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TRANSMISSION OF HERBAL KNOWLEDGE AND ITS BENEFITS IN THE MAZAHUA OTOMÍ COMMUNITY, STATE OF MEXICO

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ABSTRACT

In Mexico, the use of Medicinal Plants (MP) as natural remedies is an ancestral practice. However, there is little information linking the empirical and phenomenological knowledge related to the use and usefulness of them. The aim here was to analyze the transmission of knowledge (TK) in terms of herbal medicine from parents to children in the Mazahua Otomi community, and to determine economic benefit to the family. The research on knowledge, uses and benefits of MP was carried out through observation and by applying a structured survey to Mazahua Otomí students of health sciences, their parents or guardians and people from their communities. 84% of students identify with ethnicity. There is a TK of MP of 10% from parents or guardians to children and 32% believe that there is an economic saving related to MP use of between 10% and 50%. TK occurs mostly for lesser-known plants of local distribution. The student maintains and promotes the traditional use of MP and there is a relationship between their uses and their ethnicity and economic savings in terms of medical expenses. This can contribute to alleviating poverty in an effective, fair and sustainable way.

Keywords: home economics, multinomial logistic model, medicinal plants, nursing students.

INTRODUCTION

Due to its biocultural diversity, the Valley of Mexico and the west of the State of Mexico constitute a region meriting particular attention (Garro, 1986). In response to this need among others, in 2003 the Intercultural University of the State of Mexico (IUEM) was founded, representing the first intercultural university in the country. Here, intercultural values form a model for coexistence, where people, groups and institutions, with diverse cultural characteristics can coexist and relate openly in a shared context (Secretaria de Salud-SA, 2014). In 2013 in this ambit, the Nursing Health Sciences career was professionalized. From then on, this institution began promoting the training of professionals committed to economic, social and cultural development, particularly involving local native peoples (National Commission for the Development of Indigenous Peoples-CDI, 2015; Peña, 2017).

Nurses and health science professionals with intercultural training in general, play a relevant role in preserving and transmitting knowledge, concerning the use and conservation of Medicinal Plants (MP). To do this requires specific tools and expertise

about ethnomedicine. The use of MP, as relates to an ethnic group with herbal tradition, and economic savings for medical expenses are factors that contribute to the family economy in an effective, fair and sustainable manner. In like manner, ancestral knowledge of wild medicinal plants and a professional approach concerning their use, leads to public policies that result in the rational use and conservation of biodiversity (Guzmán-Mendoza *et a*l., 2011; Sánchez-Alejo *et al*., 2016).

Mexico is the nation with the most indigenous people in Latin America with 68 ethno-linguistic groups; in 1992 it was recognized as a multicultural country (CDI, 2015). During that era, the recognition and justification of the empirical practice of nursing began. Each accomplishment sought to identify the theoretical foundations that justify the actions of the intercultural nurse (World Health Organization -WHO, 2011). The country has great abundance and an ancestral tradition founded on the use of MP, which is a deeply rooted custom in rural and indigenous communities. Correspondingly, most people who reside in rural communities prefer to use MP as home remedies for primary health care, rather than allopathic medicine. However, there is little information on the link between empirical and phenomenological knowledge concerning the use of plants, despite the fact that an extensive herbal tradition exists (WHO, 2011).

MP are part of the history and culture of indigenous peoples; their use and application as a remedy for diseases constitutes knowledge that is transmitted from generation to generation (Hernández *et al*., 2003; Figueroa, 2019). In America, the officially recognized medicine to treat different diseases is allopathic and is based on the immoderate or uncontrolled consumption of drugs produced using technology from developed countries (WHO, 2011). However, in the past, some MP treatments may have constituted official treatment, for example shamanism in Peru, native curers in Brazil and Paraguay, acupuncture in China, or plant-based medicine in Mexico (Heinrich *et al*., 1998).

In developing countries, more than 3.5 billion people use plants for medical and healthcare. Genetic resources and various biological parts of plants are the basis for improving agriculture and medicinal products (Oliveira *et al*., 2005). The WHO (2011) considers that more than 80% of the world population habitually uses MP for the care of health problems that do not require surgery. Most traditional medicine employs plant extracts or their active ingredients and it is estimated that nearly 3,000 plant species are used for therapeutic purposes worldwide (Mazari *et al*., 1999; WHO, 2011). In Mexico, 3,000 species of plants have medicinal attributes, out of the 4,000 that are estimated to exist, representing 15% of overall Mexican flora. Likewise, it is estimated that 80% of the Mexican population makes use of them; however, 85% are extracted from the wild without any management program (National Commission for the Knowledge and Use of Biodiversity -CONABIO, 2020). The availability of the resource, cultural diversity and the lack of access to allopathic medicine help strengthen herbal knowledge within benefactor communities (Tabuti *et al*., 2003; Sánchez-Alejo *et al*., 2016).

In this social context, the nursing student and professional with intercultural training, who is competent, and has skills and qualifications to act in an original way, can use their sense of belonging and social networks for the mutual benefit of their community. This promotes a fundamental element in the synergistic connection of human capital to social capital (Núñez-Ramírez *et al.*, 2015). An intercultural perspective enables the student to enter into a permanent process that involves learning different knowledge and different traditions, with respect for cultural diversity and the rights of native peoples (Dietz and Mateos, 2010; Romero, 2011). This approach that the health science professional acquires, as well as the economic advantage provided by natural resources represent a frame of reference to understand and locate this in the right context, in terms of the role it plays in the rescue, dissemination and additional income provided by the use of traditional Mexican herbalism (Almaguer *et al.*, 2013; Rodríguez-Zúñiga *et al.*, 2019).

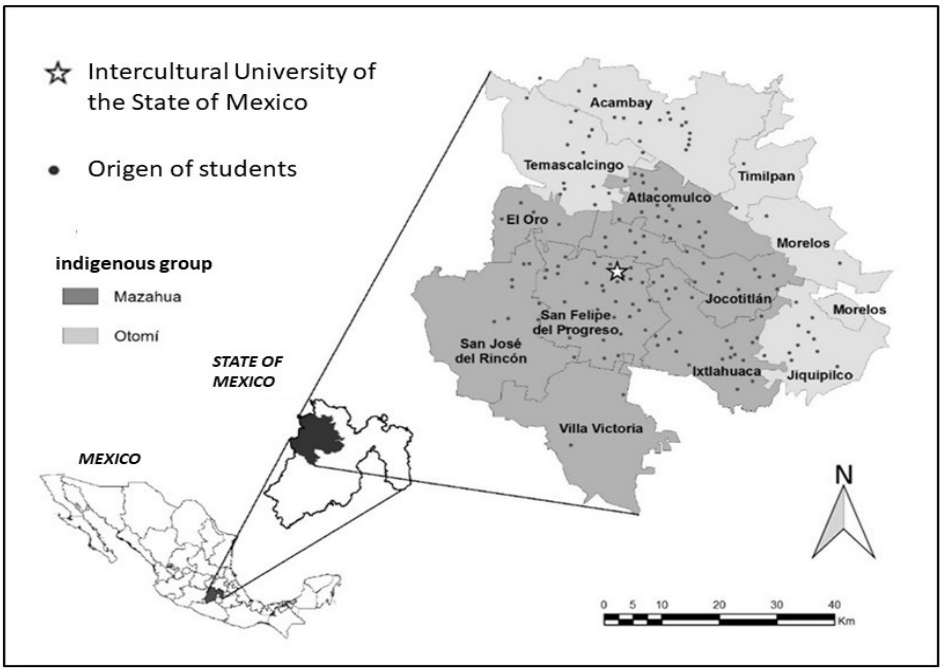
To achieve this, information on the plants used in marginalized regions is required, especially concerning the species' relative importance in the study context. Some investigations (Jusu and Cuni, 2013; Towns *et al.*, 2014) suggest that the rational use of MP in marginal rural areas acts as a conservation strategy; safeguarding knowledge, while significantly contributing to family household savings. However, factors such as underestimation of its value, over-exploitation and advance of the agricultural frontier erode ancestral knowledge and result in damage to the wild flora gene pool (Sánchez-Alejo *et al.*, 2016; Rodríguez-Zúñiga *et al.*, 2019). From the point of view of applied ethnobotany, this information will be highly relevant, as it significantly contributes to the definition of strategies and operations to rescue the tradition of good use of MP, and its use and rational management. Likewise, it will help to reassess the role of health science students, who take an intercultural approach on their route to become professionals in native communities, by promoting the traditional use of herbal medicine.

In this context, the aim of this research was to analyze the transmission of herbal knowledge from parents to children in the Mazahua and Otomí (MO) community and the benefits to the family economy related to the use of Medicinal Plants (MP). This is based on the hypothesis that knowledge of MP is a function of ethnicity and generational age. Besides this, important improvements to the family economy result from the use of MP.

METHODOLOGY

Study area

The study was carried out in the municipalities of origin of the students and parents (or guardians) of those taking the Nursing Degree with intercultural training provided by the Intercultural University of the State of Mexico (UIEM) (Figure 1). The largest population of IDEM Mazahua and Otomí ethnic group in the State of Mexico is concentrated here (National Institute of Statistics and Geography -INEGI, 2020). Among the fundamental principles of the study plan that make up the curricular structure, the following stand out: (1) community bonding and (2) sociocultural outlook (provides elements that help



Source: self elaborated based on data obtained from INEGI (2010, 2016 and 2019) and using QGIS (2021) Desktop 3.10.8.
Figure 1. Origin of students within the study area of the State of Mexico.

establish comprehensive care, while preserving elements of cultural identity that contribute to the well-being of the community) (UIEM, 2022). The research approach was exploratory, following a case study. The research techniques used were: observation, structured survey and interviews. Observation revealed the customs, uses and promotion that help preserve use of MP on the part of those in the Mazahua Otomí community. The structured survey and interviews made it possible to obtain quantitative and qualitative data on social, economic and environmental aspects of MP. Field work was carried out during the months of February and May 2021.

Design, construction and application of the survey

a) A structured survey was designed, built and applied to Nursing Degree students, taking an intercultural approach, to their parents (father, mother or guardian) and people from various municipalities in the study. Quantitative information (e.g. income, average age and impact on the domestic economy, resulting from the traditional use of MP) and qualitative information (e.g. common names of known MP, diseases treated by plants, etc.) were collected). The respondents, based on their knowledge of traditional herbalism, were given a choice from a list of 52 MP with common names used in the area and reported by Mazari *et al.* (1999), Guzmán-Mendoza *et al.* (2011) and García and Guzmán (2016), together with those that were known and used.

A total of 277 students with an average age of 20.6 years were surveyed, representing 166% more than the sample size (n= 60), according to equation (1) of maximum variance (Infante and Zárate, 2012) and based on the number of students enrolled in the Nursing Degree reported by the University, as 563 students.

$$n = \frac{NZ^2 pq}{Nd^2 + Z^2 pq} \quad (1)$$

where n: sample size; N: population size (N=563); $Z^2_{\alpha/2}$: value of Z distribution tables Z ($Z^2_{\alpha/2}$=2.6896); p: proportion of the population with a binomial characteristic, q = 1- p (pq = 0.25); d^2: desired maximum absolute error (fixed as a fraction of p) (10%) (d^2 = 0.01).

(b) The information obtained from the parents or guardians of the students was validated by fieldwork in the main communities studied, by randomly applying questionnaires to 80 people, aged between 40 and 60 years, the same age range of the parents or guardians and the students of the Mazahua and Otomi ethnic groups. For this, the 40 plants most commonly recognized by the students' parents or not known by other name(s) were selected.

We carried out a quantitative analysis using the data and information collected in the survey to define the dependency relationship between a dependent variable and a set of independent variables. For this, a multinomial logistic regression model was constructed (Infante and Zárate, 2012; López-Roldán and Fachelli, 2015). The model comprises a multivariate technique that estimates the probability of a multinomial event defined by the dependent variable ($\hat{Y}_i$) based on a set of discrete or continuous predictor or prognostic variables (X_i) (Eq. 2). The model was validated using the maximum likelihood ratio and *Cox and Snell's* R square. Finally, the Pearson correlation matrix was obtained, which shows the degree of correlation between the independent variables used (De la Fuente, 2011).

$$\hat{Y}_i = \Pr(Y = 1 / X) = \frac{1}{1 + e^{-\left(\hat{\beta}_0 + \hat{\beta}_i X_i + \ldots + \hat{\beta}_n X_n\right)}} \quad (2)$$

where $\hat{Y}_i$: The probability that a parent or guardian transfers knowledge about medicinal plants to their children (i= 1 (11-20 *PM*), 2 (21-30 *PM*), 3 (31-40 *PM*), 4(41-50)); e: Base of the natural logarithm; $\hat{\beta}_0, \hat{\beta}_i$: Intercept and estimators of independent variables (X_i); X_i: independent variables (X_1= age; X_2= average monthly income; X_3= sex; X_4= highest level of study; X_5= ethnicity; and X_6 = economic savings from the use of MP).

RESULTS AND DISCUSSION

The students and family members interviewed belong to the municipalities of San Felipe del Progreso (30%), Atlacomulco (20%), Ixtlahuaca (16%), Jocotitlán (14%) and other municipalities (20%). Ethnically, they identified themselves mainly as Mazahua (75%) and Otomi (9%); while 16% considered that they do not belong to any group (Figure 1). Their origin and belonging to the various ethnic groups on the part of students and their parents or guardians coincides with information from INEGI (2020), which reports that the municipalities of the State of Mexico (Figure 1) represent the largest Mazahua population, and the Otomi represent the second ethnic group, located to the west of the State. 84% of the study population identified themselves as native people, which enriched the analysis of the herbal knowledge of the student -and their families- because of strong ethnic roots and their role as health science professionals with intercultural orientation. For the purpose of analyzing results, people who identified with either ethnic group (Mazahua or Otomi) were taken as a single group.

Table 1 presents percentages for the knowledge of the people surveyed from the Mazahua or Otomi communities (adults from 40 to 60 years old) vs. parents or guardians of the students. The Z distribution statistical test shows that there are no significant differences (p value< 0.05) for either of the samples, validated by the reliability and homogeneity of the data.

Table 2 presents the matrix for the coefficients. In the model, age and income stand out

Table 1. Number of plants known (%) by the parents or guardians of the student (s) vs people surveyed from the Mazahua and Otomi ethnic groups (both ethnic groups as one).

No.	Common name for the plant (deseases)	P (%)	MOP (%)	No.	Common name for the plant (deseases)	P (%)	MOP (%)
1	Alarcón (AI: joint pain)	6	28	21	Gordolobo (RD: cough and bronchitis)	83	95
2	Sage (GD: stomach pain and diarrhea)	9	41	22	Burraja (OD: diuretic, sudorific, purifying and anti-inflammatory diseases)	86	51
3	Sage (WD: to facilitate childbirth)	14	44	23	Epazote bueno (GD: stomach ache)	86	78
4	Cagual (GD; AN; AI)	25	25	24	Rosa de castilla (GD: diarrhea)	86	85
5	Semonillo (GD: diarrhea)	30	30	25	Hoja de capulín (RD: pneumonia)	89	88
6	Moraditos (GD: diarrhea; OD: anti-inflammatory)	31	25	26	Ruda (RD: tonsils; GD: stomach ache)	89	97
7	Hierba blanca (AN; OD: liver pain; RD: cold)	43	39	27	Eucaliptus (RD: cold)	90	101
8	Chacalota (AI: joint pain)	46	36	28	Epazote de perro (GD: diarrhea)	91	88
9	Purple nopal (RD: cold)	48	52	29	Tejocote leaf (WD: postpartum)	91	92

Table 1. Continuation.

No.	Common name for the plant (deseases)	P (%)	MOP (%)	No.	Common name for the plant (deseases)	P (%)	MOP (%)
10	Altamisa (GD: baby colic)	48	82	30	Romero (GD: stomach ache)	91	94
11	Poleo (RD: Bronchial infection)	49	61	31	Sábila (GD: gastritis; AI: dislocations)	91	100
12	Hierba de burro (OD: digestive and sedative)	50	66	32	Barba de maíz negro (OD: antilytic and diuretic)	93	74
13	Trementina (AN: Joint pain)	55	40	33	Peach leaf (WD: pospartum)	93	91
14	Hierba amargosa (GD: Stomach ache	55	80	34	Bugambilia (RD: cough and bronquitis)	93	95
15	Too (WD: Childbirth and puerperium)	66	43	35	Ajenjo (GD: diarrhea)	94	78
16	Hierba de cáncer (WD: Postpartum)	69	61	36	Nopal (OD: diabetes)	94	97
17	Lengua de vaca (AN; GD: diarrhea)	71	81	37	Árnica (GD: gastritis; WBaB)	94	97
18	Marrubio (ER: expectorant)	74	77	38	Hierba buena (GD: baby colic)	95	96
19	Estafiate (GD: diarrhea)	75	80	39	Epazote (RD: cold)	96	97
20	Siempre viva (OD: dysentery and kidney)	80	76	40	Manzanilla (GD: baby colic)	99	99

Note P: parents or guardian of the student; MOP: Mazahua and Otomi person interviewed. WD: women's diseases; RD: respiratory diseases; GD: gastrointestinal diseases; WBaB: wounds, blows and burns; OD: other diseases; AN: analgesics; AI: anti-inflammatory
Source: Garza (2006); Guzman-Mendoza *et al*. (2011); Garcia and Guzman (2016).

as the most significant variables ($p< 0.05$) for the known plant types. As age increases, it is likely that more MPs will be known. Consequently, when people have greater knowledge of MP, there is greater use of these and savings to the family economy.

Table 2. Matrix of coefficients for the significant independent variables (p<0.05).

Categories: known plants	β	Significance (< 0.05)	Exp β	Variable
10-20	-0.93	0.008	0.912	Age of the parent or guardian (on averageranging from 40 to 60 years)
21-30	0.062	0.004	0.901	Age of the parent or guardian
31-40	0.002	0.006	1.000	Income
A	1.852	0.005	0.157	Saving of 10%
B	-1.37	0.025	0.253	Saving 10-20%
C	-1.536	0.013	0.215	Saving 20-50%

Source: self elaborated. IBM SPSS Statistics software package (V. 25.0, 64-bit Edition) based on a pre-created database in Microsoft Excel 2021.

In Figure 2, paragraphs are as follows: (a) summarizes the nominal variables, highlighting that 81% of students' parents or guardians of those surveyed are women, 84% belong to an ethnic group, and 84.6% have an educational level of up to primary or secondary school level; (b) shows the variables that contribute most to the (p<0.05) model, for example the age of the parent or guardian and the average annual income; and (c) indicates the extent that this fits with the multinomial logistic model. The fit shows a lower maximum likelihood ratio compared to when only the (β_0) intercept is included. This is corroborated by the likelihood ratio, which indicates that there is a very significant difference (p≤0.001), when all the variables in the model are included, compared to when none are included. This means, the variables contribute to explaining the transmission of MP knowledge from parents to children. The Pseudo R^2 of Cox and Snell and Nagelkerke suggest that between 22%, for the first, and almost 25% for the second, of the variation in the dependent variable is explained by the independent variables included in the model. Although this value is not high, in social research, it is considered as acceptable (Gomben *et al.*, 2012; Cruz-Huerta *et al.*, 2015). Likewise, Pearson's goodness of fit indicates that there is no correlation between the independent variables, if values close to zero are manifested. The same happens in the case of the correlation between the degree of knowledge and independent variables; showing negative correlations between the latter and the variables: maximum level of studies, ethnic group to which they belong and average monthly income. Generally, the estimated multinomial logistic model presents a satisfactory goodness of fit.

A) Summary of nominal variable

Variable		n	marginal (%)
Number of known plants (Y_i)	1 (11-20)	15	5.9
	2 (21-30)	39	15.2
	3 (31-40)	110	43.0
	4 (41-50)	92	35.9
Sex (X_1)	1 (Male)	48	18.8
	2 (Female)	208	81.3
Maximum degree of studies (X_2)	1 (No formal education)	4	1.6
	2(Elementary education)	119	46.5
	3 (Middle school education)	95	37.1
	4 (High school education)	18	7.0
	5 (Bachelor´s education)	20	7.8
Ethnic group (X_3)	1 (Ethnicity)	215	84.0
	2 (No ethnicity)	41	16.0
Economic savings by use of MP (%) (X_4)	1 (>10)	55	21.4
	2 (10-20)	90	35.2
	3 (20-50)	85	33.2
	4 (<50)	26	10.2

B) Ratio test

Variable	χ^2	g.l.	p
Age of parent or tutor (X_5)	25.656	3	0.000
Average monthly income (X_6)	8.8893	3	0.031
Sex (X_1)	0.980	3	0.806
Maximum degree of studies (X_2)	12.826	12	0.382
Identifies with any ethnic group (X_3)	4.325	3	0.228
Economic savings by use of MP (X_4)	14.066	9	0.120

C) Model fit

Fit criteria		Likelihood Ratio		
Model	Log. de verosimilitud -2			
		χ2	g.l.	p
Only intersection	606.017	64.716	33	0.001
Final	541.301	goodness of adjustment		
Pseudo R squared		Pearson	708	0.104
Cox and Snell 0.223		755.641		
Nagelkerke 0.246		Desvianza	708	1.000
		541.301		

Source: self elaborated with data from the survey and outputs from the logistic regression model displayed on a database previously created in Microsoft Excel 2001.

Figure 2. Summary of statistical data and the Logistic model and operationalization of variables in the multinomial model.

The chosen variables (X_1, X_2, X_3, X_4, X_5 and X_6) explain ($p<0.05$) the MP dependent variable (Y_i). For example, the probability that a student recognizes between 30 and 40 MP can be estimated by applying Eq. 3, which establishes the estimated coefficients for each variable, the most significant being age, average monthly income, and sex.

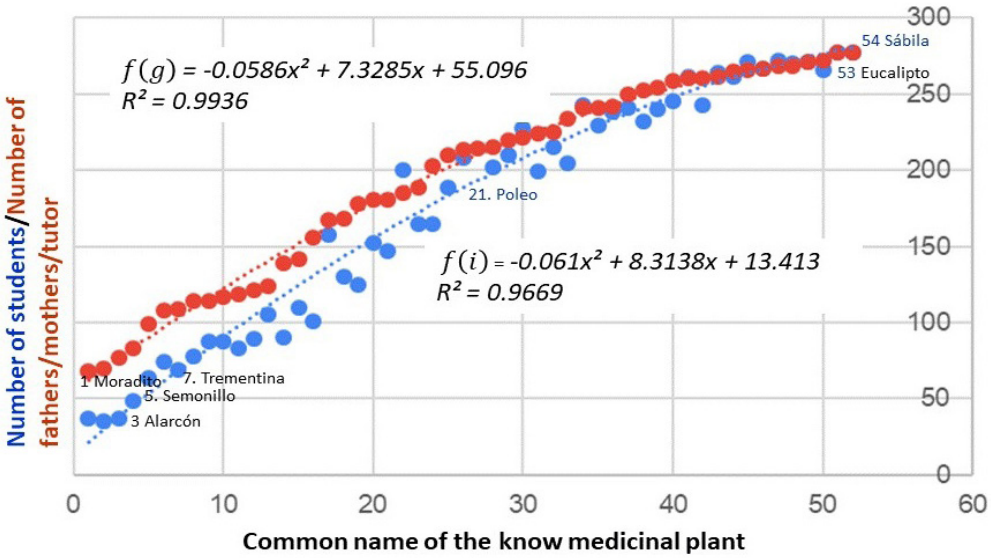
$$\Pr(1/(30-40PM)) = \frac{1}{1+e^{-(0.713+1.02X_1+1.01X_2+1.0004X_3+0.72X_4+0.01X_5+0.29X_6)}} \quad (3)$$

where X_1: age; X_2: average monthly income; X_3: sex; X_4: maximum level of study; X_5: ethnicity; X_6: economic savings.

There is a correlation (Figure 3) between MP that are recognized by the students (blue color) and by their parents (or guardians) (red color). In addition, there is a "transmission of herbal knowledge (THK) or surplus of knowledge" concerning plants on the part of parents of 9.6 % (area between the two curves) calculated graphically (Eq. 4). Likewise, there is a marked difference in terms of the number of plants recognized by the students and by their parents, especially those plants that are not very common or have only local distribution.

$$THK = \int_a^b \left(f(g) - f(i)\right) dx \quad (4)$$

where *THK*: surplus of herbal knowledge; $f(g)$: function of father/mother or guardian; $f(i)$: function of student.



Source: self elaborated based on the interpretation of data on an Excel 2001 spreadsheet.
Figure 3. Level of knowledge that students and parents (or guardians) have of common names for medicinal plants in the community.

Age is a variable related to the number of plants recognized, so that the younger the person, the less knowledge concerning MP type (Table 2). This can also be corroborated in Figure 3. For example, in order of importance (1: parent or guardian) (2: student), less common: (1)(2) moradito, (2)(1) cagual, (3)(3) alarcón, (4)(4) semonillo, (5)(5) chacalota, and (6)(7) hierba blanca; most common: (48)(48) rue, (49)(49) chamomile, (50)(52) cempazuchitl, (51)(53) eucalyptus and (52)(52) aloe vera. This is due to a generational learning process concerning MP that is deeply rooted in native communities and is documented in studies by Bello and Salgado (2007) and García and Guzmán (2016) for young Purépechas and Mazahuas, respectively. Thus, knowledge is acquired in a process replete with symbolisms and attributes that they attribute to the natural world, their language being the vehicle for transferring knowledge or, should it be the case, to its loss or detriment (Figueroa, 2019). For students and their parents or guardians, the lesser-known plants include those that are local and wild. Likewise, it is for this group of MP that parents have a "surplus of herbal knowledge (SHK)" This may be due to the fact that the study was carried out in communities with a large proportion of mestizos, who are integrated into the ethnic groups of the area (mainly Mazahuas and Otomi) in a region with a high degree of biodiversity in areas which are still forested, indicating that Cultural diversity goes hand in hand with biodiversity (Food and Agriculture Organization-National- Forestry -Commission-FAO-CONAFOR, 2011). The process of acquiring knowledge for the use of local wild flora occurs more slowly than plants for industrial herbal use, or which are cosmopolitan and are widely known by the general public (e.g. rue, chamomile, aloe vera etc).

The SHK is explained in the work by García and Guzmán (2016), who point out that in Mazahua communities, as in others with strong indigenous identity, there is a strong link in terms of a constant learning process inherited from parents by children, mainly concerning that which includes knowledge and customs. In this sense, age was one of the main factors affecting familiarity and transmission of generational knowledge (Figure 3 and Table 2). According to Castro (2015) and de Castillo (2019), who mention that among young Mazahua and Otomi, despite the cultural change that migration or lifestyle changes entail, there are mechanisms to protect identity and sense of belonging. This is why the erosion of MP knowledge is not significantly affected by new behaviors in medical care. We anticipate that the young person who enters the Intercultural University in the area of health science will further promote the therapeutic use of plants and professional application of traditional medicine.

The difference in the number of plants recognized in terms of students and their parents, and age as a variable related to the number of plants recognized, a finding which concurs with the work by Guzmán-Mendoza *et al*. (2011) and García and Guzmán (2016) carried out on indigenous students in the State of Mexico and Veracruz, referring to the fact that there is a difference between adults and young people, in terms of knowledge and application of wild MP and concerning local use.

Table 3 shows in matrix form that in the Mazahua and Otomi community, there is a strong heritable transition between generations compared to those who do not identify with any ethnic group. The results from an ANOVA test show that there is a significant difference ($p > 0.05$) between the groups surveyed (Mazahua and Otomi student, Mazahua and Otomi parent, student and parent from no ethnic group), in terms of the average number of MPs recognized.

In the Mazahua and Otomí community, there is a strong heritable generational transition, -compared to the group that does not identify with any ethnic group-, in herbal medicine, this falls on women (80% of interviewees were women). Both the students and their parents from the Mazahua and Otomi groups know more about plant varieties than those who do not belong to any ethnic group, with the greatest difference between the Mazahua Otomi parent vs. the student from no ethnic group (seven plants). Therefore, a student from an ethnic group has almost the same level of knowledge of plants as the parent of a child from no ethnic group (a difference of 0.02 plants, Table 2), despite the generational difference and the amount of knowledge normally acquired by of a more adult person.

According to Glittenberg (2004), the intercultural health science professional establishes symmetrical relationships between patient care models and models developed for professional nursing, and adheres to an interaction capable of producing cooperation and consensus. In a highly mixed and ethnic social context, during and after their training, the professional following this model must understand the message between individual-patient, not only in terms of its content, but as a symbolic expression of their culture. In the State of Mexico, the role of this professional and the herbal practice on the part of the community translates into procedures as important as: rescue, promotion and protection of this knowledge; use and conservation of medicinal flora; and above all a substantial role in terms of economic savings in marginalized areas, by promoting the correct use of this natural resource, during and after their professional training. This has been studied little or not at all in Mexico.

In their professional training and complying with the intercultural modality, the first conceptual element that the student absorbs is that of cultural diversity. This leads the

Table 3. Matrix that compares the differences in averages for MPs recognized by the student and his/her father/mother/guardian

		Father/mother or guardian	
		No ethnic group	Mazahua and Otomí
Student	No ethnic group $\bar{x}$ =30	$\bar{x}$ =34.89 Difference = 4.89	$\bar{x}$ =37.23 Difference = 7.23
	Mazahua and Otomí $\bar{x}$ =34.87	Difference = 0.02	Difference = 2.36

Source: self elaborated based on data interpretation on an Excel 2001 spreadsheet.

professional to have a sensitivity to recognize, among other community medical practices, the traditional use of MP, a practice deeply rooted in the Mazahua Otomí ethnic groups and documented by authors such as Guzmán-Mendoza *et al*. (2011) and Sánchez-Alejo *et al*. (2016). This is also evident in the differences in the number of MPs recognized by those who identify with and ethnic group vs. those with no ethnicity (36.5, ethnic group and 32.4, no ethnicity) (Table 3).

In this context of biological and cultural diversity, students and future health science professionals, who take an intercultural approach play a fundamental role that can be understood as human capital that contributes to social capital (Azqueta *et al*., 2007). Firstly, the student in his community practices, and later as a professional, correctly integrates and promotes the knowledge and use of MP in compliance with an understanding of the symbolic expressions of both mestizo and native communities; and likewise it rescues, protects knowledge and safeguards wild flora with medicinal properties.

The foregoing translates into deeds that have an impact on community well-being. Following this social capital approach of the intercultural nurse. Núñez-Ramírez *et al*. (2015) conclude that there is an added value to this professional, when considering the beliefs and values of the patient in care planning and that with this modality, there is no significant difference in this variable, taking as reference the origin on the part of the nurse, who belongs to an original group.

This work considers the fundamental role played by the professional during and after their training process, in terms of community development for the use and promotion of MP, taking into account that: (1) there is a greater degree of belonging to an ethnic group with traditional use of MP. 75% and 9% of respondents (students) identify themselves as pertaining to Mazahua and Otomi ethnic groups, respectively, and (2) a transmission of knowledge regarding the number of MPs recognized, predominates among both the students and their parents, who identify with an ethnic group compared to those who do not (Figure 3, Eq. 4 and Table 3).

Community involvement facilitates the student's contribution to the community during the four years of his university studies, when participating in one of the main sectors of the educational plan. In the university, this, together with the environment of teaching and research, through activities that involve planning and evaluation of activities, and externally, with work in communities, that pays attention to specific problems and needs (Casillas and Santini, 2008).

In this unifying activity, among other student acivities (e.g, early detection of chronic degenerative diseases and follow-up of the patient's primary care), the use and promotion of MP is promoted. Other examples include the number and focus of thesis projects that refer to the practice of traditional medicine and nursing (temazcal, herbal medicine, natural supplements, among others). In addition to this, there are also plans to rescue and promote herbal medicine by the creation of botanical gardens or living pharmacies by students in Mazahua communities (for example, in University facilities and in the

community of San Miguel Tenochtitlan). In short, the nursing student and professional who takes an intercultural approach will promote the inclusion of indigenous medicine. Besides this, within the health evaluation and treatment processes devised by the WHO (2011), the use of MP constitutes a more natural, harmless and effective therapy, at reasonable cost; and, above all, accessible to low-income populations.

Table 4 summarizes the contribution made by the use of herbs to the domestic economy according to the perception of parents or guardians of students surveyed. Two relevant aspects stand out: (1) 67% thought that the savings to the domestic economy range between 10% and 50%; and (2) in the range of 20% to 50%, with a higher percentage of opinion (a difference of 14%) manifested by those who identify with an ethnic group.

The savings and positive impact on the domestic economy due to the use of MP is another little documented aspect. In addition to the contribution of rescuing ancestral knowledge, use and conservation of germplasm; there is a saving in the household economy that relates to the promotion of knowledge and use of plants (Table 2). Savings is a variable that relates positively to generational age and the number of MP that are known. The majority of parents/guardians (67%) believe there is a 10-50% saving from a range of 30 or more known MP. However, the savings categories are always higher (Table 2) for those who identify with an ethnic group. This is explained because in the State of Mexico, the Mazahua and Otomi (50% and 43.2% respectively) are the most representative ethnic groups. In addition, they are the social groups that make the greatest use of MP, but also the most marginalized in the region (Hernández *et al*., 2003; INEGI, 2020).

This data is notable for the following reasons: (1) MP are a significant resource for the domestic economy in a highly marginalized area. The minimum monthly income (in pesos for July 2019) in a rural community fluctuates between $2,700.00 (US$145.90) and $6,799.00 (US$367.43) (National Commission of Minimum Wages -CONASAMI-, 2021), these data coincide with the average income reported- according to respondents, this amounts to 3,427.00 pesos per month, equivalent to 30% of the salary considered below the poverty line, which is, $11,290.00 (CONEVAL, 2021) (Table 4). Authors such as Rodríguez-Zúñiga *et al*. (2019) have documented the importance of forest

Table 4. Percentage of savings to the domestic economy related to the use of medicinal plants

Variable	Interval (%)	Ethnic group (MONh) (%)	No ethnic group (N) (%)	General (MONhN) (%)
Economic savings in medical expenses, due to the use of medicinal plants	Less than 10	19	30	21
	between 10 and 20	34	41	35
	between 20 and 50	34	20	32
	More than 50	13	9	12
Average monthly income ($/month)		$\bar{x}$ = 3,175.00	$\bar{x}$ = 3,121.00	$\bar{x}$ = 3,427.00

M: mazahua, O: otomí, Nh: náhuatl, N: none.
Source: self elaborated

resources (MP are non-timber resources) to savings in the domestic economy, in rural communities, which fluctuates between 10 and 35%. However, these studies include various forest resources (wood, fungi, fuel, medicinal plants, others). In this study, only MP were considered, which for one thing highlights the importance and contribution to the family economy, but likewise, the abundance manifested by those in the Mazahua and Otomí community, in terms of knowledge and use of herbal resources (García and Guzmán, 2016; INEGI, 2020); (2) the surplus of economic savings is due to the use of MP. People who identify with any ethnicity are more likely to save when using MP (14% more in savings, from 20 to 50%). According to the WHO (2011), rural populations in Mexico make greater use of MP in primary health care (PHC). This is probably due to two fundamental factors: (a) availability and diversity of the resource and cultural diversity; and (b) substitution of allopathic medicine for traditional medicine, due to economic pressure or lack of health care centers. In this sense, the first factor entails what determines this surplus. According to the results, there is no statistical difference ($p<0.05$) in the average monthly income between parents or guardians, who pertain ($3,175.00) or do not pertain to any ethnic group ($3,121.00).

It is important to emphasize that for primary health care, MP are used mostly in the case of disease: 28% respiratory, 22% urinary, 19% gastric, and others. This data coincides with that reported by the WHO (2011), where the greatest use of MPs by communities with herbal tradition for PHC is mainly gastric, respiratory and vascular. The impact on the domestic economy due to the use and promotion of MP through techniques and methods of economic valuation of natural resources requires further analysis and specification. This work provides peripheral evidence of the intercultural role played by both the student and the nursing professional, in terms of social capital in native communities.

From the point of view of social capital, the nursing student contributes to strengthening reciprocal help and cooperation. In his social role and particularly in the poorest and most marginalized sectors, he puts his acquired knowledge to contribute to improving quality of life. Likewise, he encourages and maintains the use of traditional medicine and ancestral knowledge related to MP, a very common dynamism in Mexico, where the use of flora relates to the binomial of biological diversity and cultural diversity.

We recommend undertaking studies on the forms and uses of medicinal plants and herbal medicine in the study area, considering that this information implies notable contributions to medicine. For example, the tea from the too plant (*Montanoa tomentosa* Cerv.) and its oxytocin is used by midwives to help women contract the uterus during childbirth (López, 2021). In this sense, there must be a benefit and consent for access to the genetic resources of these ethnic groups. In Mexico, indigenous communities play an important role in the conservation of biodiversity and transmission of knowledge for research and development of new products, as well as protecting the interests and rights of communities that possess this knowledge (Federal Executive Branch -FEB, 2004; Avilés-Polanco *et al.*, 2019).

This work can serve as a basis for future studies in order to make collections of each of the species mentioned above, compare them to species found in some herbaria and identify them with their scientific name. In the same way, an index could be made in order to compare the diversity and knowledge of plants between groups of people by age and ethnicity.

CONCLUSIONS

We estimated the "transmission of knowledge" about plants known for medicinal use, from the parent or guardian vs. the student, who identify mainly with the Mazahua ethnic group. This surplus was 9.6 % and occurs mostly concerning wild plants and in a local context. Age and average monthly income were the variables that most contributed to explaining the probability of transmission.

"Transmission of knowledge" could be used in future research as a constant value (9.6 or 0.96) to develop a local index of importance of medicinal plants. Likewise, there should be more emphasis on the economic valuation of medicinal plants using methods of valuation of natural resources that consider budget limitations of the local population.

In the teaching-learning process of the student from the Intercultural Nursing Degree in community, it is very important to integrate knowledge of MP in their education, as a complementary alternative for patient therapy. This marginal activity would thus contribute to the domestic economy, by conserving and strengthening the economic savings capital derived from the use of MP among the 67%, who considered that this contributed between 10% and 50% of savings. However, for those who perceived a range of 20% to 50% savings, we find a higher percentage of opinion (a difference of 14%) taking into account those who identify with some ethnic group (34%), compared to those who do not.

The Nursing Degree student, who takes an intercultural approach, can help to rescue and promote the traditional use of medicinal plants through their training and professional development in native communities. Likewise, they could also pay more attention to specific health problems and needs, which would translate into improving the domestic economy and also the quality of life of these indigenous peoples.

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