

ORIGINAL RESEARCH

Fifteen years of change in the food environment in a rural Mexican community: the Maycoba project

LS Chaudhari, RC Begay, LO Schulz

College of Health and Human Services, Northern Arizona University, Flagstaff, Arizona, USA

Submitted: 10 November 2012; Revised: 5 April 2013; Accepted: 13 March 2013; Published: 8 September 2013

Chaudhari LS, Begay RC, Schulz LO

Fifteen years of change in the food environment in a rural Mexican community: the Maycoba project
Rural and Remote Health 13: 2404. (Online) 2013

Available: <http://www.rrh.org.au>

ABSTRACT

Introduction: Indigenous populations worldwide who are shifting to a westernized lifestyle experience high rates of type 2 diabetes and obesity. These conditions are commonly the result of genetic predisposition and environmental factors that promote excess energy intake and decreased energy expenditure. The purpose of this study was to examine changes in the food environment, specifically looking at retail and subsistence-food availability, and food-acquisition behaviors in the rural Mexican town of Maycoba and surrounding communities between 1995 and 2010. The population in this area includes indigenous Pima, genetically-related to the Pima Indians in Arizona who have the highest documented rates of diabetes, and non-Pima Mexican (ie non indigenous and other indigenous). An initial study in 1995 compared the prevalence of diabetes and obesity in the Maycoba population with that of Pima Indians of Arizona and found a dramatically lower type 2 diabetes prevalence in the Maycoba region due to the protective effect of a traditional lifestyle despite a genetic predisposition to diabetes.

Methods: The 2010 follow-up study was undertaken to determine the prevalence of obesity and type 2 diabetes as well as to examine lifestyle changes over the 15 year time span, following changes to housing and the local environment. This study focused on the food environment, examining changes in food acquisition behaviors in the retail and subsistence aspects. The study included a household survey ($n=71$), two focus group discussions, and participant-observation. To determine changes in retail food availability, seven stores throughout the study region were audited.

Results: The main findings were an increasing presence and use of retail stores for food: an expansion in the selection of processed foods, their prominent placement, and refrigeration allowing more perishable foods to be available to the local population. Subsistence activities remained significant, although some aspects of specific subsistence activities are in decline, such as the area allocated to home gardens and a reduction in the variety of crops cultivated in them.



Conclusion: Although there have been a number of changes in the food environment during the 15 year period, a traditional subsistence-based lifestyle prevails.

Key words: diabetes, food environment, Maycoba Mexico, Mexican Pima Indians, obesity.

Introduction

Obesity and type 2 diabetes commonly result from the combination of genetic predisposition and an environment that promotes excess energy intake and reduced energy expenditure¹. Transitions from traditional lifestyles that include diets high in fiber and high levels of physical activity, to those that are more westernized and linked to diets higher in fats and decreased physical activity, are associated with this type of obesogenic environment. The mix of genetic predisposition and shift in lifestyle is increasingly affecting Indigenous people throughout the world. As a result, obesity and type 2 diabetes rates are dramatically increasing worldwide among Indigenous populations²⁻⁴. In this article, changes are examined between 1995 and 2010 in the food environment of a rural population in and around Maycoba located in Sonora, Mexico that is inhabited by Indigenous Pima and non-Pima people.

A number of factors affect Indigenous population health worldwide, especially in relation to diabetes and obesity. In general, Indigenous populations have a lower socioeconomic status, are marginalized, have lower educational levels and poorer health than the dominant population⁴. For instance, infectious diseases rates are higher for Indigenous populations compared with national rates⁵⁻⁷. In industrialized countries, Indigenous populations often carry higher burdens of diabetes and obesity than the dominant population⁸⁻¹⁰. The prevalence of these disease conditions in developing countries are increasing quickly and are affecting the Indigenous populations of these nations, yet the patterns have not been well examined on a global scale^{9,11}.

There are a number of smaller scale studies that suggest Indigenous status may be protective against certain health conditions. Indigenous status is a complex construct and cannot easily be defined across nations⁴. It has been operationalized in a number of ways and has been shown in area studies to confer protection against obesity and diabetes, even among genetically predisposed populations^{1,10,12,13}. These communities share several traits including rural and subsistence-based lifestyles with high levels of physical activity and diets low in fat.

In the past decade there has been a growing consensus, within a broad range of disciplines, that the environment is a key contributor to diabetes^{14,15}. Anthropologists have explored the relationship between built geographies and food environments with a focus on nutrition, as a means of elucidating the complexities of culture and health as they relate to food systems^{16,17}. Studies within developed countries demonstrate health disparities associated with access and proximity to healthy food landscapes, which are features of the built environment, or that part of the environment that is modified by humans, such as the density of fast food outlets, grocery stores, or measures of urban sprawl^{18,19}. These studies have primarily focused on urban environments. Studies in rural environments characterize and describe options for purchasing food and food choices^{20,21}. Similarly, studies in developing countries find change and transition within food environments and nutrition^{22,23}. Changes in Indigenous food environments are dynamic and the direction of change, while tending toward the patterns in more developed countries (modernization), is mediated by culture and Indigenous influences on food systems. This examination of the food environment in Maycoba and surrounding communities demonstrates both change and consistency within the culture as they are related to food availability and food behavior.



The food environment has been a particular focus as it is considered to be a significant factor in chronic diseases^{15,24-26}. Food environment access has been studied using several or all of the dimensions distinguished by Penschansky and Thomas²⁷: availability, accessibility, affordability, acceptability, and accommodation²⁸. The food environment is multileveled and complex because each of these dimensions can be explored in a number of ways. The relationship among food environment, diet, and health (specifically diabetes and obesity) is important and warrants examination. It is particularly significant in terms of the present investigation of the changes and mechanisms of change and interactions affecting the obesity and diabetes prevalence between 1995 and 2010 in and around Maycoba.

A number of review articles underscore both the gaps in food environment studies and the significance of evaluating food environments to improve the diet-related health of communities. Improving measurements that are well defined and of high quality is necessary^{24,25,29,30}. There is little consistency across studies which may include store audits, self-report surveys, geographic information systems data, and observational data^{24,28,30,31}. There is also a dearth of studies addressing the role of social factors, which can be challenging to quantify neatly, and the role of the environment, where issues of appropriate scale are problematic (eg individual, community, and neighborhood scales)^{29,32}. Since most of the studies take place in industrialized and urban settings, their relevance for rapidly changing rural and developing country food environments is limited. In this study, the focus is on assessing the food environment from multiple angles to obtain an overview of the current status and changes that have occurred since 1995 in a transitioning, rural Mexican setting. Specifically, this study looks at retail- and subsistence-food availability, and food-acquisition behaviors dimensions in Maycoba and surrounding communities between 1995 and 2010.

Study setting

Maycoba, a rural community in Sonora, Mexico and surrounding settlements, is home to both Pima Indians and non-Pimas (Fig1)^{13,33}. A 2010 community census estimated a population of 1310 individuals. The study area consists of the town of Maycoba (the largest area) where the majority of the population resides, and also covers 11 surrounding

communities. The number of households in a settlement ranges from two to 30 for the 11 settlements, and 250 for Maycoba. These communities are located in the Sierra Madre Occidental range approximately 325 km (approximately 200 miles) from the state capital Hermosillo. The vegetation is dominated by conifer-oak forests and recent land-use and land-cover analyses of the region found that mixed vegetation and dense trees are the most common land-cover categories in the area³⁴⁻³⁶.

The Indigenous Pima have inhabited this region of Northern Sonora and nearby areas of Chihuahua for centuries. Traditionally the Pima have been agriculturalists and pastoralists³⁷. These subsistence activities persist today and include hunting, fishing, animal husbandry, cultivation, and harvesting of non-cultivated plants and fungi. Cultivation includes home gardens as well as fields and ranches^{33,34,37,38}. Changes in lifestyle have been documented since 1969 and have affected local communities to varying degrees³³. The Mexican governmental *Comision Nacional para el Desarrollo los Pueblos Indigenos* (CDI) in 2003 was preceded by the *Instituto Nacional Indigenista* (INI) in 1948. The commission was established to provide a thoughtful integration of modernization with traditional resources and culture, but has had limited success. In the last 15 years, there have been a number of government programs that brought services to each household, reforestation programs, mining and lumber activities, and construction of cement houses with imported bricks that have contributed to an altered landscape^{34,38}.

In 1995, the prevalence of type 2 diabetes and obesity in the population of the Maycoba region was compared with that of genetically related Pima Indians of Arizona, where these health conditions have reached epidemic proportions^{1,39,40}. These two populations were determined to have been separated between 700 and 1000 years ago and are closely related⁴¹⁻⁴³. It was concluded that the dramatically lower type 2 diabetes prevalence in the Maycoba region was due to the protective effect of their traditional lifestyle despite a genetic predisposition to diabetes. Daily activities included high levels of physical activity, growing and gathering their own food, low mechanization of agriculture, minimal amounts of processed foods, and a diet high in fiber and complex carbohydrates while low in fat^{13,41,42}.

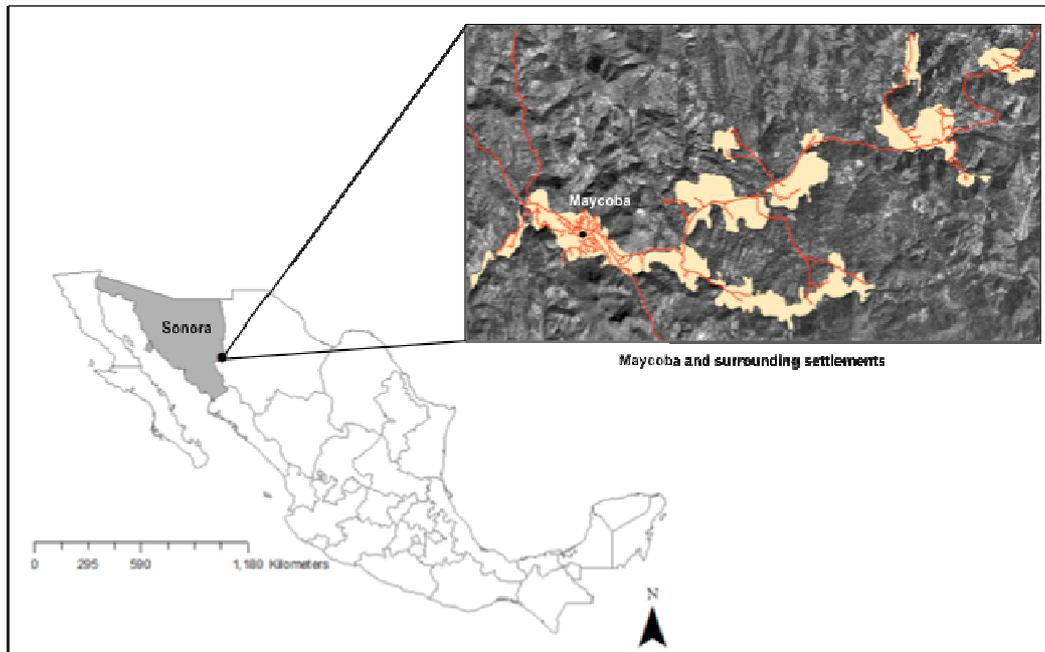


Figure 1: Study region map: Maycoba and surrounding settlements in Sonora, Mexico.

A follow-up study in 2010 was undertaken to determine the prevalence of obesity and type 2 diabetes, as well as to examine lifestyle changes over the 15 year time span. These findings will be reported in forthcoming publications. One lifestyle change that is clearly important to energy balance relates to the food environment – specifically, food availability and food-acquisition behaviors^{14,24,25,29}. Changes in the food environment were examined between 1995 and 2010, specifically food sources (retail and subsistence food production) and food-acquisition behaviors. Retail food is defined as food that is sold in stores and consumed elsewhere. In the study setting, this mainly consists of packaged and processed foods sold in the small stores. Items for sale included, but were not limited to cookies, pastries, canned beans, canned meat and potato chips. Subsistence food is defined as food that is cultivated, hunted, gathered, and raised in limited quantities for personal and family consumption. In the study setting, subsistence food activities examples are home gardens, ranching, gathering plants, and

the hunting activities of the local population. Examples of subsistence food produced include cheese, corn, and beans. Retail food availability was predominantly examined in the stores in the town of Maycoba where individuals can purchase food items. Food can also be purchased in small restaurants that are usually attached to the family residence or located next to the family home. A few individuals, mainly women, sell limited amounts of homemade food such as tortillas from their kitchen windows. The subsistence food environment was a focal point as it was clearly the predominant source of food during the 1995 study and appeared to be the case during the exploratory phases of the present study despite dramatic changes in the landscape. Another research study conducted in nearby communities in the 1980s also discussed the prevalence of agriculture and other subsistence activities despite exposure to and interaction with outside economic markets⁴⁴.



Methods

The study was undertaken between 2010 and 2011 during four fieldwork visits to the communities in the town of Maycoba and surrounding settlements (Fig1). Two researchers, one a public health expert and the other an anthropologist, led this research during February, August and October 2010 and August 2011. Each trip lasted between 5 and 10 days. A key aspect was to determine general changes that have occurred in the region from the population's perspective and the current state of the food environment in the region, especially as it may affect the rates of diabetes and obesity that were being studied as part of the larger study (defined in the study setting section).

The food environment assessment focused on food availability and food acquisition behavior. Food availability was assessed by looking at the retail and subsistence food sources available to the local population. The retail food availability assessment centered on the small stores mainly located in the town of Maycoba, this being the most common way for the local population to purchase food. Subsistence food availability was also examined because this was clearly an important source of food for local households.

To determine the composition of retail food availability, seven family-owned stores were audited throughout the study region. The food audits were conducted to inventory food items for sale, identify items that were available in the largest quantity and available in a large variety. Store shelves were inventoried, notes were taken and the entire store was photographed by the researchers, to examine the types of food currently available and patterns. The inventory lists were analyzed using descriptive statistics. The photographs were visually evaluated to look at product-placement patterns. The seven store owners and 10 key informants were interviewed in an open-ended manner to elicit information on changes in the stores between 1995 and 2010, and to discuss food items for sale as well as shopper habits. The interviewers took notes during or after the interviews and

these were qualitatively analyzed to extract data on the changes that had taken place over the 15 year period.

A household survey, focus group discussions, and participant observation were used to describe changes in food acquisition behaviors related to the retail and subsistence aspects of the food environment. A representative sample of households ($N=71$) that included at least one adult older than 35 years who had lived in the area since 1995 was selected at random from census data. These criteria were created in order to find participants who were young adults or older at the time of the initial study in 1995 and had lived through the changes in the study setting in the intervening time. Only one adult over 35 years living in a selected home responded to survey questions about changes in local food acquisition behaviors between 1995 and 2010.

Key informants helped the researchers identify five individuals to conduct the household survey. Out of these 5 women, 4 were fluent in both Pima and Spanish, and all were capable of contacting all the identified households. The researchers spent a day training the interviewers and interactively deciding on the most appropriate survey wording (in Spanish) and method for conducting it. The households were distributed among the 5 interviewers and each completed their surveys independently. The interviewers and researchers discussed any questions or concerns during this data collection process and the surveys were completed in less than 2 weeks. Thirty-four men and 37 women aged 35 to 72 years participated in the household survey. Nine individuals did not know their age and were estimated to be older than 70 at the time of interview.

Ten focus group members met the following criteria: (i) older than 35 years; (ii) had lived in the area since at least 1995; and (iii) had been identified by a community leader as cultural experts and effective communicators. Two focus groups were conducted, one with seven participants and the other with three participants, each lasting approximately 90 min. The guiding topics during these discussions included gardening, change, health, and physical activity. The discussion dialogue was audio-recorded, transcribed, and



translated into English. The discussions were conducted in Spanish or, when necessary, translated from Pima to Spanish during the focus group interviews.

The final method, participant observation, included talking with store owners about changes in customer purchasing habits, observing purchases, recording informal interviews with community members, and discussing cooking, food production, and food acquisition with residents in their homes.

Ethics approval

Northern Arizona University's Internal Review Board for Human Subjects approved this research project (no. 10.0016).

Results

Retail food availability and food-acquisition behaviour

Between 1995 and 2010 the number of grocery stores in the study area increased from 6 to 11. One of the smaller stores opened in 1995 but closed for unknown reasons. The most abundant food items for sale in the stores included cookies, pastries, sodas (carbonated, sugary drinks), and potato chips. Food items for sale that were available in a wide variety of brands, flavors and types included salsas, cookies, sodas, potato chips, and canned food. A number of highly processed food products (specifically sodas, potato chips, and cookies) were prominently displayed in all of the stores. The least abundant items included refrigerated milk, eggs, microwavable foods, fresh fruits and vegetables, tortillas, and dried spices. Pasteurized milk, microwavable foods, and fresh fruits and vegetables were the most expensive items. Other items often used in local cooking were observed to be available from other sources, including home gardens, ranching, and harvests from agricultural fields.

Refrigeration was cited as a significant change that occurred during the 15 year study period corresponding with the introduction of a community-wide electricity supply. At least

one refrigerator was noted in all stores except for the store located outside the town of Maycoba. The refrigerators mainly contained cold drinks (sodas, juices, and beer), milk, cheeses, yogurts, microwavable food, and some of the fresh vegetables for sale. Key informants and store owners indicated that sugar, green coffee beans, and sodas were the most commonly sold items in 1995. They also noted that the variety of items available in 2010 did not exist in 1995, especially the highly processed snacks such as potato chips.

The household survey respondents indicated that although households are currently purchasing more foods in stores compared with 1995, the proportion of store-bought food is still significantly small in relation to the entire household food basket, which consisted mainly of beans, corn, milk products, and other basic food sources. The frequency of grocery-store trips was reported as weekly or less often for the majority of households surveyed (Table 1). Respondents indicated that the most common items purchased in the grocery stores currently were, in decreasing order: sodas, milk and butter, meat and eggs, vegetables, and beans. Participants reported that food consumption took place mainly at home, with 87% of the respondents indicating that they never or rarely ate at one of the few small local restaurants. From focus group discussions and participant observation, it was clear that opportunities for employment were limited and usually seasonal, therefore households did not regularly spend money purchasing food items in the stores.

Subsistence food availability and food-acquisition behaviors

Subsistence activities continue to be the predominant method for obtaining food whether from agricultural harvests or gathering wild foods. Survey respondents perceived a decrease in the contribution of each of these subsistence activities in their current household food basket compared with that in 1995. Local cultivation, which included home gardens and agricultural fields, was identified as an important source of food. Most households were observed to have active home gardens of less than a half-acre located adjacent to the house.



Table 1: Food-related activity (%): subsistence, acquisition, habits - from the household survey

Food-related activities [§]	Frequency % [¶] (n=71)
Habits of eating out and food purchasing from stores	
Purchases food from local stores:	
Daily	23
Weekly	51
≤ Monthly	25
Eats out at local restaurants or cafes:	
Never	68
Rarely	19
≤ Monthly	13
Animal husbandry	
Keeps animals for food (mainly cattle, chickens)	92
Perceives amount of food from animal husbandry and cultivation is:	
Less than in 1995	61
Equal to 1995	15
More than in 1995	17
Hunting and gathering	
Family hunted and fished in 2010 (mainly deer or elk, fish, and wild turkey)	61
Family gathered wild foods in 2010 (eg greens and onions)	56
Believes hunting and gathering is:	
Less than in 1995	58
Equal to 1995	28
More than in 1995	4
Subsistence agriculture (home gardens and ranches)	
Household had a home garden in:	
2010	68
1995	70

[¶]Percentages do not total 100 as only significant responses shown.

[§]Food-related activities include subsistence and retail food habits and food acquisition activities.

Staple crops (corn, beans, squash, chili peppers, onions, and greens) were most often mentioned as being planted near the home. In addition to the gardens, almost all families maintained a larger growing area of more than an acre, which they called a ranch, in the surrounding vicinity. The distance from the home and the site of these ranches varied greatly. A few of these ranches were located a short walk from the house because they were located on their residential lot; while others were located a significant distance away and required walking several for hours or car transport to reach them. The greatest contribution to the household food supply came from these local cultivation resources.

Other sources of food included local and ranch-based animal husbandry and hunting. Most of the livestock was maintained at the ranches, although chickens and some animals were also kept near the home. Sixty-one percent of the participants in the household survey indicated someone in their family hunted wild turkeys, deer, and other animals for family consumption, although these are not commonly eaten foods. Animal husbandry provides a much more consistent source of non-vegetable products.

An important theme that emerged from the focus groups was the perception that local climate change has reduced their



agricultural capacity. The focus group participants expressed their opinion that deforestation and changes in rainfall patterns are limiting water-capturing capacity and availability. They indicated that this has affected the amount of land allocated to home gardening and ranches as well as the varieties of seeds cultivated. Linked to the changes in growing patterns, individuals also mentioned that the persistence of subsistence cultivation is in part due to the high cost of staple crop products in the stores and the limited permanent-income opportunities in the region (Table 2).

Participant-observation data were used to expand findings from the other methods about changes in food-related behavior. For instance, when children were present while their parents were being interviewed during the household survey, they were commonly seen consuming chips, chewing gum, or eating candy. Children were also frequent customers in the grocery stores. They commonly ran errands to buy food items for the house and on all occasions were observed to purchase an extra piece of candy for themselves. From the limited observation of children's food habits, no rules were observed regarding what or how much of these items children could consume.

Discussion

In Maycoba and the surrounding communities, the food environment, with regard to food availability and food acquisition behaviors, is in transition from a purely subsistence-based diet to one that also incorporates purchased foods which mainly consist of processed items. The number of grocery stores has increased and so have the quantity and variety of processed foods available for sale. The introduction of refrigeration allows for more perishable items to be sold; in 1995 this was limited by no electricity supply. The prominent placement of processed snacks with high-sugar and high-carbohydrate contents (eg chips and cookies) takes customers' attention as soon as they enter the store. Display boxes and jars of candies fill the cash-register counter, and these items are generally purchased by children.

At first glance these changes in the food environment since 1995 appear to be drastic. The incorporation of regular electricity supply has allowed the stores to sell a wider variety of items, but at the same time the amount sold appears to be relatively small. Processed and purchased foods were not commonly observed in households. Lack of a steady source of income is likely to be the most important limiting factor to retail food sales.

A wider examination of food resources offers insight into household-level changes in the food environment. The number of home gardens is virtually unchanged, although there has been a decrease in size and the variety of plants cultivated across the study area. Animal husbandry, hunting, and gathering are still important food-producing activities, but the proportion they represent in the household food basket has diminished over the last 15 years. Compared with 1995, both the amount of food cultivated in the ranches and the work effort put into growing food by families have decreased. In addition, changes in the local climate are perceived to have affected growing patterns in home gardens and may also be a direct or indirect reason for the decrease in other subsistence activities³⁸.

It is clear that subsistence food activities are important, but the proportion represented of all the traditional activities is in decline compared with 15 years ago. Household food consumption overall does not appear to be decreasing according to observation, and individual and group interviews. Because this community is in transition and integrating behaviors and elements from the outside world, the influence of the current food environment on dietary habits related to obesity and diabetes is partially unclear. Other studies among Mexican Indigenous communities have found both a protective effect of Indigenous status on health⁹ and also a detrimental influence of Indigenous status on health⁴⁵. Mexico, like many other countries in the world, is experiencing high rates of diabetes and obesity although the increases are not uniform across the country^{11,46}. Therefore, it is important to consider the multiple food dimensions in future diabetes research and interventions in this area, especially those that will include local youth.



Table 2: Representative focus group quotes for subthemes related to transitioning food environments

Subtheme	Representative quotes
Gardening as source of food	<p>“Well, for us it is good to produce because there are no jobs, and it is expensive to buy things.”</p> <p>“What we plant now is to eat.”</p> <p>“We try to produce for the house, and we help each other.”</p>
Income limitations & subsistence agriculture	<p>“From the time there was a sawmill, there was work; but now that no more wood comes, people will go back to planting. It will be like it was way before.”</p>
Persistence & change in cultivation	<p>“Everyone [works the garden]. Many times the older people enjoy it also, and the kids too when they get out of school.”</p>

The findings of the 1995 study in this area included the protective effects of the traditional lifestyle of this community despite the genetic predisposition of the Pimas. It was clear that the food environment was a significant contributor to this. As the larger 2010 study data are being analyzed, the findings of the dietary and other health status data need to be considered in conjunction with the food environment findings for future intervention studies in the area.

Limitations

This study serves as a baseline for the food environment in and around Maycoba, Mexico but it has its limitations. While the stores in the area were assessed in a systematic manner, data on the amount and types of actual sales as well as the role of children would be important to investigate in the future to further understand the multiple roles of processed foods. Children were not the focus of this study, but they were observed to be running errands to buy food items at the store and were often seen consuming store bought food (snacks and candies mainly). The household survey was important in determining the role of traditional subsistence activities and identifying changes in these food behaviors. Measuring these changes relied on the memory of household survey respondents and key informants, and inherently has a degree of associated error. This study assessing the food environment and its changes in the past 15 years is valuable, but further research needs to address the validity and reliability of the measures as seen in the critiques in various review articles^{25,29}

Conclusion

Although the changes in the retail food environment and the subsistence food environment have changed noticeably since 1995, these changes are mediated by the fact that the total amount of foodstuffs purchased in stores or restaurants is significantly less than food obtained and prepared in traditional ways. Generally, it appears that changes in the food environment have been gradual and that much energy must still be spent in food cultivation and preparing food at home.

Although there have been a number of changes in the food environment during this 15-year period in Maycoba, the results suggest that a traditional lifestyle is likely to continue at least for the immediate future.

Acknowledgments

This research was funded by award number 5R01DK082568-02 from the National Institutes of Diabetes and Digestive and Kidney Diseases. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Diabetes and Digestive and Kidney Diseases or the National Institutes of Health. The authors express their gratitude to Peter Bennett, Mauro Valencia, Julian Esparza, and Rene Urquidez Romero for their contributions. The authors particularly thank the



population of Maycoba and surrounding communities, and the interviewers and guides for their invaluable contributions.

References

1. Schulz LO, Bennett PH, Ravussin E, Kidd JR, Kidd KK, Esparza J et al. Effects of traditional and western environments on prevalence of type 2 diabetes in Pima Indians in Mexico and the U.S. *Diabetes Care* 2006; **29(8)**: 1866-1871.
2. McNamara BJ, Sanson-Fisher R, D'Este C, Eades S. Type 2 diabetes in indigenous populations: quality of intervention research over 20 years. *Preventive Medicine* 2011; **52(1)**: 3-9.
3. Naqshbandi M, Harris SB, Esler JG, Antwi-Nsiah F. Global complication rates of type 2 diabetes in indigenous peoples: a comprehensive review. *Diabetes Research and Clinical Practice* 2008; **82(1)**: 1-17.
4. Stephens C, Porter J, Nettleton C, Willis R. Disappearing, displaced, and undervalued: a call to action for indigenous health worldwide. *Lancet* 2006; **367(9527)**: 2019-2028.
5. Montenegro RA, Stephens C. Indigenous health in Latin America and the Caribbean. *Lancet* 2006; **367(9525)**: 1859-1869.
6. Anderson I, Crengle S, Leialoha Kamaka M, Chen T-H, Palafox N, Jackson-Pulver L. Indigenous health in Australia, New Zealand, and the Pacific. *Lancet* 2006; **367(9524)**: 1775-1785.
7. Ohenjo N, Willis R, Jackson D, Nettleton C, Good K, Mugarura B. Health of indigenous people in Africa. *Lancet* 2006; **367(9526)**: 1937-1946.
8. Bramley D, Hebert P, Tuzzio L, Chassin M. Disparities in indigenous health: a cross-country comparison between New Zealand and the United States. *American Journal of Public Health* 2005; **95(5)**: 844-850.
9. Stoddard P, Handley MA, Vargas Bustamante A, Schillinger D. The influence of indigenous status and community indigenous composition on obesity and diabetes among Mexican adults. *Social Science & Medicine* 2011; **73(11)**: 1635-1643.
10. Yu CH, Zinman B. Type 2 diabetes and impaired glucose tolerance in aboriginal populations: a global perspective. *Diabetes Research and Clinical Practice* 2007; **78(2)**: 159-170.
11. Rivera JA, Barquera S, Campirano F, Campos I, Saffdie M, Tovar V. Epidemiological and nutritional transition in Mexico: rapid increase of non-communicable chronic diseases and obesity. *Public Health Nutrition* 2002; **5(1a)**: 113-122.
12. Schulz LO, Weidensee RC. Glucose tolerance and physical activity in a Mexican indigenous population. *Diabetes Care* 1995; **18(9)**: 1274-1276.
13. Valencia ME, Bennett PH, Ravussin E, Esparza J, Fox C, Schulz LO. The Pima Indians in Sonora, Mexico. *Nutrition Reviews* 1999; **57(5)**: 55-58.
14. Feng J, Glass TA, Curriero FC, Stewart WF, Schwartz BS. The built environment and obesity: a systematic review of the epidemiologic evidence. *Health & Place* 2010; **16(2)**: 175-190.
15. Pasala SK, Rao AA, Sridhar GR. Built environment and diabetes. *International Journal of Diabetes in Developing Countries* 2010; **30(2)**: 63-68.
16. Panelli R, Tipa G. Placing Well-Being: A Maori case study of cultural and environmental specificity. *EcoHealth* 2007; **4(4)**: 445-460.
17. Rodning C. Place, landscape, and environment: Anthropological archaeology in 2009. *American Anthropologist* 2010; **112(2)**: 180-190.
18. Krukowski R, West D, Harvey-Berino J, Elaine Prewitt T. Neighborhood impact on healthy food availability and pricing in food stores. *Journal of Community Health* 2010; **35(3)**: 315-320.
19. Smoyer-Tomic KE, Spence JC, Raine KD, Amrhein C, Cameron N, Yasenovskiy V et al. The association between neighborhood socioeconomic status and exposure to supermarkets and fast food outlets. *Health & Place* 2008; **14(4)**: 740-754.



20. Maley M, Warren BS, Devine CM. Perceptions of the environment for eating and exercise in a rural community. *Journal of Nutrition Education and Behavior* 2010; **42(3)**: 185-191.
21. Corsi A, Englberger L, Flores R, Lorens A, Fitzgerald MH. A participatory assessment of dietary patterns and food behavior in Pohnpei, Federated States of Micronesia. *Asia Pacific Journal Of Clinical Nutrition* 2008; **17(2)**: 309-316.
22. Kuhnlein HV, Receveur O, Soueida R, Egeland GM. Arctic indigenous peoples experience the nutrition transition with changing dietary patterns and obesity. *Journal of Nutrition* 2004; **134(6)**: 1447.
23. Mavoia HM, McCabe M. Sociocultural factors relating to Tongans' and indigenous Fijians' patterns of eating, physical activity and body size. *Asia Pacific Journal of Clinical Nutrition* 2008; **17(3)**: 375-384.
24. Glanz K. Measuring Food Environments: A historical perspective. *American Journal of Preventive Medicine* 2009; **Suppl4(36)**: S93-S98.
25. McKinnon RA, Reedy J, Morrissette MA, Lytle LA, Yaroch AL. Measures of the food environment: a compilation of the literature, 1990-2007. *American Journal of Preventive Medicine* 2009; **Suppl4(36)**: S124-S133.
26. Santana P, Santos R, Nogueira H. The link between local environment and obesity: a multilevel analysis in the Lisbon metropolitan area, Portugal. *Social Science & Medicine* 2009; **68(4)**: 601-609.
27. Penchansky R, Thomas JW. The concept of access: definition and relationship to consumer satisfaction. *Medical Care* 1981; **19(2)**: 127-140.
28. Caspi CE, Sorensen G, Subramanian SV, Kawachi I. The local food environment and diet: A systematic review. *Health & Place* 2012; **18(5)**: 1172-1187.
29. Kelly B, Flood VM, Yeatman H. Measuring local food environments: an overview of available methods and measures. *Health & Place* 2011; **17(6)**: 1284-1293.
30. Bader MDM, Ailshire JA, Morenoff JD, House JS. Measurement of the local food environment: a comparison of existing data sources. *American Journal of Epidemiology* 2010; **171(5)**: 609-617.
31. Charreire H, Casey R, Salze P, Simon C, Chaix B, Banos A et al. Measuring the food environment using geographical information systems: a methodological review. *Public Health Nutrition* 2010; **13(11)**: 1773-1785.
32. Lytle LA. Measuring the food environment: state of the science. *American Journal of Preventive Medicine* 2009; **Suppl4(36)**: S134-S144.
33. Laferriere JE. Cultural and environmental response to drought among the Mountain Pima. *Ecology of Food and Nutrition* 1992; **28(1)**: 1-9.
34. Felger RS, Wilson MF. Northern Sierra Madre Occidental and its Apachian outliers: a neglected center of biodiversity. In: L DeBano et al (Eds); *Biodiversity and Management of the Madrean Archipelago: The Sky Islands of the Southwestern United States and Northwestern Mexico*. Fort Collins, CO: US Dept of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, 1995: 36-59 .
35. Bye R. Prominence of the Sierra Madre Occidental in the biological diversity of Mexico. In: L DeBano, et al., editors. *Biodiversity and Management of the Madrean Archipelago: The Sky Islands of the Southwestern United States and Northwestern Mexico*. Fort Collins, CO: U.S. Dept of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station, 1995:19-27.
36. Giraldo MA, Chaudhari LS, Schulz LO. Land-use and land-cover assessment for the study of lifestyle change in a rural Mexican community: The Maycoba Project. *International Journal of Health Geographics* 2012; **11(1)**: 27.



37. Pennington CW, Loaiza BX. *The Pima Bajo of central Sonora, Mexico*. Salt Lake City: University of Utah Press, 1979. 410 p.
38. Begay RC, Chaudhari LS, Esparza-Romero J, Urquidez-Romero R, Schulz LO. An exploration of gardens in Maycoba, Mexico: change in the environment of a population genetically prone to diabetes. *The International Journal of Health, Wellness, and Society* 2011; **1(3)**: 89-102.
39. Valencia ME, Weil EJ, Nelson RG, Esparza J, Schulz LO, Ravussin E, et al. Impact of lifestyle on prevalence of kidney disease in Pima Indians in Mexico and the United States. *Kidney International* 2005; **68(Suppl197)**: S141-S144.
40. Smith-Morris CM. Reducing Diabetes in Indian Country: Lessons from the three domains influencing Pima diabetes. *Human Organization* 2004; **63(1)**: 34-46.
41. Ravussin E, Valencia ME, Esparza J, Bennett PH, Schulz LO. Effects of a traditional lifestyle on obesity in Pima Indians. *Diabetes Care* 1994; **17(9)**: 1067-1074.
42. Schulz AJ, Israel BA, Gravlee CC, Mentz G, Williams DR, Rowe Z. Discrimination, symptoms of depression, and self-rated health among African American women in Detroit: results from a longitudinal analysis. *American Journal of Public Health* 2006; **96(7)**: 1265-1270.
43. Tishkoff SA, Kidd KK. Implications of biogeography of human populations for 'race' and medicine. *Nature Genetics* 2004; **36(Suppl)**: S21-S27.
44. Laferriere JE, Asdall WV. Contemporary agricultural patterns in a Mountain Pima village. *Kiva* 1992; **58(2)**: 155-175.
45. Villela GJ, Palinkas LA. Sociocultural change and health status among the Seri Indians of Sonora, Mexico. *Medical Anthropology* 2000; **19(2)**: 147-172.
46. Barquera S, Tovar-Guzman V, Campos-Nonato I, Gonzalez-Villalpando C, Rivera-Dommarco J. Geography of diabetes mellitus mortality in Mexico: an epidemiologic transition analysis. *Archives of Medical Research* 2003; **34(5)**: 407-414.
-