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RESEARCH

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Can family structure and contact with natural resources influence young people's knowledge about medicinal plants? An approach in the Northeast of Brazil

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Abstract

Background Individuals develop crucial survival knowledge in the juvenile phase, including understanding medicinal plants. The family context or contact with resources can influence this dynamic knowledge. By investigating the influence of these factors on young people's understanding of medicinal plants, we aimed to enhance our understanding of the knowledge-building process.

Methods The study was conducted in three communities in the State of Alagoas, Brazil: Lagoa do Junco, Serrote do Amparo, and Brivaldo de Medeiros. Semi-structured interviews were conducted with young people aged between 11 and 19 to assess their knowledge of medicinal plants. We used a generalized linear mixed model (GLMM) with the number of therapeutic targets and known medicinal species (knowledge proxy) as response variables. As predictors, we included the number of individuals per family unit and the gender distribution within the famimunícpily (family context proxy), as well as dependence on the use (contact proxy). Location (city) was added as a fixed effect to the model. We investigated how knowledge of medicinal plants correlates with the practice of collecting these species.

Results We did not identify a relationship between the number of individuals per household, gender distribution within the family, and the frequency of medicinal plant use with knowledge about these species. However, we observed a positive, albeit weak, correlation between knowledge of medicinal species and the number of species collected.

Conclusion These results highlight the importance of investigating how young people acquire knowledge about medicinal plants, emphasizing the complex interactions between humans and nature, and providing a basis for future research.

Keywords Natural resources, Traditional knowledge, Youth, Caatinga

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Background

Most ethnobiological studies involve adults investigating how knowledge and use of medicinal species are structured in Indigenous people and local communities (IPLCs) [1–4]. In doing so, they neglect how and which variables modulate these relationships before adulthood [5–8]. Although studies have shown how different variables modulate the knowledge and use of medicinal species [9–14], little information is available on how and which variables influence knowledge acquisition in young people. This gap is particularly concerning when considering that this phase is essential for physical, sexual, cognitive, and sociocultural development, which is crucial for adult life [15–17].

Although the concept of youth and the preceding periods can vary according to sociocultural, economic, and political contexts [18–20], we consider youth between 11 and 19 years old [21]. During this phase, individuals experience a significant expansion in their mastery of increasingly complex knowledge and skills [22–24]. For example, in certain cultures—Baka, Rarámuri, Tzeltal—by age 12, young people have accumulated a significant amount of cultural knowledge [8, 25, 26]. Therefore, it is crucial to understand which factors modulate knowledge acquisition in young people.

Family size (number of members) and family composition (who they are) are important elements in the process of acquiring information about the biophysical world [22, 27, 28]. This learning often occurs through observation, imitation, and social training with family members, such as parents, siblings, cousins, uncles, and grandparents [22, 29–32]. In addition, teaching about medicinal plants is intrinsically linked to subsistence practices and basic survival [22, 33–35]. Therefore, it is reasonable to assume that, since large families have more learning sources, young people will learn more from them. However, evidence indicates that gender influences knowledge about medicinal species, varying in time and space [36]. This relationship is explained by the roles and characteristics socially attributed to each gender (men and women) [37, 37–43]. In this sense, it is expected that family units of both genders can provide greater learning for young people.

Another relevant aspect of knowledge acquisition is the contact that young people have with medicinal plants, whether through collecting or using these species. We understand contact as the direct interaction or closeness that young people have with natural resources. This includes activities such as touching, manipulating, observing, experimenting with and caring for these resources. In sociocultural contexts, where the population relies on medicinal species for prophylactic purposes, adults often share knowledge with young people during family interactions, instructing them on natural treatments [2, 23, 44, 45]. In some cultures, young people actively participate in community prophylactic care by collecting and using species [35, 46, 47]. The collection of species requires knowledge, including the ability to identify, cultivate, and process natural resources [35]. During these interactions, young people involved in these activities tend to acquire a comprehensive understanding of the dynamics of the use of local pharmacopeias [35, 48, 49].

Based on this scenario, we have the following central question: Does contact with medicinal plants and family context influence young people's knowledge about these resources? We hypothesize that (a) family structure with a greater number of individuals, as well as the presence of both genders (men and women) exhibit greater knowledge about medicinal plants; (b) the frequency of use of medicinal plants is positively related to knowledge; and (c) a positive correlation will exist between the practice of collecting of medicinal species and the knowledge. To this end, we conducted a survey in different communities in the semiarid region of Brazil, using as a proxy for knowledge of the richness of known species and the number of therapeutic targets.

Methods

Study area

We conducted this study in three communities in the state of Alagoas, Brazil (Fig. 1). Two of these are located in the municipality of Santana do Ipanema: Lagoa do Junco (9°22′22.2″ S, 37°13′45.3″ W) and Serrote do Amparo (9°25′21.28″ S, 37°12′34.11″ W). The third community is in the municipality of Palmeira dos Índios: Conjunto Residential Brivaldo Medeiros Setor II (9°26′27.24″ S, 36°38′28.22″ W). Santana do Ipanema covers an area of 436.160 km^2 and has an estimated population of 46,220 inhabitants. The municipality has a Human Development Index (HDI) of 0.591, considered medium (0.550–0.700) [50]. The HDI, which ranges from 0 to 1, reflects a country's level of development, with higher values indicating greater progress. It is calculated using three primary dimensions: longevity, education, and income. Lagoa do Junco and Serrote do Amparo are home to approximately 63 and 60 families, respectively. Both are in a peri-urban environment with commercial establishments and public spaces, such as public schools, churches, and municipal health centers, guarantee access to free health and educational services for the population. The region where the communities are located is classified as having hypoxerophilous vegetation, a specific type of Caatinga domain [51]. The area, characterized by species resilient to prolonged drought and adapted to high temperatures and water scarcity, is

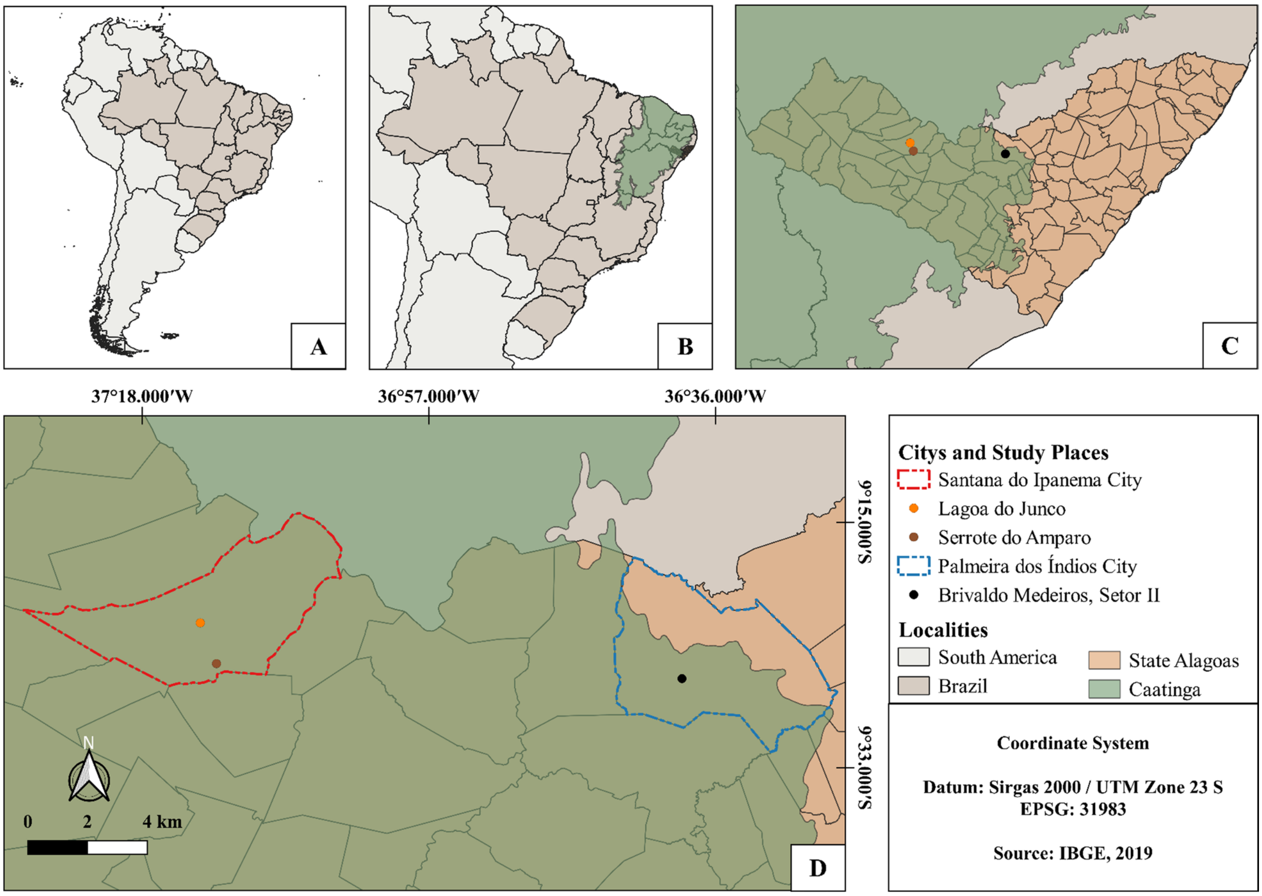

Fig. 1 Mapping of study sites. **A** Map of Latin America; **B** Map of Brazil; **C** Northeast Region of Brazil; **D** Locations of the communities: Lagoa do Junco, Serrote do Amparo (Municipality of Santana do Ipanema) and Brivaldo Medeiros Sector II (Municipality of Palmeira dos Índios), Alagoas, Brazil

undergoing a significant process of anthropization [51, 52]. This includes processes such as urban expansion, agricultural intensification, infrastructure development, deforestation, among others.

The Brivaldo Medeiros Sector II Residencial Complex (9°26′27.24″ S, 36°38′28.22″ W) is in Palmeira dos Índios, Alagoas. The municipality has an area of 450.990 km^2, an estimated population of 71,574 in habitants, and has a Human Development Index (HDI) of 0.638 [53]. The population of the Brivaldo de Medeiros Sector II Residential Complex is composed of 311 families, located in a region with the expected population growth due to the construction of affordable housing. The community is in a peri-urban environment with commercial establishments and public spaces. However, it lacks public schools or a health center, causing residents to travel to access these services. It presents predominant vegetation typical of the agreste, characterized by non-forested, deciduous, subxerophilous, and thorny formations [54]. This vegetation is associated with climates that are slightly more humid than those of Caatinga. In this type of landscape, tree and shrub species typical of Caatinga are common. The main causes of the alteration in the original vegetation cover of the municipality include urban expansion and animal farming practices in the region [54].

Participant characterization

Based on the population census of communities (comm. pers. health unit in. 2022), we reached a total of 282 young people (65 in Lagoa do Junco; 50 in Serrote do Amparo; 167 in Brivaldo de Medeiros Sector II), aged between 11 and 19 years (inclusion criterion in the study), present in the communities. We used a probabilistic sampling method to determine the sample size, ensuring that the sample accurately represents the population and allowing valid inferences to be drawn from the sample to the population. The sample size was calculated using the equation below: n_0 represents the initial sample size estimate; E_0 is the sampling error

(5%) at a 95% confidence level where n is the number of sample elements and N is the total population size [55].

$$n_0 = \frac{1}{E_0^2}$$

$$n = \frac{N \cdot n_0}{N + n_0}$$

During the interviews, we faced three main challenges: (a) respondents who refused to participate, (b) guardians who did not allow participation, and (c) the absence of participants in the community. In response, we adjusted the sampling error (E_0) in the sample size calculation from 5 to 7% in the Lagoa do Junco and Serrote do Amparo communities, and in Brivaldo de Medeiros Sector II, we adjusted it from 5 to 8.5%. The adjustments were necessary to maintain the representativeness of the sample. As a result, the total sample included 161 youths, 48 in Lagoa do Junco, 39 in Serrote do Amparo, and 74 in Brivaldo de Medeiros Sector II.

Ethical and legal aspects

The study was submitted to and approved by the Research Ethics Committee (CEP) of the Federal Rural University of Pernambuco (UFRPE) through Plataforma Brasil of the National Research Ethics Commission (CONEP) under CAAE registration number 64712522.3.0000.9547. In addition, the necessary procedures were followed by the Biodiversity Authorization and Information System (SISBIO) to obtain the required licenses to conduct this research (no. 85352-1). All individuals over 18 who agreed to participate and parents and guardians who consented to the participation of their children, grandchildren, and nephews, among others, signed the Free and Informed Consent Form (FICF). Following Resolution No. 466 of 2012 of the National Health Council, this document authorizes the collection, use, and publication of information obtained during the interviews.

Data collection

As part of the initial process, a three-month rapport was conducted with the communities, with periodic visits and home visits, and with a resident as a companion. During this stage, we present the research's justifications, objectives, and contributions to the community. We collected data between November 2023 and March 2024 through semi-structured interviews [55] with three distinct stages. The first stage included socioeconomic information: age, income, gender of the people living in the residence, and the number of people living there. Socioeconomic information that young people did not know, parents, or guardians could answer. This stage is essential for obtaining a detailed understanding of young people's family composition. We used the free-listing technique in the second stage to identify known medicinal plants [55]. The question that guided the free list was "*What medicinal plants do you know?*". Although the free listing provided us with an initial base of known species, as we asked the interviewees to answer more specific questions about these species, such as "*What do you use this plant for?*", they often mentioned new species, which were then included in the list. Later, using the list of plants, we approached each ethnospecies with the question: "*Who collects this plant?*". These questions aimed to understand the variation in knowledge about the plants mentioned by the informants and whether interaction with medicinal plants influences this knowledge.

The third stage consisted of determining the informants' degree of dependence on medicinal plants. We consider the frequency of plant use as a proxy for dependence. This is because the more frequently someone uses medicinal plants, the greater the likelihood that they rely on them for the treatment or prevention of diseases. For this purpose, we used a Likert scale model. This model was used to verify the frequency of use of medicinal plants and was conducted as follows. Initially, the participants were asked about the frequency with which they used each plant mentioned. For each plant mentioned, participants were asked: "*How often do you use this plant?*" They were instructed to assign a score from 0 to 5 based on their perception, using the following scale: (0) never used, (1) rarely used, (2) occasionally used, (3) normally used, (4) frequently used, and (5) very frequently used. In cases where the participants demonstrated difficulty in understanding the scale, practical examples were provided for clarification: "*If you consume a specific plant that is used to make tea in your daily life, how would you classify its consumption? A lot or a little?*" The participants were encouraged to score their consumption habits based on these guidelines. All steps were performed simultaneously to reduce possible biases resulting from multiple interviews. Finally, we organized the data as follows:

1. *Number of known species:* Sum of all species cited by the interviewees.
2. *Number of therapeutic targets:* Sum of all therapeutic targets cited by the interviewees. We understand a "therapeutic target" as any disease or symptom that affects the physical or spiritual health of individuals within a local medical system, as people often men-

tion symptoms rather than the disease being treated; for example, a runny nose.

3. *Distribution of family gender:* We coded the diversity of genders present in households into three types of family units: (a) all-female, (b) all-male, and (c) mixed (composed of men and women).
4. *Number of individuals per household:* Sum of all residents in the household, excluding the interviewees.
5. *Frequency of use of medicinal plants:* Average frequency of use of all medicinal plants mentioned by the interviewees.
6. *Number of species collected:* Sum of all species collected by the interviewee.

Botanical material

We adopted a guided tour approach for the collection of medicinal plants [56]. After the semi-structured interviews, each participant, or a representative—if they were unable to identify the species mentioned—presented the medicinal plants they had at home or in nearby locations where collection was possible. The specimens were archived at the Instituto de Pesquisa Agronômica de Pernambuco (IPA) in Recife, Pernambuco, and at the Instituto do Meio Ambiente (IMA) herbarium in Maceió, Alagoas, Brazil.

Data analysis

To test our hypotheses, we first observed the correlation between two response variables: the number of known species and the number of therapeutic targets. We used the Rbase *cor.test* function, where we observed a positive and significant correlation ($t = 25.84$; $df = 159$; cor $= 0.89$; $p < 0.05$) between the variables. Therefore, we chose to build only a single Generalized Linear Mixed Model (GLMM) using the response variable number of therapeutic targets to answer our hypotheses. To test the correlation between the number of species collected and our response variables—number of known species and therapeutic targets, which serve as proxies for knowledge—we used the Rbase *cor.test* function [57].

To construct the model, we used the following predictor variables: (a) the number of people per household, (b) frequency of use of medicinal plants, and (c) Distribution of family gender. We used the model's Poisson family (for count data) and location (city) as fixed effects. During the construction of all the models, we used the VIF function of the car package to check for collinearity between the explanatory variables (VIF < 1.25). We also used the *plot_grid* and *plot_model* functions, type = "*diag*" of the sjPlot package [58], and the simulateResiduals function of the MASS package [59] to test the assumptions of the models [60]. To choose the most appropriate model for our data, we used the stepAIC and direction "*both*" functions from the MASS package [59], which uses algorithms to choose the best subset of predictor variables to model the response variable, using the Akaike information criterion (AIC), with ΔAIC > 4.

Results

Descriptive results

In this study, we interviewed 161 participants, distributed among 75 men and 86 women, aged between 11 and 19 years (mean, and standard deviation: 14.09 ± 2.45). The most representative ages in our sample were 11 years (35; 21.73%) and 14 years (24; 14.91%). In contrast, 19 (4, 2.48%) years was the least representative. The number of medicinal plants cited (response variable: number of known species) by the interviewees, ranged from 1 to 14 (4.49 ± 2.77) per interviewee. The number of therapeutic targets (response variable) varied from 1 to 10 (3.54 ± 1.86). The frequency of use for these species ranged from 0.5 to 5 (2.6 ± 0.94). Regarding the gender distribution in the residence, we observed that 48 informants (29.81%) lived in places with an all-female composition, whereas 113 individuals (70.19%) lived in places with a mixed composition. We did not find any residences with an all-male composition. In Brazil, it is culturally predominant for young people to be raised by at least one female figure, such as mothers, grandmothers, aunts or sisters. Family structures composed all-male are uncommon. Regarding the number of people living with the informants, we observed a variation between 1 and 8 (3.49 ± 1.49) people per residence. The number of species collected by the participants ranged from 0 to 13 species (1.07 ± 1.93).

Species and therapeutic targets

We identified 66 medicinal plants, with the Lamiaceae family being the most predominant for more detail in Supplementary Material 1. Among the species, the one that stood out the most was *Cymbopogon citratus* (DC.) Stapf, known as lemongrass, has 132 mentions, followed by *Lippia alba* (Mill.) N.E.Br. ex Britton & P. Wilson, lemon balm, with 119 mentions, mint, *Plectranthus amboinicus* (Lour.) Spreng, with 93 mentions; *Amaranthus spinosus* L. and Mastruz, with 86 mentions. Some species were mentioned less frequently, with a total of 15, including lettuce (*Lactuca sativa* L.), garlic (*Allium sativum* L.), vick (*Mentha spicata* L.), among others, and each one with only one mention.

We identified 53 therapeutic targets, with emphasis on the most frequently cited conditions: stomachache (158 citations), flu (111 citations), and soothing (86 citations). Among the least-mentioned conditions, 17 therapeutic targets were associated with a single citation. These

Table 1 Values resulting from the generalized linear models based on the predictor variables

Variables	Estimate	Std. error	z.value	Pr (>|z|)
Number of individuals per family unit	−0.022	0.038	−0.585	0.559
Frequency of use of medicinal plants	0.028	0.047	0.610	0.542
Family gender distribution	0.030	0.114	0.263	0.793
R^2 adjust = 0.183				AIC 619.2

include anesthetics, swollen belly, fatigue, and spinal pain, for more detailed in Supplementary Material 1.

Analytical results

Contrary to our expectations, the number of individuals per family nucleus, distribution of family gender, and frequency of use of medicinal plants the did not prove to be determining factors for young people's knowledge of medicinal plants (Table 1). However, we observed a significant but weak correlation between the number of known species and the number of species collected ($t = 4.25$; $df = 159$; $r = 0.32$; $p < 0.05$). A similar relationship was observed between the number of therapeutic targets and the number of species collected ($t = 2.93$; $df = 159$; $r = 0.23$; $p < 0.05$).

Discussion

Our study demonstrated that young people's knowledge of medicinal plants remained unaffected by family context or frequency of use. In other words, regardless of the number of people or the distribution of genders in the household, young people's knowledge—measured by the number of known species and their therapeutic uses—did not vary in their understanding of medicinal plants. These results suggest development of medicinal plant expertise among youth is not directly related to the family nucleus, as initially hypothesized—that is, the number of people in the household does not necessarily increase familiarity with these plants. We observed a positive correlation between the number of species collected and knowledge of medicinal plants, indicating that young people who actively participate in collection tend to retain more knowledge about these plants. Collecting medicinal plants is common among youth in the communities in our study, mainly due to the presence of these plants in their home gardens. This easy access not only facilitates collection but also contributes to their knowledge.

Contrary to our expectations, the number of family members did not influence the knowledge of medicinal species among young people. Our results suggest that the species in young people's pharmacopeias do not merely reflect the pharmacopeias of other members living in the same environment. In other words, young people's knowledge about medicinal plants appears to be formed independently rather than simply reflecting what adults or other family members know about medicinal plants. For us, there are two groups of parsimonious interpretations of this scenario: (a) *transmission of knowledge*, which indicates that regardless of family structure or "proximity" between members, an individual's knowledge will not necessarily be shared [61]. The acquisition of knowledge from other sources, such as neighbors, friends, the internet, school, and social media, among others, can inflate the knowledge of individuals with few members, leading to similar knowledge—number of known species and number of therapeutic targets. Indeed, young individuals can employ knowledge transmission pathways sequentially or simultaneously, known as a "multistage learning process" [62, 63]. This phenomenon highlights the ability of young individuals to update their cultural knowledge using a flexible and multifaceted approach. (b) *lack of interest in learning*, in this scenario the young person may not be interested in learning about medicinal plants, either because the plants/therapeutic uses do not apply to their daily lives [64, 65], or because they prefer the use of biomedicines [66, 67].

Regarding the frequency of use, we found no relationship between the number of species or therapeutic targets. This result may indicate that young people maintain a greater range of knowledge about plants and therapeutic targets than they need—a few disease events. The plants mentioned by young people may represent a basic set of accessible and easy-to-apply knowledge, without requiring specific practices. This basic kit is known as the structural core—popular and frequently used plants with adaptive characteristics essential to the structure and function of medical systems [68]. These plants stand out for their efficacy, availability, and frequency of use, offering better chances of healing. Consequently, they are widely recognized and valued, which justifies their presence in the pharmacopeias of the young people.

On the other hand, although young people know many plants and treatments, they choose to hybridize them to their treatment. We understand hybridization as a process involving the interaction between different medical systems (local and biomedical systems), without excluding either [69, 70]. To our knowledge, no studies have been conducted on hybridization in young individuals. However, hybridization is commonly related to the proximity of urbanized environments: an increase in health units and access to biomedicines——pharmaceuticals, vaccines, and other treatments developed by Western or cosmopolitan medicine [71]——via public policies [72–74]. These factors can explain the therapeutic choices of young people, demonstrating that this knowledge can be integrated and adapted through hybridization.

Regarding different family compositions (men and women, all-female, and all-male), we did not find that young people knew different amounts of medicinal plants or known therapeutic targets. Our results show that the presence of male individuals in households does not reflect an increase in young people's knowledge. This suggests that knowledge is a resource that can be acquired through personal experience and not necessarily transmitted intergenerationally [22]. Among the various assumptions that led to this result, the most parsimonious was the social role within the family where our study was conducted. In Brazil and regions where parental care is almost exclusively female [75–77], the incorporation of medicinal knowledge from male individuals would be minimal and not noticeable compared to all-female family compositions. In this sense, the difference in knowledge (i.e., composition) about medicinal plants and their uses between genders (men and women) [78] can directly influence the knowledge that young people acquire about these species in their specific contexts. Since our sample did not have family compositions with an all-male, we cannot state that knowledge does not differ in family compositions with all-male individuals.

In contrast, our results showed that the practice of collecting medicinal species by young people is correlated with their knowledge of the species or therapeutic targets. Collecting species allows young people to learn a wider range of species because they need to distinguish plants of interest from those with similar morphological and organoleptic characteristics. In cultures such as the Baka in southeastern Cameroon, adults ask young people to participate in the collection of medicinal plants, involving themselves both passively and actively in the care of their family members [8]. This scenario is similar to that observed in the communities studied, in which adults also actively encouraged the collection of plants, often sharing information about their uses. In addition, the proximity of plants, usually exotic, grown in backyards, or near homes [44, 79], encouraged parents to use this strategy. In this way, young people, motivated by curiosity or necessity, collected plants, a growing sense of autonomy and interest in learning. Studies indicate that young people tend to incorporate into their knowledge medicinal plants that are more accessible and common in their immediate surroundings [64, 80].

Although our findings do not show increased knowledge of medicinal species or therapeutic targets, this does not necessarily indicate a decline in traditional knowledge. This is because in this age group, individuals do not normally assume responsibility for both their care and for the care of others [77–81], and over time, they tend to assume responsibility [34, 81–84]. This knowledge may present stages of learning: young people at a given moment acquire knowledge from their immediate environment and, later, from more specialized models according to the specific domain of knowledge [22, 35, 63, 85–87]. Therefore, ethnobotanical knowledge may be acquired incrementally and contextually, maturing as individuals age and face new needs and responsibilities, reflecting the continuous and adaptive integration of traditional practices into their lives.

Conclusion

Our study revealed that, regardless of the environmental context (number of individuals and gender distribution) and the dependence on resources, young people share a similar set of knowledge. This suggests that even under different conditions, these individuals maintain a core of essential species in their pharmacopeia. Furthermore, the correlation between the habit of collecting species and knowledge indicates that practical experience and daily exposure to medicinal plants are crucial for the development of this knowledge. These findings have important implications for understanding the factors that modulate young people's knowledge of medicinal plants.

Abbreviations

IPLCs	Indigenous Peoples and Local Communities
HDI	Human Development Index
CEP	Research Ethics Committee
UFRPE	Federal Rural University of Pernambuco
CONEP	National Research Ethics Commission
CAAE	Ethical Review Presentation Certificate
SISBIO	Biodiversity Authorization and Information System
FICF	Free and informed consent form
GLMM	Generalized linear mixed model

Supplementary Information

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Supplementary material 1

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Author contributions

PTM contributed to conceptualization, data curation, formal analysis, writing—original draft, writing—review, and editing. ASC contributed to data curation, formal analysis, writing—review, and editing. UPA contributed to writing—conceptualization, review and editing. RHS contributed to writing—conceptualization, review and editing. TCS contributed to conceptualization, data curation, writing—original draft, writing—review, and editing. All authors gave their final approval for publication and agreed to be held accountable for the work performed therein.

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Availability of data and materials

No datasets were generated or analyzed during the current study.

Declarations

Ethics approval and consent to participate

As mentioned in the Methods section, we conducted the research following the guidelines of the Code of Ethics of the International Society for Ethnobiology (ISE, 2008). Ethical clearance was obtained from the Research Ethics Committee of Federal Rural University of Pernambuco, Brazil. We obtained verbal and written consent from the participants before conducting interviews.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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