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A Review of Incidence and Prevalence Rates of Type 1 Diabetes (T1D) Worldwide: 2000-2022

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Abstract

Introduction: The aim of this paper is to evaluate, review, and summarize the incidence and prevalence rates of type 1 diabetes (T1D) in various regions of the world between the years 2000-2022.

Methods: 39 relevant scholarly research articles with keywords such as “incidence,” “prevalence,” “diabetes,” and “type 1 diabetes” were extracted from PubMed using search engines such as Google Scholar and Microsoft Academic.

Results: The incidence and prevalence of type 1 diabetes in young people appears to be slowly rising in most countries around the world, with the increases being most marked in the very young as well as adults. This presents an interesting and unexpected trend. Type 1 diabetes is most commonly diagnosed among children in Scandinavian countries like Finland. However, the United States and India reported the highest rates around the world.

Implications: Most research on diabetes has been conducted on type 2 diabetes, and hence, there is limited epidemiological data on type 1 diabetes. More research needs to be conducted on the prevalence and incidence of type 1 diabetes worldwide, and in developing countries in particular, to gain a better understanding of the epidemiology of this disease.

Keywords: Type 1 diabetes; Prevalence; Epidemiology; *Psychology; Neuroscience*

Abbreviations

Type 1 diabetes: T1D; Type 2 Diabetes: T2D; The United States: U.S.; Western Pacific Region: WP

Introduction

Overview

Type 1 Diabetes (T1D) is an autoimmune condition caused by the self-destruction of islet beta cells in the pancreas (Bullard et al., 2018). Despite recent technological advancements in treating and managing this disease, the causes and etiology behind T1D remain enigmatic.

T1D is more commonly diagnosed in children and adolescents at nine years of age, plus or minus 2.7 years. Considering T1D is diagnosed at such a young age, the burden of the disease remains high throughout an individual's lifetime. The out-of-pocket costs for Americans with type 1 diabetes average $2,500 a year; for some, it may even be more than $5,000, depending on the health insurance coverage [1].

One of the reasons the causes of type 1 diabetes have not been discovered is the widely variable incidence of the disease across the globe, ranging from 0.1 per 100,000 in regions of China and Venezuela to 57 per 100,0000 in Finland. Both types of diabetes threaten public health and remain a growing issue. Personal, environmental and social factors such as socioeconomic status, vitamin-D intake, birth height and weight, usage of cow's milk and genetics are among the factors that may present a more significant association with diabetes than race or ethnicity [2].

History of Type 1 Diabetes

Before Canadian physician Frederick Banting discovered insulin, type 1 diabetes was a death sentence [3]. With the self--destruction of pancreatic beta cells and the high likelihood of Diabetic KetoAcidosis (DKA), the diagnosis immediately meant death. However, the discovery of synthetic insulin through recombinant DNA allowed type 1 diabetics to live long and prosperous lives [4].

The management of diabetes has immensely evolved. Initially, the user matched a strip to a colour chart subsequent to applying a droplet of blood and waiting 50 seconds to indicate an inaccurate blood sugar reading. The first-ever easy-to-use at-home glucose monitor, Glucometer, arose in 1981 (Coulter et al., 2016). Today, one of the most significant advances in diabetic technology has been the creation of the Continuous Glucose Monitoring (CGM) system, which allows users to check their blood glucose regularly and receive alerts when levels are dangerously high or low (Reddy et al., 2020). Considering how far we have come over the decades, this has created a sense of optimism in doctors and scientists for what is still yet to come. An ultimate cure for type 1 diabetes could potentially be right around the corner.

Epidemiology

North America and The Caribbean Region

North America and the Caribbean have the highest incidence and prevalence rates among all the regions in the world [5]. In 2013, the number of children (0-14 years) with T1D was 108,600, with 16.7 new cases diagnosed per 100,000 children. Several of the top 10 countries with the highest prevalence rates are located in this region. Additionally, the prevalence of the disease varies according to the country, with Canada reporting a prevalence of about 1000 per 100,000 as 300,000 Canadians live with T1D out of the population of approximately 36 million people. According to the International Diabetes Federation (IDF), this is considered a high prevalence rate.

In the United States, non-Hispanic white adults presented a higher prevalence of T1D than Hispanic adults, which may point to genetic factors contributing to a type 1 diabetes diagnosis (Bullard et al., 2018). The overall prevalence of cases per 1,000 people was 1.93 [6]. The data was similar in boys and girls, and the prevalence increased with age from 0.82 in children aged 0–9 to 2.97 in youth aged 10–19.

Another study conducted determined that 0.55% of U.S. adults (representing 1.3 million adults) had been diagnosed with T1D. Based on IDF classifications, this represents a high prevalence of T1D. Of all the diagnosed cases reported, only 5.8% were described as type 1 diabetes, while the rest were type 2 diabetes and other diabetes types. The crude prevalence of type 1 diabetes in the U.S. did not vary much by age group or education. The prevalence of type 1 diabetes was slightly higher among men (0.64%) than women (0.46%) (Bullard et al., 2018). Males made up 55% of the diagnosis of T1D,

80% of whom identified as Caucasian and 53% reported a family history of diabetes [5]. It was also higher among people of white ethnicity (0.67%) than Hispanics (0.22%) (Bullard et al., 2018).

Each year, approximately 18,000 new cases of type 1 diabetes occur in youth aged <20 years in the United States [6]. Moreover, between 2002 and 2009, the incidence among non-Hispanic white youths rose by 2.7%. This data contradicts the findings of those who reported that the prevalence is slowing down and decreasing in the United States, especially in those aged 0-44 years, albeit they could not pinpoint the cause.

On the other hand, Mexico has a considerably lower incidence and prevalence of T1D, as the country is classified in the intermediate range. Interestingly, the incidence of T1D decreased between 2000 and 2018 [7]. A study found a correlation between a spike in the diagnosis of T1D and the influenza epidemic [7]. From 2000 through 2018, the incident cases involving T1D decreased from 3.4 to 2.8 per 100,000 people, while an increase was observed between 2000 and 2006. Females and children <5 years old presented a significant decrease in the incidence rate, while inhabitants in Central Mexico showed a significant increase [7]. This may suggest that environmental factors are associated with T1D, such as exposure to pollution and toxic chemicals. Additionally, although some studies in various regions determined a correlation between the diagnosis of T1D and the seasons, Mexico did not report a connection between the two.

The Africa Region

Data on the prevalence and incidence of type 1 diabetes in Africa is very scarce, especially in recent years. Between 2005 to today, there have only been two studies done. This includes one on the overall incidence rate in the continent and another done by a group in the United States on Rwanda. Studies have found that diabetes is rare in this continent; however, recently, there has been a surge in cases (Samrawit et al., 2014). Due to the lack of healthcare and medical professionals, many people with diabetes never get diagnosed, and the mortality rate remains high. Even when diagnosed, the lack of access to primary care physicians and endocrinologists makes the disease very difficult. Estimates from the "Diabetes in Africa Region" study show that about 39,000 had type 1 diabetes in Africa in 2013, making the incidence 6.4 per 100,000 per year in children under 14 years of age [1]. One of the prevalent patterns observed among African countries with varying levels of economic development is that the more income a country has, the higher the prevalence of T1D will be [8]. The study by IDF found that the prevalence of T1D is as follows, 4.4% in low-income, 5.0% in middle-income, and 7.0 % in upper-middle-income countries(Peer et al., 2014). This shows a direct link between economic development and the likelihood of this disease. Other studies on children from different African countries showed an incidence of 0.33 per 1000 in 5–17 year-old Nigerians and 0.95 per 1000 in 7–14-year-old Sudanese children [7]. The incidence of type 1 diabetes was reported to be 10.1 per 100,000 per year in Sudan in children <15 years old [2]. Tanzania also reported some rates, with an incidence of 1.5 per 100,000 per year with peak presentation age at 15-19 compared to 10-14 in developed regions. In South Africa, the peak age of onset in black Africans was 22–23 years, with an earlier peak from 14 to 17 years, whereas in Europeans, the peak age for type 1 diabetes was 12–13 years. Due to the lack of medical professionals, the micro-and macro-vascular complications associated with type 1 and type 2 diabetes, such as diabetic retinopathy, albuminuria, and proteinuria, remain prevalent in African countries (Mobasseri et al., 2020). Another study in Rwanda reported a prevalence of known type 1 diabetes to be 16.4 per 100,000 for those under 26 years and 4.8 per 100,000 for those below 15 years of age. The rates showed an increase with age and a higher prevalence in females. The peak age of diagnosis was between 17-22 for males and 18 for females. Type 1 Diabetes diagnosis peaks around the mean age of puberty in many regions, consistent with the finding that puberty is higher for people of African descent due to many genetic factors [1].

When the study compared their findings to other African nations, they found the estimated prevalence rates in Rwanda to be 11 times lower than Sudan, three times lower than Nigeria, six times lower than Algeria, 38 times lower than African Americans aged 0–9.9 years, and 11 times lower than African Americans aged 10–19.9 years. This could be backed up by the fact that Rwanda is a low-income country with a projected GDP of 10.50 USD billion in 2021 and lower GDPs in pre-

vious years. Additionally, the Arab ethnicity in Rwanda is small. According to studies on Arabic populations, the prevalence rates tend to be very high in this group, which in turn causes the prevalence and incidence rate of T1D to also be high in many other African countries. Other environmental factors, such as prolonged breastfeeding and delayed exposure to cow's milk, could also explain Rwanda's low prevalence rates [2].

A study in Tanzania surveyed 604 patients under 15 years of age at diagnosis (Jasem et al., 2019). The prevalence of diabetes in those <15 years of age ranged from 10.1 to 11.9 per 100,000 children, and the annual incidence was 1.8-1.9 per 100,000 children, with peak incidence at 10-14 years [9]. This was considerably higher than in Rwanda, which had a prevalence rate of 4.8 per 100,000 people in those under 15 years of age [1]. A lot of data is missing, making it difficult to correctly estimate the incidence and prevalence of type 1 diabetes in African countries.

Asia (East and South-East) Region

According to various studies done over the years, east and south-east Asia have the lowest incidence and prevalence of type 1 diabetes, despite having the largest children and adolescent populations. Southeast Asia comprises India, Sri Lanka, Bangladesh, Bhutan, Mauritius, and the Maldives.

Like many other regions of the world, type 2 diabetes is much more prevalent in this region, and type 1 diabetes is considered a rare disease. However, studies have found several differences in these people's clinical and immunological presentation compared to their European counterparts. Although this may be an exaggeration, the study done by IDF in South-East Asia has reported that some countries may be home to 80% of their population being type 1 diabetics. These countries do not have T1D registers meaning their data is limited. However, according to the available data, there is clear evidence of increased prevalence and incidence of T1D in the region.

This finding is significant for this study since it has been said to contribute to narrowing the polar-equatorial geographical variation in the prevalence of T1D [10]. Previously, it had been thought that a higher latitude and being closer to the North Pole contributed to a higher prevalence of type 1 diabetes, which these findings invalidate [11]. There are two specific clinical diagnostic criteria that differ between Asians and Europeans that are of note. The first included the presentation age, which is higher in Asians than those of European descent. The second is co-existing obesity, termed "double diabetes," which may mask the underlying diagnosis and complicate management.

The SEA region has one of the highest prevalences of T1D in children, with 77,890 affected in 2013. India has the second-highest number of children with type 1 diabetes (67,700) after the US and the largest proportion of incident cases of T1D in children.

Interestingly, the metabolic profile, often manifested in obese and elderly white populations, is seen in young and non-obese SEA populations [10]. This could potentially present as T1D or T2D. The study by Kim et al. in Korea, which surveyed 706 patients with T1D, found that the incidence rate per 100,000 people was 3.19. They found incidence rates of 1.68, 3.16, and 4.46 in children 0–4, 5–9, and 10–14 yr, respectively. The T1D incidence was 2.84 in boys and 3.56 in girls, reflecting a higher incidence in girls [12]. This is consistent with the findings of the studies stating there is a female excess in low-incidence countries.

However, type 1 diabetes is rising as a higher T1D incidence was seen during 2012–2014 than from 1995-2000 [12]. Korea has always had a very low incidence; more than half of the cases were seen in those aged 10-14. The T1D diagnosis was also most commonly made in the winter months, between December and February. This is inconsistent with some European and middle eastern countries, which report spring months as having the most diagnoses [13]. This study has said that the seasonal differences are statistically insignificant [12]. Korea has shown a 2.33-fold increase in T1D incidence from 1995–2000 and from 2012–2014.

Another study was done in China, which reported 5018 newly diagnosed type 1 diabetes cases between 2010-2013 [11]. The estimated incidence of type 1 diabetes per 100,000 of all ages in China was 1.01, which is considered a very low rate.

The highest incidence rate was reported at 1.28 per 100,000, peaking in the 10-14 age group. There was a slight difference between the incidence in males and females, which was found to be positively correlated with latitude Factors such as age group, latitude, and exposure to sunlight were statistically significant and correlated with the incidence of T1D in China [11].

Strangely, they found that although T1D is a disease affecting childhood and adolescence, the incidence of diagnosis was highest among adults over 30. A study done in Taiwan between 2003 and 2008 reported an incidence of 5.3 per 100,000 children, which has been stable and did not show any significant differences between sexes or age groups [14]. However, a slight difference showed that girls are more likely than boys to develop T1D, and the incidence rate increased with age.

According to other studies, which compared their data to Asia, in Japan, the incidence of T1D among children <15 yr was 1.5 per 100,000 population between 1986 and 1990 [12]. In Asian countries, female predominance exists, and boys are typically diagnosed with T1D after puberty [10]. Additionally, a worldwide trend of countries with a traditionally low incidence of T1D has shown a tendency for a rapid increase in the incidence of T1D in children and adolescents, which needs to be addressed urgently.

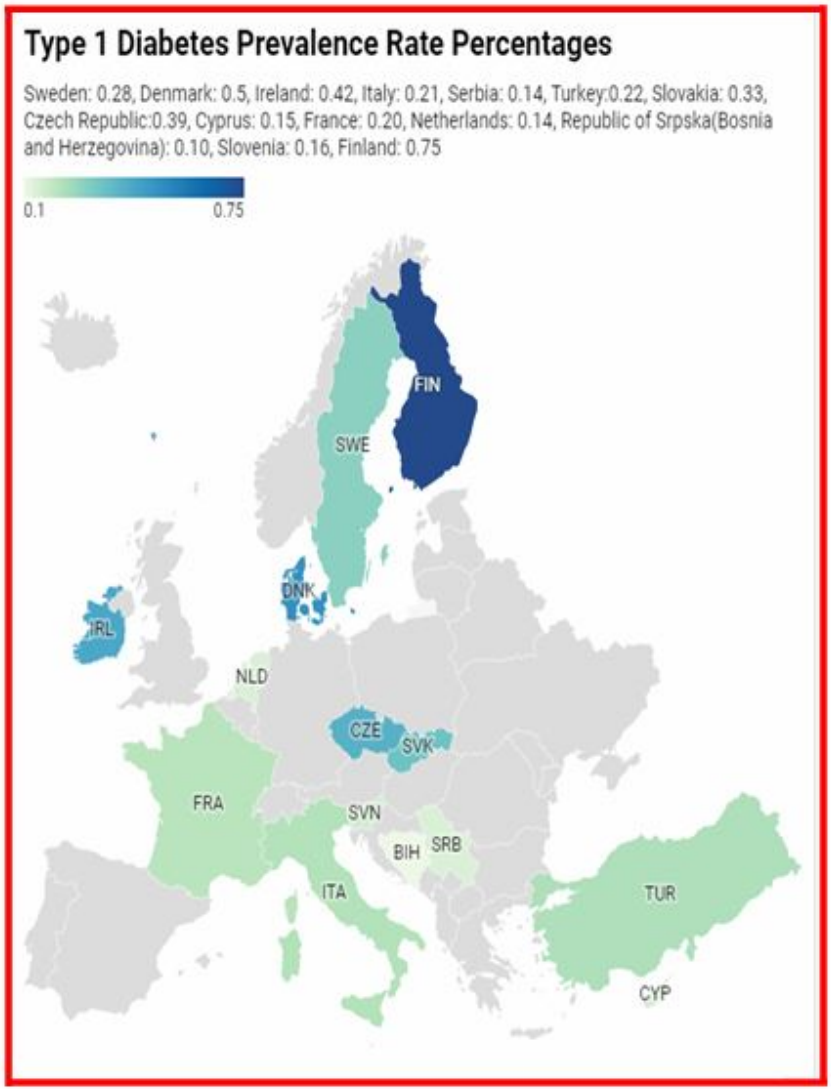

Figure 1: Prevalence of T1D in Europe

Europe

Historically, T1D has been most prevalent among Caucasians in Europe and other continents, including North America. A combination of genetic makeup and environmental triggers has made certain regions in Europe ones with the highest incidence and prevalence rates worldwide. But the question remains why; how do Europeans' genes and environment differ from those of people on other continents? Many studies are being done and published in various European countries yearly, giving lots of data to examine and report on. Scandinavian countries remain those with the highest incidence rates [6].

A study done in Kronoberg, Sweden, reported the incidence of T1D on 177,000 inhabitants, 95% of whom were Caucasian, to be 37.8 among 0-19 year-olds and 27.1 per 100,000 in 20-100 year-olds (Thunander et al., 2008). The data was reported to be bimodal, with equal peaks, in 0-9 year-olds and 50-80 year-olds. As type 1 diabetes is a disease of childhood and adolescence, the peak between 0-9 year-olds would be justified. However, another peak between 50-80 year-olds could be an interesting finding.

There were no gender differences in type 1 in any age group, except some small ones in pediatric subgroups. Incidences of type 1 diabetes in children and adults were very high and as high above the age of 50 years as in children. Like many other populations, most of the diabetic cases were classified as type 2, and only 6.9% were type 1 diabetes diagnoses. Another study in Denmark in 2016 reported the prevalence of diabetes, which was 0.5% for T1D, with annual increases of 0.5% since 1996 [15]. A decrease in mortality was reported for type 1 diabetes, which gives us hope as the novel treatment and management methods for T1D decrease the disease's burden. The median age at diagnosis for patients with T1D was around 30 years, slightly older for men than women, which shows that T1D is starting to become a disease in adults as well. For men, there was an increase to about age 18, a plateau and a slight increase to age 40, whereas women showed an increase until about age 15 and a decrease after that. The excess in men was consistent with findings among other high-risk countries, which often report a lower incidence among women [12].

A study was done in Ireland in the same year, 2016, using the pharmacy claims data, showed that there were 20,081 prevalent cases of type 1 diabetes in 2016 [16]. The crude prevalence was 0.42%. There were 1527 new cases of type 1 diabetes in 2016, giving an incidence rate of 32 per 100,000 population per year, which is considered a fairly high incidence. The prevalence and incidence were 1.2-fold and 1.3-fold higher in men than women, which were 0.46% vs. 0.37%, respectively. Something interesting to note is that 35% of incident cases were in the age group of 35–64 years, which is in line with a recently published study using the UK Biobank, as well as other studies being done in the United States, showing that as many as 42% of type 1 diabetes cases may be diagnosed between 31 years and 60 years of age [16].

An Italian study was done in the Lombardy Region during the Covid-19 pandemic reports on the “double wave” occurrence and the correlation between the current Covid-19 pandemic and the soon-to-be type 1 diabetes epidemic [4]. The estimated incidence proportion of T1D was 16 per 100,000 in 2020, compared to 14, 11 and 12 in 2019, 2018 and 2017, respectively. When incidence wasadjusted for age and gender, the incidence was significantly lower in 2018 and 2017 compared to 2020 but no difference between 2019 and 2020. However, the cases of COVID-19 would not be detected in Italy until the very end of 2019. As with many other diseases, including type 2 diabetes, stroke and heart attacks, there was a reduction in the number of T1DM diagnoses in March and April 2020 compared to other years, as the number of Covid-19 cases was rampant in many Italian hospitals. But no differences were later observedin October-December, which could be warranted by the fact that people were no longer as worried about the Covid-19 pandemic as knowledge of it increased. The average age at onset was similar across the years. However, the percentage of the new diagnosis in the youngest children of new-onset was the highest in 2020. Since many people waited to go to the hospital for their type 1 diabetes diagnosis, the numbers of DKA and severe DKA peaked when the Covid-19 hospitalizations fell during the off-peak times.

Another study was done in Serbia to assess the incidence and prevalence of type 1 diabetes mellitus. There was an increase in the incidence of the disease in children between 0-14 years

old and a decrease in the incidence after the age of 15 [17]. A significant increase in incidence was recorded in two age groups, namely 5–9 and 10–14 years of age. The highest increase was in children aged 5–9, and the highest incidence rate was in children aged 10–14. In Serbia, type 1 diabetes accounts for 5% of all diabetic patients. The greatest number of new T1DM cases are typically diagnosed in childhood; the peak age is 10–14. While boys and girls are almost equally affected by T1DM, later in adulthood, males have a 50–70% higher risk of suffering from this type of DM than females. There was a significantly higher incidence rate of T1DM in the age group 10–14 compared with the age groups 0–4, 15–19, 20–24 and 25–29. The results of this study showed that in Serbia, after the age of 15, the incidence rate of T1DM is significantly decreasing. The risk of T1DM declines steeply after age 15 in European countries with high incidence rates, such as Finland, and in countries with low incidences, such as Lithuania and Italy [4]. The increase in type 1 diabetes in children but not young adults can be suggestive of different etiologies for the disease in children compared to adolescents and adults. A study done in Turkey between 2009 and 2019 shows the incidence of type 1 diabetes to be 16.7 per 100,000 per year, which is considered an intermediate rate [18]. There was an increase of 7.8% per year in the observation period. The mean age at diagnosis was 8.8 years for both genders, with no significant differences between the two sexes. A higher incidence was noticed among urban residents compared to rural ones. The greatest percentage of cases were diagnosed in winter (32.9%). They were born in summer (33.3%), and according to the study, not all seasons according to birth have an equal likelihood of a type 1 diagnosis.

Some data is also available in Slovakia. During the period 2004–2008, the T1D incidence increased to 14.5 ± 7.9 per 100,000 in girls and to 10.7 ± 5.1 in boys and peaked between the years 2014–2017 with the incidence of 15.1 ± 10.7 per 100,000 in girls, and 13.4 ± 3.1 in boys [19]. The proportion of young children being diagnosed also increased over the decades. The Czech pediatric population saw a peak of 13.6 per 100,000 girls and 16.0 per 100,000 boys in the period 2009–2013. This was also seen in Austria, Poland and Hungary, which are assumed to have similar genetics to those of Slovakia. Another study reported the distribution in incidence and prevalence of Type 1 diabetes in children under 16 in the island nation of Cyprus [20]. A total of 107 new cases of T1D were identified between 2001 and 2016 in children and adolescents younger than 16. Of these, 49 (45.7%) were girls, and 58 (54.3%) were boys. The median age of type 1 diabetes diagnosis was 9 years old, and it was similar between girls and boys. The mean annual incidence rate for boys was 11.86 per 100,000, and for girls, 10.65 per 100,000. Highest among children 9-12 years, followed by 5-8 years old. The overall mean incidence was 11.1 per 100,000 between 2001-2016. It was seen that most new cases of type 1 diabetes were diagnosed in March and April, and higher incidences were more common in the winter months than summer months.

A French study between 2010 and 2015 reported the incidence of type 1 diabetes as approximately 15.4 per 100,000 per year across all age groups [21]. The annual rate of increase was also 4.0 % in each age group. The incidence has been seen increasing in France over the years, as it also increased from 15.4 in 2010 to 19.1 in 2015. This was seen in both genders and all age groups. The Netherlands' incidence rates have more than doubled from 1978-1980 to 2010-2011, from 11.1 to 21.4 per 100,000 people [22]. In the youngest age group, under 5 years, the incidence rate doubled between 1996 and 1999 and remained stable. There were no relevant incidence differences between the sexes. The overall prevalence of type 1 diabetes in the Netherlands during 2009–2011 was 143.6 per 100,000 children, similar for boys and girls. This is one of the highest incidences reported worldwide.

The incidence of T1D in children living in eastern and central Poland increased 1.5-fold over the 5-year observation period, with the highest rise in 10 to 14-year-olds [22]. The incidence rates were statistically significantly higher for urban boys aged 5 to 9 years and 10 to 14 years and urban girls aged 0 to 4 years, 5 to 9 years, and 10 to 15 years. The rapid increase in incidence in earlier years and then levelling off is a trend being observed. The incidence of T1DM for the age group 0–18 yr in the Republic of Srpska was 7.5 per 100,000 per year [23]. For the same period and the same age group, incidence in Slovenia was 12.5 per 100,000 per year. Incidence is higher in Slovenia than in the Republic of Srpska. According to other

studies, not within our time frame, the incidence rate in Bosnia and Herzegovina is significantly lower than in other European countries in the same region.

Table 1: Incidence rates in Europe

Country	Incidence Rates (Per 100,000)
Sweden	0.0378
Denmark	0.500
Ireland	0.0843
Italy	0.016
Serbia	5.000
Turkey	0.0167
Slovakia	0.0145 in girls and 0.0107 in boys
The Czech Republic	0.0136 in girls and 0.0160 in boys
Cyprus	0.111
France	0.0154
Netherlands	0.0214
Poland	0.0075
Republic of Sprksa	N/A
Slovenia	0.0125

Middle East and North Africa (MENA)

Most of the Middle East and North Africa's population is comprised of Arabs, who make up 60% of the population [13]. The Arab world includes 22 Arab-speaking countries. These countries include high-income countries, such as Bahrain, Kuwait, Oman, Saudi Arabia, Qatar, and the United Arab Emirates; middle-income countries, such as Algeria, Egypt, Iraq, Jordan, Lebanon, Libya, Morocco, Palestine, Somalia, Sudan, Syria, and Tunisia; and low-income countries such as Comoros, Djibouti, Mauritania, and Yemen [24]. Arabs are known to share several HLA haplotypes with other ethnic groups, which could either have a positive correlation with the incidence of type 1 diabetes or the opposite [25]. Since first-cousin marriages and familial connections are the highest among this population reported in the world, that is known to be responsible for the creation of many inbreeding communities, which has led to an increase in homozygosity (runs of genotypes) of both the HLA haplotypes and non-HLA genes associated with either protection or susceptibility to type 1 diabetes. Older studies have shown that Caucasians are at an increased risk for T1DM. However, Arabs could potentially have a higher incidence and prevalence rate. A study done by found that the concordance rate in monozygotic twins for T1D is around 70%, and the heritability of T1D is estimated to be around88% [25].

In the MENA region, there are approximately 60,000 cases of T1D in children less than 15 years old [24]. A number of studies have shown a large variation in T1D incidence among Arab countries, ranging from a low of 2.54 per 100,000 in Oman to a high of 29 per 100,000 in Saudi Arabia [13]. Although type 1 diabetes incidence is high in Arabic countries, there is an excess in females which is the opposite of Euro-

pean populations. Saudi Arabia is said to be at the top of the list, followed by middle-income countries such as Egypt, Sudan and Morocco. The exact same high prevalence in Saudi Arabia was reported for the AL-Baha region. The prevalence of T1DM in the AL-Baha region was 355 per 100,000 population in participants aged 0 to 19 years, and the incidence was more common among boys than girls. This study saw that most diagnoses were made in Spring, which is contradictory to Asian studies done in Korea and China, which saw the disease be more commonly diagnosed in the winter months [6]. Within this region, Al-Madinah, which is a large urban city, had the highest incidence rate of all Middle East and North Africa. Saudi Arabia is among the top 10 countries with a high prevalence of diabetes and supports the role of environmental factors in the development of T1DM. Additionally, the presentation of T1DM with DKA ranges from anywhere between 12.8% to 80%. Still, these rates are particularly high in the United Arab Emirates and Saudia Arabia, which could be attributed to weather patterns and warmer climates leading to more dehydration and further DKA as a result [31]. Another study in Southern Iraq attempted to report the prevalence and incidence in this country. Out of the 2536 people registered, 53.5% were males, the mean age at diagnosis was about 15.3 years, and it was higher than in Saudia Arabia and Turkey, which can be attributed to the late age of puberty in Iraq compared to the other two countries (Almafoodh et al., 2017). The average incidence rate was 7.4 per 100,000, and the prevalence rate of T1DM in people 40 years old and younger in 2016 was 87 per 100,000. The higher prevalence in boys and men might be due to the fact that boys go out of the house more often, being exposed to more toxins and chemicals. This was consistent with a finding to that of Tunisia and Kuwait. Iraq fits into the intermediate category of incidence rates similar to France and Italy. It is well established that high socioeconomic status is considered a risk factor for developing type 1 diabetes mellitus [24]. Another study done in Northern Egypt showed a calculated age-adjusted incidence of T1DM in 1996, 2006, and 2011 were 0.7, 2.0 and 3.1 per 100,000 per year, respectively [26]. The age at diagnosis was lower for Egypt, at 5-10 years, compared to other Middle Eastern and European countries. There was a female excess, and knowing Egypt is a low-incidence country, this is in line with findings of European and North American studies. Overall, Egypt saw an increase in the incidence of T1DM over the past 18 years. The last Middle Eastern study within our time frame was in Lebanon. The prevalence of diabetes mellitus in the surveyed population of 17,832 persons was 7.95% [27]. The prevalence of T1DM, in particular, was estimated at 0.1%, or almost 1% of all detected cases of diabetes mellitus. This was a much lower number than International estimates. However, the accuracy of the number is not guaranteed as a large population was randomly surveyed, and there wasn't a type 1 diabetes register for primary care physicians and endocrinologists to report their cases to. Therefore, this is considered insufficient T1DM data. In conclusion, the interesting and unique genetic make-up of Arabs makes the Arab world an ideal population to study, resulting from highly prevalent endogamous and consanguineous marriages (10–70 %), with an ever-lasting preference for first-cousin marriage, which is still on the rise among the population and could potentially be responsible for the high prevalence of T1DM [2].

Australia

Within this study's time frame, only one study has been done in Oceania, in Australia. No data from New Zealand or other island nations have been recorded or reported. However, certain comparisons have been made between Australia and New Zealand and other regions of the world, whose data would most likely be old; however, they will be discussed here. It has been seen that type 1 Diabetes is more common in females than males in the New South Wales region of Australia, which is a rare finding as an excess in males is usually observed [25]. It is said that female incidence tends to be higher in low-incidence countries, including Asian countries such as Korea and China [12]. In the study done by Tuomilehto in 2013, it was found the incidence in Australia and New Zealand is fairly high at 15–25 per 100,000 persons per year. The high incidence rate may be due to the large population of people of European descent, which explains the high numbers, as Europe has some of the highest incidence and prevalence rates globally. However, this invalidates those studies that have found the percentage of females higher in low-incidence countries, as Australia is a high-incidence country with a female excess. Between 2002 and 2017, there were 16 783 newly

diagnosed cases of type 1 diabetes in children aged < 15 years, giving a mean incidence of 25.0 per 100,000 persons per year. This study found that the incidence of type 1 diabetes is highest in the 10-14-year-old age group, followed by the 5-9-year-old age range, and lastly, the lowest prevalence is in the youngest age group. These findings contradict certain countries reporting record numbers in the youngest age groups. However, it is complementary to a study done in the Netherlands that found the incidence of type 1 Diabetes stabilizing in children under five. An interesting finding regarding the incidence of type 1 Diabetes flattening was a 15% decrease in incidence upon introducing the rotavirus vaccinations into the required childhood vaccinations, which could explain the lowest incidence in the 0-4 age group [28].

Risk Factors

Immigrants and Refugees

Since the causes of type 1 diabetes remainunknown, thissectionaims to determine whether genetic/ethnic factors or environmental factors are in charge of the high incidence and prevalence rates in specific countries but lower rates in others. According to a Swedish study, a decreased risk of a type 1 diabetes diagnosis was observed for all immigrants and adoptees from Asia, South-East Asia, Africa and South America, except for children with parents from Finland (Thunander et al., 2008). This could be explained by the fact that Finland has the highest incidence of T1DM worldwide [25]. Swedes adopted a total of 51,557 children born in foreign countries (Thunander et al., 2008). Those adopted from Eastern Europe, Soviet countries, India, Pakistan, Afghanistan, East and Southeast Asia, Chile, and other Central and South American countries significantly decreased incidence of T1DM. All second--generation immigrants showed a decreased risk of type 1 diabetes compared with native Swedes, except for children with parents from Finland, as previously mentioned. The lowest incidence among adoptees was from Southeast and East Asian countries since these countries have the lowest incidence rates. In summary, the diagnosis rates of those immigrants or adoptees from abroad resembled the incidence and prevalence rates in their respective countries, indicating the significance of ethnic and genetic components. Other studies, including (insert name), have also reported on the deceased incidence of T1D in adoptees and immigrants from lower-incidence countries in South America, East Asia and South-Easy Asia to more high-incidence countries in Europe and North America. It has been said that the discrepancies between higher rates in immigrants and adoptees compared to those back in their origin show the relevance of environmental risk factors and triggers, which need to be studied in more depth.

Environmental Risk Factors and Triggers

As a way of understanding the various incidences and prevalences of type 1 diabetes worldwide, many studies have looked at the potential causes and triggers for this disease. After a search for the potential triggers for T1DM, two studies came up within the intended time frame, one of which reported the association between childhood obesity and the subsequent diagnosis of T1DM. They included eight case-control studies and 1 cohort study, and of these 9 studies, 7 reported a correlation between childhood obesity, BMI, or % weight for height increased risk for T1DM [29]. Twin studies indicate a joint contribution of genetic and environmental factors to the etiology of type 1 diabetes. However, many other factors, such as duration of breastfeeding and exposure to cow's milk, are being investigated as potentially more relevant environmental triggers for T1DM and childhood obesity did not provide sufficient reasoning in this study. Therefore, obesity does not account for the vast differences in the incidence of type 1 diabetes, ranging from 0.57 per 100,000 persons per year in China to more than 48 per 100,000 persons per year in Sardinia and Finland [25]. A positive correlation has recently been observed, but correlation does not necessarily mean causation. It has been suggested by several authors that increased childhood growth and weight gain increase peripheral insulin demand, which could place greater stress on the β-cells and make them more vulnerable to autoimmune attacks [30]. Many other factors are currently being investigated as potential causes or triggers of type 1 diabetes, including but not limited to bacterial and viral infections, Vitamin D deficiency, duration of breastfeeding, exposure to cow's milk, and type of cereal used in childhood (Gomez-Diaz et al., 2014). Viral infections have been identified as a potential cause of T1D. However, bacterial infections have rarely been discussed. En-

teroviruses have also shown a correlation in human and animal models, which would make sense as certain countries have found lower T1DM incidence in childhood upon introducing specific vaccines into routine childhood vaccinations. Intriguing evidence suggests that enteroviral infections during pregnancy might result in persistent infection and islet autoimmunity in the mother and offspring. Childhood vaccines have not been seen to exacerbate the likelihood of islet autoimmunity or a type 1 diabetes diagnosis. Quite interestingly, one of the causes of increased T1D incidence over the years could be a lower amount of childhood infections due to improved hygiene in most countries.

Furthermore, Colorado reported an association between islet autoimmunity and early childhood gastrointestinal infections [6]. ABIS showed that less than daily consumption of vegetables (3–5 times per week) in the mothers' diet was associated with an increased risk of islet autoimmunity. Vitamin D deficiency and sunlight exposure have also been shown to inverse the incidence of type 1 diabetes. Vitamin D has been examined as a potential protective factor because it has an active role in regulating the immune system and metabolic pathways relevant to diabetes. In Belgium, the monthly averages of daily hours of sunshine were inversely related to the number of new patients with type 1 diabetes per month. Other countries have seen that having nitrates, nitrites or nitrosamines in water can cause islet cell autoimmunity. However, Germany was not able to confirm this definitively in their studies. In addition to childhood obesity and subsequent type 1 diabetes, higher birth weight and rapid weight gain during age 12–18 months have been linked to type 1 diabetes. The magnitude of the effect is modest, and the associations have been noted in Scandinavian countries but not in the USA or Germany. The relevance of higher birth weight and height was also reported in other studies, and a faint correlation has been determined. However, the data is not statistically significant enough to answer the increasing incidence and prevalence of T1DM in various countries worldwide.

Conclusion

The incidence and prevalence rates for type 1 diabetes in the young appear to be slowly rising in most countries in the world, with the increases being most marked in the very young and adults, presenting a trend never seen previously. A meta-analysis showed that the incidence of type 1 diabetes is 15 per 100,000 people, and the prevalence is 9.5%. Projections show that there will most likely be a more than 50% increase in the prevalence of diabetes (both Type 1 and Type 2) in the United States (Bullard et al., 2016). There will also be a 53% increase, making the cost of diabetes management $622.3 billion. However, data on type 1 diabetes is currently limited, particularly in third-world and developing countries, and more standardized epidemiological data are needed to allow informed healthcare planning for diabetic patients. The data presented in this text showed that Europe has the highest incidence rates, while Asian and South American countries report very few cases of type 1 diabetes each year. Certain HLA genes, as seen in the Arabic population, environmental susceptibilities and exposure to certain materials and chemicals could potentially exacerbate the possibility of a type 1 diabetes diagnosis. However, looking at it broadly, the highest estimated numbers of new cases annually were in the United States (13,000), India (10,900) and Brazil (5000). Only some 6% of children with type 1 diabetes come from the Western Pacific (WP) Region, despite it having the largest childhood population. Much more research is necessary to understand the etiology behind type 1 diabetes in an attempt to discover a cure.

Conflict of Interest

No reported conflicts

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