, environmental and demographic aspects that converge to the occurrence and increase of dengue incidence in Brazil. This fact does not reflect the PCNEM recommendation of contextualized information connected with the students' reality. Excepting DT1, the textbooks distinguish the two clinical forms of dengue: the classic and the hemorrhagic. From the clinical point of view, dengue is an acute febrile illness, caused by four viral variants (dengue viruses 1, 2, 3 and 4) of the genus *Flavivirus* that belongs to the family Flaviviridae, of benign evolution in the classic form, but severe or lethal in the hemorrhagic form [28,29].

Textbook DT6 does not specify the clinical manifestations of classic and hemorrhagic dengue separately, not contributing to the symptomatological distinction between them. The fact that DT6 does not highlight any peculiarity of the symptomatology of the dengue clinical forms can induce students and teachers to think that the classic dengue results in the coexistence of all symptoms described for the hemorrhagic dengue. For Assis et al. [13], the awareness of the symptoms and the aggravations of the classic and hemorrhagic dengue contribute to both self care and initiative in searching treatment, opening the possibility to suspect or distinguish the symptoms that may manifest with dengue.

Regarding the etiology of dengue, none of the textbooks mentioned that the infirmity is caused by a virus of genome RNA, classified as an *arbovirus*, of which four serotypes, presently named DENV-1, DENV-2, DENV-3 and DENV-4, can cause the disease. Additionally, textbooks DT4 and DT5 cited only the genus (*Flavivirus*) which the dengue virus belongs to; textbook DT1 refers only to the virus family (*Flaviviridae*), and DT6 does not mention genus or family. High-school textbooks should be the students' guide for the use and practice related to nomenclature and scientific names, because they are aware and can better understand the importance of complete classifications, which contribute to the enrichment of the content [30].

Regarding treatment, it is worth mentioning that DT4, DT5 and DT6 satisfactorily alert that no medicament should be used without

Disease	Didactic textbooks					
	DT1	DT2	DT3	DT4	DT5	DT6
Dengue	+	-	-	+	+	+
Gastroenteritis	-	-	-	-	-	-
Leishmaniases	+	+	+	+	+	+
Septicemia	-	-	-	-	-	-
Tuberculosis	+		+	+	+	+
Total of identified diseases	3	1	2	3	3	3

Signal (+) indicates that the disease is included in the analyzed textbook. Signal (-) indicates that the disease is missing in the analyzed textbook.

Table 1: Identification of diseases in the analyzed textbooks.

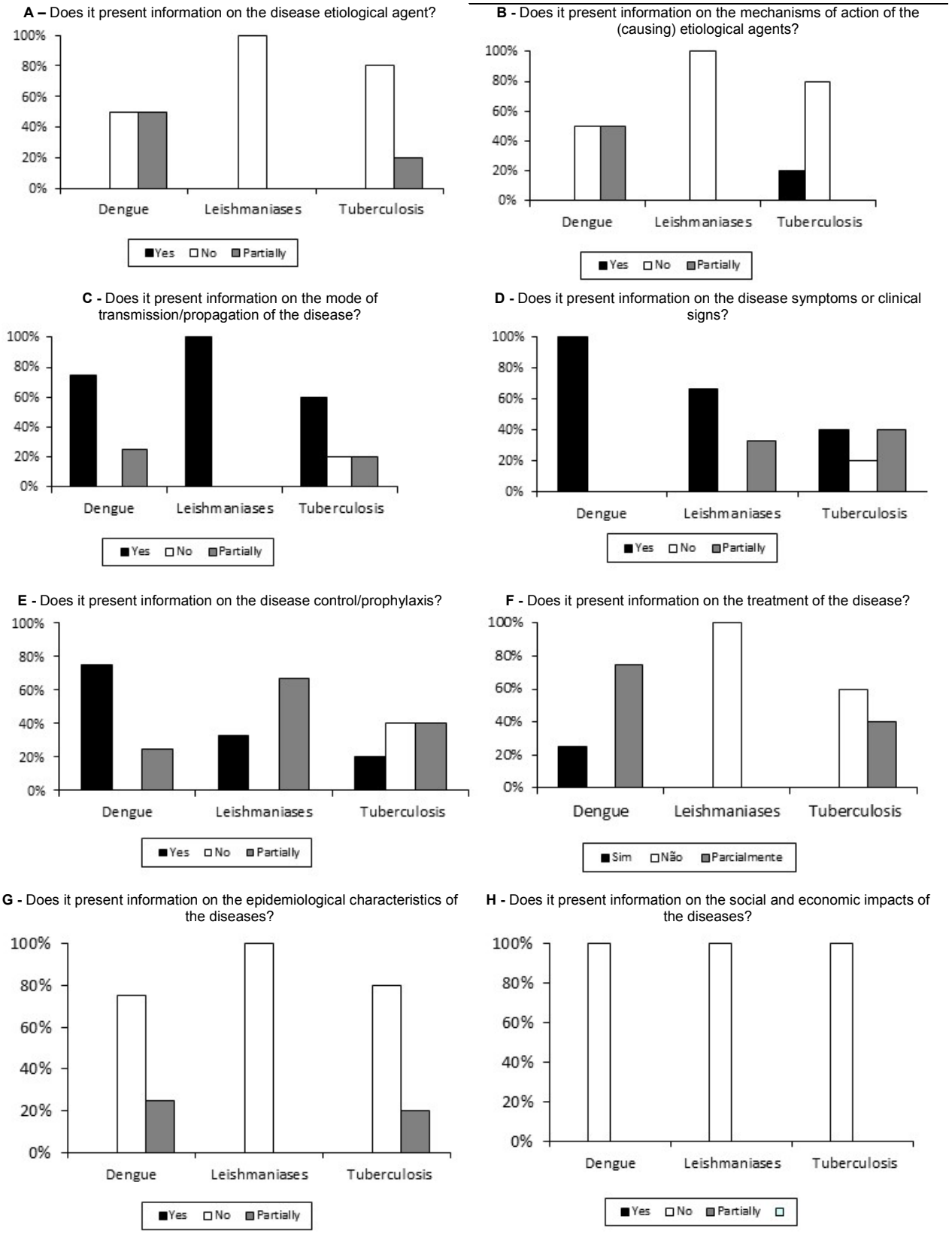

Figure 1: Assessment of Biology textbooks regarding the theoretical contents related to pro-learning.

prescription. According to these textbooks, the use of analgesics containing acetylsalicylic acid in a suspected case of dengue must be avoided; as such substance favors hemorrhages, contributing to the worsening of the condition.

Textbook DT4 presents inexact information regarding the dengue vector breeding. It states that the oviposition occurs *"em água parada"* (in still water). It must be pointed out that females lay their eggs on the wall of any possible/potentially floodable damp container, slightly above the liquid surface, outside the water [31, 32, 27]. The eggs are very resistant to desiccation, remaining viable for more than a year. After the contact with water (*e.g.* rainwater) the eggs can hatch in the first 15 minutes [27].

Textbook DT4 cited imprecisely that "*o vírus (gênero Flavivirus) é transmitido pela picada de duas espécies de mosquito: Aedes aegypti e o Aedes albopictus. No Brasil, só ocorre a primeira espécie*". In fact, from 1986 on, *Aedes albopictus* has already been detected in Brazil, in the states of Minas Gerais, Rio de Janeiro and Espírito Santo (southeastern region of the country). However, up to now, it has not been found naturally infected in Brazil, because it is neither very domestic nor very anthropophilic [27,33]. Textbook DT4 could have explained that the dengue virus is transmitted by the mosquitoes *Aedes aegypti* and *Aedes albopictus,* and that in Brazil the vector species is *Aedes aegypti*.

Similarly to the study of Assis et al. [13], another relevant aspect identified in DT4 was the inaccuracy of the information concerning the disease etiology: *"Quem já teve dengue, mesmo uma forma assintomática, ou quem é portador de doença crônica, como diabetes, artrite reumatóide ou lúpus, pode contrair dengue hemorrágica, provocada por outro tipo de vírus"*. In fact, the hemorrhagic dengue can be associated with any serotype of the dengue virus, and not with any other virus, as highlighted in the book [13].

Contradictorily, the textbook DT4 highlights *"campanhas de vacinação"* as a measure of dengue prevention. Despite the ongoing research, up to now no vaccines or antivirus drugs have been developed specifically against the four existing serotypes [28]. We point out, as discussed by Gonçalves [34], that in view of the lack of a vaccine that guarantees immunization, the control is centered in the breakup of the disease transmission chain, and consequently the best control measure is to eliminate the sites favorable to the development of the *A. aegypti* mosquitoes, which are mostly found inside the houses.

Concerning the mosquito morphology, only textbooks DT4 and DT5 present the *A. aegypti* characteristics. However, DT4 described in a poorly instructive way the morphology of the dengue mosquito: *"Aedes aegypti é pequeno, de cor escura"*. Such description is devoid of useful information that could help recognize the *A. aegypti* mosquito. On the other hand, the morphological aspects reported in DT5 can more effectively help the identification: *"tem abdômen rajado de preto e branco, com um desenho prateado na parte dorsal do tórax"*. White and silver stripes on the chest are the mosquito main characteristics [35].

A major gap found in the analyzed textbooks is that they do not bring complete information on the disease cycle (humans – *A. aegypti* – humans) and the transmissibility period.

All the books indicated that the transmission of the dengue virus occurs only by the bite of the female mosquito of the *A. aegypti* species. However, only textbook DT4 did explain the reason why females are the only ones that need to feed on blood, differently from the male that feeds on substances containing sugar, e.g., fruit and plant nectar [36]. Males are not hematophagus, only females are, because they need human blood to make the maturation of the eggs possible [37].

Another interesting aspect that could lead to the adoption of proper control measures refers to the mosquito hematophagus habit. Textbooks DT1 and DT5 mention that the female bites occur during the day. *A. aegypti* is a mosquito of daytime eating habits, preferably early in the morning and late in the afternoon [38]. Gonçalves et al. [34] point out the importance of knowing the mosquito habit in relation to the most critical period of the day in which it can potentially infect a person, so that protection can be provided against its bite.

Only textbooks DT5 and DT6 informed that *A. aegypti* is also a vector species for other diseases. It is important that the textbooks contextualize other diseases transmitted by *A. aegypti*, such as yellow fever, chikungunya and the zika virus, emphasizing that *A. aegypti* is of great sanitation concern.

Regarding control measures, the textbooks do not present any discussion with contextualized information on the mobilization of the society in handling sites and containers favorable to oviposition in their homes, so that the disease control measures are brought to the students' daily lives. It is crucial that students be able to learn about and identify mosquito breeding sites present in their homes and surroundings (specially wastelands) and to think about the possible prevention actions.

Textbook DT5 points to the use of chemical substances as larvicides and insecticides for the *A. aegypti* control: *"Usar substâncias químicas como larvicidas e inseticidas para combater as larvas e os adultos desses insetos"*. However, studies such as those developed by Braga and Valle [39] show that the constant insecticide application can lead to the generation of resistant *Aedes aegypti*.

According to Neves et al. [27], the majority of the mosquitoes die with massive insecticide application, whereas the more resistant to these products repopulate the environment. To be lethal to resistant populations, a higher dosage of the insecticide must be pulverized, but this can be impractical, in view of the significant toxicity to man and domestic animals and the high cost to the Government [27,40]. It is pointed out that the chemical control should be carried out only in extreme situations, where the epidemic risk is imminent.

Textbook DT1, without much contextualization, highlights the use of biotechnology in the biological control of the dengue vector: *"Pesquisas recentes criaram uma população transgênica de mosquitos A. aegypti. Espera-se que, após a introdução desses mosquitos na natureza, se obtenham, da união de machos alterados geneticamente com fêmeas normais, fêmeas incapazes de voar por apresentarem atrofia nas asas"*. This statement implies a certain limitation of the use of biotechnology techniques as alternative measures to the use of insecticides in the dengue vector control. Further in relation to dengue prevention and control, DT1 alerts that *"vasos com plantas devem ter a água trocada diariamente"*. It must be considered, as discussed by Assis et al. [13], that the adoption of such measure is not fully efficient, because the *Aedes aegypti* eggs can remain attached inside these containers, waiting for the contact with water to hatch.

Textbook DT4 recommends that water should be prevented from accumulating in v se dishes, *"colocando areia grossa nos pratos sob os vasos de plantas"*. However, it is necessary to mention that the adoption of such measure is also of low efficiency, because, if the sand is not constantly changed, its volume will be reduced with time, leading to the formation of a water layer above the layer of sand [13].

Leishmaniases

Regarding leishmaniases, textbooks DT1, DT2, DT4 and DT5 focused on two clinical forms of the disease. Classically, two types of leishmaniases are distinguished in humans, depending on the parasite species: the American Integumentary Leishmaniasis (AIL), popularly known as Bauru Ulcer, which causes sores on the skin and on mucous membranes, and the Visceral Leishmaniasis (VL), popularly known as kala-azar, which affects organs or viscera, such as lymphnodes, liver and spleen, leading to death, if the patient is not submitted to specific treatment [41,42].

Textbooks DT3 and DT6 specify the "*Bauru Ulcer*" only (stigmatizing way of referring to AIL, according to França et al. [9], not mentioning the visceral form (VL), considered the most severe leishmaniasis form. Silva [29] points out that it is of prime importance to deal with VL in didactic textbooks so that the students can learn and know more about it, once the disease has been reaching large urban centers and affecting larger proportions of the society.

Textbook DT6 brings as title of the content the term "leishmaniases" (plural), without even mentioning along the text that leishmaniases present two forms: AIL and VL. It just explains that *"leishmanioses são um grupo de doenças causadas por protozoários"*.

According to the World Health Organization, an ample spectrum of clinical forms can be found in AIL patients: cutaneous leishmaniasis (CL), mucocutaneous leishmaniasis and diffuse cutaneous leishmaniasis [27]. When dealing with AIL, none of the textbooks reported the distinction between the several AIL types, textbook DT1 introducing the subject with the subtitle Cutaneous-Mucosal Leishmaniasis.

According to França et al. [9], even if the description of the three AIL types may be too specialized for school students, it would be interesting to specify in didactic textbooks that, among the varied forms of the disease, the most common AIL form is the cutaneous and that it manifests as ulcerated skin lesions. Therefore, students and teachers will not think that there is only one AIL type. For Assis et al. [13], when exposing contents related to health, as well as themes of scientific nature, the use of a language accessible to the public is necessary, but attention must be given to excessive simplifications during this translation.

Regarding the leishmaniases etiological agents, textbooks DT1, DT3 and DT6 mention that the diseases are caused by protozoa of the flagellate group of the genus *Leishmania*, without specifying that these parasites can present different forms in their evolutionary cycle. It is known that the species of genus *Leishmania spp*. has two distinct evolutionary forms, when present in their different hosts. Thus, the promastigote, with free flagellum, is found adhered to the digestive tract of the invertebrate host, in the peripheral blood of the vertebrate host and in the culture media, whereas the amastigote, rounded forms with no flagella, is found in the cytoplasm of the macrophages of the vertebrate hosts [27].

On the leishmaniasis transmission, only textbooks DT1, DT4 and DT5 correctly indicate that only the bite of the infected female phlebotomine/sandfly can transmit the disease to man. However, none of the textbooks mentioned the reasons why females are the only ones that blood feed. The females are responsible for leishmaniases dissemination because their mouthparts are adapted to bite the vertebrate skin and suck their blood [43]. Females blood feed to obtain the protein that makes the maturation of the eggs in the ovarian follicles possible.

Textbook DT4 describes that: "*esse protozoário é transmitido pela picada de mosquitos fêmeas da família dos flebotomíneos e do gênero Luzomya, conhecidos como mosquito palhas ou biriguis"*. Besides highlighting that the parasite transmission occurs by means of a *"mosquito"*, it conveys the erroneous information that the insect vector belongs to the *Phlebotomine,* rather than the *Psychodidae*, family [27]. This textbook also misspelled the name of the genus of the insect vector.

Regarding possible natural leishmaniases hosts, textbooks DT2, DT3, DT4 and DT6 did not cite the different mammal species (such as marsupials, rodents, edentulous, canines and primates, including man) can be infected by protozoa of the genus *Leishmania*, which act as infection source transmitted by insect vectors. Textbook DT1 cited: *"roedores silvestres, gambas e canídeos, entre outros organismos servem como reservatório"* for AIL, and: *"o cão e a raposa são seus principais reservatórios"* for VL. For both leishmaniases, textbook DT5 cited that *"ratos, cães e gambás atuam como reservatórios do parasita"*.

When dealing with VL, the authors of textbook DT4 point out that: *"é transmitida pelas fêmeas de algumas espécies de mosquitos do gênero* Lutzomya*, que se contaminam ao picar um vertebrado"*. The text conveys the idea that any vertebrate species can be considered a host of the leishmaniases etiological agent. Besides, it is not clear that the contamination of these insects occurs when they bite a contaminated mammal. The textbook fails when it does not inform which vertebrate species (that is, mammals) can promote Leishmania circulation in the environment.

In relation to the preventive measures of leishmaniases vector control, DT4 and DT6 warn that it is necessary to control the insect vector and the breeding sites, respectively. Despite the information contained in these textbooks is correct and according to the specialized literature, once the control and elimination of phlebotomines is fundamental to break the disease cycle, the information is not properly relevant or informative, because important issues for the understanding of the vector control measures are omitted. For example, which measures must be taken to eliminate phlebotomine breeding sites? Which measures must be taken to avoid insect vector proliferation? Which practices contribute to the decrease of the man-vector contact? Which are the breeding sites and where are they found? These measures must be deeply investigated in didactic textbooks, because one of the main actions to avoid leishmaniases transmission is the vector control and elimination, as mentioned before.

Textbook DT2 brings an erroneous information about leishmaniases prevention and control: *"o combate ao mosquito pode ser feito pelo aterro de lagoas e poças d'água que servem de criadouro para as larvas"*. In fact, females lay their eggs in damp places where there is accumulation of organic matter in decomposition (under dry leaves, old tree trunks, organic waste and animal feces) and not in water, which is the mosquito breeding site [9]. A consequence of this erroneous information is the incorrect control of phlebotomines, which can lead to leishmaniases epidemic.

Authors such as França et al. [9] point out that landfill does not prevent leishmaniasis, being an improper action for the environment sustainability and the maintenance of its biodiversity. Another mistaken suggestion found in textbook DT2 related to preventive measures is: *"cobrir camas com cortinado de filó"* in order to avoid phlebotomine bites when sleeping. The mesh size used in common mosquito nets are not efficient to block the passage of phlebotomines (which in general do not exceed 0.5 cm in length), once they are smaller that common mosquitoes. These inadequacies were also mentioned in França et al. [9].

Continuing with the preventive measures, textbooks DT1, DT2,

DT3, and DT4 recommend the use of screens, protective nets and even veils, in order to avoid the "mosquito" attack and bite. The textbooks do not indicate the mesh size, so that the adoption of such resources may be inefficient, once the mesh size may not refrain the "mosquito" from attacking, as suggested by the textbooks. Only DT5 brings a more appropriate explanation about the use of screens to prevent the access of the insect vector: *"Uso de telas nas janelas com malha bem fina, pois eles passam em malhas mais grossas como as usadas nos mosqueteiros comuns"*.

Textbooks DT2 and DT4 use inadequate sanitation terms regarding the *"combate dos mosquitos"*. The use of the terms "extermination" and "combat" are not adequate because they remind of outdated health education models of the end of the nineteenth century, which confers a campaign nature of a "bellicose" and "war" discourse, contributing to scaremongering rather than properly ensuring access to information [13,44].

Tuberculosis

Regarding tuberculosis, the textbooks that deal with the disease indicate the scientific name of the etiological agent that causes the infirmity: *Mycobacterium tuberculosis*. Textbooks DT1, DT4 and DT6 cite that the microorganism is also known as Koch bacillus. Textbooks DT1 and DT6 mention that the term Koch bacillus is in reference to the scientist Robert Koch, who isolated and identified the bacillus. Textbook DT1 includes the names of etiological agents of less epidemiological importance: *Mycobacterium bovis*, *Mycobacterium africanum* and *Mycobacterium microti.*

Textbooks DT4, DT5 and DT6 give little attention to tuberculosis. In general, there is a lack of information related to the students' reality, such as updated epidemiological data of the tuberculosis problem in Brazil, inter-relation between social factors involved in tuberculosis epidemiology and the main challenges of its control. It would be appropriate if the textbooks presented more detailed information on tuberculosis, once it is a severe public health problem, at present classified as the second main cause of mortality by infectious diseases in the whole world, being AIDS the first [1].

Textbooks DT4 and DT6 present short and succinct written texts on the disease. By means of a chart, not treating in depth and without contextualizing the subject, textbook DT5 cites in an extremely conceptual manner the name of the etiological agent, mode of transmission, some characteristics of the infection and prophylactic measures against the disease. Textbook DT1 treats the subject in a more comprehensive way, with more enlightening and relevant information. Textbook DT1, respecting the contextualization of the subject, brings important information that contributes to the understanding of the main signs and symptoms, the measures against tuberculosis by means of vaccination, medication and diagnosis, the increase of tuberculosis occurrences in HIV-positive individuals, and the factors that have contributed to the permanence of the disease.

All textbooks mentioned that tuberculosis affects primarily the lungs, once the bacillus has preference for lung parenchyma. Consequently, these textbooks give information only on the pulmonary tuberculosis, not mentioning the extrapulmonary tuberculosis, certainly in view of the clinical and epidemiological importance of the former.

Textbook DT4 cites that other organs besides the lungs can be affected, but does not mention which. Textbook DT5 states that the disease *"atinge os pulmões, provocando infecções e pode passar para o sangue e a linfa, atingido outros órgãos como o fígado, baço, medula óssea, rins, sistema nervoso"*, thus being classified as extrapulmonary tuberculosis. Textbook DT6 points out that tuberculosis can also affect *"os rins, os ossos e os linfonodos"*. Textbook DT1 highlights that tuberculosis can also affect *"faringe, a pele, o intestino, os rins, os ossos, os testículos, os ovários e as meninges"*.

A major mistake found in all textbooks is that they do not explain how such organs can be affected by the tuberculosis bacillus, and which are the related clinical evidences. For Vasconcelos and Souto [24], when the student is deprived of explanations and access to complete information on a certain theme, he will not be able to build knowledge in order to understand the reality that surrounds him.

Regarding the transmission forms, textbook DT4 does not mention the transmission modes. Textbook DT5 explains the usual form of transmission of the pulmonary tuberculosis: *"inalação de gotículas espalhadas no ar pela fala, espirro e tosse de pessoa contaminada"*. It is inferred that the tuberculosis transmission is from person to person by the inhalation of particles infected with *Mycobacterium tuberculosis*, such as bacilliferous sputum droplets dispersed in the air and expectorated by patients with pulmonary tuberculosis, as they talk, cough or sneeze [45]. The *in natura* transmission by milk is currently unlikely, but the exposition in laboratories can occur, when bio-security is not properly followed.

Superficial and confuse explanations on the prevention of tuberculosis were observed, for example, in textbook DT6: *"como os bacilos são transmitidos pelo ar, uma importante medida preventiva é adotar os mesmos hábitos higiênicos recomendados para a prevenção de toda doença em que o agente etiológico pode estar presente na atmosfera"*. This information is not clear or detailed enough to help the student to better understand and assimilate the content. Which hygienic habits are associated with the least risk of development of diseases? Of which diseases are the etiological agents found in the atmosphere? Regarding hygienic and sanitation measures, scientific studies recommend aeration and solar exposure of infected sites, once the bacillus is easily destroyed by sunlight and heat [46].

Regarding preventive measures, all textbooks mention vaccination against tuberculosis. It is worth mentioning that the Bacillus Calmette-Guerin (BCG) vaccination of newborns was implemented in Brazil in 1927. Only textbooks DT1 and DT5 do point out that the prevention of the disease is mainly by treating bacilliferous patients. For this reason, early diagnosis and monitoring until the patient is cured is currently advertized, so as to attain the effective control of the disease.

Textbook DT4 suggests as preventive measure: *"melhorias dos padrões de vida das populações mais pobres"*, without even explaining that the propagation of tuberculosis is closely linked to poor living conditions and, consequently, it is necessary to provide better social-economic and sanitation conditions to the population in need, in order to control tuberculosis. It would be better if the textbooks gave emphasis to the fact that infectious diseases, such as tuberculosis, proliferate in a more severe way in areas where urban infrastructure, including sanitation and housing, is precarious, and affect a large number of people who are undernourished and live in poverty.

Graphic Elements

A total of 26 images were computed in the analyzed Biology textbooks. The highest number de images correspond to leishmaniases (46.15%), followed by dengue (42.30%). Few illustrations were dedicated to tuberculosis (11.53%), probably because of the reduced

content. The textbooks mostly bring photos and photomicrographs (65%), rather than drawings and figures (35%).

According to Vasconcelos and Souto [24], a complete image must contain a self-explanatory caption, be inserted as the information is presented in the text, and must make the contextualization possible. In this sense, all textbooks present clear, appropriate and consistent images as part of the main text and are accompanied by captions in conformity with the identified graphic element, which contributes positively with its interpretation, aiding the student's learning.

Regarding the captions, 89% of the textbooks indicate when using fantasy colors. All images that present fantasy colors cited in the captions are compatible with the real colors or induce the student to this perception. However, no textbook refers to the graphic elements in the text body, the images being disconnected from the information contained in the text. It is necessary to point out that, when the image is not linked to the text, the information it presents becomes inaccurate, that is, the image does not clearly expose the ideas that it represents.

Regarding the use of scales to indicate the real proportions of the subjects represented in the images, no scales were shown in 19% of the analyzed images. For example, textbook DT1 brings an image representing the dengue vector, a figure of the dengue virus, and another explanatory figure with elements related to the mosquito life cycle with no scales.

In textbook DT5 there is a figure of the sandfly with no reference to the magnification in relation to the actual size of the insect vector (Figure 2). According to Assis et al. [13], the scale ensures that teachers and students do not create misleading images regarding living organisms and their recognition in their real form.

Reducing the potential of (Figure 3) as a didactic aid, textbook DT1 does not explain it in the written text. Consequently, the relevance of the use of such image is questionable, because the understanding of such information is compromised. Besides, the image shows the mosquito life cycle, from oviposition to the adult mosquito with no scales or indication of the fantasy colors in the caption, leading to the misinterpretation of the correct size of the elements represented in the image.

When dealing with the prevention measures against the proliferation of the dengue vector, an illustration in textbook DT6 shows the addition of sand at the border of a plate under a vase with violets (Figure 4). Such image is not a proper example of control of *A. aegypti* proliferation, as violets need very little water.

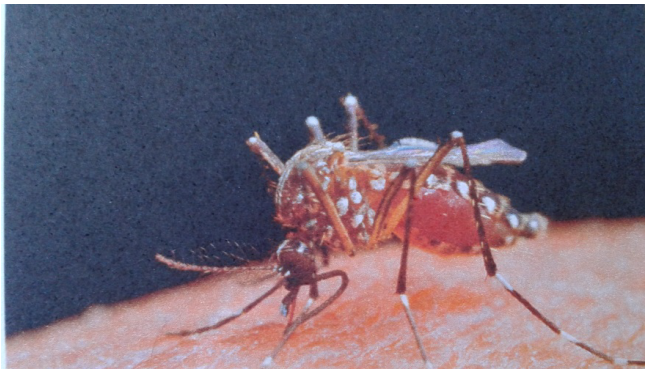

Figure 2: Example of an image without reference to the magnification in relation to the actual size of the insect vector.

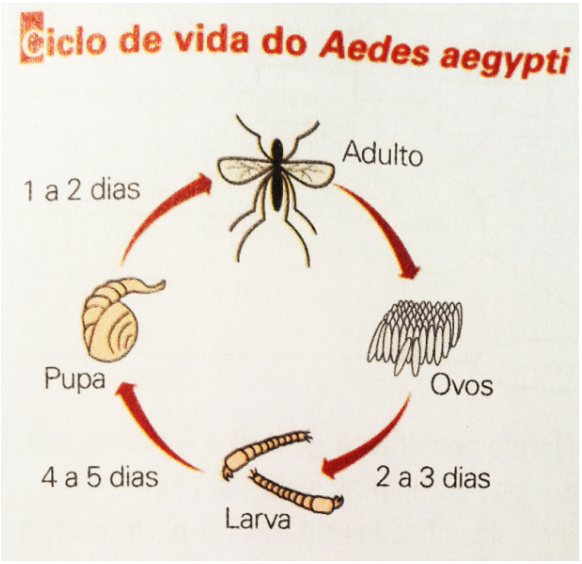

Figure 3: Example of an image without any scale or indication in the caption of what the colors represent [27].

Figure 4: Inadequate image used to illustrate a control measure against the *Aedes aegypti* mosquito proliferation.

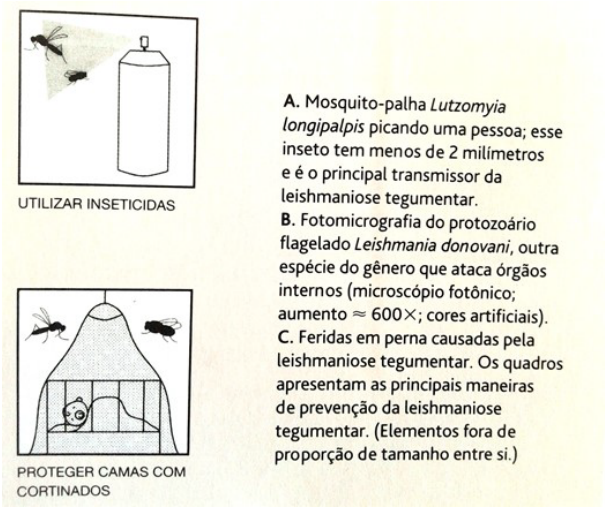

Figure 5: Inadequate images to illustrate measures to avoid phlebotomine bite [48].

Textbook DT2 reproduces in the images wrong information found in the text concerning prophylactic measures against leishmaniasis. As shown in (Figure 5), the book recommends the installation of screens in doors and windows to prevent the insect from entering the house, without informing the mesh size that guarantees the success of such measure; the use of insecticides without calling attention to the toxicity problem that such substance can cause, and finally the use of veils on the beds, which, as mentioned before, are unable to block the passage of phlebotomines, due to the size of the insect vector. The textbooks should avoid the use of images with information that can lead to misinterpretations.

Conclusions

According to the results obtained in this study, it is evident that considerable deficiencies exist in Biology textbooks adopted in schools regarding scientific contents and illustrations, when dealing with infectious and parasitic diseases, such as dengue, leishmaniases and tuberculosis.

In general, the didactic textbooks present very simplified and superficial information on such diseases, most of the time focusing of transmission forms, symptoms or clinical signs, control and prophylaxis, leaving aside information on epidemiological characteristics and social and economic impacts related to these diseases.

We believe that the scientific contents and concepts present in didactic textbooks do not favor the building of knowledge that would help the students acquire competences and abilities necessary to interpret facts and, thus, seek for solutions to situations within their social and cultural context.

We conclude that the textbooks analyzed in this study must be reviewed, in order to better contribute to the learning process regarding infectious and parasitic diseases. Besides, this study shows that it is necessary that teachers pay attention to the contents of the textbooks used in their educational practices.

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