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Original article

Synergy in ethnopharmacological data collection methods employed for communities adjacent to urban forest

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A B S T R A C T

Several ethnopharmacological techniques used for sampling and data collection cannot be used as they are for different areas and cultural groups. This study combined and adapted reported ethnopharmacological research techniques for sampling and data collection of medicinal plants in forests adjacent to urban areas, and evaluated their potential applicability. The areas considered in this study included the neighborhoods adjacent to the Botanical Garden of the Federal University of Juiz de Fora, MG, Brazil. Application of combined ethnopharmacological research techniques ensured a practical strategy and reliability in the collected data. Preliminary interviews with 303 questionnaires constituted the general sampling of the population, and interviews with eleven people knowledgeable of medicinal plants constituted specific sampling. Using the two techniques, it was possible to identify sixty species, which are stored in the CESJ Herbarium. Given the lack of specific ethnopharmacological research tools in the context of multi-cultural urban communities located adjacent to forest areas that require preservation, this study shows that the synergistic use of techniques provides more reliable and reproducible data. The combined use of these techniques provides safety and simplifies the tools for future use in similar studies.

Introduction

Ethnopharmacology in the context of urban areas is of great scientific importance and serves as a valuable shortcut for drug discovery (Balick and Lee, 2001). Urban areas reflect a particular cultural and heterogeneous space (Molares et al., 2012), which may also serve the purpose of conservation of natural areas. Ethnopharmocology also contributes toward instilling values of cultural and environmental importance to the resident populations (Gandolfo and Hanazaki, 2011).

An ethnopharmacological study, applied to urban areas adjacent to green areas, can contribute to both conservation of plant biodiversity and maintenance/spread of the cultural knowledge within the communities. Thus, it is of critical importance to conduct such studies in the vicinity of urban forests, in this case, the Botanical Garden of the Federal

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University of Juiz de Fora. These gardens constitute a section of rainforests inserted in the ecological corridor of the municipality of Juiz de Fora.

Sampling or participant selection

Drawbacks associated with previous ethnopharmacological studies are related to the selection criterion of survey respondents (Albuquerque et al., 2010). The use of probabilistic and non-probabilistic sampling techniques (Bernard, 1988; Sampieri et al., 2006) during element sampling (Almeida and Albuquerque, 2002; Nunes et al., 2003) can often confuse beginners in the field of ethnopharmacology.

Reliable methodological standards are scarce in current literature. Researchers have used several complex and nonspecific techniques; thus, making it a challenging endeavor for researchers to employ the reported methodologies. Furthermore, individual preexisting models are unresponsive to challenges faced by urban ethnopharmacologists, generating flawed and biased results.

Data collection

According to Albuquerque et al. (2010), data collection primarily involves the union of theoretical and methodological skills in several disciplines. For conducting ethnopharmacological studies in urban areas adjacent to forest and other green areas, it is necessary to adapt and combine techniques so as to generate a general framework of methodology that future studies can employ for similar studies.

Establishment of robust methods for data collection and sampling can ensure reliability of the results; thereby enabling the efficient management of the vegetation and minimizing the impact of the adjacent urban population on the local forest.

Thus, the aim of this study was to formulate strategies for robust sampling and data collection regarding medicinal plants, but in a simplified manner in the context of urban areas adjacent to urban forests. For this purpose, widely used techniques were adapted for communities in the Botanical Garden of the Federal University of Juiz de Fora vicinity.

Materials and methods

Studied area

The study was conducted in the neighborhoods adjacent to the urban forest belonging to Botanical Garden of the Federal University of Juiz de Fora, in the municipality of Juiz de Fora, Minas Gerais state, Brazil (Fig. 1). A total of 1,110 households with a population of approximately 2,980 inhabitants at the beginning of this study were identified, as documented by Conde (2012). Origins of the residents varied; however, most of them have lived at the current site for over 30 years. As for religion, residents were predominantly catholic; evangelicals were next, while fewer people practiced other religions.

Techniques used

Preliminary strategies

Preliminary survey: structured interviews (Albuquerque et al., 2010) using questionnaires (Alexiades, 1996), were carried out to establish a community pre-profile in order to choose the most appropriate methodology. Preliminary interviews were conducted at the popular hangouts in the neighborhoods under study. These included parks, bus stops, bars, fairs, churches, among others. People willing to be interviewed were selected and some personal data, such as age and knowledge about the use of medicinal plants, were collected.

The community approach strategy involved the formation of a tight bond between researchers and the community. For this, a partnership was established between the researchers and the residents' associations of the neighborhoods under study.

Figure 1 – Aerial view of JB-UFJF with the community (neighborhoods) under study outlined in black. The image was captured from Google Earth (Google).

The *Sementinha* Project, devised by the leadership in one of the neighborhoods, involved the researchers. Objectives of this initiative were established during meetings with the residents' association, and involved planning, presentation, and execution of lectures to residents during meetings and other events in schools of the district, highlighting the importance of preserving the environment. In these meetings, researchers communicated the goals of the ethnopharmacological study prior to its beginning. Subsequently, at two large public meetings, where residents, leaders, councelors, and the local press were present, strategies for environmental conservation were promoted and the objectives of this study were presented. Simultaneously, native Atlantic rainforest seedlings were planted in one of the neighborhoods.

Sampling

General sampling: Selection of interviewees was done using a fishbone pattern (Conde, 2012). In this method, residents of every other household on the right and left sides of each street in all the communities were interviewed. The pattern of houses chosen during this stage resembles a fishbone (Fig. 2); thus, the name fishbone was chosen to designate this method. The fishbone method aims to select a sufficient number of interviewees, so as to obtain a large sample of the total universe. A direct comparison of the number of respondents by statistical methods was also performed (Bernard, 1988; Sampieri et al., 2006).

Elderly people were preferred as interviewees. The oldest person in each residence was interviewed based on his/her availability. Preliminary data showed that older people (mean age, 55 years) were more likely to be aware of the uses of herbal medicine. Other authors, such as Pinto et al. (2006) and Cakilcioglu et al. (2010), have used similar techniques.

Specific sampling: Participants with greater knowledge of medicinal plants were termed "knowledgeable of medicinal plants" (KMP). The objective in this step was to improve data quality regarding medicinal plants. Since informal interviews allow the establishment of closer ties (Bernard, 1988), they were used in this method. Primary KMP contacts indicated other KMP for information regarding specific applications of medicinal plans (snowball technique; Bernard, 1995; Cotton, 1996). Unscheduled visits were made (Conde, 2012). Local members were chosen occasionally in the streets, churches, squares, and at other sites. During informal interviews (Bernard, 1988), participants were asked to give the names of KMP.

Data collection

For general sampling criteria: structured interviews were performed (Albuquerque et al., 2010) using semi-structured questionnaires (Rodrigues, 2007), through which data were collected regarding the use of medicinal plants.

For specific sampling criteria: Open interviews (Posey, 1987), with voice recording (Alexiades, 1996) and participatory observations (Malinowski, 1975), were conducted to obtain additional data. KMP were requested to list (Bernard, 1988) the medicinal plants and their respective uses.

Botanical material collection and identification

Collection of plant material: Plants identified to possess medicinal properties by the interviewee were collected *in loco* using the guided tour technique (Albuquerque et al., 2010), which involved accompanying the interviewee to the location of the plant. For this, pruning shears were used (Santos et al., 2010). A botanical data sheet, recommended by Lipp (1989), was filled *in loco* to record habit, flowering, fruiting, and other relevant data of the plants.

Herborization: Following the instructions suggested by Alexiades (1996) for the wet protocol, samples that were moistened in a solution of ethyl alcohol and water were placed between sheets of paper, so as not to lose their characteristics en route to the UFJF Department of Botany. Subsequently, they were subjected to herborization; pressed and dried in greenhouses and prepared as herbarium specimens.

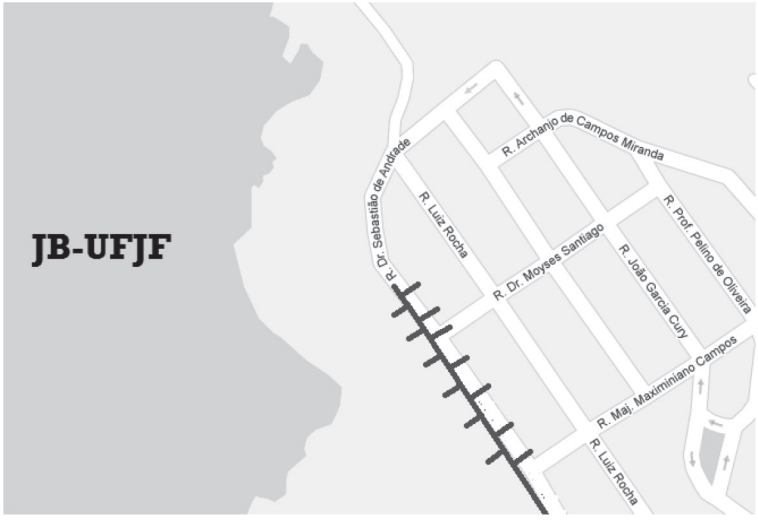

Figure 2 – Map of the path taken by the researchers (fishbone pattern) during interviews in one of the streets of a neighborhood. R, street.

Identification of fertile species: Prepared botanical materials were identified by the team of experts of the Department of Botany of UFJF or, when necessary, by experts at partner institutions. Subsequently, the materials were deposited, under specific registration numbers, at the CESJ Herbarium.

Identification of infertile species: Infertile specimens, which could not be registered in the herbarium, were identified by comparison with specimens of the CESJ Herbarium, recorded images from Herbaria Virtual Musém National d'Histoire Naturelle in Paris, Royal Botanical Gardens Kew in London, and New York Botanical Garden in New York.

Identification of botanical species in the absence of botanical material: When the plant material, identified only by its vernacular name, was not immediately found, and it was unlikely that the plant could resurface within a year for several reasons, visual stimulus techniques were adapted to save time and increase the quality of the data. Consequently, during subsequent interviews, photographs of botanical species were presented to the respondents so that the referred species could be identified using a check-list of botanical characteristics (Alexiades, 1996; Conde, 2012). The collection of photographs/figures from the Ethnobotany Laboratory of the Federal University of Juiz de Fora and various botanical species in the Herbarium containing CESJ duplicates were used during this process.

Results and discussions

Preliminary strategies

The preliminary survey (400 participants) revealed the profile of the participants who were aware of the medicinal plants in the communities targeted in this ethnopharmacological study. The average age of participants who were knowledgeable of medicinal plants, *i.e.*, self-proclaimed experts on herbal use for medicinal purposes, was 55 years. Retention of knowledge about medicinal plants in this age group was consistent with the findings of Schardong and Cervi (2000), Mendonça-Filho and Menezes (2003), and Souto and Ticktin (2012). These previous reports enabled us to develop subsequent strategies to continue the study along similar lines. Such a strategy can be used when one does not have to pre-establish the profile of the community under study.

The community approach strategy enabled us to strengthen ties with community leaders, health professionals, and teachers in schools of the neighborhoods. Interviewees participated willingly in most cases (98%); they offered their assistance because they had knowledge of this study through the awareness created by the *Sementinha* project. Furthermore, all interviewees favored the advancement of the *Sementinha* project and considered that it was an excellent initiative in environmental education.

Similar methodological initiatives that are quite efficient for urban population mobilization, even in the absence of previous contact with the studied community, should be encouraged in future studies. This is also a way to implement initiatives in environmental education.

Sampling methods

Using the fishbone sampling method, it was possible to carry out general interviews in 303 households, representing approximately 27% of total households in the communities under study. This analysis also took into account the proximity to the urban forest, based on the geographical spread of the sample, and was based on the assumption that a larger sample led to conclusions with higher levels of confidence. The average length of the interviews was 90 min.

It must be noted that, initial awareness of the climatic conditions of the regions under study can assist the careful planning of the work, because rainy seasons in Brazil can make it impossible to conduct fieldwork.

Eight KMP were identified during specific sampling, five by the snowballing technique and three by random identification. Eight KMP were identified during the semi-structured phase of general sampling; however, four among these were already identified during specific sampling. Of the twelve KMP, it was possible to conduct interviews with eleven, because one KMP died before the scheduled meeting. These results demonstrate the effectiveness of the synergistic application of all techniques mentioned above.

To save time, it is recommended that a combination of techniques "participant observation," "snowball," and "random identification" be used in future studies. However, it must be noted that, since these are anthropological techniques, the efficiency of the same will depend on the ethnobotanist, like the "rapport" he/she establishes (Amorozo and Viertler, 2010) or the interviewer–interviewee relationship he/she builds.

Data collection

Results for the sampling based on population revealed that 70% of the respondents use medicinal plants; 30% of the respondents cited the eight KMP as their source of information. This strategy also allowed for the identification of 54 plant species used for medicinal purposes in the studied neighborhood. Although the data were not collected in the presence of KMP, they were involved in qualifying and reviewing the data. In all the 303 interviews conducted, the older resident was sought; however, on 52 occasions (18%), physical/psychological factors and the absence of family members impeded interviews with the older person. Researchers who choose similar methods constantly face such a reality.

Data collection during specific sampling made it possible to collect and identify fifty species of medicinal plants. Employing the two methods for data/sample collection, it was possible to identify sixty species of medicinal plants; 48 species were common to both the stages, while medicinal application of six plants were identified independently by KMPs and the general community (Table 1). Taken together, these results show that both techniques of data collection have similar efficiencies. Furthermore, these results also demonstrate the great influence of KMP and endorse the use of a specific sampling technique for data qualification, allowing a reduction of research time.

By comparison with the specimens from the herbarium, nineteen of the twenty infertile species collected during fieldwork were identified (Chart 1). The use of this identification method is recommended because it is simple, reliable, and

Table 1
Species of medicinal plants identified at the quantitative and qualitative survey. Scientific and vernacular names of the medicinal plants, along with their use they are most often cited for and the voucher specimen number, are indicated. "X" represents presence of plant as indicated during the survey with the population or with people who were knowledgeable of medicinal plants (KMP).

Scientific nomenclature	Vernacular name	Prominently used as/for	Survey with population	Survey with KMP	Voucher number
Mentha crispa L	hortelã	Vermifuge	X	X	57126
Mentha arvensis L.	vick	Flu	X	X	57120
Plectranthus barbatus Andrews	boldo	Liver problems	X	X	57068
Ocimum gratissimum L.	alfavaca	Flu	X	X	56961
Mentha pulegium L	poejo	Flu	X	X	57143
Ocimum selloi Benth.	erva-doce	Soothing	X	X	56729
Ocimum basilicum L.	manjericão	Cardiac problems	X	X	56732
Leonurus sibiricus L.	mané-turé	Stomach problerms	X	X	56956
Rosmarinus officinalis L.	alecrim	Cardiac tonic	X	X	57853
Salvia officinalis L.	sálvia	Cardiac tonic	X	X	56733
Glechoma hederacea L.	erva-terrestre	Flu	X	X	58348
Ageratum conyzoides L.	erva-de-são-joão	High cholesterol	X	X	56960
Mikania glomerata Spreng.	guaco	Pneumonia	X	X	56736
Solidago chilensis Meyen	arnica	Showers	X	X	57142
Vernonia polyanthes Less.	assapeixe	Pneumonia	X	X	58050
Vernonia condensata Baker	necroton	Liver problems	X	X	56724
Bidens pilosa L.	picão	Jaundice	X	X	57140
Baccharis trimera (Less.) DC.	carqueja	Slimming	X	X	58343
Solanum cernum Vell.	panacéia	Depurative	X	X	57854
Chenopodium ambrosioides L.	santa-maria	Vermifuge	X	X	57061
Alternanthera brasiliana (L.) O. Kuntze	terramicina	Infections	X	X	56735
Alternanthera sp.	carrapixinho	Infections	X	X	57136
Amaranthus sp.	cariru	Milk scab	X	X	56962
Cymbopogon citratus (DC) Stapf.	capim-limão	Soothing	X	X	57859
Coix lacryma-jobi L.	conta-de-lágrima	Flu	X	X	58052
Desmodium incanum DC	carrapicho	Febrifuge	X	X	58049
Eugenia uniflora L.	pitangueira	Diarrhea	X	X	58051
Ruta graveolens L.	arruda	Conjunctivitis	X	X	56723
Arrabidaea chica (Bonpl.) B. Verl.	cajurú-do-índio	Kidney problems	X	X	58351
Rosa alba L.	rosa-branca	Uterine infections	X	X	56916
Rubus brasiliensis Mart.	amora-silvestre	Flu	X	X	58045
Kalanchoe brasiliensis Cambess	saião	Ulcer	X	X	56997
Aloe arborescens Mill.	babosa	Burns	X	X	58046
Foeniculum vulgare Mill.	funcho	Belly ache	X	X	57071
Echinoduros grandiflorus (Cham. & Schltdl.)	chapéu-de-couro	High blood pressure	X	X	56861
Tournefortia paniculata Vent	marmelinho	Kidney problems	X	X	56915
Bixa orellana L.	urucum	High pressure	X	X	57137
Costus spicatus (Jacq.) Sw.	cana-de-macaco	Kidney problems	X	X	56956
Punica granatum L.	romã	Sore throat	X	X	56728
Gossypium hirsutum L.	algodão	Infections	X	X	57852
Malphighia glabra L.	acerola	Flu	X	X	58051
Morus alba L.	amora	Menopause	X	X	56917
Plantago major L.	transagem	Infections	X	X	57026
Talinum paniculata (Jacq.) Gaertn.	pronóbis	Anemia	X	X	56957
Petiveria alliaceae L.	guiné	Muscle aches	X	X	57060
Phyllanthus tenellus Roxb.	quebra-pedra	Kidney problems	X	X	56955
Lippia alba (Mill.) N.E. Br.	erva-cidreira	Soothing	X	X	57122
Zingiber officinale Roscoe	gengibre	Sore throat	X	X	58047
Passiflora edulis Sims	maracujá	Soothing	X		58054

Table 1 *cont.*

Scientific nomenclature	Vernacular name	Prominently used as/for	Survey with population	Survey with KMP	Voucher number
Persea americana Mill.	abacate	Kidney problems	X		58341
Nicotiana tabacum L.	tabaco	Diarrhea	X		56914
Citrus limom (L.) Burm.f.	limão	Flu	X		57857
Ocimum basilicum. var. *purpureum* L.	manjericão-roxo	Flu	X		56071
Bauhinia purpurea L.	pata-de-vaca	Diabetes	X		57850
Vitex agnus-castus L	viagra	Impotence		X	57138
Acmella uliginosa (Sw.) Cass.	jambu	Toothache		X	57139
Cynara cardunculus L.	alcachofra	Slimming		X	58342
Solanum lycocarpum St. Hil	fruta-de-lobo	High cholesterol		X	57862
Impatiens sultani Hook.f.	beijo-branco	Uterus infection		X	57855
Tropaeolum majus L.	capuchinha	Anemia		X	56913

Chart 1
Infertile medicinal plants identified by comparison with species in the herbarium.

Scientific nomenclature	Popular Name	Prominently used for
Plectranthus neochilus Schlter.	boldinho	Liver problems
Mentha cf. *piperita* L.	elevante	Flu
Lavandula angustifolia Mill.	lavanda	Anxiety
Matricaria chamomilla L.	camomila	Soothing
Cnicus benedictus L.	cardo-santo	Liver problems
Tanacetum parthenium L.	artimijo	Flu
Artemisia canphorata Vill.	cânfora	Sore bumps
Lycopersicon esculentum Mill.	tomate-cereja	General infections
Solanum melingena L.	berinjela	Lower cholesterol
Saccharum sp.	cana	Flu
Zea mays L.	milho	General inflammations
Pterodon emarginatus Vogel	sucupira	Rheumatism
Stryphnodendron sp	barbatimão	Ulcer
Euphorbia hirta L.	erva-de-santa-luzia	Diarrhea
Euphorbia tirucalli L.	aveloz	Several cancers
Ricinus communis L.	mamona	Hemorrhoids
Psidium guajava L.	goiabeira	Diarrhea
Citrus aurantium L.	laranja	Flu
Jacaranda sp.	caroba	General infections

Chart 2
Medicinal plants identified by correlation with images/ figures from archives of botanical samples and their medicinal properties.

Scientific nomenclature	Popular Name	Prominently used for/as
Tabebuia impetiginosa (Mart. ex DC.) Standl.	ipê-roxo	Muscle pain
Sedum dendroideum Moc.	bálsamo	Ulcer
Laurus nobilis L.	louro	Gastritis and Ulcer
Allium cepa L.	cebola	Sore throat
Mangifera indica L.	mangueira	Cystitis
Allium sativum L.	alho	Flu
Symphytum officinale L.	confrei	General inflammations
Ananas comosus (L.) Merr.	abacaxi	Kidney
Carica papaya L.	mamão	Flu
Ipomoea batatas (L.) Lam.	batata-doce	General inflammations
Dianthus caryophyllus L.	cravo	Headache
Brassica rapa L.	mostarda	Low blood pressure
Maytenus ilicifolia (Schrad.) Planch.	espinheira-santa	Ulcer
Nasturtium officinalis R. Br.	agrião	Anemia
Davilla sp.	cipó-caboclo	Blood cleanser
Equisetum giganteum L.	cavalinha	Anemia
Averrhoa carambola L.	carambola	Kidney cleanser
Polygonum hydropiper L.	erva-de-bicho	Intestinal infection
Cecropia sp.	embaúba	Asthma
Piper aduncum L.	jaborandi	Circulation problems

can be performed by taxonomy experts. Furthermore, it is well suited for studies in similar communities, where it may not be possible to visit regularly the community for a new collection.

Analysis of the data from the surveys using the general population or KMP revealed that the prominent medicinal uses of the common plants identified during the two sampling stages overlapped completely; the plants were used for the same medicinal purposes by both groups. This observation underscores the influence of KMP in the community. It has to be noted that the people interviewed had lived in the same community for a long time (average period of residence = 30 years), thus, helping the propagation of the influence of KMP.

Identification of botanical species in the absence of the material

Visual stimuli, in the form of pictures and images from online and local herbariums, along with a check-list were provided to the eleven KMP for the identification of the 22 plants (plant materials). These plants/materials were reportedly used by the interviewees to provide relief against ailments (Chart 2). Such a method of identification/ data recording provides some clues for the identification of the related species; in the absence of such records, the vernacular terms referring to these medicinal plants are discarded over time. However, this method has its drawbacks, given the advanced age of the participants who often suffer from loss or reduction of vision and since it is only possible to sense aromas, flavors, and thoroughly evaluate the plant in its natural context.

Ethnopharmacological research plays a critical role in creating awareness regarding the diversity of the vegetation in multi-cultural urban communities located adjacent to forest areas. The current study combined and adapted ethnobotanical techniques in an attempt to format a methodological standard that can assimilate and secure data, and simplify tools for use in similar future endeavors. The tools used in this study are summarized in Chart 3.

The diversity and multidisciplinary nature of the parameters in ethnopharmacology require that the current techniques should be improved and adapted to the demands and specificity of the research. The present study is an insurance model because it is supported by major, widespread world scientific literature techniques and is applied in a specific and adapted way. Further studies in similar areas based on the model outlined here will facilitate subsequent meta-analysis and data comparison for further refinement of the ethnopharmacological tools.

Authors' contributions

BEC, data collection, statistical analysis, and specimen and manuscript preparation; AMS, data collection and statistical analysis; ITSR, data collection and statistical analysis; JSM, data collection; GGB, data collection and statistical analysis; MQF, data collection, statistical analysis, and specimen preparation; LMC, design and concept of the experiments, research supervision, and manuscript preparation; DSP, design and concept of the experiments, research supervision, and manuscript preparation.

Conflicts of interest

The authors declare no conflicts of interest.

Chart 3
Overview of the tools used in each step of this ethnopharmacological study.

Preliminary Strategies	Sampling	Data Collection	Botanical Material (Collection and Identification)	Identification of Botanical Species (in the Absence of Botanical Material)
Preliminary survey	Quantitative sampling of the population	Qualitative sampling of the population	Modes of data collection	Visual stimuli for the identification of plants
1. Use of structured forms during interview	1. Fishbone pattern for selecting interviewees	1. Use of semi-structured forms during interview	1. Walking in the wood	1. Images/figures from herbariums and a check- List
		2. Recruiting the oldest person in a household for the interview	2. Wet method	
			3. Herborization	
Strategy for community approach	Associated techniques for the selection of KMP	For sampling based for KMP	Identification of infertile species	
1. *Sementinha* Project	1. Observations made by participants	1. Open interviews	1. By comparison with collections in the herbarium.	
	2. Snowball sampling	2. Recorded (oral) interviews		
	3. By identification as a point of information dissemination in the neighborhood	3. Free listing		
	4. Informal interviews			

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