From Irrigation Engineers to Victims of Type 2 Diabetes

Connecting Natural Resource Conditions with Type 2 Diabetes in the Pima Indians of the Gila River Reservation

By

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INTRODUCTION

For over a century, Pima Indians living just south of Phoenix, Arizona on the Gila River Indian Reservation have suffered from an epidemic of type 2 Diabetes Mellitus. Over half of the Pima population living on the reservation is diagnosed with diabetes while the socioeconomic conditions of the tribal community are in an unstable and dilapidated state (Unnatural Causes 2008).

Fifty percent of the Pimas living on the Gila River Indian Community live below the poverty level (Unnatural Causes 2008). Displacement from traditional customs and neglect from the U.S. federal government are just some of the detrimental impacts the people have faced over the last century (Unnatural Causes 2008). The discussions within this paper will attempt to address how and why the Pima Indians have experienced such severe changes in lifestyle and economy over the last century and what affect this has had on the physical health of the people in the community. By addressing these overarching issues, one should find that socioeconomics and conditions of physical health are strongly connected. Looking even closer though, specifically at the epidemic of type 2 diabetes and the contributing risk factors that this population suffers from, one will begin to question how within just a matter of 3 decades the number of diagnosed cases of type 2 diabetes doubled among the Pima and how the rates are some of the highest recorded in the entire world. Moreover, the underlying issue is not simply a cause of poor diet, change in activity levels and unfavorable genetics, rather - being robbed of a critical natural resource, forced to adapt to unfavorable economic changes and in the end, the U.S. government failure to intervene – are truly the underlying causes that have impacted the health of the Pima Indians of Southern Arizona.
The Pimas are people of their natural environment. Having a long history of living along the Gila River, the Pima were water irrigation engineers (Unnatural Causes 2008). Cultivating local crops, living off the land and providing for themselves using waters of the Gila River in an arid climate is as much a part of their culture as is their ancestral bloodline.

The research presented in these discussions will look at the identical ancestry of Pima Indians living in Southwestern Sonora, Mexico in the Sierra Madre Mountains of Maycoba in order to evaluate the Pima tribe’s predisposition to the disease. The significance of looking at these groups is that their genetic history is the same based upon linguistic and genealogy studies (Schulz, Bennett, Ravussin, Kidd, Kidd, Esparza, Valencia, 2006). However, the Pima living in Sonora have not seen the same ever-increasing rates of type 2 diabetes or even obesity, as their northern counterparts have. Notably, the Mexican Pima have not experienced the same environmental changes (i.e. drought) either. Subsequently, the Pima of Sonora have been able to continue their traditional ways of life including subsistence farming and healthy diet and exercise.

A historical background of the Arizona Pimas will be provided, from their cultural traditions as irrigation engineers to their participation in federal subsidy programs and their current economic state. In-depth historical accounts will also be made for the history of water law in the Southwestern United States, including what drove white settlers’ demand for water west of the Mississippi over the course of two centuries, to the attempts to mitigate the severity of drought on Native American reservations through multiple legislative acts. Information regarding the Mexican Pima’s current economy, levels of physical activity and typical diet will be presented in comparison to the present health and economic conditions of the Arizona Pima.
RESEARCH METHODS

In order to illustrate that environmental factors play a larger role in the epidemic of diabetes in the Pima of the Gila River Reservation as opposed to genetic determinants, the methods undertaken include an extensive review of previously completed studies over the last several decades. Because extensive literature exists that look at this same issue and potential causal factors, the research presented here will essentially be a formulated review of primary and secondary source data along with complementary and comprehensive analysis.

The literature review includes quantitative studies on the prevalence and incidence of diabetes in both Arizona and Mexican Pimas and recommendations from studies on prevention. Various databases were searched: E-book database, general catalog inquiries on journal databases such as JSTOR and Academic Search Complete as well as Google Scholar. Boolean logic operations were applied to narrow search results. Specific searches were made using key words including: Gila River, Gila River Reservation, Pima, Water, History, Water Rights, Arizona, and GRIR. Throughout the research, various discrepancies were found using keywords, thus limiting results. For example, within the scope of Native American Water Rights, more information was found under “Western Water Initiatives, where “irrigation” was more effective than “water” and “Gila River Reservation” was more effective than “Pima”. Additionally, the term “Akimel O’odham” and “Hohokam” were much more effective (from an archaeological perspective) than “Pima” when inquiring about pre-Spanish colonial and colonial conditions. When searching for more current information on recommendations (within the previous two decades), the term “Pima Indian” was most effective as the primary key term, while the “must contain” line was “diabetes” and the phrase line included “prevention OR treatment”. Searches were completed between, start date, and end date.
The premise of the paper is that environmental factors have a very significant impact on an individual’s quality of life and their ability to maintain a healthy lifestyle. Several studies show that economic and socially limiting factors are connected to the environment that one lives in and impacts health (Schulz et al., 2006).

Non-Insulin Dependent Diabetes Mellitus is a health-related disease reflecting medical history, diet and genetic susceptibility. However, these variables should not be the only considerations when determining cause.

The Pima in Southern Arizona on the Gila River Indian Reservation have been the victims of type 2 diabetes for decades, and not by choice. Evidence does exist that a specific genotype in individuals leaves them more vulnerable to developing the hyperglycemia, insulin inefficient disease. Research studies have hypothesized that a specific gene known as the “thrifty gene” evolved from historical populations that survived through feast and famine (Dabelea, Hanson, Bennett, Roumain, Knowler, Pettitt 1983). This gene would give the individual the ability to store energy (calories) in the form of fat to better prepare their bodies for periods of famine (Dabela et al, 1983). These studies observed that high levels of fat storage were directly associated with increased insulin levels in response to the increased food consumption. Subsequently, this physiological evolution now leaves those same populations carrying such a gene with a now “steady food supply” vulnerable to very active insulin levels in the blood as a response to the continuous fat storage in the body and potential onset of obesity.

The Pima Indians of Mexico have not seen the obesity and resulting high diabetes rates as those exhibited by their Arizona-based tribal relatives. Based on the fact that these two groups carry the same genes and share common biological history, it is the environment primarily impacting the present-day disease rates among Gila River Indians.
LITERATURE REVIEW

ENVIRONMENTAL CHANGE

I. Pre-Colonial (A.D. 1000 – A.D. 1300)

The Pima living along the Gila River of Southern Arizona were irrigation engineers centuries ago prior to colonialization, before the United States was formed, dating back to when indigenous peoples were free to settle the land and sustain a culture of their own. How might one know that the waters of the Gila River saw variable, but lush flows at this time if documentation and records are limited? A number of studies have been done over the past several decades with current technology in order to determine the river’s behavior predating 800 B.C. One particular group of studies look at the geomorphology and stream flows of the Gila River through tree ring research. The results are based on seasonal stream flow behavior and provide insight into the aboriginal irrigation methods applied by the Pima during this pre-colonial period, between A.D. 1000 – A.D. 1300. These studies look at the implications of the applied irrigation methods over centuries and draw conclusions on the river’s morphology.

The studies performed “retrodictions” or long-term stream flow reconstructions in order to provide an account of flow behavior from A.D. 534 to 1988. For the purpose of this review, only the earlier sections of the reconstruction study will be evaluated to reveal the early historical (or pre-historical) development of the Gila River. The significance of these study findings rests upon “the specific adaptations forged by aboriginal irrigation agriculturalists living along [the river].” (Doyel, Dean Betancourt 1995, p. 121).

Irrigation adaptation was necessary for the early Pimas. The River Channel Morphology findings indicate that the Gila experienced high variability in flows annually. Moreover, the availability of water in the Gila River made one-time construction of canals and other irrigation
systems impossible. This meant a need for constant maintenance and repair to sustain a functional irrigation system. Acclimatization was absolutely necessary for the Pima to survive.

Catastrophic floods and subsequent geomorphic effects are said to be “causal factors in the decline of Classic period Hohokam social systems…” (Doyel et al., 1996, p. 122). It has been argued in several different studies why and how the Hohokam declined – a pre-historic agrarian cultural group of indigenous tribes living along the Phoenix River Basin, including who is considered the Pima today (Bigler, 2007, p. 5). In fact, the Pima are traditionally referred to as the Akimel O’odham, or “river people” (Wood 1911).

Colonial history reveals that when the Spanish arrived in the Southwest at what is now Arizona, the Pima were discovered micro-irrigating where the original Hohokam irrigations systems were in place less than 300 years earlier (Doyel et al., 1996, p. 120). Doyel and associates continue by stating, “…it is clear that the Pima were practicing successful canal-irrigation agriculture at the time of contact and had been for some considerable period of time.” (1996, p. 120). Needless to say, the Gila River sustained stream and base flows that made irrigation a way of life for the early Pima. In fact, according to similar studies by Dean and Funkhouser, the irrigation systems that the Pima adopted after A.D. 1300 were heavily influenced by the long-term climate patterns on the greater Colorado Plateau, “These [study] results point to a large climatic disruption that would have had a major impact on the Colorado Plateau. For two centuries a fairly simple, long-term, stable pattern was interrupted by a complex, chaotic conformation that represents an unprecedented change in conditions to which the human and biotic populations in the region had become accustomed; just the change from a persistent stable pattern to an unstable one would have had important adaptive repercussions.” (Dean and Funkhouser 1995, p. 94). In Figure 1.1 below the climatic changes are shown
illustrating the “shift away from a long-term pattern of high variability and prolonged periods of low flow with conditions more favorable for agricultural irrigation” (1996, 119). It is believed that these large-scale climatic changes on the Colorado Plateau took effect immediately, but discharged on the Gila more gradually and most likely contributed to the “attractiveness” of the Gila riparian region as an area of refuge for many upper basin populations. Moreover, the Gila River was a highly desirable natural resource for pre-colonial indigenous populations because of its low flows best for agrarian subsistence.

**Figure 1.1**: Gila River Flow Rates (1427-1905)

On the Gila’s neighboring Salt River, flooding was a common occurrence, which made agricultural irrigation difficult. Thus, upon the arrival of Anglo farmers, dam construction (including Roosevelt Dam) and other facilities led to a great degree of human control over Phoenix River Basin resources. Early construction of irrigation systems by the first Anglo settlers along the Gila led to significant expansion overtime. By the 19th century, the Pima were
dissatisfied with the lack of water because of upstream diversion to the point of threatening warfare (Southworth 1919, p. 118-120). By the beginning of the 20th century after the Desert Land Act of 1877 and the construction of the Florence Dam just north of the reservation, non-Indian allocation increased from 13.6% to 41.3% and Pima allocation decreased by 62% (DeJong 2007).

It was about five or six hundred years before the Spanish arrived in what is now central and Southern Arizona when the Hohokam were applying these irrigation practices. The system they were using was as simple as wooden digging sticks and a variety of stone axes across more than 125 miles of canals in the Phoenix River Basin (Meyer, 1984, p. 12). These canals were in full operation by A.D. 700 and, as was noted above, reached their maximum nearly 600 years later (Meyer, 1984, p. 12). It was this pre-historic system that made possible the cultivation of the crops for the Hohokam’s (including the Pima) traditional diet (Meyer, 1984, p. 12). The traditional diet includes corn, beans and squash – all crops capable of growing in an arid desert environment. Shown in Figure 1.2 on the following page, these canals were up to 30 feet wide and 10 feet deep – designed to prevent loss through seepage. The hardened bottom also indicates that the canals were lined with some sort of adobe plastering (Meyer, 1984, p. 12). The diversion headgate of the river system started much further north than the elevated terraces these irrigation canals were constructed in. In turn, strategic measures were taken in order to prevent evaporation from too slow flow and erosion from too rapid flow up the gradient (Meyer, 1984, p. 12). Clearly, the early Pima ancestors were irrigation engineers. Agriculture was a huge part of their culture and even more so of their survival.
II. Colonial and Western Expansion (A.D. 1400 – A.D. 1800)

Environmental and Irrigation Conditions

Once the early Hohokam broke off after centuries of maintaining extensive irrigation networks, the late Pima became flood farmers, building small diversion dams and check dams,
which served slow runoff and percolation into underground aquifers (Meyer, 1984, p. 79). Upon the arrival of Spanish colonialists in the 16th century, when European diseases were exposed to local tribes, demographics shifted and so did the subsistence culture of the Southwestern Pima. Aboriginal flood irrigation systems could no longer be maintained and were thus abandoned (Meyer, 1984, p. 79). It was then that Indian culture as a whole in the Southwest began to see the advantages to tradeoffs in using their water as a means to producing agriculture for sale to the colonialists. At this time, water to the indigenous peoples, including the Pima, became a commodity rather than a way of life.

**Beginning Outside Contact**

*A Brief Overview of Spanish Colonialism and “The New Frontier” in the United States*

“If Spaniards had to produce their titles, Indians did also, and they were even more unlikely to have them, or, if they did, to have them in proper form” (Meyer, 1984, p. 147). This quote signifies the premise of a number of legal disputes between the Spanish and the Native Americans when the colonialists began to divert the Southwestern water for their own use and expansion. The second legal principle, applied in water-related legal disputes, was the doctrine of prior appropriation, “a concept generally argued on the basis that the water had been used *de tiempo immemorial, or de costumbre immemorial*” (Meyer, 1984, p. 148). This historical legal doctrine is considered to be extremely misunderstood in that it was not an “absolute concept” that ruled over “all other factors in the distribution” (Meyer, 1984, p. 148). Moreover, it was not a concept that sustained the idea that whoever used the water first, had outright ownership of that resource. Rather, this principle was used to the advantage of “New Spain” to help maintain their water rights when documentation could not be provided during legal disputes between the Natives and the colonialists (Meyer, 1984, p. 148).
While Spanish colonialization introduced the Pima to the impacts that exploration and Western expansion would have on their natural resource, it wasn’t until the land west of the Mississippi River was divided up and parceled out to white settlers when the Pima began experiencing the detrimental changes in their way of life. Anglo-farmers of the 1862 Homestead Act, The Desert Land Act of 1877 and other fundamental legislative acts that shaped Western expansion began moving into the land and exploiting it’s natural resource. However, at the time, this growth within the United States was not seen as an exploitation of natural resource rather it was seen as a “Jeffersonian Utopia of Small Farming” according to social reformers of the time. This political thought derived from years of preceding policy to assert total sovereignty over the land, which was in fact institutionalized by a landmark Supreme Court case, Johnson v. M’Intosh (123). This settlement essentially claimed that tribal nations did possess “usufruct” rights to the land, but U.S. federal rights were pre-empt providing the settlers legally bound rights over the land they settled (DeJong, 2007, p. 14).

Before Arizona statehood and the designation of the Pima Indian Reservation, this tribal nation, shown below in Figure 2.1 as depicted in the 18th century, was geographically positioned as a stopping point along a series of desert trails that settlers and California gold miners passed through along their journey (DeJong, 2007, p. 50).
This in turn provides an opportunity to look at an accurate account of who the Pima were (their agrarian lifestyle and hospitable culture) post-New Spain and at the onset of contact with American settlers. This also offers a venue in which to look at the condition of the Pima’s economy and how it shifted after being introduced to American technology and being faced with the on-going residual effects of Western settlement.

Explorers and settlers of the 19th century described the land, specifically the river conditions, as “far surpass[ing] anything… ever witnessed for fertility” and representing “a series of the finest fields” that they’d ever seen (DeJong, 2007, p. 67). The Gila River was an oasis in the Sonoran Desert, the land native to the Pima Indians for centuries long before (DeJong, 2007, p. 66). The Pima strategically managed their land in an effort to maximize their agrarian trade economy. Kindness and courtesy and an “anxious spirit” to conduct the trade of
“cornmeal, flour, watermelon… beads” to trade are other qualities documented by travelers (DeJong, 2007, 7p. 6). Their trade systems shifted though, as more emigrants arrived in the villages, “the demand for shirts and cloth” increased and “the Pima shifted to more of a cash economy” (DeJong, 2007, p. 77). This phenomenon is representative and indicative of how Western expansion overtook the land and economy, ultimately putting the Pima in a position to adapt in order to sustain their livelihood, rather than maintain tradition. The overall trend of adaptation that the Pima were faced with moving into the 20th century as Arizona gained it’s statehood, may be accurately and chronologically represented in a comprehensive timeline from DeJong’s 2007 essay on “The Sword of Damocles: Pima Agriculture, Water Use and Water Rights” as shown on the following page. This timeline is intended to transition the reader into the next “phase” of environmental change for the Pima - facing extreme drought, famine and subsequently a series of federal legislative battles with the U.S. federal government. Figure 2.2 (Dejong, 2007, 11)
Once it was realized that it was the land that brought American settlers to the West, but the water kept them there, the Gila River became a lifeline and survival for another geo-social group in the
American Southwest. Tribal nations were no longer the only group demanding the natural resource of this arid land.

Economic Liberalism and the Fight Against American Federal Policy

According to Dejong’s research, “As the commercial interests of the United States expanded west via the Santa Fe, Southern and Oregon trails, trade increased, with tens of thousands of emigrants crossing the territory of the western tribes. Protection of U.S. citizens traveling in or engaging in commerce… became paramount…” (2007, p. 18). It was by these commercial interests of the United States that historians like Douglas R. Hurt believe that Native Americans were “transformed… into passive yeoman agriculturists” after the establishment of the federal policy designating the American Indian Tribal Reservation System in 1851 (Dejong, 2007, p. 18). Post American Civil War government attempted to “assimilate” tribal nations through the creation of a Board of Indian Commissioners ultimately to alter their “property, legal, social and political” rights (Dejong 2007, p. 19). Evidence of this may be seen in a series of Supreme Court rulings in the late 19th and early 20th centuries including Lonewolf v. Hitchcock (1903), which proved to uphold federal authoritarian policy giving Congress the right to “unilaterally” change agreements made with tribal nations (Dejong 2007, p. 19). Further arguments have been made regarding “economic liberalism” and the policy that supported this idea of the superiority of U.S. commercialism over the cultural preservation of a people rooted in the land and it’s resource for many years preceding contact. It was not until the landmark Supreme Court Case, Winters v. United States (1908) that political thought shifted from less “Darwinian” ideals and towards a more compromising approach – although outright restoration of tribal rights were not fully recognized. An excerpt from Tribal Justice and Property Rights:
The Evolution of Winters v. United States by A. Dan Tarlock denotes the intent, both literal and implied, of this case ruling:

Winters v. United States held that Indian tribes could claim a hybrid riparian and appropriative right to irrigate their reservations so that a nomadic people could be transformed into civilized pastoralists. Although Winters created a hard property right, for years the case remained a jurisprudential puzzle and a legal backwater. It provided little wet water for most tribes because many U.S. Department of Justice claims were modest and subordinated to state rights, and Indian irrigation projects were underfunded compared to reclamation projects for non-Indian irrigators. The western states vigorously tried to limit Winters, but in the 1970’s it became a source of tribal power when recast as a reparations doctrine. The generous potential scope of the right, which was defined as the [feasible] irrigable acreage of a reservation, ultimately triggered a series of congressional Indian water rights settlements as tribes saw that they could obtain more benefits through this avenue compared with protracted quantification litigation. These individual acts allowed many tribes to obtain wet water, federal funds and management authority over the reservation watershed. [Overall], Winters proves that hard property rights can sometimes afford more justice for indigenous peoples victimized by conquest, compared to softer, anthropologically sensitive rights… (p. 471)

Clearly there was an intense struggle between Western expansionists (backed by the federal government) and the Native American population on this New Frontier, including the Pima. The issue of drought condition and the severe changes in lifestyle are without question. The critical question to address now is, how in fact have these environmental changes impacted the Pima’s economy, tribal condition as a whole and their overall health – including diet and physical activity. How do these compare with that of other tribal nations such as their
neighboring ancestors in the Southern Sierra Madres of Sonora, Mexico? In the following section of these discussions, present day health and economic conditions of the Pima will be evaluated looking at previous studies and recent data while inherently making strict comparisons to the similarities and differences between the Mexican and Arizona Pima.

PRESENT DAY CONDITIONS

I. Defining Type 2 Diabetes in the Pima Indians

Pima Indians living on the Gila River Reservation in Southern Arizona have had some of the highest rates of type 2 diabetes or Non-Insulin Dependent Diabetes Mellitus (NIDDM) in the world (Schulz et. al., 2006).¹ According to The World Health Organization (WHO), diabetes is a condition primarily defined by the level of hyperglycemia. Type 2 diabetes specifically, according to the National Institute of Health, is a “group of metabolic disorders characterized by abnormally high blood glucose secondary to inefficient action and/or secretion.” which often results in long-term morbidity including disability, amputation, loss of eyesight, renal failure, and premature death (Narayan 1997). In 2002, the American Diabetes Association (ADA) estimated that the overall national cost of diabetes in America was around $132 billion and projected to rise to $192 billion in 2020 (WHO, 2006).

Multiple studies have been done which evaluate the prevalence and incidence of diabetes and obesity as a risk factor in the Pima. One study in particular by Pavkov and associates looked at the incidence of diabetes in the Pima across both adult and youth populations over an approximate 40-year period, from 1965 to 2003 (2007). A clear understanding of the difference between prevalence and incidence as well as other medical statistic terms is necessary, as they will be used on several occasions throughout this section, therefore a list of definitions has been

¹ Note that type 2 diabetes, NIDDM and Diabetes Mellitus will be used interchangeably throughout these discussions.
provided below in Table 3.1 based off of information provided by the New York State Department of Health.

**Table 3.1: Prevalence vs. Incidence and Morbidity**

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevalence</td>
<td>Prevalence is a measure of disease that allows us to determine a person's likelihood of having a disease. Therefore, the number of prevalent cases is the total number of cases of disease existing in a population. A prevalence rate is the total number of cases of a disease existing in a population divided by the total population.</td>
</tr>
<tr>
<td>Incidence</td>
<td>Incidence is a measure of disease that allows us to determine a person's probability of being diagnosed with a disease during a given period of time. Therefore, incidence is the number of newly diagnosed cases of a disease. An incidence rate is the number of new cases of a disease divided by the number of persons at risk for the disease.</td>
</tr>
<tr>
<td>Morbidity</td>
<td>Morbidity is another term for illness. A person can have several co-morbidities simultaneously. Prevalence is a measure often used to determine the level of morbidity in a population.</td>
</tr>
</tbody>
</table>

Pavkov and associate’s found that incidence rates increased and decreased depending on age-adjusted cohorts. Rates of incidence increased in youth and young adults, ages 5-24 years old, while rates decreased significantly in adults 25-34 (Pavkov et al., 2007). Although the incidence rates decreased among this 5-year male/female cohort, prevalence of the disease increased from approximately 18.9 cases to 22.2 cases from 1965 to 2003 ((Pavkov et al., 2007). The significance in the difference between prevalence and incidence is critical at this point when
evaluating the data. Moreover, considering incidence measures the number of new cases diagnosed within a specific time period and incidence was highest and experienced an overall dramatic increase in children and young adults, it may be accurate to claim that this disease is problematic when the highest number of new cases are found in children. Additionally, it is correct to assume that prevalence also increases in the next age cohort (25-34) as a result of the previously younger cohort aging, indicating an overall increase in the development of the disease within the population overtime.

Research suggests that there is great significance and strong implications associated with the noticeable increase in diabetes incidence in youth among the Pima. First of all, why there was a dramatic increase in diabetes among youth populations is thought to be due to the steady increase in diabetic incidence overtime in adults, ultimately shifting the “onset of diabetes to younger ages” (Pavkov et al, 2007). One study released by the National Institute of Diabetes, Digestive Diseases and Kidney suggests that a greater count of exposure to diabetes in utero (in the womb) is a strong determinant of these developments in children (Dabelea, Hanson, Bennett, Roumain, Knowler, Pettitt 1998). Moreover, mothers who are diabetic and/or obese during pregnancy put their children at risk for early onset of Type II Diabetes by the age of ten (Dabela et al., 1998). This study, among many others, however, reiterates the underlying cause of this increasing epidemic. Narayan explains in “Diabetes Mellitus: The Problem and its Implications” that there are two potential reasons why the prevalence of type 2 diabetes is growing: 1) Increase in survival and/or increase in incidence (i.e. the number of cases diagnosed each year) (1997). The study’s results go on to explain that diabetes mellitus does not contribute to high mortality earlier than the age of 55, so an increase in survival due to improvements in treatment is not a feasible justification, therefore incidence (i.e. new cases) would best explain the increase in
prevalence of diabetes among the Pima in Southern Arizona (Narayan 1997). Now the question is why has there been abnormal growth in the number of new cases of Type II Diabetes diagnosed per year?

Genetic predisposition is one commonly relevant consideration. However, dramatic lifestyle changes among the Pima in the last century due to inevitable adaptation, forcing a shift away from traditional habits including traditional diet and physical activity, should also be heavily considered there are bigger questions to answer such as why over 50% of the population living on the Gila River Reservation over the age of 35 suffer from diabetes and other morbid risk factors such as obesity. And most importantly why is it now advertently affecting the younger population even earlier on in their life (Unnatural Causes, Bad Sugar 2008)?

Obesity is a key risk factor for developing diabetes mellitus. Poor diet and low levels of physical activity are risk factors for the development of obesity and subsequently NIDDM (Shulz et al., 1994). An article published in Diabetes Care in 1994 discusses the degree of impact that obesity and physical activity have on the Pima’s susceptibility to developing NIDDM. Even further, the study draws a clear connection between genetic vulnerability and environmental factors explaining that a changing lifestyle (i.e. Westernization) is a “causal factor of the obesity and NIDDM epidemic in the Pima community of Arizona” (Shulz et al., 1994)

**II. Comparison Factor – Mexican vs. Arizona Pima Indians**

As was previously mentioned, genetic predisposition is very well a contributing factor to consider in this situation. However, when looking at the rates of diabetes in the Pima’s ancestral counterparts living in the Sierra Madre Mountains of Southern Sonora, Mexico, there are clear discrepancies in the data - the Mexican Pima are not experiencing nearly the degree of health issues that the Arizona Pima are with respect to weight, BMI (Body Mass Index) and cholesterol.
Looking closely, their physical environments and economies are also vastly different. The map presented below illustrates the geographic relationship of the two groups, notice the Pima living on the Gila River Indian Reservation are about 60 km south of Phoenix and the Pima of Sonora live about 340 km from Hermosillo – the capital city of Sonora and the closest urban area to the Mexican Pima village.

**Figure 3.2: Map of Geographical Relationship Between Arizona and Mexican Pima**

Shulz and associate’s study observed how and why the Mexican Pima had less than significant levels of obesity and diabetes while their diet and level of physical activity dramatically contrasted that of the Arizona Pima (Shulz et al., 1994). The geographic differences between the two groups are significant considering the Mexican Pima live within a natural isolation from modernity and urban development – a whole 340 km (or 211 miles) from urban development and then geographically enclosed by a discrete mountain range 1,400 meters above
sea level. This area is known as the village of Maycoba, where about 60% - 70% of the Mexican Pima population live (Shulz et al., 1994). Additionally, this Mexican Pima group were completely disconnected in terms of transportation until the 1990’s when the first thru highway was constructed to directly connect the rural village of Maycoba to the the state capital, Hermosillo. Prior to the road’s development, the only connection between this rural community and the nearest metropolitan was by off-road vehicle and about a 10 to 12 hour drive from Hermosillo or Ciudad Obregón (Shulz et al., 1994). Contrastingly, the Arizona Pima live less than 20 minutes from the Interstate -10 freeway and under 30 minutes from the Phoenix metropolitan. Proximity to a metropolitan area has large effects on an areas health and it’s environment because of the higher level of exposure to western conveniences and urban development patterns. Moreover, with consideration of this kind of isolation from more developed civilization and westernization, it is consistent to say that the subsistence-based lifestyle this Pima community in Maycoba sustains is less by choice and more by geographic favorability.

Essentially isolated from this “Westernization”, Shulz and associate’s study concluded that the Mexican Pima diet consist of 13% protein, 23% fat, 63% carbohydrates, less than 1% of alcohol and more than 50% fiber (Shulz et al., 1994). Table 3.3 on the following page diagrams specific foods as a part of the Mexican Pima diet that were recorded during Ravussin’s study.
Table 3.3: Principle Food and Weekly Frequencies of the Pima Diet in Maycoba, Mexico

<table>
<thead>
<tr>
<th>Food</th>
<th>4–7 days/week</th>
<th>1–3 days/week</th>
<th>&lt;1 day/week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn tortillas</td>
<td>Milk</td>
<td>Squash/Zucchini</td>
<td>Onion</td>
</tr>
<tr>
<td>Beans (cooked)</td>
<td>Rice</td>
<td>Apples</td>
<td>Avocados</td>
</tr>
<tr>
<td>Coffee</td>
<td>Sodas</td>
<td>Peaches</td>
<td>Bananas</td>
</tr>
<tr>
<td>Sugar</td>
<td>Pasta soups</td>
<td>Oranges</td>
<td>Mangos</td>
</tr>
<tr>
<td>Flour tortillas</td>
<td>Green pepper</td>
<td>Meat</td>
<td>Chicken</td>
</tr>
<tr>
<td>Eggs</td>
<td>Tomato</td>
<td>Tequila</td>
<td>Beer</td>
</tr>
<tr>
<td>Potatoes</td>
<td>Cabbage</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Image Source: (Shulz et al., 1994, p. 1070)

The level of physical activity recorded from this study found that all of the men spent at least 40 hours a week performing hard labor occupational activity such as farming and wood milling, while the women performed strenuous housework like having to carry laundry to and from the river banks for washing (Shulz et al., 1994). The ultimate conclusion that this study drew was that even in a genetically vulnerable population, with healthy diet and exercise, the Mexican Pima have resisted the development of diabetes mellitus overtime (Shulz et al., 1994). What is most interesting about the results of these study findings is that the healthy lifestyle the Mexican Pima maintain is not directly intentional - meaning, the community is not making any extra effort or resolution to transform their dietary and exercise habits. Rather, they are maintaining cultural and historical tradition.

The lifestyle of the Mexican Pimas are protecting them from some of the major risk factors that are impacting the onset of diabetes in the Arizona Pima, specifically obesity. A study published in Journal for Diabetes Care by Shulz and Associates state that although “cause and effect” cannot be proven in a cross-sectional study, they conclude that the lower prevalence of type 2 diabetes in the Mexican Pima is “largely, if not entirely” a result of the lower levels of obesity among the population (Shulz, Bennet, Kidd (2), Ravussin, Esparanza, Valencia 2006, p. 26).
That being said, the conclusion drawn indicates that changes in lifestyle associated with Westernization is the major influencing factor in type 2 diabetes rates among the Pima Indians of Southern Arizona. Westernization may be defined as the modernization and commercial of a society, which includes dependence on the automobile, the use of modern technology for entertainment (i.e. television, video games, cellphones) and the mass commercialization of fast food corporations. Such Westernization influences include a significant change in daily physical activity, accessibility to healthy affordable foods and change in economy. Undeniably all of these elements are interdependent. Table 3.4 below outlines a conceptual comparison between the Mexican and Arizona Pima based upon the conclusions from the various quantitative studies evaluated throughout these discussions:

Table 3.4: Lifestyle Comparison Factors Between Arizona and Mexican Pima

<table>
<thead>
<tr>
<th></th>
<th>*Arizona Pima</th>
<th>Mexican Pima</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economy</td>
<td>Service (Entertainment, Food, Social Service, Education)</td>
<td>Agrarian, Subsistence Farming</td>
</tr>
<tr>
<td></td>
<td>• Nearly 50% of the work force works in the service industry</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Only 5% work in Agriculture</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• More than 50% of the population live at or below the poverty level</td>
<td></td>
</tr>
<tr>
<td>Accessibility to Healthy Food</td>
<td>45 minute distance by automobile to nearest superstore</td>
<td>2 Sustained by subsistence farming. Plow with oxen and mules, planting and harvesting crops.</td>
</tr>
<tr>
<td>Physical Activity</td>
<td><strong>Men:</strong> (12.1 h/week) <strong>Women:</strong> (3.1 h/week)</td>
<td><strong>Men:</strong> 32.9 (h/week) <strong>Women:</strong> 22.1 (h/week)</td>
</tr>
<tr>
<td></td>
<td>70% of the workforce population commutes to work by car</td>
<td></td>
</tr>
</tbody>
</table>

*All data, unless otherwise indicated, is from the Demographic Analysis of the Gila River Indian Community completed by the Arizona Rural Policy Institute

2 Data Source: Shulz 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, 29(8), 1869. 2006.

3 Data Source: Shulz 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, 29(8), 1868. 2006.
The connection between water availability in the Gila River and the Westernization of the Gila River Indian Community exists and has lead to epidemic rates of type 2 diabetes in the Pima Indians of Southern Arizona. Without surface and groundwater flows along the Gila River, which has been the case until a century ago, the Pima Indians are unable to irrigate their land and grow crops to sustain not only themselves, but also their economy. As their economy shifted over time, so did their diet and physical activity. Poverty rates reached an all-time high due to lack of work and education. The rural layout of the community forced dependence on automobiles, while food subsidy programs through the U.S. federal government became their only meal option (Unnatural Causes, Bad Blood 2008). Until the early 2000’s, fresh fruits and vegetables were not offered as a part of the food subsidy program – only processed, canned and starchy foods. (Unnatural Causes, Bad Blood 2008).

**RECOMMENDATIONS**

With consideration of the data presented throughout these discussions, recommendations for intervention measures can be made respective to studies performed by the National Institute of Health (NIH), NIDDK and the American Diabetes Association (ADA). There are various ways in which prevention and treatment of type 2 diabetes may be approached. From a symposium of experts on type 2 diabetes in children and representatives from the NIH, CDC and NIDDK specific questions were resolved regarding the classification, epidemiology, treatment and prevention of type 2 diabetes in children. For the purpose of this recommendations section, two of the six questions asked from the symposium will be addressed in these discussions. Issues of “high-risk” patients were key in determining solutions to treat and prevent NIDDM. To first
evaluate the onset or risk of developing the disease, the Consensus Panel recommended that, “if an individual is overweight – defined as BMI > 85th percentile for age…” or have a history of type 2 diabetes in first or second-degree relatives, belong to a susceptible ethnic group (including American Indian) or have signs of insulin resistance, testing should be completed regularly every 2 years starting at age 10 (American Diabetes Association 2000 p. 676). There are different treatment measures that are suggested for both adults and children. While a pharmacologic approach is favorable in adults, drug therapy in children who are either at risk for type 2 diabetes (having impaired glucose tolerance – IGT) or are ill, is not recommended (ADA 2000 p. 677). Ultimately, lifestyle changes are considered the most effective and viable solution to reducing risk for the disease and it’s severity, if already diagnosed. Seeing that obesity and high BMI are number one risk factors for the development of the disease, weight reduction is highly recommended as an approach to treatment and prevention – especially in children. Sustained weight reduction is typically unusual in adults; however, increased physical activity (approximately 30 min of mild exercise per day) in adults is strongly encouraged. In fact, lack of physical activity, according to the experts on this panel, is the largest contributor to the development of type 2 diabetes in children and young adults (ADA 2000 p. 680). Overall, only 25% of high school students in the United States participate in daily physical activity – this is indicative of similar rates seen among the Pima Indians in the U.S. (ADA 2000 p. 679). In a Diabetes Prevention Program study, the definitive conclusion drawn is centered around reduction of risk factors:

Treatment of diabetes is often unsuccessful in preventing its adverse outcomes, including vascular disease, neurological complications, and premature death. Prevention of type 2 diabetes would, therefore, be preferable, and may be possible through modification of
risk factors. Despite considerable variation among people in the relative importance of genetic and environmental causes of type 2 diabetes, in all populations and ethnic groups, most patients have both insulin resistance and β-cell dysfunction. These appear to be the underlying metabolic abnormalities leading to the disease. Thus, interventions aimed at reducing insulin resistance and preserving β-cell function are anticipated to be beneficial in delaying or preventing most cases of type 2 diabetes in all populations. (The Diabetes Prevention Program 1999).

Obesity and physical inactivity are considered “potentially modifiable” risk factors, but nonetheless are very difficult to address (DPP 1999). Behavioral intervention is recommended by specialists across the field to be the best means for prevention among any population. Although very difficult, the symposium of experts suggest a public health approach targeting the general population (2000). School and community based programs are recommended (ADA 2000). Comprehensive programs like these not only take a direct approach, but also increase awareness and encourage overall behavior and lifestyle changes while minimizing drug therapy.
Works Cited


