The Effects of Nutrition, Environment, Lifestyle, and Previous Health on the Onset of Type 1 Diabetes and the Application of Alternative Medicine

AnnMarie Pino

The College of New Jersey

Spring 2012

Abstract: This paper investigates non-genetic factors that influence the onset and/or risk of type 1 diabetes. In order to develop type 1 diabetes, certain genetic factors need to be present as well as environmental triggers. Past literature has identified these triggers and include introduction to cow's milk, gluten, breastfeeding, insufficient vitamin D and fish oil, stress, being underweight, viruses, and antibiotics. Some of these factors have unclear associations with the onset of type diabetes and this thesis attempts to further understand these relationships. Additionally, these associations will be used to promote cost savings for the individual as we as the national medical costs through the promotion of alternative medicine. By examining which factors may trigger type 1 diabetes, alternative medicine prior to diagnosis can play a role in reducing the incidence rates.

Introduction

Diabetes Mellitus, more commonly known as type 1 diabetes, is an autoimmune disease that affects as many as three million people in the United States alone. A diabetic individual's immune system destroys the cells necessary for producing insulin and in order to stay alive, people with type 1 diabetes must inject or infuse insulin daily. Additionally, monitoring of blood sugar multiple times of day is necessary in order to avoid serious hypoglycemic or hyperglycemic episodes (JDRF). Because of the nature of this disease and the constant monitoring required, type 1 diabetes costs an estimated $14.4 billion in medical costs and lost income yearly. When compared to the $174 billion type 2 diabetes costs annually, these costs may seem quite small. However, when examined on a per-patient basis, type 1 diabetes has a substantial and disproportionate economic impact, particularly in indirect costs (Tao 10).

Medical costs in the United States have increased drastically and the nation spends approximately 16% of its GDP on the health care sector. Physician care, hospital care, and prescription drugs make up approximately 60% of these costs. The costs of type 1 diabetes are mainly encompassed in these three categories so theoretically if the costs of this disease are reduced, the burden of health care costs would also decrease. Unlike type 2 diabetes, the factors influencing the development of this disease are not well known so it is more difficult to promote prevention. However, researchers believe that both genetic factors and environmental triggers are involved (JDRF). The main genetic factor is the presence of certain human leukocyte antigen genes (HLA) that are inherited from both parents. Also, the insulin gene is the region of DNA that codes for the protein which is crucial aspect of type 1 diabetes. Certain viruses and antibiotics in

early stages of life have shown an increased prevalence in type 1 diabetes. Nutritional factors such as gluten and early cessation of breastfeeding have also shown an increased prevalence while factors such as vitamin D and fish oil have displayed a protective effect on developing this disease. Lastly, lifestyle factors such as stressful events and being overweight have been shown to increase type 1 diabetes risk.

Literature Review

The most significant genetic factor that has been found is linked with certain human leukocyte antigen (HLA) genes. These genes make up the HLA complex which, according to the U.S. National Library of Medicine, "helps the immune system distinguish the body's own proteins from proteins made by foreign invaders such as viruses in bacteria" (Genetics 1). The proteins produced from these genes are present on almost all cells inside humans. The variations of HLA genes allow individual's immune system to react to foreign bodies. Different alleles have been associated with over a hundred diseases (2). Over half of the genetic risk for type 1 diabetes can be attributed to the HLA region. The association between HLA and susceptibility for type 1 diabetes has been researched for years and is well known. One of the earlier studies that documented this association was conducted by Andrea Steck, et. al., which followed children at increased risk of type 1 diabetes for twelve years. The researchers found a significant association between two HLA alleles: HLA-DR3 and HLA-DR4. These two forms of the allele are present in 95% of all type 1 diabetics. About 30% of type 1 diabetics have both DR3 and DR4 present. The presence of these alleles in the general population is about 30% for DR3 or DR4 and the frequency of having both alleles range from 1% to 3%.

Although both DR3 and DR4 increase the risk of type 1 diabetes, they tend to manifest differently when type 1 diabetes develops. For instance, diabetics with the DR3 allele usually develop diabetes later in life which is the opposite of what usually occurs with the DR4 allele. However, the inheritance of both alleles tends to develop diabetes at the youngest age and have the highest levels of antibodies against insulin (Genetics 2). Because of these attributes, it is important to note the significant increase in likelihood of developing type 1 diabetes with certain HLA genes.

Another genetic aspect that influences developing type 1 diabetes is the insulin gene which is located at the IDDM2 locus of DNA. As the key autoantigen in the autoimmune process, insulin is crucial in the development of type 1 diabetes. Because diabetes destroys the cells necessary for producing insulin, lack of insulin production is crucial to the development of all forms of diabetes (Pugliese 1). Specifically the variable number of tandem repeat (VNTR), a region in the insulin gene has been attributed to be the main susceptibility determinant in the insulin gene. About 75% to 85% of type 1 diabetics as compared to about 50% to 60% of the general population possess VNTR I allele, which is a smaller VNTR region. A longer region which is associated with the VNTR III allele, on the other hand, has shown a protective effect. If a person inherits two VNTR I genes, there are approximately two to five times more likely to inherit type 1 diabetes than a person who inherited at least one long allele (4). A Romanian study by C. Guja looked into the prevalence of both the HLA and insulin genes in type 1 diabetic patients. The researchers found that about 1.5% of the cases of type 1 diabetes do not have a genetic susceptibility. More importantly, when examining first degree relatives of these patients, it was shown that approximately 50% were genetically susceptible but did

not develop the disease (Guja 6). Because of these findings, it is important to pay attention to the environmental factors that may trigger the onset of type 1 diabetes. Since all of those studied were genetically susceptible, there must be some difference between those who do and do not develop type 1 diabetes.

In addition to having a genetic predisposition to type 1 diabetes, environmental factors also play a role in increased risk and prevalence of this disease. Looking first at nutritional factors, research has shown that early introduction to gluten and cow's milk early on in childhood have shown an association with increased risk of type 1 diabetes. Annette Ziegler et. al. (2011) examined whether breastfeeding duration or age of introduction to gluten containing foods increases the risk of developing autoantibodies associated with type 1 diabetes. Their study followed 1,610 newborn children of parents with type 1 diabetes and information on these factors were recorded and then examined autoantibody frequency at age five. The study found that, "Autoantibody risk was significantly increased in children who received gluten-containing foods in their first 3 months of life (Ziegler 4). According to their results, introducing gluten into children diets before the age of 3 months displayed a five fold higher risk for development of autoantibodies associated with type 1 diabetes. This study, however found no increased risk associated with reduced breastfeeding. Additionally, a prior study conducted by Hans Akerblom et. al. found inconclusive results regarding breastfeeding and the introduction of cow's milk as well. Akerblom noted that the relationship between cow's milk and type 1 diabetes has been debated for years. Because of the inconclusive results concerning breastfeeding and cow's milk, it will be included in this thesis in hope to gain a more conclusive result regarding this factor.

The other nutritional factors that will be examined are vitamin D and fish oil. According to previous research, higher intakes of both of these have displayed a protective effect against developing type 1 diabetes. One such study was conducted by Susan Harris (2005) which looked at the protective effect of vitamin D in reducing the risk of type 1 diabetes. Vitamin D can be obtained by infants when the skin is exposed to sunlight and also from foods and supplements such as formula and vitamin supplements. It has been shown that breast milk alone contains insufficient amounts of vitamin D for infants while formula-fed infants receive adequate intakes. According to Harris the strong protective association of vitamin D occurs with doses around 50 µg/d. Current U.S. recommendations are between 5-25 µg/d. Additionally the use of fish oil, which contains vitamin D and the fatty acids eicosapentaenoic and decoshexaenoic, has been associated with lower risk of type 1 diabetes. Fish oils are often used as vitamin D supplementation in colder regions of the world where vitamin D cannot always be obtained from sunlight (Lars & Joner). Additionally, the fatty acids in fish oils have anti-inflammatory properties that may also prevent type 1 diabetes. One study that researched this was a Norwegian by Lars Stene and Geir Joner (2003). The authors found a significant association of cod liver oil being used during the first year of life and a lower risk of type 1 diabetes. Unlike other studies, Stene and Joner found no association between risk of type 1 diabetes and other vitamin D supplements. However this study only examined 10µg of vitamin D so this may account for the lack of association as was shown in Harris' previous study. Because of this, the results of this study further support Harris's study and add fish oil as another potential factor that influences diabetes.

In addition to these nutritional factors, it is also important to examine lifestyle factors largely influenced by their parents. Two of the most important factors to look at in this category are stressful events early in life and being overweight. Stress has been linked to a multitude of symptoms including high blood pressure, heart disease, obesity, anxiety, and stomach issues (Mayo). Additionally, stress has been linked to higher incidence rates of both type 1 and type 2 diabetes. In a study by Hagglof et. al. (2011), the author investigated life events prior to the onset of type 1 diabetes in children up to fourteen years old. The results of the study noted, "Events related specifically to actual or threatened losses within the family, events that may affect children differently in different age groups, were reported with a significantly higher frequency by diabetic patients than by referent subjects" (Hagglof 1). Because of these findings, the authors reinforced the notion that stressful events may actually be a risk factor for type 1 diabetes. The same results were found in a previous study conducted by Martin Crosgrove (2004) that additionally found an association between the onset of diabetes and a recent stressful event. Crossgrove's study noted that not only were stressors an additional factor but actually sometimes attributed to the onset of diabetes (Crossgrove 4).

The other important lifestyle factor to pay attention to is being overweight or obese. People who are overweight have an increased risk at developing a multitude of health problems including heart disease, stroke, liver disease, and respiratory problems. Additionally, obesity is a well known risk factor for type 2 diabetes but some researchers have found an increased risk of type 1 diabetes as well. One study that found these results was conducted by Elina Hypponen and the Childhood Diabetes in Finland Study

Group (2000). Over a four year span, Hypponen examined children diagnosed with type 1 diabetes. The average weight and height did not differ between the diabetic group and the control group but the study found that, "Both boys and girls who developed type 1 diabetes were heavier than control children from early infancy onward" (Hypponen 2). Even after adjusting for certain socioeconomic factors, these results were consistent. To explain this phenomenon, the researchers hypothesized that increased insulin secretion and β-cell stress. The authors noted:

> "Hyper functioning β-cells have been shown to be more susceptible to the cytoxic effect of various cytokines. If the basic mechanism is a genetic susceptibility to hyperinsulinemia that increases the vulnerability of the β-cell or a possible overcompensated β-cell function triggered by early lesions of the β-cells, then both increased with and height gain could be considered as risk markers for type 1 diabetes" (5).

Similar to some of the nutritional factors identified before, weight is crucial if it is a factor to developing type 1 diabetes because if approached properly, it can lower the risk of developing this disease.

The last group of risk factors of developing type 1 diabetes is viruses and antibiotic used in childhood. According to the JDRF, during childhood the body establishes immunoregulation primarily through microorganisms in the gastrointestinal tract. Changes in the makeup of these microorganisms can be due to antibiotics (JDRF 3). In a study conducted by Anders Hviid and Henrik Svanstrom (2009), the authors evaluated the association between antibiotic use in childhood and later development of type 1 diabetes. Using national databases, classifying antibiotics, and following children to see if they developed type 1 diabetes, the researchers conducted their study for ten years. As they hypothesized, Hviid and Svanstrom did in fact find an association between antibiotic use and type 1 diabetes in childhood independent of the number of

courses of antibiotics, class of antibiotics, and age of exposure (Hviid 4-5). Because no specific group of antibiotics proved to have a significantly higher association than another, this factor proves more difficult to analyze. For instance, if one group of antibiotics was responsible for the majority of the association, then it would be advised to use other courses of treatment. However, since it is all antibiotics, it is not as straightforward. Unlike other factors previously discussed, it is not without large repercussions that the medical field can recommend discontinuing antibiotics use since they are used to cure other medical ailments.

Closely related to antibiotics are viruses which may also have an association with type 1 diabetes. Research has shown that viruses alter the microorganisms in the gastrointestinal tract that is similar to the way antibiotics behave. Although there are over a million different viruses in the world, researchers have identified some that may have an increased association with type 1 diabetes. In M. C. Honeyman's (2000) article the author identified the rotavirus having a potential risk factor in developing type 1 diabetes. Because the retrovirus could potentially trigger islet autoimmunity, Honeyman examined genetically higher risk children measuring the retroviruses and tracking the onset of type 1 diabetes. Honeyman stated, "[Retrovirus] infection was significantly associated with an increase in islet antibodies … Our findings suggest that [retrovirus] infection may trigger or exacerbate pancreatic islet autoimmunity on the HLA-DR4 background" (Honeyman 4-5). In a review written by H.S. Jun and J.W. Yoon (2001), the two researchers examine what viruses have been associated with the development of type 1 diabetes and why this occurs. The authors state the association is, "largely due to the rapid destruction of beta cells by the replication of the virus within the beta cells (Jun

1). The compiled list of viruses to date that have shown an association with higher risk of developing type 1 diabetes are the retrovirus, coxsackie B, Encephalomyocarditis, mengovirus, foot-ant-mouth disease virus, rubella, bovine viral diarrhoea-mucosal disease, mumps, reovirus, kilham rat, cytomegalovirus, Epstein-Barr, varicella zoster (2). Although vaccines are available for some of these viruses such as mumps and rubella, these viruses are not always easily preventable.

Although it is important to understand these environmental factors that have been seen to either protect from or increase the risk of developing type 1 diabetes, the true significance is how these are applied. For this, we look towards alternative medicine. Duygu Arykan (2008) examined the types of alternative medicine used among children with type 1 diabetes. His research survey revealed that in Erzurum, Turkey, approximately 52% of parents of children diagnosed report use of alternative medicine such as herbal preparations including *Aloe Vera* and *morus alba* (Arykan 6). Additionally, 69.2% of the families using alternative did not report this to their healthcare providers. Because of these findings, we see that many diabetic patients are open to trying alternative medicine after diagnosis. Because of the multitude of factors that may increase the risk of type 1 diabetes, use of alternative medicine prior to diagnosis could prove beneficial.

Prevention methods such as these would be cost-effective and fairly easy. However, in order for these to be widely accepted, especially prior to diagnosis, there must be certain policies and support for alternative medicine. It has been noted that complementary and alternative medicine has been increasing in popularity within the United States (Jones 3). In Michael Goldstein's (2002) report, it was also noted the rise

in use of alternative medicine. Goldstein notes that physicians, unlicensed healthcare professions such as massage therapists, and other groups are all looking to legitimize their knowledge of alternative medicine. Currently, there is little regulation on providers of alternative medicine (Goldstein 14). In order to continue to increase the acceptance of alternative medicine in the United States, the author states that, "As [complementary and alternative medicine] is increasingly integrated into American life and health care, these external forces of support are likely to become even more important in furthering the institutionalization and legitimacy of [complementary and alternative medicine]" (18).

One factor that was not examined by Goldstein was health insurers. This was addressed in Robert Tillman's (2001) article in which the author looks at coverage of alternative medicine by health insurance. The majority of alternative medicine treatments in the past are paid for completely out of pocket. In response to the increased interest of alternative medicines, some insurance companies and HMOs have created programs specifically for alternative medicine coverage (Tillman 3). Usually these programs, however, are separate from typical health insurance plans. The reasons for such reluctance to include alternative medicine coverage are according to Tillman:

> "General absence of scientific evidence to support claims by alternative medical practitioners, … may medical practitioners have been trained outside traditional educational institutions, … and administrative difficulties encountered in attempting to integrate a system of medicine that focuses on wellness into accounting systems that are built are principles and categories of allopathic medicine" (7).

Because of these issues, it is important to continue research on alternative medicine's effectiveness, safety, and efficacy. However, for the factors that influence type 1 diabetes, these have been examined. This thesis intends to reinforce the importance of

such factors as well as the role that alternative medicine prior to diagnosis can play in reducing the incidence rates as well as costs of type 1 diabetes.

Theory

Based on the previous literature, a hypothesis was created that stated by decreasing early gluten consumption, stress factors, viruses, and antibiotic use the rate of type 1 diabetes will decrease. Additionally, an increase of vitamin D, fish oil, weight, and alternative medicine will display a negative correlation with type 1 diabetes. Because there are many factors, including breastfeeding and introduction to cow's milk, the model will include variables that were either not examined by the prior research or had inconclusive results. In addition to breastfeeding and cow's milk, foods that induce Candida and mother's health will be added.

After some research Candida, which is a species of yeasts that have been shown to cause a multitude of diseases, was selected as a possible factor. Although previous literature was not found on the possible association between Candida and type 1 diabetes, it will be included it in the model due to personal suspicion that there may be a link between the two. Candida is the excessive growth of candida yeast in the body, particularly within the intestines, which can cause toxins and severe damage. Usually caused by a weakened immune system, candida can result in gastrointestinal issues, food allergies, and pain. Because type 1 diabetes may also be influenced by weakened immune system (due to limited vitamins, stressors, etc.) the co-occurrence of the two can be significant (Candida 2). Since candida may be an element contributing to a weakened

immune system, this too may be a contributing to diabetes. Because of this possible relationship, Candida will be included in this study.

Mother's health is an important concern because there has been links with other diseases and the health of the mother. Because the main factors that influence the rate of type 1 diabetes are not known, mother's health should also be examined. Pre-existing health conditions, health conditions during pregnancy, smoking, drinking, and stress factors will be examined. By looking at these additional variables, this study hopes to identify which factors have the strongest association and therefore recommend how to utilize this information in order to potentially reduce the rate of type 1 diabetes or help manage this disease. Additionally, multivitamin consumption will be examined in order to include the possible intake of vitamin D. Although multivitamins contain other nutritional sources, vitamin D can also be obtained via this method of intake.

Data

In order to obtain data for this thesis, a retrospective survey was conducted. Before the survey could be administered, The College of New Jersey's Institutional Review Board (IRB) needed to approve the survey. An expedited review was permitted because the research involved minimal risk to the participants since it was an anonymous and voluntary survey. By obtaining approval, I ensured that the study would meet the regulations set in place for participants in the research.

In order to find participants, I contacted multiple associations to find type 1 diabetes survey participants. In the end, various JDRF chapters in the New Jersey, New York, and Pennsylvania, a total of five groups, agreed to put the link to the survey on

their websites. For the non-diabetic cohort, students from The College of New Jersey completed the survey. This control cohort also completed the same online survey which only altered the questions by substituting any use of the term "type 1 diabetes" or "diagnosis" and just asked about childhood, having initially confirmed that they were not diabetics. The survey consisted of twenty-eight questions and took approximately ten minutes to complete. The survey can be seen in **Appendix C**. After submission of the survey, the participants could not be contacted in anyway in addition to not being identified.

The factors that the survey inquired about included the intake of nutrients, vitamin D exposure, fish oil consumption, weight, stressful life events, antibiotic use, viruses, and mother's health. The survey was completely anonymous. Its webpage access link was announced by participating type 1 diabetes activist groups as well as being distributed to prior classmates. While the survey was open to both parents and type 1 diabetics, in practice only 36% of the diabetic respondents were the type 1 diabetic themselves. The remaining respondents were either the mother or father of the type 1 diabetic. It was helpful to have so many responses from parents of type 1 diabetics, and not the diabetics themselves, since many of the factors would have occurred at such a young age that the diagnosed children may not know the accurate answers. Additionally the questions asked not only about the diagnosed child's history but also asked about familial history concerning type 1 diabetes and factors reflecting parental behavior such as breastfeeding, antibiotic use, and vitamin consumption. Medical histories prior to diagnosis were also taken into account, including antibiotic use, illnesses, and types of medical attention received.

In total, forty people responded for the type 1 diabetes cohort while thirty-nine non-diabetic participants completed the survey. After the survey period closed, the data was coded and the variables that had uniform negative responses were discarded. **Table 1** shows the summary statistics of the entire data set while **Table 2** displays the diabetic respondents and **Table 3** the non-diabetic respondents.

Methods

The total variables that were created from the survey are listed in **Appendix A**. The dependent variable, *JD*, is whether or not the respondent had juvenile diabetes. The second variable listed, *diagnosed*, will be used as a dependent variable in later analysis. The other twenty-seven variables are all independent variables which are based on the survey questions. The model is attempting to show the likelihood of type 1 diabetes based on the differences within the independent variables. Based on the literature review, the majority of the independent variables cover what has already been shown to have an association with the onset of type 1 diabetes. This includes looking at the nutritional factors of gluten intake, when cow's milk was introduced, vitamin D intake, and fish and cod liver oil supplements. Additionally, because the association between cow's milk introduction and type 1 diabetes was unclear in previous studies, whether or not the child was breast fed or formula fed and the duration of either were also examined. In order to account for other intakes of vitamin D, multivitamin consumption was obtained as well as the average amount of time a child spent outside playing which was the variable *stroller*. The fatty acids in fish were also taken into account by the variable *anyfish* which accounted for the average monthly consumption of tuna, salmon, and sardines. Lifestyle

factors translated into the variables weight and stressful life events during childhood. Lastly, information on childhood illnesses, virus, and antibiotic use during childhood was obtained.

Basic demographic information was asked in order to produce the variables concerning mother's age and where the child lived the majority of their life. In addition, the variables concerning Candida, alternative medicine, and the mother's health were included. Candida was taken into account by looking at the average monthly consumption of sugar, packaged and processed dry goods, bakery goods, cheese, condiments, sauces, and vinegar-containing foods, processed and smoking meats, melons, fruit juices, and yogurt during childhood. These foods were identified from William Crook's book, *The Yeast Connection*, which lists the foods that must be avoided in order to minimize the risk of Candida which can cause toxins and severe damage due to a weakened immune system (83-84). Alternative medicine was looked at to gauge people's perception about using non-traditional remedies as well as to examine the potential influence on the onset of type 1 diabetes. Lastly, the mother's health was examined by looking at alcohol consumption, smoking, and stressful life events prior to pregnancy. This was included to see if there was any relationship between the health of a mother and the subsequent health of a child, which in this case is looking at type 1 diabetes.

Using the literature review, the following model was created:

JD = f (weight, stroller, breastfed, formfed, flength, wheat, cowmilk, anyfish, vitamind, antibiotic, illness, viruses, loss) **(Equation 1).**

The hypothesis is that lower weight, time outside, age of beginning consuming wheat and cow's milk, age of consuming other foods besides breast milk or formula, fish intake, and

vitamin D intake will be associated with higher rates of type 1 diabetes. Additionally, higher antibiotic use, illness rates, viruses contracted, and stress are hypothesized to be associated with a higher rate of type 1 diabetes. Although previously studied, there has been no consensus of whether or not exclusive breast or formula feeding will result in a higher or lower association. A stepwise regression will also be used as a parsimonious specification conducted to understand multicollinearity. In a stepwise regression the independent variables enter according to their statistical contribution in explaining the variance in type 1 diabetes.

The next model includes the addition of the other variables exclusive to the child's health including multivitamin use, alternative medicine and/or herbal remedies used, and factors influencing Candida. The following model was created:

JD = f (weight, stroller, breastfed, formfed, flength, wheat, cowmilk, anyfish, vitamind, antibiotic, illness, viruses, loss, multivitamin, altprior, candida) **(Equation 2).**

These three variables were included to see if other health concerns besides those identified exclusively by the literature had any association with an increased risk of diabetes. The hypothesis is that a high rate of alternative medicine usage and multivitamin intake would be associated with a lower rate of type 1 diabetes while higher consumption of Candida inducing goods would have a positive relationship.

The last probit regression that will be run is based on the model formulation Equation 2 with the addition of the variables concerning the mother's health. The following model was created:

JD = f (weight, stroller, breastfed, formfed, flength, wheat, cowmilk, anyfish, vitamind, antibiotic, illness, viruses, loss, multivitamin, altprior, candida, malc, msmoke, mloss) **(Equation 3).**

This third model was created to see if factors that occurred even before the child was born would have an effect on the onset of type 1 diabetes. Although the genetic components of type 1 diabetes have been extensively, these factors are looking at the lifestyle and stress factors that may have negative effects on the mother's health and have subsequent secondary effects on the child.

After these three models are run via a probit regression and successive stepwise regressions, the results will be analyzed to determine which factors display a strong associate with type 1 diabetes. Changes to variables will also be made in order to capture different possible measurements and associations. In Ziegler's study, the results found that antibody risk associated with type 1 diabetes was increased when children were introduced to gluten-containing foods prior to the first three months of their life (4). Because of this, the variable *gluten3* will be a binary variable that will indicate if the child was introduced to gluten prior to three months old or not. The variables *vitaminD*, *multivitamin*, and *stroller*, are all included in the analysis to take into account the average amount of vitamin D was taken in by the child. To account for these three variables examining the same factor, the new variable *vitDall* will be created. The data points in stroller were converted into a binary output which stated whether or not the child was in the sun two or more times a week or not. Both *vitaminD* and *multivitamin* were also turned into binary variables by indicating whether or not the child took either of these supplements. To create *vitDall* the three binary variables were totaled to get a ranking of the child's overall vitamin D intake.

Lastly, to examine the mother's health, her consumption of alcohol, cigarette consumption, illnesses, and stress factors were questioned in the survey. Illnesses were

not included in the model because of the low number of non-zero data for this question. However, a new variable *Mhealth* will be created to account for the other three factors and give an overall health rating for the mother's health. In order to create this variable, alcohol consumption will become a dummy variable indicating whether or not the mother consumed more than two drinks a week which according to a Gallup poll in 2004, is the average frequency of alcohol consumption for women in the United States (Blizzard 2). Additionally, smoking and loss will be dummy variables. The total of all of these variables will be the value recorded for *Mhealth*.

Due to these changes the Equation 2 will become the model:

JD = f (weight, breastfed, formfed, flength, cowmilk, anyfish, antibiotic, illness, viruses, loss, altprior, candida, vitDall, gluten3) **(Equation 4)**

and Equation 3 will become the model:

JD = f (weight, breastfed, formfed, flength, cowmilk, anyfish, antibiotic, illness, viruses, loss, altprior, candida, vitDall, gluten3, mhealth) **(Equation 5)**

in order to account for the different variables in the models. These changes will be made to account for multicollinearity again while attempting to have a more accurate reading on vitamin D intake, mother's health, and gluten consumption. Since the survey conducted was a retrospective survey, it was necessary to ask multiple questions to account for a single factor. By changing the variables, the probit regressions will display if there are different associations with type 1 diabetes with different measures.

Results

Because the dependent variable is dichotomous, whether or not the respondent had type 1 diabetes, it was necessary to run a probit regression. In this model, the probit

model estimates the parameters by looking at nonlinear approaches which is necessary for a binary model. Using Stata, the first trial of this regression was run with all of the independent variables in the model. However, Stata did not produce the appropriate output for this regression. This could have occurred due to the nature of the independent variables in the model. For instance, there are many zeros involved in the dataset which may result in Stata not being able to produce a probit regression. To account for any entry errors in the data which may have caused this output error to occur, a standard regression was run which then produced an output. Because the standard regression was able to create an output, human error in the data was ruled out.

In order to compensate for the full probit regression not working correctly, a probit regression was run with just the variables that were from the literature review, which is Equation 1. The results of this regression can be seen in **Table 4** which shows that the model overall had a Chi^2 value of 40.42 which is makes the model significant at the 10% level. The variables *viruses* and *anyfish* proved to be significant at the 10% level and *cowmilk* was significant at the 1% level. Unlike a standard regression, the interpretation of a probit regression's output is not as straightforward to interpret and just the sign of the coefficient can be examined at this point. Since the coefficient for *anyfish* was negative, as fish intake increases, the likelihood of type 1 diabetes decreases which is consistent with the literature review. The coefficient for *cowmilk* was positive, as the age of which a child began drinking cow's milk increased, the likelihood of diabetes increased. Although this has no specific association between cow's milk and type 1 diabetes has been supported, this is contradictory to previous beliefs. Lastly, *viruses* also had a negative coefficient which is inconsistent with the literature review.

Additionally, the stepwise regression's results for this model can be found in **Table 5**. This stepwise regression found the order in which the variables entered the model begins with *cowmilk, viruses,* and then *anyfish*. Because *cowmilk* and *viruses* were the first two variables to enter the model, it is important to investigate why the coefficient is not what was expected. In order to investigate why this occurred, a correlation matrix was created which can be seen in **Table 18**. None of these variables exhibited high correlation coefficients with any of the other variables. Next, a regression was performed with viruses becoming the dependent variable however this equation was not significant. A regression with cow's milk as the dependent variable was ran next and the results can be seen in **Table 6**. *Weight* was significant at the 1% level while *breastfed, wheat,* and *vitamind* were significant at the 5% level. However, as **Table 7** shows, when these variables are removed from the probit regression, the results do not vary by much. Removing these factors due to possible multicollinearity did not change any of the originally significant variables and therefore *weight, breastfed, wheat,* and *vitamin* will stay in the model. Because of these results, it is probable that the coefficient of viruses and cow's milk being the opposite of what the hypothesis predicted can be attributed to the small number of observations in the data set. Also, for cow's milk there is potential that there may be two way causation involved that cannot be taken into account at this point in time.

The contents of **Table 8** show the results of the probit regression on the second model (Equation 2). This model ran includes the variables multivitamins, alternative medicine during childhood, and Candida inducing foods. The inclusion of these variables caused the model to shift in the sense that in addition to *cowmilk* and *viruses, vitaminD*

enters the model at the 5% level while *anyfish* is dropped. The coefficients for *cowmilk* and *viruses* keep the same sign so their interpretation does not change. *VitaminD's* coefficient is positive which is consistent with the literature review since the variable is defined as the age at which the child began taking a Vitamin D supplement. The coefficient indicates that as the age that a child begins taking a vitamin D supplement increases, so does the risk of type 1 diabetes. Additionally, the stepwise probit regression of this model again had cow's milk coming into the model first followed by viruses and then vitamin D which can be seen in **Table 9**. The Chi^2 value for the model is 50.66 which indicates that it significant not only at the 10% level but also at the 5% level.

The last model, which includes the three variables on mother's health: consumption of alcohol, smoking, and stress, resulted in the variables cow's milk, vitamin D, viruses, and multivitamin having statistical significance. The results of this model can be seen in **Table 10** in which *cowmilk's* is significant at the 1% level while *vitaminD, viruses,* and *multivitamin* were significant at the 10% level. The coefficients for *cowmilk, vitamin,* and *viruses* stay consistent with the analysis in the previous models. *Multivitamin's* coefficient is negative which indicates that as the age at which the child began taking a multivitamin increases the likelihood of type 1 diabetes decreases. However, this variable was not reviewed specifically within the previous literature but is consistent with the hypothesized results of this variable. Additionally the model's Chi^2 value was 53.31 indicating that this model is significant at the 1% level. Lastly, the stepwise regression for this model, as seen in **Table 11**, has the following order for variables entering the model: *cowmilk, viruses, multivitamin,* and *vitaminD.*

Although the results of the previous three models proved to be significant and improve as the other variables were added, the changes of the variable models were still run in order to determine if these variables better capture the hypothesized results. Model 2 was changed into Equation 4 which include the variables concerning childhood health whose probit regression results can be seen in **Table 12**. The significant variables in this model were *cowmilk*, *anyfish*, and *illness*. *Cowmilk* was significant at the 5% level while *anyfish* and *illness* are included at the 10% level. In the original models, *cowmilk* was also significant in all of the probit regressions while *anyfish* was only included in Equation 1. The coefficients for *cowmilk* and *anyfish* are consistent with prior models. The coefficient for *illness* is positive which indicates that as the number of illnesses during childhood increases, so does the likelihood of type 1 diabetes which is consistent with the previous literature reviewed. The Chi^2 value is 44.73 which makes this model significant at the 5% was also true for the model of Equation 2.

The changes of the variables concerning mother's health come through in Model 3. The probit regression output of Equation 5 can be found in **Table 13**. In this model, only *cowmilk* was significant at the 5% level and *anyfish* was significant at the 10% level. The coefficients are still consistent with the prior models and thus the literature as well. The Chi^2 value for this model is 46.12 which indicates that the model is significant at the 5% level.

The alteration of these variables does not cause major alterations in any of the output. The most important results are the inclusion of *illness* and *anyfish* in these models which had consistent coefficients with the literature review and hypothesis. However their inclusion causes the Chi^2 value to decrease and barely alters the original

three models. Overall, the best model therefore is the third model which depicts Equation 3 and the fourth model of Equation 4. Based on model 3 it can be seen that the variables *cowmilk*, *vitaminD*, *viruses*, and *multivitamin* are all significant in predicting the likelihood of type 1 diabetes within our dataset. However, because of the results of Equation 4, it is also important to examine the variables *anyfish* and *illness*.

In order to gain supporting evidence and potential explanations for incorrect variable coefficients, another set of regressions were run. This time, however, the model used the age at which the type 1 diabetic was diagnosed as the dependent variable. The first model used the variables from in the original model 3 and additional variables obtained from the survey to create:

Diagnosed = f (mage, living, weight, stroller, breastfed, formfed, flength, wheat, cowmilk, multivitamin, vitamind, fishoil, loss, antibiotic, illness, viruses, millness, mhealth, anyfish, altprior, candida) **(Equation 6).**

However, to account for potential two way causation the following model was created as well:

Diagnosed = f (mage, living, weight, stroller, candida, anyfish, loss, antibiotic, illness, viruses, mhealth) **(Equation 7).**

In the first set of regressions run, the non diabetic respondent data was not used and only the type 1 diabetic data was run. **Table 14** displays the results of Equation 6 with the only the diabetic respondents. Although based off of the F-value the model was significant, *altprior* was the only significant variable. However, the coefficient of this *altprior* was positive which indicates that as the use of alternative medicine increases, the age of diagnosis also increases. When looking at the output of Equation 7 in **Table 15**, which is attempting to measure the variables that are less likely to have two way causation, *viruses* becomes the only significant variable. Once again, viruses turn out to

have the opposite sign as what was expected which is consistent with the prior models. The entire model was significant again when looking at the F-values.

The next regressions run were Equations 6 and 7 again but with all the respondents. Since the non-diabetic responses had no value for diagnosed, a value of 120 was assigned as the age of diagnosis. **Table 16** displays the results of Equation 6 with all of the responses and **Table 17** shows the results of Equation 7 which both were significant according to the F-values. Both of the regressions had significant heteroskedasticity and to correct for this robust regressions were run. Equation 6 with all of the respondents had *mage, cowmilk, multivitamin*, *vitaminD, viruses,* and *altprior* all significant at the 5% level. *Viruses, multivitamin,* and *cowmilk* all have the opposite signs than expected which is what appeared before for cow's milk and viruses. However, in previous models, multivitamin's variable did have the correct sign. Additionally, *altprior* and *vitaminD* had the correct coefficients which are consistent with previous models and the literature. This was the first model in which mother's age was a significant variable. *Mage* had a positive coefficient which indicated as the mother is older at the time of the child being born, the onset of type 1 diabetes is delayed. Although there was no specific literature review on mother's age, this demographic variable could be important to analyze in the future.

In Equation 7 with all of the survey respondents, *viruses* is again significant with the opposite sign at the 1% level. Entering the model for the first time in this regression was *weight* which was significant at the 5% level. However, *weight*'s coefficient was positive indicating that as a child was heavier during childhood, their onset of type 1 diabetes occurred later. This is inconsistent with the literature review that stated heavier

weight during childhood was associated with increased risk of type 1 diabetes. However, when looking at the coefficient for weight in Equations 6 and 7 with only the diabetic respondents, the correct coefficients are displayed. Although the variable was not significant in either of these models, it is important to note that when just the diabetic responses are taken into account, there is the predicted effect. In Equation 6 with only the diabetic respondents, weight is significant at the 20% level. Although this is not significant enough to include in the model, the coefficient can be examined for interpretation in this case.

Equation 6 and 7 reinforced the fact that viruses, cow's milk, and vitamin D are all important factors to include in the model. Additionally, these models also had viruses and cow's milk with the opposite coefficient sign then expected which was the case before and allows these results to be more likely due to the sample itself. Also, vitaminD had the correct sign throughout all of the regressions. Although multivitamin showed the opposite sign in these models, it was correct in the previous probit regression so it should still be examined. Additionally, these regressions included three new variables. Alternative medicine use and mother's age were significant and had the same signs as what was expected from the hypothesis and literature review. Weight was also added but the interpretation of the coefficient depended on which model was being examined.

Discussion and Conclusions

In each of the models created, each was significant at least at a 10% level which indicates strength in the models. When examining the hypothesized models, Equation 3 is strongest judging by the Chi^2 value which is significant at the 1% level. In this model

the variables *cowmilk*, *viruses*, *vitaminD*, and *multivitamin* were all significant at least at the 10% level. Additionally the stepwise included the variables in the following order: *cowmilk*, *viruses*, *multivitamin*, and *vitaminD*. Because cow's milk consumption was the first to enter this model, this variable should be looked at in detail. When examining the probit regression output for this variable, it proves to be significant not only at the 10% level but also at the 1% level and is the only variable to do so. Additionally, cow's milk was significant at least at the 5% level for each probit regression run and had a positive coefficient in each case.

Although this may seem as though *cowmilk* is the strongest variable in the model, the coefficient indicates that as the age at which a child begins drinking cow's milk increases, the likelihood of developing type 1 diabetes increases. As noted in Akerblom's previous study, the relationship of cow's milk and type 1 diabetes is unclear. However, the relationship that is presented within the data set clearly shows that early introduction to cow's milk is actually a protective factor. In his study it is noted that according to the American Academy of Pediatrics, "Removal of CM proteins from the diet of infants at risk of type 1 diabetes has been suggested as prevention of type 1 diabetes" (5). In order to further examine why this coefficient occurred, interactions with other variables were examined and no significant correlation seemed be occurring. Additionally, when *diagnosed* was the dependent variable, *cowmilk* still had the incorrect sign. Because there were statistical tests run to account for interaction with other variables in the model there are two other possible explanations for the opposite sign in the model. The first could be the sample. The data was collected retrospectively which leaves room for error due to not recalling certain answers. Additionally, the sample size

is small and this may result in the discrepancy. The second possibility could be that since this debate about cow's milk effect on type 1 diabetes has been around for some time, it is possible that parents who know that their children are genetically predisposed to type 1 diabetes may withhold feeding their children cow's milk for longer periods of time. In this case our coefficient can potentially be interpreted as parents of diabetics are more likely to introduce their children to cow's milk later.

The next variable that will be examined is *viruses*. As discussed before, the coefficient in all of the models created, *viruses* had the opposite coefficient as what was expected after reading prior literature. Although there were statistical tests, there did not seem any reason for the opposite coefficient of *viruses*. However, it is interesting to note that in the models that *illnesses* was significant, the sign was consistent with the hypothesis. Similar to *cowmilk*, statistical tests could not account for *viruses* having a negative coefficient but perhaps this is due to the actual data collected. The variable *viruses* is measured by the number of the following viruses contracted during childhood Bornholm Disease (Coxsackie B Virus), Chicken pox, Cytomegalovirus (CMV Disease), Epstein-Barr (EBV), Gastroenteritis (Chronic digestive problems), Meningitis, Mumps, Retrovirus, Rubella, and Shingles. Since many of these are not common diseases, the likelihood that people would have contracted them within this sample is small. With a bigger sample size, it is possible we would see different results. Also there may be a sample-selection bias within the non-diabetic respondents. People who were ill during childhood may have been more likely to respond to the survey because they have a higher concern for health research and may be more inclined to participate. This may affect the fact that the coefficient is the opposite of what was expected.

Multivitamin's coefficient was negative which indicated that as the age in which a child began taking multivitamin's increased, the risk for type 1 diabetes decreased. Although not specifically examined by previous studies, we can use vitamin D's previous studies as a basis for what the coefficient should be. This being said, the coefficient of multivitamin is opposite of what should be expected. However, it is likely that those genetically predisposed to type 1 diabetes might begin taking multivitamins at a younger age. Additionally, it is not uncommon for people to begin taking multivitamins during adulthood which may also have an affect on the data collected.

Lastly, *vitaminD* is also an important variable because of its potential implications. The coefficient for the variable positive and thus consistent with the previous literature reviewed. Since the consumption of vitamin D seems to have a protective effect on developing type 1 diabetes, those at higher risk genetically should take these supplementation at a young age. Additionally, consuming vitamins requires both minimal expenditures, effort, and changes in behavior. This can also be said about cow's milk and the ease at which this behavior can be incorporated into most people's lives. This is not as true for viruses which are usually out of one's control to determine whether or not they contract a virus besides taking precautions such as vaccines and normal health practices.

Although the specific variable coefficients may not have been what were expected, the model is still strong. The regression analysis using *diagnosed* as the dependent variable reinforced the findings with *viruses*, *cowmilk*, and *vitaminD*. These regressions also showed that *altprior*, *mage*, *multivitamin*, and *weight* may also have an important influence on the age it which type 1 diabetes occurs. Because these regressions

also had a small sample size, especially when only the diabetic respondents were used, these models are used more as supporting evidence than new finds. However, the results led to the identification of other variables within the sample that may be of importance. It is also important to note that in the second set of these regressions including the non-diabetic respondents, a value for diagnosed was assigned. Because they all received the same diagnosed picked arbitrarily high at 120, this may impact the results and analysis. However, because these are used as supporting statistics, they can still be utilized to better understand the hypothesized models.

One variable that was not significant throughout the regression analysis was alternative medicine use during childhood. This variable included the factors pointed out by Arykan's study included Aloe Vera juices or supplements, Morus Alba (white mulberry), stinging nettle, and honey. Although these specific alternative medicines were popular in Turkey for type 1 diabetics, this was not the case within this specific data set. Although the factors outlined by Arykan were not significant, we can look towards the vitamin D as a form of alternative medicine. If consumption vitamin D were to increase, it is likely based on the models created here that the onset of type on diabetes may not be triggered or delayed. Additionally, in the *diagnosed* regressions, alternative medicine did becomes significant which may indicate that it does not in fact determine if diabetes is developed but perhaps delay the onset of diabetes. If this is the case, then alternative medicine as identified by Arykan should be utilized in order to delay the onset of type 1 diabetes.

The data used in this study left room for error because it was collected through a retrospect survey and in the end had a smaller sample size than would be ideal. In order

to obtain additional results, different research methods should be utilized such as a prospective cohort study. Additional measures to capture variables such as cow's milk, viruses, and multivitamins may prove useful in determining their association with type 1 diabetes since these variables did not have their hypothesized impact. However, many of the results obtained did in fact prove to be consistent with the hypothesis created. Future research should continue to examine variables that have already been identified and especially continue research on vitamin D, multivitamins, fish consumption, and illnesses and their association with the development of type 1 diabetes. Additionally, alternative medicine and demographic variables such as mother's age and weight during child should be examined especially when looking at the time of onset of type 1 diabetes.

Future models should examine these variables in depth because if they continue to prove to have significant associations with type 1 diabetes, preventative measures can be set in place to delay onset, avoid development, and lastly reduce costs. Many of these variables would be easy to either avoid or increase consumption of and if they prevent or delay diabetes, would result in cost savings for the patient. Further research should be done to see if alternative medicine may reduce suffering once diagnosed with type 1 diabetes as well. If this is so, steps should be made to move these payments of these medicines away from the individual as to further promote their use. Additionally, implementing guidelines on alternative medicine use and other variables such as vitamin D and fish consumption for those genetically predisposed to type 1 diabetes has the potential to lead to decreased incidence of this disease. Continual research on this topic can ultimately lead to a more clear understanding of the non genetic factors that influence the development of type 1 diabetes.

Works Cited

Akerblom, Hans, et. al. "Environmental Factors in the Etiology of Type 1 Diabetes." American Journal of Medical Genetics. Volume 115 (2002): 18-29. 1 November 2011. <http://onlinelibrary.wiley.com/doi/10.1002/ajmg.10340/full>.

Arykan, Duygu, et. al. "Complementary Alternative Medicine Use in Children with Type 1 Diabetes Mellitus in Erzurum, Turkey." Journal of Clinical Nursing. Volume 18 (2008): 2136-2144. 1 November 2011.

Blizzard, Rick. "Americans and Alcohol: Drink, Drank, Drunk?" *Gallup*. 24 August 2004. Web. 2 April 2012. <http:// www.gallup.com/poll/12790/americans-alcohol-drink-drank-drunk.aspx.>

"Candida Information and Resources." Candida Info. 2011. 11 January 2011. <http://www.candidainfo.org/>.

Crook, Willaim G. The Yeast Connection. New York. Vintage Books: 1986.

Crossgrove, Martin. "Do Stressful Life Events Cause Type 1 Diabetes?" Occupational Medicine. Volume 54 (2004): 250 – 254. 1 November 2011. <http://occmed. oxfordjournals.org/content/54/4/250.full.pdf>.

Goldstein, Michael S. "The Emerging Socioeconomic and Political Support for Alternative Medicine in the United States." Annals of the American Academy of Political and Social Science. Volume 583 (2002): 44-63.

Haggalof, B, et. al. "The Swedish Childhood Diabetes Study: Indications of Sever Psychological Stress as a Risk Factor for Type 1 (Insulin-Dependent) Diabetes mellitus in Childhood." Diabetologia. Volume 34 (1991): 579-583. 1 November 2011. <http://www.springerlink.com/content/wj552w04646n2211/

Harris, Susan. "Vitamin D in Type 1 Diabetes Prevention." Journal of Nutrition. Volume 135 (2005): 323-325. 1 November 2011. <http://jn.nutrition.org/content/ 135/2/323.full>.

"HLA Gene Family: Histocompatibility Complex Genes." Genetics Home Reference. 2009. U.S. National Library of Medicine. 13 December 2011. <http://ghr.nlm. nih.gov/geneFamily/hla>.

Honeyman, M.C. et. al. "Association Between Rotavirus Infection and Pancreatic Islet Autoimmunity in Children at Risk of Developing Type 1 Diabetes." Diabetes. Volume 49 (2000): 1319-1324. 11 December 2011. <http://diabetes.diabetes journals.org/content/49/8/1319.full.pdf+html>.

Hviid, Anders and Henrik Svanstrom. "Antibiotic Use and Type 1 Diabetes in Childhood." American Journal of Epidemiology. Volume 169 (2009): 1079-1084. 11 December 2011. <http://aje.oxfordjournals.org/content/169/9/1079.full.pdf+html>.

Hypponen, Elina, et. al. "Obesity, Increased Linear Growth, and Risk of Type 1 Diabetes in Children." Diabetes Care. Volume 23 (2000): 1755 – 1760. 11 December 2011. <http://care.diabetesjournals.org/content/23/12/1755.full.pdf+html>.

Jones, Wayne. "Policy, the Public, and Priorities in Alternative Medicine." Annals of the American Academy of Political and Social Science. Volume 583 (2002): 29-43).

Jun, H.S. and J.W. Yoon. "The Role of Viruses in Type 1 Diabetes." Diabetologia. Volume 44 (2001): 271 – 285. 11 December 2011. <http://www.springerlink.com/content/dmg1gh323yq7lqg0/fulltext.pdf>.

Guja, C, et. al. "Effect of HLA (IDDM1) and Insulin Gene (IDDM2) in Type 1 Diabetes Patients and Their First-Degree Relatives in Romania." Clinic of Diabetes. 13 December 2011. < http://professional.diabetes.org/Content/Posters/2006/p1062-P.pdf>.

Pugliese, Alberto. "The Insulin Gene in Type 1 Diabetes." IUBMB Life. Volume 57 (2005): 463 – 468. 17 December 2011. <http://onlinelibrary.wiley.com/doi/10.1080/15216540500163301/pdf>.

Steck, Andrea, et. al. "Association of Non-HLA Genes With Type 1 Diabetes Autoimmunity." Diabetes. Volume 54 (2005): 2482-2486. 13 December 2011. <http://diabetes.diabetesjournals.org/content/54/8/2482.full>.

Stene, Lars, et. al. "Use of Cod Liver Oil During the First Year of Life is Associated with Lower Risk of Childhood-Onset Type 1 Diabetes: A Large Population-Based, Case-Control Study." American Journal of Clinical Nutrition. Volume 78 (2003): 1128-1134. 1 November 2011. <http://www.ajcn.org/content/78/6/1128.short>.

"Stress Management." Mayo Clinic. Mayo Foundation for Medical Education and Research. Mayo Clinic. 13 December 2011. <http://www.mayoclinic.com/health/stress-symptoms/SR00008_D>.

Tao, Betty, et. al. "Estimating the Cost of Type 1 Diabetes in the U.S.: A Propensity Score Matching Method." PLoS One. Volume 5 (2010): 1-11. 13 December 2011. <http://www.plosone.org/article/info:doi%2F10.1371%2Fjournal.pone.0011501>

Tillman, Robert. "Paying for Alternative Medicine: The Role of Health Insurers." The Annals of the American Academy of Political and Social Science. Volume 583 (2002): 64-75.

"Type 1 Diabetes Fact Sheet." JDRF: Improving Lives. Curing Type 1 Diabetes. 2010. JDRF. 13 December 2011 <http://www.jdrf.org/index.cfm?page_id=102585>.

Ziegler, Annette, et. al. "Early Infant Feeding and Risk of Developing Type 1 Diabetes-Associated Autoantibodies." Journal of the American Medical Association. Volume 290 (2003): 1721-1728. 1 November 2011. <http://jama.ama-assn.org/content/290/13/1721.full>.

Appendix A: Variable Definitions

JD:	Dummy variable, whether the respondent has type 1 diabetes (1) or not (0)
Diagnosed:	Age at which child was diagnosed with type one diabetes
Mage:	Age of mother when child was born
Living:	Where child was living primarily throughout childhood
Weight:	Ranked scaling of weight during childhood from significantly below average (1) to significantly above average (5)
Stroller:	Average amount of time per week child spent outside playing or in a stroller
BreastFed:	Dummy variable, whether or not the child was exclusively breastfed
FormFed:	Dummy variable, whether or not the child was exclusively formula fed
Flength:	Length of time in months the child was fed only breast milk and/or formula before being introduced to other food
Wheat:	Age at which child began eating wheat products
CowMilk:	Age, in months, at which child began drinking cow's milk
Candida:	Average monthly consumption of the following goods during childhood: sugar, packaged and processed dry goods, bakery goods, cheese, condiments, sauces, and vinegar-containing foods, processed and smoking meats, melons, fruit juices, and yogurt
AnyFish:	Average monthly consumption of the following fishes during childhood: salmon, sardines, and tuna
Multivitamin:	Age at which the child began taking a multivitamin
VitaminD:	Age at which the child began taking a Vitamin D supplement
FishOil:	Age at which the child began taking a fish oil or cod liver oil supplement
Loss:	Dummy variable, whether during childhood the child experienced the loss of a loved one, parents' divorce, a serious accident, or any other traumatic/stressful life event
Antibiotic:	The child's average yearly antibiotic use during childhood

Illness: Number of the following illnesses contacted during childhood oral thrush, severe diaper rash, ring worm, projectile vomiting, chronic stomach aches or nausea, eczema, food allergies, frequent constipation, frequent diarrhea, and frequent headaches

Viruses: Number of the following viruses contracted during childhood Bornholm Disease (Coxsackie B Virus), Chicken pox, Cytomegalovirus (CMV Disease), Epstein-Barr (EBV), Gastroenteritis (Chronic digestive problems), Meningitis, Mumps, Retrovirus, Rubella, and Shingles

AltPrior: Monthly frequency of any of the following alternative medicine or herbal remedies during childhood Aloe Vera juices or supplements, Morus Alba (white mulberry), stinging nettle, honey, other herbal remedies

AltPost: Current monthly frequency of any of the following alternative medicine or herbal remedies Aloe Vera juices or supplements, Morus Alba (white mulberry), stinging nettle, honey, other herbal remedies

Millness: Number of the following that the child's mother was diagnosed with prior to pregnancy Type 1 diabetes, type 2 diabetes, HIV/AIDS, chronic pain, arthritis, anxiety disorder, depression, head aches or migraines, thyroid conditions, and heart conditions

Malc: Average monthly consumption of alcohol by the child's mother prior to pregnancy

Msmoke: Average cigarettes smoked daily by child's mother prior to pregnancy

Mloss: Dummy variable, whether the child's mother experienced the loss of a loved one, a serious accident, or any other traumatic/stressful life event during pregnancy

VitDall: Total vitamin D consumption captured by adding together a binary measure of stroller (in the sun over two times a week (1) or not (0)), vitamin D supplements consumed (1) or not (0), and multivitamin consumption (1) or not (0)

Gluten3: Whether gluten was introduced to their child prior to three weeks (1) or not (0)

Mhealth: Overall health rating of mothers health captured by adding together a binary measure of alcohol consumption (more than two drinks a week (1) or not (0)), a binary variable of smoking (1) or not (0), and whether they experienced a stressful life event during pregnancy (1) or not (0).

Appendix B: Tables

Table 1

Summary Statistics of all Responses

Explanatory Variables	Mean	Std. Dev.	Min	Max
jd	.4936709	.5031546	0	1
weight	2.607595	.9394177	0	5
stroller	6.601266	3.135181	0	10
breastfed	.8525641	1.159682	0	10
formfed	.6923077	.4645258	0	1
flength	6.137975	2.897758	0	12
wheat	8.082895	2.87093	0	12
cowmilk	8.638461	3.216364	0	12
multivitamin	2.202564	2.351677	0	6
vitamind	1.324675	2.343477	0	6
fishoil	.2943038	1.16421	0	7
loss	.3544304	.4813969	0	1
antibiotic	2.43038	6.122538	0	52
illness	.9615385	1.270978	0	5
viruses	.6493506	.7568326	0	3
millness	.4605263	.8073131	0	3
malc	2.546613	3.809529	0	15.05
msmoke	.18	.3932711	0	1.5
mloss	.1733333	.3810843	0	1
anyfish	7.538532	11.7063	0	30.4
altprior	1.589842	4.956804	0	30.4
candida	11.58165	7.051067	.2	30.4

Table 2

Summary Statistics for Diabetic Respondents

Explanatory Variables	Mean	Std. Dev.	Min	Max
jd	1	0	1	1
weight	2.358974	.8425269	1	4
stroller	6.820513	3.321555	0	10
breastfed	.6923077	.4675719	0	1
formfed	.7948718	.4090739	0	1
flength	5.75641	3.308426	1.5	12
wheat	8.75	3.156626	0	12
cowmilk	10.26316	3.110003	0	12
multivitamin	1.434211	2.063751	0	6
vitamind	1.283784	2.382053	0	6
fishoil	.3974359	1.405719	0	7
loss	.3589744	.4859705	0	1
antibiotic	2.948718	8.334136	0	52
illness	1.157895	1.305421	0	5
viruses	.4210526	.5987184	0	2
millness	.5641026	.9117615	0	3
malc	2.486763	3.854004	0	15.05
msmoke	.1842105	.3520414	0	1.5
mloss	.2105263	.413155	0	1
anyfish	5.904615	10.69457	0	30.4
altprior	1.489692	4.924731	0	30.4
candida	11.04179	7.286566	.2	30.4

Table 3

Summary Statistics for Non Diabetic Respondents

Explanatory Variables	Mean	Std. Dev.	Min	Max
jd	0	0	0	0
gender	.5	.5063697	0	1
weight	2.85	.9753369	0	5
stroller	6.3875	2.968828	1	10
breastfed	1.012821	1.566454	0	10
formfed	.5897436	.4983102	0	1
flength	6.51	2.416906	0	12
wheat	7.4825	2.475406	1.5	12
cowmilk	7.095	2.496659	0	12
multivitamin	2.9325	2.399293	0	6
vitamind	1.3625	2.336959	0	6
fishoil	.19375	.87429	0	5
loss	.35	.4830459	0	1
antibiotic	1.925	2.600666	0	12
illness	.775	1.224483	0	5
viruses	.8717949	.8328609	0	3
millness	.3513514	.6756156	0	2
malc	2.608081	3.815452	0	15.05
msmoke	.1756757	.4364665	0	1.5
mloss	.1351351	.3465835	0	1
anyfish	9.1316	12.54437	0	30.4
altprior	1.695405	5.056146	0	30.4

Table 4

Probit Regression of the Literature Model

Explanatory Variables	Coefficients	z	P>z	Regression Statistics	
weight	-.2351271	-0.82	0.414	n	71
stroller	.0463731	0.63	0.531	χ^2	40.42
breastfed	-.0814305	-0.22	0.825	Prob > χ^2	0.0002
formfed	.7836684	1.40	0.163	Pseudo R^2	0.4122
flength	-.0360468	-0.40	0.689		
wheat	-.0749136	-0.84	0.399		
cowmilk	.3279161	3.37	0.001*		
anyfish	-.0410122	-1.83	0.067***		
vitamind	.1166814	1.13	0.258		
antibiotic	-.0866626	-0.67	0.504		
illness	.1451856	0.81	0.419		
viruses	-.4902427	-1.73	0.083***		
fishoil	.1324949	0.61	0.542		
loss	.3256945	0.65	0.513		
_cons	-1.906848	-1.17	0.241		

Table 5

Stepwise Probit Regression of the Literature Model

Explanatory Variables	Coefficients	z	P>z	Regression Statistics	
cowmilk	.2253432	3.74	0.000*	n	71
viruses	-.4703606	-1.82	0.069***	χ^2	30.31
anyfish	-.0371111	-2.16	0.031**	Prob > χ^2	0.0000
				Pseudo R^2	0.3090

*Statistically significant at 1% level
** Statistically significant at 5% level
*** Statistically Significant at 10% level

Table 6

Cowmilk Robust Regression to test for Multicollinearity

Explanatory Variables	Coefficients	t	P>t	Regression Statistics	
viruses	-.4188451	-0.77	0.446	n	71
weight	-1.092801	-3.52	0.001*	F (11,59)	5.37
stroller	-.0239698	-0.26	0.798	Prob>F	0.0000
breastfed	-.8387591	-3.24	0.002**	R^2	0.4226
formfed	.065705	0.10	0.925		
flength	-.0061102	-0.04	0.965		
wheat	.4279462	3.23	0.002**		
anyfish	.0169496	0.52	0.606		
vitamind	-.3771336	-2.33	0.023**		
antibiotic	.2448255	0.98	0.332		
loss	-.1287645	-0.19	0.849		
_cons	9.022344	3.94	0.000		

Table 7

Probit Regression of the Literature Model without Breastfed, Wheat, and Vitamin D

Explanatory Variables	Coefficients	z	P>z	Regression Statistics	
stroller	.0553437	0.87	0.386	n	75
formfed	.7116515	1.46	0.143	χ^2	40.86
flength	-.094697	-1.17	0.240	Prob > χ^2	0.0000
cowmilk	.2872198	4.10	0.000*	Pseudo R^2	0.3930
anyfish	-.0350516	-2.06	0.040**		
antibiotic	-.0003341	-0.01	0.993		
illness	.153328	0.91	0.363		
viruses	-.6424074	-2.43	0.015**		
fishoil	.1822528	1.15	0.252		
loss	.0020161	0.00	0.996		
_cons	-2.236472	-2.50	0.012		

*Statistically significant at 1% level
** Statistically significant at 5% level
*** Statistically Significant at 10% level

Table 8

Probit Regression of Equation 2

Explanatory Variables	Coefficients	z	P>z	Regression Statistics	
Weight	-.3493183	-1.02	0.310	n	68
Stroller	.1115052	1.23	0.218	χ^2	47.72
breastfed	-.4675831	-0.90	0.369	Prob > χ^2	0.0001
formfed	.4523869	0.65	0.518	Pseudo R^2	0.5066
flength	-.0473505	-0.45	0.654		
wheat	-.0880755	-0.94	0.346		
cowmilk	.3608508	3.29	0.001*		
anyfish	-.0369722	-1.42	0.155		
vitamind	.2436355	1.92	0.055***		
antibiotic	-.0190545	-0.13	0.896		
illness	.0816426	0.38	0.704		
viruses	-.7287654	-1.98	0.048**		
loss	.2573545	0.42	0.674		
multivitamin	-.1787147	-1.61	0.108		
altprior	-.0608218	-0.65	0.514		
candida	.0379728	0.92	0.359		
_cons	-1.462288	-0.74	0.457		

Table 9

Stepwise Probit Regression of Equation 2

Explanatory Variables	Coefficients	z	P>z	Regression Statistics	
cowmilk	.2799873	3.60	0.000*	n	68
viruses	-.5285292	1.86	0.063***	χ^2	40.34
vitaminD	.22558	2.21	0.027**	Prob > χ^2	0.0000
				Pseudo R^2	0.4282

*Statistically significant at 1% level
** Statistically significant at 5% level
*** Statistically Significant at 10% level

Table 10

Probit Regression of Equation 3

Explanatory Variables	Coefficients	z	P>z	Regression Statistics	
weight	-.2312494	-0.65	0.515	n	68
stroller	.1210432	1.29	0.196	χ^2	50.23
breastfed	-.698063	-1.21	0.228	Prob > χ^2	0.0001
formfed	.208617	0.30	0.763	Pseudo R^2	0.5331
flength	-.0831328	-0.72	0.469		
wheat	-.123761	-1.25	0.211		
cowmilk	.4274345	3.29	0.001*		
anyfish	-.0404781	-1.35	0.178		
vitamind	.2792908	1.94	0.052***		
antibiotic	-.0302492	-0.21	0.837		
illness	.1771496	0.80	0.426		
viruses	-.6925529	-1.79	0.074***		
loss	.0236704	0.04	0.971		
multivitamin	-.2428897	-1.84	0.065***		
altprior	-.0711613	-0.49	0.625		
candida	.0544582	1.16	0.245		
malc	.0021173	0.03	0.976		
msmoke	-.8061386	-0.96	0.335		
mloss	1.224411	1.21	0.225		
_cons	-1.652936	-0.74	0.457		

Table 11

Stepwise Probit Regression of Equation 3

Explanatory Variables	Coefficients	z	P>z	Regression Statistics	
cowmilk	.2799873	3.60	0.000*	n	68
viruses	-.5285292	-1.86	0.063***	χ^2	40.34
multivitamin	-.195414	-2.20	0.028**	Prob > χ^2	0.0000
vitaminD	.22558	2.21	0.027**	Pseudo R^2	0.4282

*Statistically significant at 1% level
** Statistically significant at 5% level
*** Statistically Significant at 10% level

Table 12

Probit Regression of Equation 4

Explanatory Variables	Coefficients	z	P>z	Regression Statistics	
weight	-.2901396	-0.98	0.326	n	69
breastfed	-.1405932	-0.48	0.628	χ^2	44.73
formfed	.4840249	0.71	0.475	Prob > χ^2	0.0000
flength	-.0708134	-0.67	0.504	Pseudo R^2	0.4677
cowmilk	.3028007	3.16	0.002**		
anyfish	-.0387773	-1.76	0.078***		
antibiotic	-.1334785	-0.90	0.367		
illness	.3483348	1.65	0.100***		
viruses	-.3612978	-1.00	0.318		
loss	.2045617	0.35	0.729		
aloeprior	-1.035766	-0.98	0.327		
candida	-.015811	-0.40	0.691		
vitdall	.3084106	0.89	0.372		
gluten3	.4411761	0.46	0.646		
_cons	-1.495963	-0.93	0.355		

*Statistically significant at 1% level
** Statistically significant at 5% level
*** Statistically Significant at 10% level

Table 13

Probit Regression of Equation 5

Explanatory Variables	Coefficients	z	P>z	Regression Statistics	
weight	-.5223915	-1.50	0.135	n	68
breastfed	-.3565955	-0.72	0.470	χ^2	46.12
formfed	.627556	0.90	0.370	Prob > χ^2	0.0001
flength	-.0829717	-0.78	0.436	Pseudo R^2	0.4896
cowmilk	.2837433	2.94	0.003**		
anyfish	-.0419688	-1.76	0.078***		
antibiotic	-.0760902	-0.49	0.622		
illness	.2694635	1.29	0.198		
viruses	-.4631098	-1.18	0.240		
loss	.5109933	0.80	0.426		
aloeprior	-1.359186	-0.95	0.341		
candida	-.0095934	-0.23	0.820		
vitdall	.3941774	1.02	0.308		
gluten3	.2026208	0.21	0.837		
mhealth	-.445962	-0.92	0.355		
_cons	-.690235	-0.37	0.709		

*Statistically significant at 1% level
** Statistically significant at 5% level
*** Statistically Significant at 10% level

Table 14

Regression of Equation 6, Type 1 Diabetic Respondents Only

Explanatory Variables	Coefficients	t	P>t	Regression Statistics	
Mage	.091351	0.51	0.624	n	32
Living	-1.093356	-0.40	0.696	F(21, 10)	2.35
weight	-2.292671	-1.46	0.175	Prob > F	0.0823
stroller	.1742633	0.41	0.687	R^2	0.8314
breastfed	-1.776847	-0.64	0.536	Adjusted R^2	0.4773
formfed	-5.174659	-1.43	0.183		
flength	.3499428	1.06	0.312		
wheat	-.2980963	-0.59	0.571		
cowmilk	-.004556	-0.01	0.994		
multivitamin	-1.058338	-1.62	0.136		
vitamind	.0037217	0.01	0.994		
fishoil	-.9407111	-0.46	0.659		
Loss	5.296005	1.80	0.103		
antibiotic	-.6280939	-0.58	0.576		
illness	.5116135	0.62	0.546		
viruses	-1.164624	-0.50	0.627		
millness	-.6715226	-0.60	0.561		
mhealth	-2.098926	-0.98	0.352		
anyfish	-.1548517	-1.11	0.294		
altprior	5.076912	2.95	0.014**		
candida	-.1220731	-0.52	0.614		
_cons	19.13862	1.63	0.133		

*Statistically significant at 1% level
** Statistically significant at 5% level
*** Statistically Significant at 10% level

Table 15

Regression of Equation 7, Type 1 Diabetic Respondents Only

Explanatory Variables	Coefficients	t	P>t	Regression Statistics	
mage	.0335647	0.20	0.840	n	36
living	-1.305197	-0.57	0.574	F(11, 24)	1.89
weight	-.3861624	-0.28	0.785	Prob > F	0.0926
stroller	-.4162468	-1.32	0.201	R^2	0.4646
candida	.0634662	0.37	0.713	Adjusted R^2	0.2192
anyfish	-.0362947	-0.44	0.661		
loss	2.220605	0.91	0.374		
antibiotic	.1155425	1.01	0.325		
illness	.8791467	1.28	0.213		
viruses	5.124856	2.86	0.009**		
mhealth	-1.266735	-0.74	0.469		
_cons	9.836894	1.43	0.165		

*Statistically significant at 1% level
** Statistically significant at 5% level
*** Statistically Significant at 10% level

Table 16

Robust Regression of Equation 6, All Respondents

Explanatory Variables	Coefficients	t	P>t	Regression Statistics	
Mage	.091351	0.51	0.624	n	65
Living	-1.093356	-0.40	0.696	F(21, 43)	13.07
weight	-2.292671	-1.46	0.175	Prob > F	0.0000
stroller	.1742633	0.41	0.687	R^2	0.6366
breastfed	-1.776847	-0.64	0.536		
formfed	-5.174659	-1.43	0.183		
flength	.3499428	1.06	0.312		
wheat	-.2980963	-0.59	0.571		
cowmilk	-.004556	-0.01	0.994		
multivitamin	-1.058338	-1.62	0.136		
vitamind	.0037217	0.01	0.994		
fishoil	-.9407111	-0.46	0.659		
Loss	5.296005	1.80	0.103		
antibiotic	-.6280939	-0.58	0.576		
illness	.5116135	0.62	0.546		
viruses	-1.164624	-0.50	0.627		
millness	-.6715226	-0.60	0.561		
mhealth	-2.098926	-0.98	0.352		
anyfish	-.1548517	-1.11	0.294		
altprior	5.076912	2.95	0.014**		
candida	-.1220731	-0.52	0.614		
_cons	19.13862	1.63	0.133		

*Statistically significant at 1% level
** Statistically significant at 5% level
*** Statistically Significant at 10% level

Table 17

Robust Regression of Equation 7, All Respondents

Explanatory Variables	Coefficients	t	P>t	Regression Statistics	
mage	1.37433	1.22	0.227	n	70
living	-6.644448	-0.42	0.674	F(11, 58)	11.24
weight	24.42475	3.17	0.002**	Prob > F	0.0823
stroller	.4989647	0.23	0.821	R^2	0.8314
candida	.2880478	0.31	0.759	Adjusted R^2	0.4773
anyfish	.3247918	0.72	0.471		
loss	2.187293	0.15	0.879		
antibiotic	-.4812967	-1.00	0.320		
illness	-4.278631	-0.88	0.382		
viruses	24.6267	3.98	0.000*		
mhealth	8.262306	0.78	0.437		
_cons	-63.21187	-1.76	0.083		

*Statistically significant at 1% level
** Statistically significant at 5% level
*** Statistically Significant at 10% level

Table 18: Correlation Matrix

	jd	age	mage	living	weight	stroller	breastfed	formfed	flength
jd	1								
age	-0.2	1							
mage	-0.194	-0.16	1						
living	-0.148	0.0259	-0.224	1					
weight	-0.263	0.1035	0.1157	-0.46	1				
stroller	0.0695	-0.053	0.1399	-0.152	-0.174	1			
breastfed	-0.139	-0.012	0.2417	0.7094	-0.333	-0.038	1		
formfed	0.2222	-0.073	-0.233	0.1099	-0.134	-0.019	-0.0853	1	
flength	-0.131	0.0854	0.0536	-0.315	0.2985	0.1306	-0.2079	-0.3802	1
wheat	0.2219	-0.013	0.0946	-0.146	-0.131	0.0842	-0.163	0.0982	0.1013
cowmilk	0.4955	-0.248	-0.102	-0.198	-0.17	-0.014	-0.2398	0.0434	0.05
multivitamin	-0.321	0.0327	-0.045	-0.018	-0.063	-0.01	0.0842	-0.0767	0.1031
vitamind	-0.017	0.068	0.0692	0.1978	-0.093	-0.133	0.1204	0.0823	-0.121
fishoil	0.088	-0.06	0.0747	-0.031	0.0278	-0.139	0.0232	-0.235	0.0671
loss	0.0094	0.0544	0.1709	-0.119	-0.057	0.0396	-0.0472	-0.1572	-0.1927
antibiotic	0.0841	-0.012	0.0737	-0.059	-0.048	-0.27	-0.0122	0.0707	-0.0944
illness	0.1516	0.0112	0.0108	0.0703	-0.112	0.1759	0.0353	0.0969	-0.053
viruses	-0.3	0.4694	-0.098	-0.017	0.1833	-0.027	-0.084	-0.033	0.117
millness	0.1326	-0.256	0.0213	0.0938	-0.152	0.0973	0.2447	0.0097	-0.0704
malc	-0.016	-0.037	0.0408	-0.042	-0.032	-0.049	-0.0096	-0.1511	0.0908
msmoke	0.0109	0.1247	-0.322	-0.066	-0.05	-0.1	-0.1936	0.0825	-0.0832
mloss	0.0996	-0.253	-0.157	-0.063	-0.069	-0.11	-0.0972	0.1143	-0.041
anyfish	-0.139	-0.091	0.058	0.3091	-0.16	-0.096	0.2341	0.145	-0.1347
altprior	-0.021	0.0843	-0.076	-0.06	-0.13	-0.084	-0.0308	0.1647	-0.0447
candida	-0.076	0.2172	-0.018	0.0229	-0.191	0.0341	0.0238	0.1036	-0.1067

	wheat	cowmilk	multivitamin	vitamind	fishoil	loss	antibiotic	illness
wheat	1							
cowmilk	0.4321	1						
multivitamin	-0.09	-0.1172	1					
vitamind	-0.147	-0.2847	0.2572	1				
fishoil	-0.182	0.1159	0.0236	0.0219	1			
loss	0.0507	0.0596	-0.1678	-0.0966	0.0974	1		
antibiotic	-0.116	0.1073	-0.1208	0.2333	0.0438	0.2042	1	
illness	0.0283	-0.0299	-0.0053	0.0862	0.1714	0.1502	-0.0296	1
viruses	-0.155	-0.1516	-0.0128	-0.0057	0.1055	0.0773	0.0017	0.0109
millness	0.0861	0.0737	-0.0995	-0.0856	-0.065	0.0009	-0.1193	0.0311
malc	-0.033	-0.0415	-0.054	-0.0417	0.1813	0.3549	0.16	0.1884
msmoke	0.2414	0.1236	-0.1839	-0.2083	-0.099	-0.031	-0.0842	0.0667
mloss	0.2273	0.0501	-0.0354	-0.0581	0.149	0.1105	0.2373	-0.147
anyfish	-0.135	0.0203	0.1518	0.0595	0.1599	-0.107	0.0659	0.0684
altprior	-0.003	0.1236	0.091	0.1438	-0.046	0.0996	0.6189	-0.054
candida	0.1006	-0.0657	0.0883	0.0134	-0.219	0.205	0.0034	-0.09

	viruses	millness	malc	msmoke	mloss	anyfish	altprior	candida
viruses	1							
millness	-0.158	1						
malc	0.0337	-0.2539	1					
msmoke	0.0852	0.0297	-0.002	1				
mloss	-0.1666	-0.0904	0.1372	0.0821	1			
anyfish	0.0758	-0.0524	0.1422	-0.0606	0.011	1		
altprior	0.0403	-0.1047	0.0203	-0.0982	0.113	0.1009	1	
candida	0.2228	0.1096	0.1128	0.1482	-0.106	0.0228	0.1598	1

Appendix C: Survey

TCNJ

Thank you for participating in this survey which is completely anonymous. The information from this survey will be used towards a senior thesis in economics. The goal of this thesis is to better understand the causes of juvenile diabetes and use this information to potentially reduce the risks, symptoms, and costs of juvenile diabetes.

Your participation in this study is voluntary. You do not have to be in this study if you do not want to be. You have the right to change your mind and leave the study at any time without giving any reason. Any new information that may make you change your mind about being in this study will be given to you. If you would like to keep a copy of this consent form, please print this page or email it to yourself. You do not waive any of your legal rights by signing this consent form.

By choosing "Yes" you consent to participate in this study.

- ○ Yes
- ○ No

Your relationship to a juvenile diabetic:

- ○ I am a juvenile diabetic
- ○ I am the mother of a juvenile diabetic
- ○ I am the father of a juvenile diabetic

Gender of juvenile diabetic:

- ○ Male
- ○ Female

Current age of juvenile diabetic:

- ○ 0 to 3 years old
- ○ 4 to 6 years old
- ○ 7 to 9 years old
- ○ 10 to 15 years old
- ○ 16 to 20 years old
- ○ Over 20 years old

At what age was the juvenile diabetic diagnosed?

- 1 to 3 years old
- 4 to 6 years old
- 7 to 9 years old
- 10 to 15 years old
- 16 to 20 years old
- Over 20 years old

What age was the mother when the child was born?

- 15 to 20 years old
- 21 to 25 years old
- 26 to 30 years old
- 31 to 35 years old
- Over 35 years old

Where was the child living prior to diagnosis?

- City
- Suburb
- Rural

What was the juvenile diabetic's weight when diagnosed?

- Significantly below average
- Below average
- Average
- Above average
- Significantly above average

On average, how many times a week would the juvenile diabetic be outside playing or in a stroller prior to diagnosis?

- 1
- 2 - 3
- 4 - 5
- 6 - 7
- Over 7
- Never

Was the juvenile diabetic breastfed or fed formula?

- Exclusively breastfed
- Both breastfed and fed formula
- Exclusively fed formula

How long was the juvenile diabetic fed only breast milk and/or formula before giving the child other food?

- 1 - 3 months
- 4 - 5 months
- 6 - 9 months
- Over 9 months

At what age did the juvenile diabetic begin drinking cow's milk?

- Less than 3 months
- 4 - 5 months
- 6 - 9 months
- Over 9 months
- Never

At what age did the juvenile diabetic begin eating wheat products? (Ex: Crackers, toast, cream of wheat, etc.)

- Less than 3 months
- 4 - 5 months
- 6 - 9 months
- Over 9 months
- Never

Describe, on average, the juvenile diabetic's consumption of the following foods prior to diagnosis:

	Never	Yearly	Monthly	Weekly	Daily
Sugar	○	○	○	○	○
Packaged and Processed Dry goods	○	○	○	○	○
Bakery Goods	○	○	○	○	○
Cheese	○	○	○	○	○
Condiments, Sauces, and Vinegar-containing foods	○	○	○	○	○
Processed and Smoked Meats	○	○	○	○	○
Melons	○	○	○	○	○
Fruit Juices	○	○	○	○	○
Yogurt	○	○	○	○	○

Please indicate how frequent the juvenile diabetic ate the following prior to diagnosis:

	Salmon	Sardines	Tuna Fish
Never	○	○	○
Yearly	○	○	○
Monthly	○	○	○
Weekly	○	○	○
Daily	○	○	○

At what age, if at all, did the juvenile diabetic begin taking a multivitamin?

- ○ Less than 1 year
- ○ 1 - 2 years
- ○ 3 - 4 years
- ○ Over 4 years
- ○ Never

At what age, if at all, did the juvenile diabetic begin taking a Vitamin D supplement?

- ○ Less than 1 year
- ○ 1 -2 years
- ○ 3 - 4 years
- ○ Over 4 years
- ○ Never

Did the juvenile diabetic ever take fish oil or cod liver oil supplements prior to diagnosis? How often?

- ○ Yes, once daily
- ○ Yes, 4 - 6 times a week
- ○ Yes, 2 - 3 times a week
- ○ Yes, once a week
- ○ Yes, once a month
- ○ No

Before the juvenile diabetic was diagnosed, did they experience the loss of a loved one, parents' divorce, a serious accident, or any other traumatic life even?

- ○ Yes
- ○ No

Please indicate the juvenile diabetic's antibiotic use in the 2 -3 years prior to diagnosis:

- ○ Never
- ○ Less than once a year
- ○ 1 - 2 times a year
- ○ 2 - 6 times a year
- ○ Once a month
- ○ Twice a month
- ○ Once a week

Please indicate if the juvenile diabetic had any of the following prior to diagnosis. Select all that apply:

- ☐ Oral thrush
- ☐ Severe diaper rash
- ☐ Ringworm
- ☐ Projectile vomiting
- ☐ Chronic stomach aches or nausea
- ☐ Eczema
- ☐ Food allergies
- ☐ Frequent Constipation
- ☐ Frequent diarrhea
- ☐ Frequent Headaches

Please select any of the following the juvenile diabetic had contracted before diagnosis. Select all that apply:

- [ ] Bornholm Disease (Coxsackie B Virus)
- [ ] Chicken pox
- [ ] Cytomegalovirus (CMV Disease)
- [ ] Epstein-Barr (EBV)
- [ ] Gastroenteritis (Chronic digestive problems)
- [ ] Meningitis
- [ ] Mumps
- [ ] Retrovirus
- [ ] Rubella
- [ ] Shingles

Before diagnosis, did the juvenile diabetic use any of the following? Please indicate frequency of use.

	Never	Yearly	Monthly	Weekly	Daily
Aloe Vera Juices or Supplements	○	○	○	○	○
Morus Alba (White Mulberry)	○	○	○	○	○
Stinging Nettle	○	○	○	○	○
Honey	○	○	○	○	○
Other Herbal Remedies	○	○	○	○	○

If you have used other herbal remedies, please indicate which types and their intended use:

After diagnosis, did the juvenile diabetic use any of the following? Please indicate frequency of use.

	Never	Yearly	Monthly	Weekly	Daily
Aloe Vera Juices or Supplements	○	○	○	○	○
Morus Alba (White Mulberry)	○	○	○	○	○
Stinging Nettle	○	○	○	○	○
Honey	○	○	○	○	○
Other Herbal Remedies	○	○	○	○	○

If you have used other herbal remedies, please indicate which types and their intended use:

Was the mother of the juvenile diabetic diagnosed with any of the following prior to pregnancy? Check all that apply

- [ ] Type 1 diabetes
- [ ] Type 2 diabetes
- [ ] HIV/AIDS
- [ ] Chronic pain
- [ ] Arthritis
- [ ] Anxiety Disorder
- [ ] Depression
- [ ] Head aches or migraines
- [ ] Thyroid conditions
- [ ] Heart Condition(s)
- [ ] Don't Know

Did the mother have any of the following conditions during pregnancy? Check all that apply

- [ ] Preeclampsia
- [ ] Heart Condition(s)
- [ ] Gestational Diabetes
- [ ] Don't Know

On average, how often did the mother drink alcohol prior to pregnancy?

- ( ) Daily
- ( ) 5 - 6 times a week
- ( ) 3 - 4 times a week
- ( ) 1 -2 times a week
- ( ) 1 - 2 times a month
- ( ) 1 - 2 times a year
- ( ) Never
- ( ) Don't know

Did the mother smoke prior or during pregnancy? If so, please indicate the frequency.

- ○ Yes, less than 1/2 a pack a day
- ○ Yes, between 1/2 a pack and 1 pack a day
- ○ Yes, over 1 pack a day
- ○ No, did not smoke

Did the mother experience job loss, loss of a family member, a major accident, or any other stressful events during pregnancy with the juvenile diabetic?

- ○ Yes
- ○ No
- ○ Don't know

We thank you for your time spent taking this survey.
Your response has been recorded.