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The Diet and Subsistence Methods of the Maya: Their Health and Cultural Consequences from the Pre-Classic Era to Today

Abstract

The Maya, a once great civilization, seemingly vanished without an obvious reason, before the Spanish landed in the region. Some say that their downfall was a result of famine and inadequate nutrition. Surprisingly, most of the archaeological evidence surrounding the Classic Maya diet and subsistence methods indicates that they both adequately sustained the population to the point where there has been practically no change over hundreds of years. Change did not occur to the Maya diet or the classic subsistence methods until the late twentieth century when the tourism industry exploded in the area of the former Maya empire. The introduction of tourism caused a dramatic shift away from an agricultural economy towards a cash economy. This shift altered the diet and nutrition of the Maya, creating wealth disparities that had never before been faced by the Maya people. Research has now indicated that the modern Maya, due to the effects of tourism and coca-colonization, are in a worse situation regarding diet, subsistence methods, and resulting health complications than the Classic Maya were.

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*The Diet and Subsistence Methods of the Maya: Their Health and Cultural Consequences
from the Pre-Classic Era to Today*

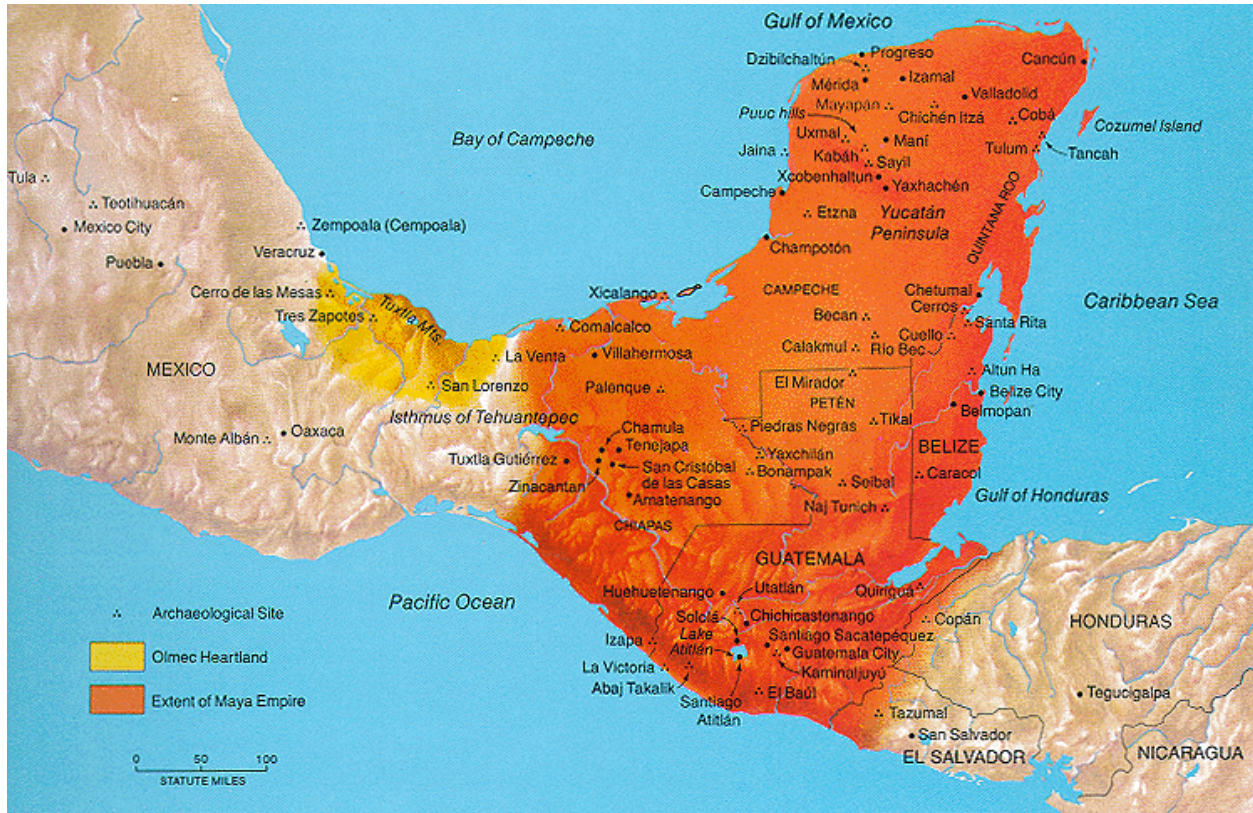
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Map of the Maya Region with many of the sites mentioned in this paper indicated

Introduction

The Maya, a once great civilization, seemingly vanished without an obvious reason, before the Spanish landed in the region. One theory that floats around the field is that the Classic diet and subsistence methods were unable to sustain the people. This, supposedly, led to famine and turmoil which undermined the authority of the leaders leading to the ultimate collapse of the civilization as a whole. However, most of the archaeological evidence surrounding the Classic diet and subsistence methods indicates that both adequately sustained the population to the point where there has been practically no change over the hundreds of years until the introduction of a cash economy focused on tourism. Research has now indicated that the modern Maya, due to the effects of tourism and coca-colonization, are in a worse situation regarding diet, subsistence methods, and resulting health complications than the Classic Maya were with the traditional diet and subsistence methods.

Classic Maya Diet

Classically, the Maya have always received criticism and judgement for their diet. Some view their foods as nutritionally deficient and blame the type of food and subsistence methods for the collapse of this once great civilization. Upon first glance many describe the Maya diet as lacking, with maize as the main staple. Thanks to archaeological finds and the unique theories of many scholars, there are different views on the composition of the Classic Maya diet. Although most research supports the maize staple theory, there are very important theories about supplemental foods which would cause the Maya diet to be more nutritious than previously thought.

One theorist, Bennet Bronson, supports a theory that the Maya utilized crop diversification and used supplements to fill the vital nutritional gaps offered by a maize staple diet (Willey 36). According to him, the maize diet was supplemented with root crops such as sweet potatoes and manioc which have “higher caloric value per unit of land” than other foods (Willey 141). Evidence of these crops can be seen as early as pre-Classic Maya civilization and appear at a variety of sites across the Maya territory (Willey 140). Although there is a lot of evidence to support the supplementation of the diet with different crops, root crops are present at some of these sites most likely as a regional variation. However, some researchers go even further than Bronson’s theory about the Maya diet.

Contrary to Bronson, Dennis Puleston claimed that maize was not the primary staple food, but that ramon (also known as breadnut) was the key to this civilization. He made these claims because ramon was the most efficiently produced food per person per hour of work (Willey 101). The presence of the breadnut trees in the compounds and Puleston’s discovery that ramon could be stored for long periods of time cause it to be the “line of least resistance” for Maya nutrition (Willey 141). Puleston’s beliefs are still highly controversial in the field and never gained much standing; instead ramon is viewed as a possible supplement to maize or a famine food. According to Sanders, ramon is variable year to year and has a cultural view today as a second-class food that is a poor substitute to maize and these negative stereotypes were likely the same in Classic times (Willey 102). Both Bronson and Puleson made the claim that there was only one staple food crucial to the Classic Maya diet, however, further research has shown that the reality may not have been so simple.

It is most likely that the real diet of the Classic Maya was a combination of all the theories and follows a standard most similar to Netting’s Model. Netting’s Model is an

ethnographic study of subsistence in the tropical forests of Nigeria, specifically the Ibo Tribe (Willey 84). This tribe in Africa, though located on the other side of the planet, does exhibit a similar environment to where the Maya live. Therefore, it is reasonable to hypothesize that the people of the Ibo tribe would have similar subsistence methods to the Classic Maya. This theory suggests that the groups would use an “Infield-Outfield” cultivation system (Willey 84). This means that they would use both household garden plots (kitchen gardens) as well as more extensively grown crops farther away from the houses to grow staple foods in larger quantity (Willey 84). This supports Bronson’s theory of crop diversification but goes further. The Maya diets would be supplemented not just with root crops, but also with orchards providing fruit and nut trees (including ramon). This theory has since been thoroughly tested by the several different field studies and has successfully stood up to archaeological finds.

One such archaeological site that works to support the Netting’s model is Cerén, El Salvador. Researcher, Michelle Woodward, made a remarkable archaeological discovery into the diet of Classic Maya by her excavation at Cerén—a perfectly preserved Maya town frozen in time by a volcanic eruption. Here the world discovered that based off of the presence of plant remains in milpas, storage areas, and kitchen gardens the people who lived here were concerned with food security and nutritional values (Woodward 22). Here the staple crop was maize which is a “good source of carbohydrates (energy) and provides significant amounts of oil, vitamin A, thiamine and phosphorus” which also has relatively good storage capabilities (Woodward 23). Maize was not the only food that was produced at this site. There seemed to be a clear importance on supplementing the diet. There were a variety of other crops found at the site including: “legumes, cucurbits, manioc, chile, cacao, nance, hackberry, cotton, gourds, capulin, avocados, pine, guava, and more” (Woodward 24). This site demonstrated the infield/outfield

agricultural method suggested by Nettings' Model. The mass produced staple foods at Cerén were maize, legumes, and cucurbits; the other various fruits and vegetables were found in kitchen gardens. There was also wild animal protein remains found suggesting some hunting to supplement with protein (Woodward 26). The crop diversification through the infield crops would have perfectly supplemented nutritional gaps in a maize-legume diet and show that the nutritional requirements of humans would have been met by the diet at this site (Woodward 30). This find counteracts the popular theory that the Classic Maya did not have nutritious diets and were plagued by famine and food insecurity. Though it is only one site, the remarkable preservation speaks volumes about the diet and nutrition of the Classic Maya.

Unfortunately, the majority of Maya sites are not as well preserved as Cerén; the climate in these areas does not provide optimal conditions for substantial conversation. Therefore, different subfields of bioarchaeology have been utilized in an attempt to uncover the mysteries of the Classic Maya diet. Scientific advancements now allow for trace amounts of bone to be analyzed for isotopic values, detailing the chemical profiles of the foods consumed so long ago. Isotopes are present in everything and all isotopes contain unique signatures. Once these signatures are discovered for specific foods, bone remains can be cross checked for these isotopes. This is used to discover how much of their diet was comprised of specific foods and more generally what types of food they were eating. David Reed analyzed the diet at another significant site known as, Copán, by looking at isotopic signatures from bone remains, paleobotanical analysis, paleopathological analysis, and social interpretation of the archaeological record (Reed 211). In his analysis, Reed discovered animal remains from deer, peccary, dog, paca, rabbit, as well as jaguar and puma. However, the last two were only in ritual contexts (Reed 212). The plant remains found at this site included maize, beans, squash, nance,

chayote, bottle gourds, wild grapes, palm/ coyol, ciruela, avocado, zapote, hackberry, and more (Reed 212). Reed's findings suggest that the staple foods in Copán were similar to Cerén and thus included: maize, legumes, and squash with a variety of supplemental foods (Reed 212). Although Reed also found there were notable absentee crops at this site, namely sweet potatoes, manioc, ramon, chili peppers, and cacao; this absence could be explained by simply accounting for regional differences (Reed 212). Manos and metates were also found at the site, which are tools that were used to process maize (Reed 212). No tools were found that would be used to process root crops or ramon which solidifies the idea that maize acted as the staple here (Reed 212). Isotopic analysis of bone remains support the paleobotanical and archaeological findings that the people at this site had a diet rich in maize with some small supplement from other sources (Reed 213). Another study at Copán suggested a diet rich in C4 plants (primarily maize) that was supplemented with small amounts of other foods (Whittington 160). The primary source of meat was deer, but isotopic analysis shows that meat was only a very minor part of their diets otherwise the deer and human samples would have had more similar isotopes. These findings are pretty uniform across the former Maya territory. Besides isotopic analysis, phytolith and starch records from dental remains can also provide insight to diets of the deceased.

Phytolith and starch analysis of food remains in tooth tartar is a newer method to examine the diet of remains. The site analyzed in the study done by Linda Scott Cummings and Ann Magennis was Kichpanha in Northern Belize. The study was hoping to explore the possible staple foods such as maize, root crops, or even ramon (Scott Cummings and Magennis 213). Maize starches were found on the dental remains of 86% of the sample, suggesting that this was the staple food (Scott Cummings and Magennis 217). Other phytoliths and starches were discovered in their sample, suggesting supplementation. In 36% of the sample there was manioc

starch and 29% of the individuals had *Palmae* phytoliths, or fossilized remains of palm nuts (Scott Cummings and Magennis 217). Thus, most of the archaeological and biological evidence suggests that the staple food for the Maya was maize.

Therefore, based upon previous field research and multiple theories, it is likely that the Maya had a primarily maize-legume diet that was supplemented by a large variety of fruits, vegetables, and some meats. There were regional variations among the Maya as to what specific supplements were consumed (for example ramon in North East Petén and root crops in Cerén). It is thought that more than 80% of the food consumed was maize and beans leaving only the remaining 20% to be comprised of these supplemental foods (Higbee 460). The subsistence methods used by the Maya are also debated by archaeologists.

Subsistence Methods

An important part about understanding the diet of the Classic Maya is knowing how they produced the food. It is most commonly believed that the major subsistence method of the Maya was—and still is—a slash and burn clearing method known as milpa farming. The Classic Maya were not engaged in much commercial agriculture and mostly grew for their own families and to pay taxes (Higbee 458). The soil of the Yucatan is generally shallow and leached of most minerals that are needed for successful productivity. Milpa farming or slash and burn agriculture is okay on a small scale but is destructive on a larger scale. It is a challenging subsistence method because even though burning the forest does fertilize the soil, it only lasts for a few growing seasons (usually three) and then requires a lengthy fallow period to allow for second growth (Higbee 459). This “shifting agriculture” was a long rotation constantly requiring moving to new land and subsequently returning to old land after regrowth had occurred (Higbee 461). This subsistence method is considered to yield limited amounts of crops. Many theorize that the

limited food production did not successfully support the increased population which led to famine and food insecurity. Ultimately, becoming one possibility for the Maya decline, but there is evidence suggesting other possible subsistence methods and signs of agricultural intensification.

It is unlikely that milpa farming alone produced the entire diet. It is more likely that the Maya used a combination of subsistence methods such as “short fallow milpa, crop rotation, companion planting, hand weeding, mulching, multiple annual cropping, kitchen gardens (“infield”), crop diversification including tree and root crops, terracing, and raised field farming near streams or still water” (Willey 98). The signs of agricultural intensification are supported by some and dismissed by others. Large scale terracing can be seen in the Rio Bec region of the central Yucatan Peninsula as well as in Western Belize. These terraces are comprised of “some degree of stone construction as silt traps and to prevent erosion” (Willey 98). There is more than 10,000 square kilometers of this terracing which would have required a large amount of labor to create and maintain (Willey 141). Other evidence shows that there were raised fields on the banks of the Rio Candelaria, which is on the western edge of the lowlands that are similar to the chinampas in Central Mexico and bajo areas in other places in the peninsula (Willey 99). The most significant find was that there were “hundreds of square km [of canals] that can be seen from the air over Quintana Roo” in the Yucatan (Willey 99). This grid like canal system would help to “maximize natural resources, variability in crops, and was a huge labor investment in large scale agricultural intensification” (Willey 142). The presence of these agricultural structures shows that there was some public “expenditure of effort” to improve agricultural sustainability and output in this region by the rulers (Willey 98). Objectors to this evidence, such as Dennis Puleston, claim that these are just natural formations, for example the “canals” are just

gilgai (Willey 99). Based off of further analysis, these counterclaims seem highly unlikely. However, the presence of these various structures was not consistent throughout the Maya territory due to geographic variation that would render such structures impractical. The evidence of the Classic Maya agricultural intensification suggests that they practiced some aspects of obtaining food security, which is shown through other safeguards at the archaeological site, Cerén.

Consequently, with a main subsistence method of slash and burn agriculture, in an area prone to drought, with crops that are unreliable, there is a lot of evidence suggesting routine famine and food shortages. There is evidence that the Maya learned ways to combat this insecurity. The citizens of Cerén were clearly prepared for crop failure by growing drought resistant crops such as squash and manioc (Woodward 25). They had also developed techniques to preserve and store surplus foods for times of famine or shortages such as drying and processing the foods before placing them in storage vessels, ground storage, and hanging (Woodward 25). Some of these methods are still used today. There is also evidence at this site of agricultural intensification. The volcanic soil was very nutritious which helped to yield a higher amount of crops. The Maya here used the traditional slash and burn agriculture that is thought to be the signature of these people. The milpas were relatively close to the house which helped ease the maintenance of these plots, and the perfectly preserved fields show the ridges and furrows created by the farms to “promote the stability and growth of their maize plants [and] to facilitate water absorption and run-off within the fields” (Woodward 26). There is also evidence of “fallowing and field burning/clearing to improve food production in the fields adjacent to their household compounds” (Woodward 26). This site demonstrates that the Maya were more prepared for crop failures than previously thought.

Even though milpa farming has its faults and the environments that the Maya lived in were not perfect, archaeological evidence supports that the Maya were producing enough food. The subsistence methods used as well as the types of foods produced are just a piece of the puzzle to understanding the Maya diet. Not all Maya had the same diet, and often times social status, gender, and age affected the types of foods an individual would have access to and consume.

Socioeconomic, Gender, and Age Dietary Differences.

In many societies, diet can differ based on social stratification and even by the age and sex of an individual. There is evidence showing dietary differences among the Maya based off of socioeconomic standing, gender, and age within the population. Skeletal remains can share information about the life that person once lived and a glimpse of the society. At various excavation sites, there is evidence of socioeconomic, gender, and age related nutritional differences in the skeletons.

At sites that clearly demonstrated social stratification, there were dietary differences between those of different statuses. Often there was a certain food that served as a symbol of wealth and prestige. However, there was regional variation over which food was considered the most prized. At Pacbitun, elites were defined by heavy maize consumption, but at Lamanai, which is closer to the sea, high status was more defined by high nitrogen levels which can be attributed to consumption of marine protein (White et al. 366). This shows that even though the food that was considered the most prized by one region may vary in another. However, in both areas this evidence demonstrates that there was a clear pattern of socioeconomic status being

shown in dietary differences.

Among the ancient Maya there were clear diet markers that differed based on social standing in the society. At Pacbitun, maize consumption was thought to be a symbol of status and the level of consumption differed by social standing. Based off of grave type and isotopic analysis, it was concluded that individuals buried in crypts, the most elaborate burials, had the highest consumption of C4 foods (70% of their diet); whereas urn children, the lowest social ranking burials, had the lowest amount of C4 consumption (only 51% of their diet) (White 363). When considering social statuses, researchers from different sites also found that there were dietary differences depending on station. For example, at Copán, Reed found that the higher status burials yielded a wider carbon isotope distribution than lower status ones (Reed 215). In other words, the elites had a much more varied diet than commoners. This isotopic analysis was also paralleled with the bone and paleobotanical remains found at this site (Reed 215). These findings show that maize consumption and dietary variety was a sign of socioeconomic position for the Maya at these sites. However, these findings also work to prove that *status* is more significant than *gender* when looking at access to maize.

Regarding gender, at Pacbitun, all analysis showed that adult men had more maize consumption than females and children. A crypt female (elite), had signs of the lowest maize consumption compared to all the other crypt burials, but when compared to rural pit burials she had nearly twice the C4 values of the rural male counterparts (White et al. 365). While at Copán, isotopic analysis showed that male and female maize consumption of individuals with similar status differed only slightly, by .5%, which suggested that gender was a social factor on diet but at this site, it was not statistically significant (Reed 216). These findings suggest that regarding dietary differences, gender was not as large of a factor as social status was. In addition to the

differences found with socioeconomic standing and gender, age was also an influencing factor to determine diet.

Reed's study showed that age was a significant factor in diet as well as gender and social standing. At Copán, isotopic analysis of skeletal remains showed that as the age of an individual increased their maize consumption decreased (Reed 215). This suggests that if a family had a variety of foods, they were saved for the adults and the children would get mostly corn, which was their staple crop. This is a very important finding considering that children are at the most risk for nutritional deficiencies causing stunting or other effects.

The work done at both Copán and Pacbitun show evidence of dietary discrepancies among the skeletal remains. These differences were a result of the age, gender, or most commonly socioeconomic standing of the individual. These finds show that there was an inherent dietary inequality within the culture of the Maya. The dietary differences among the remains also relates to the evidence for disease among the Maya. The quality and contents of diet paints a picture of nutrition that provides insight on overall health and disease.

Nutrition Related Diseases and Health Effects

In addition to providing information about diet, skeletal remains preserve evidence of diseases and can record nutritional stress. Studying the paleopathology can show different types of illnesses that the individual suffered and when (/if) they suffered nutritional stressors. The remains of the Maya, which have been able to be studied, do show signs of illness. At various excavation sites, there was evidence of nutritional related markers such as enamel hypoplasia, porotic hyperostosis, and stature differences.

Enamel hypoplasia are lines on the teeth in the enamel that develop at times of extreme

nutritional stress. The exact development rate of teeth are well known and relatively uniform, therefore, studying the location of the hypoplasia can tell the age that the stress occurred. Enamel hypoplasia most commonly is caused by malnutrition, infectious disease, or a combination. At the Maya site of Cuello, enamel hypoplasia most commonly occurred at 3-4 years old and was present in 59% of the sample (Whittington 34). This was most likely from weaning stress, possibly heightened by malnutrition or infectious disease. Further research showed that larger sites had more childhood health disruptions, evident by the presence of enamel hypoplasia, than smaller, rural areas (Whittington 137). This suggests that the diet and food security was better in rural areas, possibly because families were growing their own foods. Although, enamel hypoplasia is not the only indicator of poor childhood nutrition.

In addition to enamel hypoplasia, anemia is also present among the Maya skeletons. Anemia is a nutritional deficiency of iron, which is “the most common nutritional problem in the world” (Wright 924). Infants need more iron than adults because of their rapid development. Classic Maya children had very high rates of anemia, possibly from a combination of a low iron diet and poor iron absorption from having intestinal parasites or other micronutrient deficiencies (Wright 925). Porotic hyperostosis and cribra orbitalia are signature skeletal deformations that indicate anemia. As a bodily response to anemia, the vault of the skull becomes porous and spongy (porotic hyperostosis) and cribra orbitalia are lesions in the orbital roof. In young infants, cribra orbitalia occurs first and then in more prolonged cases the porotic hyperostosis develops (Wright 925). Lesions that are active at the time of death look different than healed or partially healed lesions. Healed lesions are filled with new bone which will remodel the lesions and the skull more (Wright 925). In Central America, severe anemia was a problem because of their iron poor diets and prevalence of parasitic infections. Findings at both the Playa del Carmen

and Tancah sites show abundant presence of porotic hyperostosis and cribra orbitalia in adults with signs of healed anemia (Wright 927). Anemia was extremely common among the Maya according to other archaeological finds: 32/36 of the Alter de Sacrifice skeletons, 24/36 of skeletons studied at the Peabody museum, 52/54 skeletons at the National museum of Anthropology in Mexico, and 4/11 skeletons at Tancah all had anemia (Whittington 59). In addition to all of these, out of the 288 skeletons from the Playa del Carmen site, 33.33% had porotic hyperostosis, 40% had cribra orbitalia, and 11.76% had enamel hyperplasia (Whittington 60). These are very important findings but there is a caveat.

This is a clear sign that the Classic Maya diet had serious nutritional gaps, but there is also evidence that many people were living to old age despite severe anemia, and many had signs of healing lesions. The signs of healing are important to consider. It is possible that the presence of porotic hyperostosis and cribra orbitalia are not signs of the severity of the anemia, merely the length of time they had it. The high prevalence of these indicators of anemia show that there was a nutritional gap in their diets but that it was not necessarily severe. This could also mean there were not many other health stressors that caused people, weakened by the anemia, to die. Enamel hypoplasia, porotic hyperostosis, and cribra orbitalia are physical markers on the skeletal remains that indicate nutritional deficiency; however, they are not the only indicators present among the Maya.

Another indicator of poor nutrition or nutritional deficiencies was stature. The analysis of skeletal remains at various Maya sites showed that the average heights of the people varied depending on the period that they were from. Stature is determined by measuring the long bones or the femur, tibia, humerus, and ulna. It was found that for Pre-hispanic Maya in the Yucatan Peninsula, the average lengths of the long bones were greatest during the Pre-classic era

(Whittington 55). The average lengths then dropped overall during the Classic era but the sample size was much larger (Whittington 55). In the Post-classic era, the average lengths increased but did not reach the Pre-classic averages (Whittington 55). The drop in average lengths from Pre-classic to Classic suggests that the quality of nutrition also dropped during this time period. This could be because increased population density caused stress on the available food supply and increased the incidence of infectious disease. Then as the values recovered in the Post-classic era, it suggested that the nutrition improved during this time, possibly because of a lower population density. This shows the importance of nutrition on overall health and stature. It also shows how wider social change, such as increased population density, can have domino effects and change the health of the entire population.

The diet of the Classic Maya had nutritional gaps that led to the skeletal markers and stature changes in the population. That being said, the diet was sufficient enough to remain practically the same from classic time all the way into the 1970s. Major dietary shifts did not occur until the economy and lifestyle of the Maya were radically changed with the introduction of a cash economy. This economy, focused on tourism, began in the late twentieth century, caused enough change to overtake the milpa agriculture for what appears to be the first time.

Early Modern Tourism Diet (1970s/1980s/1990s)

The diet of the Maya remained very similar to the Classic times for a long time, until the shift away from the traditional culture towards working in the service industry occurred. In the 1970s, the main staple and the source of calories was still maize supplemented with beans, squash and chile peppers, helping to provide protein and vitamins (Kintz 77). The diet was also supplemented with fruits such as mandarin oranges, sour oranges, limes, papayas, avocados, and bananas (Kintz 77). Other supplements besides fruits included herbs, tomatoes, chiles, onions,

garlic, and tobacco (Kintz 78). One major change from the Classic era to modern Maya is increased meat consumption. In early modern times, Maya increasingly consumed eggs, chicken, turkey, pork, and beef to supplement the diet that is mainly composed of corn, beans, and squash (Kintz 8). As the tourism industry exploded in this area in the 1980s and 1990s, the diet of the natives saw more major shifts away from the traditional Maya foods that were still making up the majority of the diet in the 1970s.

When the tourism industry grew, foods became more commoditized. This led to the Maya becoming “increasingly dependent on non-traditional and store bought foods” (Leatherman and Goodman 835). This introduced new processed foods into the diet. Local diets often included commercial foodstuffs like rice, pasta, soda, and processed snack foods (chips, candy, etc.) (Leatherman and Goodman 838). Small local stores would have some fresh foods such as tomatoes, potatoes, cabbage, carrots, onions, garlic, peppers, and seasonal local fruit (Leatherman and Goodman 838). Many small local stores could not keep a variety of foods in stock because of isolation and limited storage capabilities. People would have to travel to larger cities to get a more varied food supply. This shift from locally produced foods to market based consumption has been “associated with negative impacts on nutrition in developing countries” like Mexico (Leatherman and Goodman 835). When the Maya began to rely on store bought food there were social and cultural shifts as well as nutritional.

The economic shift from an agricultural economy to a service based tourism economy had ripple effects in social and cultural values as well. The family sizes decreased because there was no longer a need to have many children to work on the milpa. In addition, there was a shift away from a strong dependence on the larger extended family to a smaller focus on the immediate, nuclear families. The startling cultural shift from the Classic Maya’s dependence on

corn to the early modern disregard for traditional crops can also be seen in tortillas. Corn tortillas were a common staple in Maya households. With the economic shift, they became stigmatized as an inexpensive food to fill the stomachs of poor families (Leatherman and Goodman 840). Corn tortillas transitioned from a highly regarded cultural symbol and staple food to more people eating white flour tortillas which do not have the same nutritional benefits (Leatherman and Goodman 840). Diet is more dependent on economic and social trends than one may think. Alarmingly, “the consumption of junk food and carbonated beverages was widely spread in all the wealth groups... Coca- Cola was preferred to milk” (Robles-Zavala and Fiechter-Russo 195). The cultural shifts also are seen in the new preferences for processed, surgery goods which are directly linked to campaigns from the soda companies.

The most serious dietary shift has been a result of Coca-colonization. As a part of the commercialization of the food industry in this area, Coca Cola and Pepsi began a cola war. The increased prevalence of the soda, assorted chips, cookies, candies, and other high-sugar, high-fat, empty calorie snack foods had serious nutritional and dietary consequences on the Maya in these areas (Leatherman and Goodman 838). The increased exposure to these junk foods caused an increase in consumption. In areas that tourism was bigger, the diet was comprised of “half the tortillas, three times the soda and snack foods, three times dairy, twice the fruit, and from one and a half to four times the meat contribution to calories” (Leatherman and Goodman 839). These places show a less classic diet and a more general shift away from Maya cultural traditions, foods, and subsistence methods.

In the early modern era, the Maya moved away from tradition and towards a more western lifestyle and cash economy. This cultural transition can be seen by analyzing their diet and food preferences. The major contributing factor to this cultural and dietary shift was the stark

change in the economy. The shift from an agricultural economy to a cash economy because of the growing tourism fosters the larger cultural and dietary deviations.

Early Modern Subsistence Methods and Transitioning Economy

It is striking how the diet of the Maya did not change very much until the economy began to transition to a service/tourism based one. In the 1970s, the majority of the staple foods were grown in the milpas with a variety of supplemental foods grown in the kitchen gardens (Kintz 10). In the milpas, corn, beans, squash, root crops, jicama, and some other fruit trees were grown and were worked on by men (Kintz 27). On the other hand, the kitchen gardens in the yards of the house compounds, had fruit trees, herbs, smaller scale vegetables and domestic animals (chicken, pigs, turkeys, and goats) (Kintz 11). These were tended to by the women to supplement the diet, as in classic times (Kintz 11). There were also families that made a living by keeping cattle and apiculture (bee keeping) (Kintz 13). But still in the late 1970s “every family in Coba agree[d] that the route to economic success is through the cultivation of large milpa plots” (Kintz 25). This belief about subsistence methods quickly declined through the 1980s and into today because of the unsustainable methods of farming and cultural shifts that created a stigma against working milpas.

Milpas are the traditional slash and burn agriculture that the Maya have been thought to use for centuries. In modern times, this method of agriculture becomes increasingly difficult. With higher population densities and more rigid concepts of property ownership, farmers cannot have the extremely long fallow periods that are needed to fully restore the nutrition into the soil. More so, to use modern machinery for farming the Maya would have to permanently destroy the forest by removing the stumps of trees (Higbee 463). After only a few years of plowing, the shallow soils of the Yucatan would be severely damaged by erosion and totally depleted of

nutrients (Higbee 463). The reliability of the crop yield would drop, the ability to compete with farmers from better environments would fall, and the overall success of the milpas would tumble. Even though in the 1970s that area was still very isolated from the rest of the world and seldom touched by the effects of tourism, soon their culture, diets and economic structure would be changed forever.

The tourism industry took off very quickly in the Yucatan peninsula of Mexico through the 1980s. This rapidly changed the landscape, economy, and culture of the native Maya who still lived there. According to Leatherman and Goodman, “tourism development affect[ed] environmental degradation, water quality, nutrition, and health” of the native people and it also causes “environmental resources, labor, and food to be increasingly commoditized ... disruptions to environment, economy, culture, and health are inevitable” (Leatherman and Goodman 834). The Maya, who had maintained their cultural autonomy for centuries, now have increasing exposure to the Western world and cultural ideals thanks to improved infrastructure and the tourism boom.

Subsequently, tourism began to overtake the Maya economy. This overhaul of the economy caused the reliance on milpa farming and kitchen gardens to plummet while the dependency on urban centers and service jobs increased (Leatherman and Goodman 835). In addition to the shifts in subsistence methods, the culture also saw major changes. In both the early modern times and today, milpa farming is thought of as “trabajo rudo” or rough work by the younger generation (Leatherman and Goodman 835). This stigma associated with milpas causes the youth to have little to no interest in pursuing milpa agriculture as a way of life. The resulting shift away from milpa farming had ripple effects in the general culture. In these villages, as milpa farming declined the family sizes also decreased, the likelihood of families

pooling their resources to help each other declined, and the closeness of families in general was eroded. This economic and cultural shift showed “an erosion of the very meaning of family and community and, in more practical terms, means an erosion of social and economic security for parental generations” (Leatherman and Goodman 835). Without the large families as a source of labor, the entire basis of Maya life was uprooted. This causes more financial and food insecurity and cultural panic as the tourism economy resulted in economic disparities within the communities.

Regrettably, the economic shifts towards the tourism economy did not help the Maya. Poverty is extremely prevalent in this area of the world and has had devastating nutritional and health consequences. The perception of poverty is very interesting because it varies from person to person. Overall, in rural areas, men associated poverty with agricultural productivity, whereas women associated poverty with family dynamics such as food insecurity, drugs, or violence (Robles- Zavala and Fiechter-Russo196). Robles-Zavala and Fiechter-Russo’s wealth study in the Yucatán peninsula ranked wealth in regard to food security as follows: wealthy has year-round food security, middle wealth has generally good food security with seasonal worsening, and the poorest are in a food deficit most of the year (Robles-Zavala and Fiechter-Russo 197). The study concludes that “the richest are those that have a salary and do not depend on the milpa” (Robles-Zavala and Fiechter-Russo 197). Food security in this area is low for the Maya. Work is often seasonal and the wages are sporadic. In the busy season a family may be financially fine but then in the slow season they could struggle. By no longer producing their own food, the families are at the mercy of the markets. In the Yucatan Peninsula, the “rapid economic development leads to large disparities in wealth rather than increased wealth for the population as a whole” (Leatherman and Goodman 835). This extreme disparity among the

people, leave many “unable to avoid market prices, and decreased subsistence production coupled with an inability to purchase foods will lead to reduced dietary diversity” (Leatherman and Goodman 835). The new economy created greater wealth disparities within the Maya than in Classic times.

The shift from an agriculturally based economy to a cash economy focused on the tourism industry has left the Maya in the Yucatan with less dietary diversity. Their limited wages and lack of nutritional diversity can cause food insecurity and nutritional gaps. As a result, the tourism industry has left the Maya people in some places with greater food insecurity than ever before and the nutritional and health consequences are clearly reflecting that.

Effects of diet (nutritional deficiencies and consequences)

Diet and food security is directly related to the economy and wealth of individual families. The shift away from producing their own foods to relying on markets, when they have limited monetary resources, has left the Maya struggling with dietary shifts towards unbalanced nutrition and the incorporation of processed foods. These shifts triggered health consequences. These health consequences have developed just since the 1970s when the economy and cultural shifts began.

In the 1970s, Ellen Kintz’s research revealed that protein was only a sporadic component of diet for the Maya children and adults (Kintz 37). Much of the meat consumed was by chance from hunting for the poor families (Kintz 37). Regular meat consumption was exclusively for the wealthy that had the ability to own livestock such as chicken, turkeys, and pigs or had the money to buy excess meat from families who owned livestock. She concluded that protein from meat was “desired by all [but] limited by money” (Kintz 37). This posed an issue especially for

children. The rapid development that children undergo requires them to have more nutrients than adults. Infants would be getting enough protein and other nutrients from their mother's breastmilk, so long as they were breastfed. However, weaning stresses and nutrient deficiencies in childhood can have devastating health consequences. Chronic malnutrition was present in this area. This results in stunting and predisposed children to infectious diseases and other health complications which was noticed by the Mexican government.

The Maya children of Mexico were plagued by undernutrition. Undernutrition is shown in a population by a "high prevalence of underweight and stunting" (Cuanalo De La Cerda et al. 38). The Mexican government has tried to fight this serious issue with a program called "Oportunidades" which aimed to "improve the nutritional status of families with malnourished children" (Cuanalo De La Cerda et al 38). In the small village of Tabi, a study was conducted to research the health and nutrition of the infants there. After a series of measurements were conducted by researchers, the infants were categorized as undernourished or normal in terms of growth and development (Cuanalo De La Cerda et al. 39). It was found that all of the mothers with undernourished infants were receiving aid from the government "Oportunidades" program (Cuanalo De La Cerda et al. 39). This shows that the program was not efficiently combating the chronic issue of undernourishment in these areas. After looking at a 24-hour dietary recall for the undernourished children it was discovered that the undernourished infants on average were 72% short of their daily energy intake for their weight (Cuanalo De La Cerda 42). These children were born at a normal weight but they were then stunted for height after 3-4 months and for weight after 6 months (Cuanalo De La Cerda 44). This shows that the problem was rooted in their diet. Globally, many cultures believe that because children are small they only need to eat a little, but this could not be farther from the truth. Children need nutritious foods in the correct

quantities to ensure proper growth and development. The growth and development in this area was stunted not only by poor diet, but also because of prevalent parasitic intestinal infections and respiratory infections (Cuanalo De La Cerda 45). Mothers needed to be educated on the proper nutrition for children and the dangers of intestinal parasites. The government “Oportunidades” program should have incorporated an educational aspect to improve results. This research showed that the “Oportunidades” program was not successful as stunting continued to be prevalent.

Stunting was a serious problem in the Yucatan. Maya children were shorter than the World Health Organization averages for their ages. Comparing the height of Maya children from “1938, 1987, and 1998 revealed increases in child growth” but these increases were about “half the rate observed for Maya children who migrated to the US” and Maya born in the US are of normal stature (Leatherman and Goodman 842). In 1998, “65% of Yalcoba children were stunted... and 20% were very stunted” (Leatherman and Goodman 843). These high levels of stunting show that malnutrition was still very high in this area during the 1990s.

Malnutrition is not just defined as the absence of needed nutrition, but also an excess of the wrong nutrients leading to obesity. Even though the Yalcoba children were under-height for their age set in comparison to the world, many were “above average weight-for-height” (Leatherman and Goodman 843). This suggests that their “caloric intakes [were] in excess for some children” (Leatherman and Goodman 843). This would point to eating too much of unhealthy foods, while still not getting the necessary nutrients that they needed to properly grow and develop.

Health is very closely related to diet, which walks hand in hand with subsistence methods. The recent changes due to the transitioning economy have had ripple effects in all areas

of Maya life. In order to see if the transitioning economy is still effecting the small villages of the Yucatan, primary research is needed.

Coba Today

In January 2017, as a senior, I traveled with Dr. Kristi Krumrine, Dr. Melinda Lull, and several other anthropology students to Coba, Mexico. Here Dr. Krumrine has been researching the nutrition, growth, and development of a cohort of children who live in the village. This firsthand look into the life the Maya are living today gave me a better perspective into their diet and nutrition, while also giving me vital exposure to firsthand fieldwork.

Coba, Mexico is located on the southern side of the Yucatan peninsula, just a few hours inland from the Caribbean Sea. We arrived in Mexico by flying into the Cancun airport and then driving several hours through dense jungle to the village of Coba. This initial trip shows the differences in the effects of tourism in this area. In Cancun, the extreme modifications to target tourists is stifling. Directly outside the airport there were multiple stands selling alcoholic beverages, countless advertisements for resorts, clubs, and other tourist traps. The entire atmosphere is focused on spring breakers or other tourists coming to drink and party in the sun. As a result, the work in the tourism industry is more consistent, and the people living in this larger center have access to more diverse foods. After the constant chaotic energy in Cancun, with its eight lane highways and where stoplights are suggestions, driving away was a relief. As we exited the city it was remarkable how the roads were cut through the jungle, leaving the forest so close. It seemed like the wilderness biding its time, waiting to overtake the industrialization. Just a couple hours away from Cancun, in the smaller village of Coba, the divide between the old and new ways is striking.

Walking through the village, it is clear that there is a cultural tug of war currently waging in this area. The older generations still speak Maya, the older women still wear the traditional Huipil (Maya embroidered dresses and shirts), whereas, the younger generation only speak Spanish and wear western style clothing. Many now work on the Coba Archaeology Site instead of in the milpas, but the tourism here is startlingly different than in Cancun. The tourism that comes to Coba is to see the classic site, that has the tallest pyramid in the Yucatan (Nohoch Muul) as well as Cenotes—underground caves that are filled with crystal clear fresh water—that scatter the entire peninsula. Often times people come in for a few hours and leave for one of the larger, more famous sites. As a result, this area faces more than just the cultural transitions due to the increasing shift towards tourism. There are also large disparities faced due to the lack of resources the industry has left them with.

The sporadic work and little wages are hurting the Maya in this small village. The houses and lifestyle show the disparities and lack of resources they struggle with. Several Maya in Coba still do not have running water, working bathrooms, garbage disposals, or even postal service. All of the running water in Mexico is not safe to drink and families need to buy bottled water to drink and cook with. Some still only have outdoor kitchens and cook over a fire instead of an electric or gas stove. This being said, nearly every person has a cellphone—often smartphones—television, and internet access. These modern amenities are easier to access than things that are considered necessities. Many of the families still use thatched structures as part of their housing compounds and only the better off families can afford a cinderblock house. This was very striking because when going into these thatched structures and seeing a television or an internet router it just does not seem expected that these modern amenities would be incorporated into traditional house structures such as these (see figure 1).



Figure 1: Here is one of the houses that we interviewed in, depicted is a classic thatched structure with the Maya hammocks visible and a television playing.

The poor economic standing, irregular work, and shifting cultural beliefs also have an impact on diet. The people in Coba have to buy bottled water to drink and cook with, but a competitor to water is soda. Coca-colonization has successfully infiltrated this village and the negative results are clear. The Maya people are losing a culture, including diet, that has withstood so much because of the shifting economy.



Figure 2

This picture perfectly sums up the cultural tug of war being waged in Coba today.

Towards the left of the frame the family matriarch is shown wearing a traditional Huipil whereas everyone else is in western clothes. The thatched structures are shown in the background but front and center on the table are two bottles of Coca Cola, one nearly empty. The shifting culture and subsistence methods has an important impact on the diet and nutrition of the people who live here and are important to take into consideration. My own research focuses on the shifting diet and subsistence methods that show there are even more shifts now, solidifying economic disparities and unhealthy dietary transitions, that will soon be shown in rising health concerns.

Methods

Dr. Krumrine has been coming to the village of Coba for many years for her own research. Dr. Krumrine is looking at how the shift from an agricultural economy to a cash economy—focused on tourism—is affecting the diet and nutrition of the village children and their growth and development. As part of her research, she measures the same group of children yearly and conducts interviews with the children's mothers. As part of the trip, I aided in her measurements of the children. We measured height, knee height, weight, elbow breadth, and skinfolds at the triceps and scapula for each child. For my data in this paper, I only used information gathered through the interviews conducted with the mothers of the children measured. The data is comprised of information from 53 interviews, 18 of which were completed on the trip I was part of in January 2017, and the other 35 were conducted on previous trips Dr. Krumrine had completed in August 2015 and January 2016. The interviews were looking at household size, occupation, yearly and monthly income, where the families obtained their foods (whether they grew any as well as where they bought it), whether or not they have different amenities (car, internet, cellphone, bathroom, etc.), a rough dietary recall, breastfeeding habits, and if/when their children had specific illnesses. As part of these interviews, I also took notes on

the general appearance of their homes, types of structures in the compounds, types of trash in the yard, and other variables that seemed relevant about their living situations that may not come up as part of the interview questions. Based off of these interviews I was able to analyze the modern diet, subsistence methods, and dietary effects in these areas today.

Modern Maya Diet in Coba

In Coba today, there is trash everywhere. This garbage actually provides insight to the diets of the people. The wrappers and bottles show that there is a large consumption of processed, high fat, high sugar foods. The family in the village that hosted us had copious amounts of soda as a part of every meal. While walking through various homes for the interviews we saw that in addition to cases of bottled water, there were large cases of soda everywhere. The incorporation of processed, sugary foods are a part of a larger dietary shift.

The diet has shifted away from the Classic Maya diet because of the introduction of western foods. In other areas near Coba, it has been cited that there is a stigma created around traditional foods (Leatherman and Goodman 2005). I witnessed that there is a clear belief among the youth that most things Maya are old fashioned and inferior. As a result, more people are eating more westernized foods. For example, many people prefer white flour tortillas instead of the more nutritious corn tortillas that were more popular classically. The only bread the Maya in this area have access to is white bread, which is high in sugar and low in nutrients. The cereals commonly found in local tiendas are the high sugar, unhealthy brands such as Choco Krispies; there is nothing multigrain or whole grain. To have a better idea of what the people of Coba are eating, part of the interview asked the general composition of each meal (breakfast, lunch, and dinner).

While interviewing the mothers, we asked what types of foods the family would eat for each meal. For breakfast the seven most popular items are milk, cereal, bananas, apples, eggs, bread, and cookies; these seven food were cited in more than 25% of the interviews (see Table 1). There are concerns because these foods are all high in sugar. For lunch the seven most cited foods are: chicken, beans, rice, carrots, potatoes, tortillas, and squash, which were cited in 37% or more of the interviews (see Table 1). The most popular lunch items are less concerning than the breakfast ones because they appear to be more nutritious but there is still concerns about high sugar content. The rice that the people of Coba have access to, is white rice which is high in sugar. Also, the cultural shift to have tortillas made with flour contain a higher sugar content than corn tortillas have.

The five foods highlighted in Table 1 are the most problematic with regards to nutrition. These foods would not have been available to be part of the Classic diet. These foods have nutritional gaps and concerns surrounding them, therefore, it is problematic to have such high percentages of the population to be eating them (see Table 1). In compiling this data one major flaw in the interviewing process arose; chips, cookies, soda, and other sugary snacks were not specifically asked about in all interviews and therefore could not be calculated out to an accurate number of people consuming them on a regular or semi-regular basis. During some interviews, when junk foods were addressed, the mothers seemed to either be very against their children eating them or sheepish about admitting they allow the children to have them. This is good because it shows that the people are at least beginning to see that these processed foods are not the healthiest option for their children. Hopefully this awareness concerning the stigmas of consuming junk food will cause a stronger shift away from them. However, this shift away from junk food should not just stay with children. Women, especially those who are pregnant or

breastfeeding need the proper nutrients as well. Their good health will translate into the health of their children and this begins with breastfeeding.

Table 1: Percentage of Households Where Foods Are Eaten by Children for Breakfast and Lunch (n=53).

Breakfast	%	Lunch	%
Milk	75.5	Chicken	69.8
Cereal	56.6	Beans	64.2
Bananas	40.0	Rice	58.5
Apples	39.6	Carrots	45.3
Eggs	34.0	Potatoes	41.5
Bread	32.0	Tortillas	39.6
Cookies	26.4	Squash	37.7
Grapes	22.6	Soup	35.9
Fruit	17.0	Vegetables	24.6
Chocolate Milk	15.1	Chiote	24.5
Beans	13.2	Pork	20.3
Coffee	11.3	Eggs	18.8
Torta	7.6	Pumpkin	18.9
Chocolate	7.5	Meat	15.1
Empanadas	7.5	Fruit	15.1
Hotcakes	5.7	Apples	15.1
Yogurt	5.7	Bananas	13.2
Squash	5.7	Pasta	11.3
Cantaloupe	5.7	Orange	7.5
Watermelon	5.7	Grapes	7.5
Tomatoes	3.8	Broccoli	7.6
Juice	3.8	Fish	5.7
Oranges	3.8	Venison	5.7
Yuca	3.8	Jicama	3.8
Carrots	3.8	Empanadas	3.8
Cayote	3.8	Beef	3.8
Sandwich	3.8	Pumpkin	3.8
Mangos	3.8	Lentils	3.8
Tortillas	3.8	Turkey	1.9
Vegetables	3.8	Lentil Soup	1.9
Salsa	1.9	Quesadilla	1.9
Milkshake	1.9	Chaya	1.9
Crackers	1.9	Mandarins	1.9
Ham	1.9	P. Melon	1.9
Sweet Bread	1.9	Watermelon	1.9
Strawberry	1.9	French Fries	1.9
Huevos Rancheros	1.9	Plums	1.9
Papaya	1.9	Mango	1.9
Eggs with Chaya	1.9		
Quesadilla	1.9		

Dinner was not recorded in the table because the majority stated that lunch was the one big meal of the day and dinner was primarily leftovers or light snacks that were already listed above.

As part of Dr. Krumrine's research about childhood growth and development, the mothers were asked if, and for how long, they breastfed their children. Breastfeeding rates are important to consider for the nutrition of a population because nutrition at the early years of life continues to impact an individual for their whole lives. The World Health Organization (WHO) suggests exclusive breastfeeding for the first 6 months and then supplementing with solid foods but to continue breastfeeding until 2 years old. Based off of these suggestions our results are both good and bad. The good thing is that 73.5% of the mothers interviewed breastfed their babies for 6 months or more (see Table 2). The bad news is that the percentage starts to drop and then plummets after the one year mark. A mere 7.5% breastfed for the full two years suggested by the WHO (see Table 2). Breastfeeding has nutritional and economic impacts on families.

Duration	Number of Children
Up to 5 months	3
6 months	11
7-9 months	10
10-12 months	13
13-18 months	1
19-24 months	3
25-36 months	1
Unknown duration	1
Not breastfed	10

This table highlights the breastfeeding patterns that had been used for the cohort of children in Dr. Krumrine's study

It is important to understand that breastfeeding is the best option for the people of Coba for multiple reasons. Breastfeeding provides infants with the perfect balance of nutrition that they require for proper growth and development, but more importantly, it is the more cost conscious option. Breastfeeding is free and the alternative option of using formula is extremely expensive. Using formula in this area is concerning not just because of the price of the formula, but also the lack of access to clean water. Most of these families have to buy bottled water because if they have running water it is not safe to drink. Using formula instead of breastfeeding puts economic

pressure on the family to buy more bottled water, which has been increasing in price, as well as the formula itself. Looking at the formula itself raises new concerns.

In the grocery stores in Valladolid and Playa del Carmen, the baby formula sold was Nestle. There was not a large variety of options and the ingredients of this formula are not ideal (see figures 3 and 4).



Figures 3 and 4

After translating the back label (see figure 4), we discovered that the first four ingredients in this formula are (in this order): wheat flour, cow's milk (28% fat), table sugar, and vegetable oil (corn, canola, and palm). These first few ingredients are not as healthy as breastmilk would be and have nutritional concerns. This formula is marketed for children one year old, which explains the use of cow's milk (cow's milk is not supposed to be consumed before the one year mark). Still, with table sugar as the third ingredient it is a sign that there is a very high sugar content which can have health consequences later on and is not the best for young, developing children. The introduction of formula as well as the introduction of other western processed foods that are high in sugar, demonstrate of the cultural shifts that we observed.

The changing diets of the Maya people, specifically in Coba, show that the incorporation of new, unhealthy foods is slowly overtaking the traditional diet. Besides the shift in the types of foods consumed, there is also a serious shift in subsistence methods that heavily impacts diet and

the culture of the Maya as a whole.

Subsistence methods

The lifestyle of the Maya in Coba has been shifting with the new tourism economy. This lifestyle and economic shift has created ripple effects in the subsistence methods of these individuals. In Coba, work can be seasonal for those who are employed through the tourism industry. Even in the busy seasons, the pay is little and irregular. The families who were better off in the village are those who do not work in tourism, but are the teachers, police officers, or administrators of the community. These people are also the people who had managed to go further with their education. Even in the 90s, researchers found that the majority of people thought that milpa farming was the way to success and nearly everyone used kitchen gardens and fruit trees that they owned to supplement their diets, but this has drastically changed.

Today in Coba, only 11 of the 53 families we interviewed still had milpas even fewer, routinely worked the land (see Table 3). Besides milpas, kitchen gardens and even fruit trees were in decline for household food production. 35.8% of the families interviewed produced none of their own foods (see Table 3). Another 35.8% only had fruit trees, probably because they had been planted in a different time and remained in the yards (see Table 3). Furthermore, of the minority 26.4% of the families who still had kitchen gardens, the number of crops grown were not nearly as high as they would have been in Classic times and even the late 20th Century (see Table 4).

Table 3: Households Food Production (n=53)				
Nothing	Garden	Fruit Tree(s) Only	Milpa	Sell milpa products
19	14	19	11	3 (of the 11)

Number of Items Grown	Number of Households
None	19
1-5	2
6-10	4
11-15	6
16-20	1
21-25	0
Did not specify number of crops	1
Fruit tree(s) Only	19

The foods grown by the few families still producing their own foods are healthy and remain beneficial supplements to their diets. The concern is the decline in self food production and the lack of desire to produce their own foods. These families have such little income, and the stores have such a limited variety, that buying foods with proper nutrition and balance is difficult in Cuba. Several mothers confessed that they only sometimes have meat, or worse, only sometimes have vegetables. The possible gaps in proteins and micronutrients combined with a high sugar and carb diet is not good for the health of these people. No family in Cuba produced all of the foods in their diet and therefore the location that the families buy their food has a large impact on their diets.

With the shift in subsistence methods from self-producing with kitchen gardens and milpas, to buying most or all foods in the market, there are concerns about the nutrition the individuals are receiving. The town of Cuba is quite small. The markets and stores in this town do not have a large variety or many options. If families were capable of going into the neighboring cities of Valladolid, Tulum, Playa del Carmen, etc. they would have access to a great variety of nutrition for better prices. During the interviews, we inquired about where most of the foods for the families is purchased. These interviews revealed that 66.7% of those interviewed were buying all or most of their food within the town of Cuba and only 15.7% went outside of the town to purchase all of their food (see Table 5). This is concerning because the

vast majority of mothers are purchasing foods from an extremely limited selection that is available in Coba. This has negative impacts on diet because they are more likely to develop nutritional gaps due to the lack of variety or choice. In addition to the limitations in available foods, the low income of these people often leaves them unable to afford the correct types of foods, whereas, if they were still producing their own it would be more reliable and healthy.

Place	Number of Households
Coba- most or all	34
Coba- some	9
Coba- none	8
Vallodolid	18
Tulum	6
Chemax	4

The shift in subsistence methods from self-producing milpa farming and kitchen gardens to a market based method based on local markets and shops with limited selection has caused food insecurity and nutrition gaps to increase for the Maya living in more rural areas such as Coba. Before the implementation of the tourism economy the Maya diet had stayed relatively consistent from Classic times.

Comparing diet now to then

The shifting diets and the shift in subsistence methods of the modern Maya have created a nutritional situation that is arguably worse than the Classic diet. The more interesting aspect of this phenomenon is found when analyzing the types of foods that the Maya, who were still self-producing are growing.

The foods that are grown by those still producing foods is remarkably similar to the archaeological finds concerning Maya agriculture in Classic and even Pre-classic times (see Tables 6 and 7). This shows that very little changed among the staple and supplemental crops the

Maya utilized multiple centuries ago. The results from our interviews solidify that the Classic Maya diet most likely had an adequate nutritional content. The issues with the diet today are a result of moving away from the traditional diet and subsistence methods and towards a western diet of sugar, carbs, and processed grains brought to the area by tourism.

Table 6: Plants and Fruit Trees Grown in Coba Milpas (n=7)

Plants	Number of Milpa	Trees	Number of Milpa
Maize	7	Nance	3
Beans	7	Banana	3
Squash	4	Zapote	1
Jicama	3	Plum	1
Pumpkin	3	Mame	1
Comote	3	Coconut	1
Yuca	3	Lime	1
Chile	2		
Lentils	2		
Sweet potatoes	1		
Macal	1		
Batata	1		

Table 7: Plants and Fruit Trees Grown in Coba Households (n=47)

Plants	Number of Households	Trees	Number of Households
Chile	10	Sour orange	14
Mint	9	Banana	12
Chaya	4	Coconut	13
Cilantro	4	Lime	8
Saimoya	2	Sweet orange	8
Onion	3	Guaya	7
Pumpkin	2	Mandarin orange	7
Sugar cane	1	Avocado	6
Grosellera (berry)	1	Nance	6
		Zapote	4
		Grapefruit	4
		Plum	3
		Pomegranate	2
		Ramon (breadnut)	2
		Mango	2
		Guanava	2
		Tamarind	2
		Caimito	2
		Cirbuelo nabosa (slug plum)	1
		Chiri-chojom	1
		Limon frances	1
		Guava	1
		Mame	1
		Anona	1
		Almond	1
		Noni	1
		Ruta	1
		Papaya	1
		Indio	1

The diet of the Maya remained incredibly consistent until modern times. As diet changes, health changes, because the two are closely related and intertwined. The recent decline in nutritional standing with the incorporation of high sugar and processed foods, should have interesting implications about modern health compared to Classic Maya health.

Comparing health now to then

Classic Maya health appeared to have its faults. There was a high incidence of anemia and stature differences throughout the eras that implied that nutrition was not consistently adequate. These findings suggest that the diet remained practically unchanged for so long, also this suggests that there is new information about health changes between history and today.

As previously stated anemia had a high prevalence in Classic Maya times. This was discovered by analyzing many skeletal remains which were found with porotic hyperostosis and cribra orbitalia. A case study was done in rural Guatemala (1995) to assess if anemia continues to be a common health concern in a modern sample. As with the Classic Maya, younger children suffer from anemia more than older children. In this area of Guatemala, 23-30% of children in different regions of the country suffered from anemia (Wright and Chew 928). Anemia is still common in these areas because of the high prevalence of parasitic infections inhibiting iron uptake and the high level of calcium carbonate in the maize diets that also impedes the absorption of iron (Wright and Chew 929). The number of children with anemia is higher when the children are younger and then declines as the child matures (see figure 5).

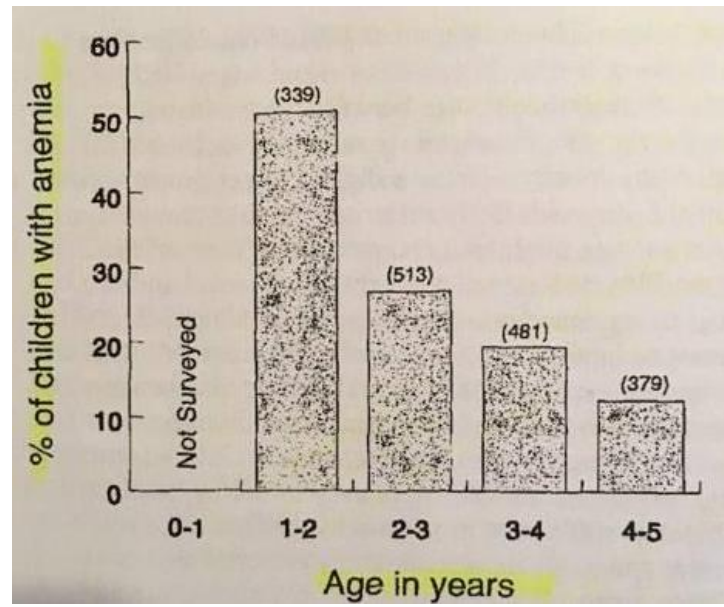


Figure 5: Prevalence of Anemia in Guatemalan children, 1995 (Wright and Chew 930)

In the modern skeletal sample, 3 out of 26 skulls had observable cribra orbitalia and a different 3 skulls had signs of porotic hyperostosis (Wright and Chew 930). With 30% of children having anemia, the low rates of skeletal evidence with anemia does not make sense. Furthermore, the evident decline in anemia as children get older, may cause one to surmise that the children's health just improves. However, the reality of the situation is that more children with anemia die in the first five years of life than children without anemia (Wright and Chew 933). Children with anemia suffer from more severe diarrhea and respiratory infections, both of which are leading causes of child mortality which would suggest that they have a higher mortality rate than those without anemia (Wright and Chew 933). Wright and Chew theorize that there is more skeletal evidence in the Classic Maya for anemia because more people with anemia survived into adulthood than today (Wright and Chew 933). Porotic hyperostosis and cribra orbitalia are not a sign of the severity of anemia but act as a measurement of how long they have had it (Wright and Chew 933). They suggest that there is a higher child mortality today than in

Classic Maya times because of old world diseases, such as measles and whooping cough, that are major contributors to child mortality and that afflict those with anemia more severely than those without (Wright and Chew 933). Another possibility for the high child mortality could be caused by “a recent trend to shorten the period of breastfeeding” because breastfeeding “provides immunological benefits to toddlers, in addition to nutrients that augment solid foods” (Wright and Chew 933). The presence of skeletal anemia is not the only evidence that Classic Maya were healthier than modern populations.

In addition to the evidence regarding anemia among the Maya, stature has also had health implications throughout history. The average lengths of long bones for Pre-Hispanic Maya peaked in the Pre-classic era, dropped in the Classic era, and then began to recover in Post-classic but never returned to the Pre-classic levels (see figure 6) (Whittington 55). This being said, the present-day sample has the *lowest* measurements of all the cultural periods (see figure 6) (Whittington 55).

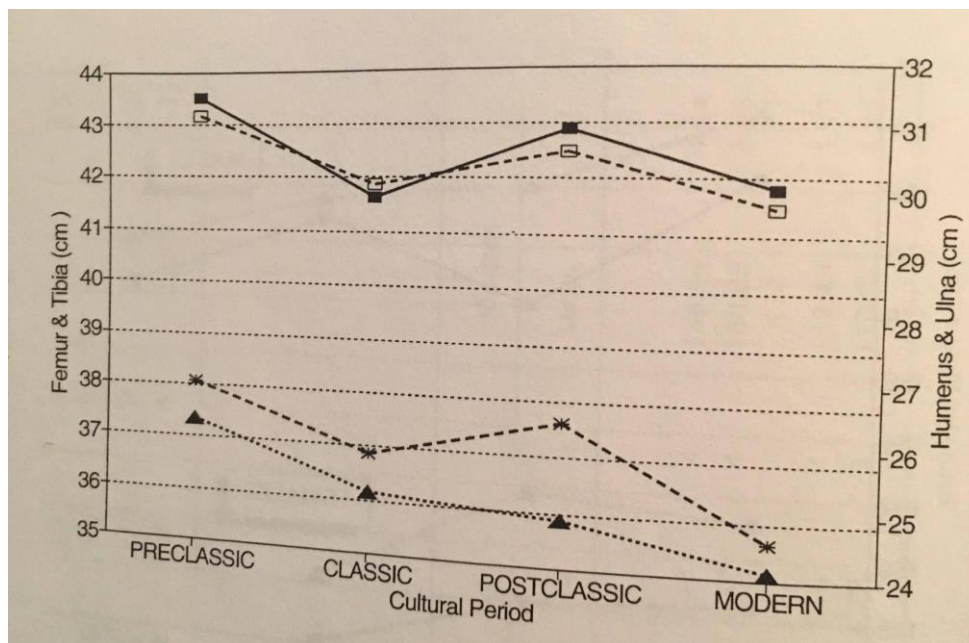


Figure 6: This chart shows the changes in maximum length of long bones in males through the periods (Whittington 58)

This stature reduction shows that Maya from the Classic period, even though they were the shortest of the Maya eras before, were still taller than the modern population. This is practically unheard of in the world. Generally, populations increase in stature as long as health improves, which usually correlates with technological improvements. According to Wright and Chew, Pre-Hispanic Maya were better able to “with stand anemia and fend off early death... and better reach their growth potential” than modern Maya children in Guatemala are (Wright and Chew 934).

In regard to Coba, Dr. Krumrine found that although the children are shorter than the WHO world averages for their age, they do not exhibit stunting. This being said, even though the children are shorter than average, they have a higher than average fat content. The higher than average BMI is most likely a result of the dietary shifts in the area towards processed foods and away from the traditional diet. During the interviews, mothers— to the best of their memories— told us if their children had ever been sick and with what. The results from the interviews show that the prevalence of parasitic infections is the highest of any other illness in Coba, but that it is not as high as in Guatemala in 1995 (see Table 8). One possible reason for this could be that according to the Coba Clinic’s nurse, the clinic does routine health checks at the schools, during which every child is given anti-parasite medicine. According to this nurse, the clinic does this because it is easier and less expensive than checking each child individually for infections. If a child does not have parasites, the medicine will do nothing, and even if they have one, it will hopefully catch the infection early enough to prevent major effects and nutritional deficiencies. The village of Coba is fortunately healthier than other areas of the former Maya Empire but they still exhibit some prevalence of infections that influences their nutrition and that can have health consequences.

Illnesses	Number of Children	Percentage of Children
Parasitic	19	35.2
Respiratory	16	29.6
Diarrhea	10	18.5
Asthma	7	13.0
Ear	5	9.3
Anemia	1	1.9
Fever- non-specific	2	3.7

Based upon the high sugar, high fat diets the people in Coba exhibit with the introduction of westernized foods and the preliminary findings from Dr. Krumrine, it is clear to observe that the children have higher than average fat content for their height. Moving forward in Coba, diseases such as diabetes, high blood pressure, and high cholesterol should be monitored because their incidence may rise as a result of the shifting diet. Overall, the evidence seems to indicate that the Classic Maya were healthier than the Modern Maya. This could be a result of the introduction of Old World diseases with high child mortality, or negative dietary shifts creating nutritional consequences that predisposed the population to be unhealthier. Diet walks hand in hand with disease and overall health. The shifting diet and lifestyle of the Maya are already showing health consequences and will continue to exhibit them moving forward without intervention.

Conclusions

Other areas of the former Maya Empire today are struck with severe nutritional deficiencies, stunting, and poor health. These developments suggest that the diet and lifestyles of the Maya in Pre-classic, Classic, and Post-classic eras were healthier than in Modern populations. Consequently, the dietary and lifestyle shifts are concerning with regards to health

complications such as diabetes, high blood pressure, and high cholesterol. One way to combat the nutritional gaps in the diet is to introduce more nutrient rich foods that still conform to the desire of western foods. A study done by Kantar et al. looked at the varying nutritional content of pepper varieties around the world and concluded that it would be beneficial to replace some indigenous species with more nutritious varieties that are comparable with taste and level of hotness (2016). Other objectives similar to Kantar et al. could be implemented to introduce enriched flours and other grains into the area in order to combat the high sugar and nutrient poor breads, cereals, and rice that the Maya currently have access to. In addition to fighting the nutritional gaps present in the modern diet, there is a need for more government programs to counteract the effects of unsteady work and low wages to battle the large wealth disparities within the country.

The Maya are a great people. Their friendliness, openness, and joy are the most memorable aspects of the trip. I left Mexico with a new appreciation for their culture and a desire to educate the world about their needs. The tourism economy effectively altered a culture that withstood colonization. It has created more problems for the Maya than ever before. Wealth disparities, food insecurity, and the effects of Coca-Colonization need to be a focus of change in this area to prevent the current trends towards more serious health complications as a result of the diet.

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