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IDF Diabetes Atlas

Diabetes in Europe: An update

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ABSTRACT

Diabetes is among the leading causes of death in the IDF Europe Region (EUR), continues to increase in prevalence with diabetic macro- and microvascular complications resulting in increased disability and enormous healthcare costs. In 2013, the number of people with diabetes is estimated to be 56 million in EUR with an overall estimated prevalence of 8.5%. However, estimates of diabetes prevalence in 2013 vary widely in the 56 diverse countries in EUR from 2.4% in Moldova to 14.9% in Turkey. Trends in diabetes prevalence also vary between countries with stable prevalence since 2002 for many countries but a doubling of diabetes prevalence in Turkey. For 2035, a further increase of nearly 10 million people with diabetes is projected for the EUR. Prevalence of type 1 has also increased over the past 20 years in EUR and there was estimated to be 129,350 cases in children aged 0–14 years in 2013. Registries provide valid information on incidence of type 1 diabetes with more complete data available for children than for adults.

There are large differences in distribution of risk factors for diabetes at the population level in EUR. Modifiable risk factors such as obesity, physical inactivity, smoking behaviour (including secondhand smoking), environmental pollutants, psychosocial factors and socioeconomic deprivation could be tackled to reduce the incidence of type 2 diabetes in Europe.

In addition, diabetes management is a major challenge to health services in the European countries. Improved networking practices of health professionals and other stakeholders in combination with empowerment of people with diabetes and continuous quality monitoring need to be further developed in Europe.

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1. Introduction

Diabetes is one of the most challenging health problems in the 21st century in the IDF Europe Region (EUR). It is among the leading causes of death and diabetic macro- and microvascular complications are resulting in increased disability and enormous healthcare costs. This increase will place an enormous financial burden on a declining working age population in Europe. Despite the increasing prevalence and the human and economic burden, valid epidemiological data on diabetes are scarce in EUR. While infectious diseases are carefully monitored, this non-communicable disease is usually not required to be continuously registered. The aim of this review is to comment on the population-based data on diabetes [1] and diabetes-related complications in Europe published by the IDF Diabetes Atlas, and to discuss the possible impact of risk factors on geographic variation within Europe.

2. Diabetes epidemiology

2.1. *Type 2 diabetes*

2.1.1. *Prevalence estimates: heterogeneity of results and time trends*

The IDF Europe Region includes 56 diverse countries from the Russian Federation in the northeast, Kazakhstan in the east, Iceland in the northwest to Portugal in the southwest. The countries vary markedly in size, language, ethnic groups and affluence. Diabetes prevalence in the European countries is similarly heterogeneous with an age-standardised comparative prevalence ranging from 2.4% in Moldova to 14.9% in Turkey in 2013. Overall, the raw prevalence of diabetes in EUR in 2013 is estimated to be 8.5%, which corresponds to 56 million cases (age 20–79 years) and an age-standardised prevalence of 6.8% (type 1 and type 2 diabetes – known and undiagnosed). The estimated proportion of undiagnosed diabetes ranged from 29.3% in European low-income countries (EUR-LIC: e.g. Kyrgyzstan, Uzbekistan) to 36.6% in European high-income countries (EUR-HIC: e.g. Denmark, Finland, United Kingdom (UK)).

The highest age-standardised diabetes prevalence in EUR was estimated for Turkey with 14.9%, based on a population-based survey performed in 2010 (TURDEP II) that included comprehensive phenotyping and diabetes diagnosis according to WHO guidelines (1999) – the gold standard for epidemiologic studies [2,3]. Turkey has also experienced the highest increase in diabetes [4,5]. While the prevalence was estimated at 7.5% in the 2011 IDF-Atlas, the estimate for 2013 was almost twice as high. These estimates are based on two surveys (TURDEP-I and -II) using similar methods [2,4]. However, TURDEP-I used the 1985 WHO protocol for diabetes diagnosis [6] while TURDEP-II used the 1999 WHO protocol. The diabetes prevalence in TURDEP-II would have been approximately 3% lower if the 1985 WHO criteria had been used. Other explanations for the steep increase in diabetes prevalence during the 12 years between the studies include: an increase in life expectancy of 4–5 years [7], a longer survival of patients with type 2 diabetes, and changes in lifestyle. Furthermore, the mean BMI increased between surveys from 26.6 to 28.6 kg/m^2 and mean waist circumference from 87.2 to 94.5 cm [2]. Unfortunately, updated surveys were available only for Turkey, Germany and Spain to describe changes in diabetes prevalence. In Germany, estimates for known diabetes increased by 38% from 4.7% to 5.6% between two nationwide surveys with a high comparability conducted in 1998 and 2012 [8,9]. Of the 38% increase, 14% were explained by demographic changes but 24% remained unexplained. For Spain, a new nationwide survey using OGTT was utilised to generate the estimates for 2013 [10]. The prevalence estimates for Spain increased from 8.1% to 10.8% from the 2011 to the 2013 Atlas editions [1,11]. In contrast, the selection of a nationwide source [12] instead of two regional databases [13,14] for the current edition resulted in a considerably lower prevalence estimate in Poland (6.5% compared to a previous estimate of 10.6%). For many countries including Portugal, France, Italy, Switzerland, Hungary, Albania, Russian Federation and Uzbekistan the databases and estimates remained almost unchanged since the last estimates in 2011, largely because few new studies have been published in those countries [15–24].

2.1.2. *Undiagnosed diabetes*

Lack of nationwide data for estimating the prevalence of known type 2 diabetes is still apparent in Europe, especially for many eastern European countries. Overall, nationwide data were available for only 34 (61%) of all 56 countries [1]. However, most striking was the paucity of nationwide studies that used the WHO 1999 protocol for estimating undiagnosed diabetes. In total, only four studies selected for analysis (from Turkey, Spain, Portugal and Finland) used this gold standard for epidemiologic studies that included measurements of fasting plasma glucose and 2h-glucose [2,10,15,25]. Other methods, based on fasting glucose measurement alone, can underestimate the prevalence of unknown type 2 diabetes (DECODE) [26]. In the 2013 IDF Diabetes Atlas, the proportion of undiagnosed diabetes ranged from 20% based on HbA1c [15], 30% based on FPG [27], to 44–61% based on OGTT [2,10,15,25]. These proportions are comparable to other studies using corresponding methods [28,29]. Therefore, undiagnosed diabetes is considered to account for 40–50% of all cases with diabetes in Europe when the gold standard for epidemiologic studies is applied, although this may vary by population.

The OGTT-based studies also provided estimates on pre-diabetes (including impaired fasting glucose and impaired glucose tolerance) which ranged from 14% in Spain to 30% in Turkey. Since pre-diabetes is an important risk factor for future type 2 diabetes, the high numbers in Turkey suggest that the prevalence of diabetes in this country is not likely to decrease in the near future.

2.1.3. *Regional differences*

For the 2013 edition of the IDF Diabetes Atlas, nationwide population-based data was given priority over regional data. However, it should be noted that, in Europe, considerable regional differences in diabetes prevalence within countries are known to exist, which are important for planning local approaches to prevention and healthcare. For example, in Germany, regions of the former German Democratic Republic consistently have up to a twofold higher standardised prevalence in known type 2 diabetes [30], hypertension [31] and an increased waist circumference [32] than in the south [30]. Regional differences in the prevalence of type 2 diabetes were also found comparing eastern and south-western Finland as well as the Helsinki-Vaanta region [33]. Diabetes prevalence also varied between regions in England [34].

Structural deprivation may explain part of the regional differences along with individual socioeconomic status or ethnic mixture [34,35]. Additionally, national estimates are unlikely to represent diabetes prevalence in ethnic minority populations. For example, Turkish immigrants living in Sweden, type 2 diabetes prevalence was higher among females compared to males (similar to findings from Turkey [2]) while the opposite pattern was found among the Swedish population. This might be associated with sex differences in obesity prevalence between populations [36]. Diabetes prevalence among South Asians was lower in the UK than in the Netherlands, suggesting a modification of diabetes risk by the environment in which minorities live [37]. Although the role of regional differences related to deprivation or ethnicity is a complex issue, this needs to be addressed in future European studies.

2.2. Childhood onset type 1 diabetes

2.2.1. Incidence estimates and time trends

Compared with other regions, EUR has the most informative and reliable data on type 1 diabetes incidence, as many countries maintain incidence registries – either nationwide or covering different parts of the country and using standardised methods.

The updated estimates of the incidence (20.04 per 100,000 per year) and prevalent cases (129,350) of type 1 diabetes in children 0–14 years old in Europe for 2013 [38] reflect an increasing trend of 3–4% per annum during the past 20 years [39].

Core data for the European estimates of type 1 diabetes in childhood originate predominantly from the EURODIAB Study Group. All EURODIAB centres operate in geographically defined regions using standardised definitions and at least two independent data sources for registration of new type diabetes cases (completeness >90%) [39,40]. Therefore, the estimates can be assumed to be valid, and the observed heterogeneity in the incidence level can be presumed to mirror real patterns, although the extrapolation of estimates from small regions to the whole country might be questionable in some countries due to possible within-country heterogeneity.

Besides geographic variation in the level of type 1 diabetes incidence, recent data from EURODIAB Study Group indicated a considerable heterogeneity in the increasing incidence over time. The rise in incidence was most marked in low-incidence countries [40]. Increasing incidence in some European countries was not uniform during the 20 years of observation but showed periods of more or less rapid increase [39]. Long-term incidence data from Finland, Sweden and the Czech Republic recently showed lower rates of increase in the 1980s and an accelerated increase in the 1990s, to a stabilised trend in the 2000s [41–43].

The IDF Diabetes Atlas presents data on type 1 diabetes only for the children under the age of 15 years. Only a few European registers investigated type 1 diabetes rates up to the age of 30 years [44]. These studies indicated the incidence in older age groups was lower than in the 0–14 year age range and the rate in males was about twice that in females, unlike in the younger age group (0–14 years) in which sex differences were less marked [45]. Swedish data provides evidence for stationary or declining type 1 diabetes incidence rates in young adults (<35 years), indicating a shift to younger age at onset. However, data from Italy, the UK, and Finland showed an increasing trend in type 1 diabetes incidence also in the age group of young adults [46–48]. Studies covering all age groups are still lacking but these are necessary to investigate changes in the cumulative lifetime incidence of type 1 diabetes over time.

2.2.2. Risk factors

The incidence rates of type 1 diabetes in European countries were positively associated with country level income [49]. However, the drivers for the observed pattern with geographical differences and varying time trends are still unclear. Susceptibility to type 1 diabetes definitely has a strong genetic component (HLA genotype) [50], but the heterogeneity of type 1 diabetes cannot be explained solely by the prevalence of susceptibility genes [51–53]. Thus, the reasons for changes in the incidence are likely to be attributable to changes in environmental risk factors or lifestyle habits acting differently across European countries – possibly in interplay with genetic factors. Environmental factors and the underlying pathogenetic mechanisms, currently discussed, are listed in Table 1. Some studies suggest that the increasing incidence originates, at least in part, from an accelerated progression from initiation of beta-cell autoimmunity to overt type 1 diabetes, rather than an increase in the prevalence of beta-cell autoimmunity itself [54].

So far there is no clear evidence for measures that may prevent type 1 diabetes [43]. Therefore, the major focus for type 1 diabetes should be on diabetes care to support the best possible quality and quantity of life among people with type 1 diabetes.

3. Morbidity and mortality

As the global prevalence of diabetes increases so will the number of people with diabetes developing complications. In contrast to the relatively well-documented (global) prevalence of diabetes, much less is known about the epidemiology of diabetes complications. Because diabetic complications are responsible for most of the morbidity and mortality associated with diabetes, there is an urgent need to fill this gap.

3.1. Diabetic retinopathy

Diabetic retinopathy is a very frequent microvascular complication with comparatively good quality data available [76–78]. The crude prevalence of any diabetic retinopathy in primary care clinic studies in Europe assessed by fund us photography ranged from 25% [79] to 28% [80] in patients with known type 2

Table 1 – Environmental factors associated with the increase in type 1 diabetes in Europe.

Environmental factors	Hypothesis and mechanism [source]
Lifestyle	• Overload of the beta cells sensitises them to immune damage [56,57]
Foetal and peri-natal factors	• Rapid weight gain in childhood [58] • Caesarean section [59,60] • Breastfeeding, birth order, maternal age, birth weight, viral infections [61–67]
Dietary factors	• Early introduction of complex dietary proteins [68–70] • Vitamin D deficiency [71,72]
Exposure to pathogens	• Decreased exposure to pathogens [73] • Enterovirus infections [55] • Environmental pollution [74,75]

Adapted from Knip [55].

diabetes. When assessed by medical record review, the range was wider and the prevalence varied from 11% in a French study [81] to nearly 51% in Germany [82]. There is a large number of factors affecting the prevalence estimates, predominantly the method used to diagnose diabetic retinopathy [76]. Therefore, standardisation of the diabetic retinopathy assessment and grading is the first step to increase comparability of prevalence estimates between countries in Europe.

3.2. *Diabetic nephropathy*

Although diabetic nephropathy increases the risk of mortality, European estimates on the prevalence of microalbuminuria and diabetic nephropathy are scarce. Country-specific estimates are difficult to compare because of different assessment methods and different settings and study designs (e.g. [83,84]). A global primary care study on microalbuminuria estimated the global prevalence of microalbuminuria and macroalbuminuria (measured by dipstick) to be 39% and 10%, respectively, with slightly lower estimates in people of European ancestry [85]. These high estimates have implications for the incidence of end-stage renal disease and the future use of renal replacement therapy [86]. The age- and sex-adjusted prevalence of renal replacement therapy among diabetic patients in Europe in 2011 ranged from about 95 to 220 per million [87].

3.3. *Diabetic neuropathy*

A comparison of prevalence of peripheral diabetic neuropathy (PNP) between studies is difficult. Study composition, ethnicity, diagnostic criteria, and source of a particular study population have direct implications for the observed occurrence of PNP [88].

The prevalence of PNP in type 2 diabetes varies between 18% and 35% for European study populations [89–98]. In general, reported prevalence rates are somewhat higher for hospital-based study populations [90–92,94] than for primary care or population-based samples [89,96,97]. There is much less data on the occurrence of polyneuropathy in patients with undiagnosed diabetes screened by OGTT on population-level [99–101]. In these studies, prevalence rates of polyneuropathy in individuals with undiagnosed diabetes were found to range between 4% and 19% [102]. In one survey in Southern Germany, among subjects with known diabetes who reported to have had their feet examined by a physician, 72% subjects with PNP were unaware of having the disorder, suggesting inadequate attention to diabetic foot syndrome prevention [103].

3.4. *Cardiovascular disease in diabetes*

There are very few recent studies on the prevalence of cardiovascular disease (CVD) in diabetic patients in European countries [104]. There is marked heterogeneity of incidence studies in terms of duration of follow-up, assessment of cardiovascular events [105–107] and setting such as hospital- or population-based [104,105,107,108]. Because of this paucity and heterogeneity of data it is not possible to quantify the prevalence and incidence of CVD in patients with diabetes in Europe.

3.5. *Disability and quality of life*

The evidence for the relation between diabetes and physical and functional disability is currently being reviewed [109]. In general, diabetes and diabetes complications negatively affect quality of life [110]. There is also evidence that interventions, be they educational, pharmaceutical or surgical, have a positive impact on quality of life of diabetes patients [111]. Condition-specific instruments to measure the impact of diabetes complications on health related quality of life may be better than generic instruments [112].

3.6. *Mortality*

In Europe, as for other regions such as North America [113], a decline in the diabetes-related mortality has been observed in recent years. In Iceland, CVD-related mortality in persons with type 2 diabetes was compared between two cohorts ten years apart, and CVD-mortality in persons with type 2 diabetes declined by 32% and all-cause mortality rate by 19%[114]. Similarly, mortality rates declined from 117 to 46 per 1000 persons during the 8-year follow-up of a British study [115,116]. However, in comparison to the UK general population, people with type 2 diabetes still had a reduced life expectancy (6–8 years reduction in persons diagnosed at age 50) [115]. It is of particular concern that an increased mortality seems to be prevalent already in undiagnosed diabetes [117].

CVD mortality also decreased substantially during the last 10 years in people with type 1 diabetes [118,119], likely due to improvements in care. For example, mean survival time of patients starting renal replacement therapy in Finland has progressively increased since 1980 [120]. However, in a Finnish study the positive trend only applied for individuals with diabetes onset between age 0 and 14 years [121].

3.7. *Mortality and socioeconomic status*

In a different Finnish study based on death records, diabetes-related mortality also declined between 1997 and 2006 in all socioeconomic groups [122]. Mortality was substantially higher in farmers and manual workers than in non-manual workers and lowest in upper non-manual workers. Disparities in mortality have also been found for different levels of area-based social deprivation in Scotland [123].

3.8. *Death certificates*

Many epidemiological studies rely on mortality registries. Though, death certificates tend to underestimate diabetes prevalence and falsely estimate the numbers of diabetes-related deaths. Besides, certificates, selection and coding rules and their presentation vary between countries and publications. Standardised completion of death certificates and standardised reports on diabetes related mortality stemming from mortality registries are required [124].

Table 2 – Key findings from the InterAct study[a] on the association between dietary factors and the risk of future type 2 diabetes.

Risk of developing type 2 diabetes	Dietary factors [source]
Reduced risk	Mediterranean diet pattern [130] Fruit and vegetable intake [131] Fermented dairy products [132] Fatty fish intake [133] Tea intake [134]
Elevated risk	Red and processed meat intake [135] Sweetened beverages [136]
Null association	Total dairy products or milk intake [132] Total fish intake [133] Dietary energy density [137] Carbohydrate intake [138]

[a] Further information about the InterAct project can be found at www.inter-act.eu. There are also other forthcoming publications on dietary factors and the risk of diabetes.

4. Determinants of health: risk factors and social environments

Type 2 diabetes is a result of the interplay between lifestyle, environmental and genetic factors. This section focuses on understanding the association between risk factors and diabetes, as well as understanding their distribution and trends in EUR.

4.1. *Established risk factors*

Overweight and obesity and increasing age form the most potent risk factors for type 2 diabetes. According to the WHO, obesity prevalence has tripled over the past two decades, with one in five Europeans being obese (BMI $\geq$30 kg/m^2) and 25–70% being overweight (BMI $\geq$25 kg/m^2) in 2010. Overall, there is a threefold variation in obesity prevalence among European countries, from around 8% in Romania and Switzerland to over 25% in Hungary and the UK [125].

Clinical trials of the primary prevention of type 2 diabetes have demonstrated that diet and physical activity are important modifiable risk factors for diabetes [126]. In the InterAct study, a one-category difference in physical activity was independently associated with a 13% relative reduction in the risk of diabetes [127,128]. The Eurobarometer survey highlighted that 34% of EU citizens reported being never or only seldom physically active [129]. The surveys document, that respondents in the Nordic countries and the Netherlands tend to be the most physically active, while those in southern European countries and new Member States are generally the most inactive [129]. The low levels of physical activity in Europe provide an opportunity to intervene in order to prevent diabetes. Thus efforts to understand the determinants of physical activity behaviour need to be intensified. The use of objective measurement of physical activity and validated instruments are further important priorities to monitor trends.

InterAct has also provided recent insights on diet and diabetes across Europe (Table 2). The distribution of dietary intake in Europe is difficult to assess, but it is clear that intake varies considerably. From Health-at-a-Glance surveys, the percentage of adults who reported consuming fruit daily varied from 45% in Bulgaria and Romania, to 75% in Italy, Malta and Slovenia, and 84% in Switzerland [125]. Daily vegetable consumption ranged from around 50% in Estonia, Germany, Malta and the Slovak Republic to 75% in France and Slovenia, with Belgium and Ireland highest at 85% and 95%, respectively [125].

In addition to lifestyle factors, it is known that type 2 diabetes has a strong genetic component. Recent genome-wide association studies have identified >60 genetic variants that are associated with type 2 diabetes but individual effects of genetic variants are considered to be small [139,140].

4.2. *Emerging risk factors*

There is accumulating evidence that smoking behaviour and psychosocial factors, as well as exposure to environmental pollutants, and biomarkers of metabolic pathways may contribute to developing type 2 diabetes.

Active smoking is a documented risk factor for type 2 diabetes [141]. Overall, the proportion of daily smokers among the adult population varies greatly across European countries [125] but smoking rates have declined on average by about 5 percentage points since 2000. Besides active smoking, several cohort studies also found an increased diabetes incidence among passive smokers [142]. Finally, in-utero exposure to maternal smoking is associated with overweight and obesity which may predispose to diabetes and other metabolic disturbances in the offspring [143].

Psychosocial factors encompass two broad areas which are more closely related to socioeconomic status or to psychological/psychiatric factors. Within the InterAct study, people who had a lower educational level had a 70% higher relative risk for diabetes, which remained at around 40% even after adjustment for differences in obesity [144]. The association between emotional stress, job strain, anxiety and depressive disorders and increased incidence of type 2 diabetes is less well-established, but recent data [145–147] strongly indicate that this area merits further study to better understand the relationship between these potential risk factors.

Prospective studies observed that exposure to components of traffic and industry-related air pollution such as nitrogen oxides (e.g. NO_2) and fine particulate matter increase the risk of type 2 diabetes [148]. Air quality has improved in many countries throughout Europe during the last decade, although regional variations are considerable [149], and air pollution lies below levels often found in cities of developing countries [148]. However, the risk association is apparently linear and not dependent on a threshold effect, thus the widespread exposure to air pollutants remains a metabolic risk factor. Also, man-made persistent organic pollutants showed consistent associations with type 2 diabetes [150], but the possibility of residual confounding, for example by social inequalities, needs addressing.

Finally, there is evidence that a range of biomarkers of metabolic pathways including markers of subclinical inflammation, oxidative stress, endothelial and renal dysfunction, adipose-tissue derived hormones, liver enzymes, proteins in blood-coagulation and in tissue damage/remodelling, vitamin D and iron metabolism may be aetiologically related to developing type 2 diabetes [151,152].

In conclusion, there is considerable variation across Europe with respect to the prevalence of established and emerging risk factors for diabetes. Overall, the burden of many risk factors seems stable or declining, although increasing age of both native and migrant populations and the long-term exposure to obesity are likely to contribute to a significant increase in the burden of type 2 diabetes in EUR.

5. Care and management

Management of chronic diseases, including diabetes, provides a major challenge to health services across Europe as a consequence of increasing prevalence, multi-morbidity and lack of co-ordination between different components and professional groups within health systems. The St. Vincent Declaration provided a set of goals for diabetes care in Europe in 1989 [153] and a review 20 years later suggested that, although some progress had been made, considerable gaps remained [154]. A 2009 review [155] identified the following approaches that different European countries were taking to address the burden of chronic diseases:

1. disease prevention and early detection (although the authors pointed out that prevention ‘‘plays only a secondary role in European health systems’’),
2. new professions, qualifications and settings including nurse-led clinics and presence of secondary-care physicians at community-based clinics,
3. disease management programmes based on co-ordinated, evidence-based care, and
4. integrated care models that attempt to combine treatment for multiple morbidities rather than having a single disease focus and to co-ordinate care between community, out-patient/ambulatory and in-patient settings.

The complexity of integrated care models makes meaningful evaluation particularly difficult [156]. Encouraging self-management of diabetes appears to be challenging in all settings and the roles of blood glucose monitoring for people who are not treated with insulin [157] and of tele-healthcare/remote monitoring [158] remain controversial.

Some countries use financial incentives to motivate healthcare providers to meet certain quality standards for structures or processes of care, with the assumption that meeting such standards will improve outcomes. In the UK, where a pay-for-performance scheme, the Quality and Outcome Framework, provides approximately 25% of general practices’ income, the scheme appears to have resulted in more systematic care and has reduced some healthcare inequalities, possibly at the expense of less effective treatments for conditions that are not part of the scheme [159]. Such schemes are only likely to be feasible in health systems that support continuity of care. For example, since 2007, the Dutch minister of health introduced a bundled-payment approach for integrated diabetes care [160].

5.1. *Barriers to care and access*

Four main barriers (and facilitators) to effective care have been identified [161]:

1. the patient (for example, lack of knowledge, motivation to change behaviour or to adhere to proposed lifestyle or pharmaceutical interventions),
2. the individual professional (for example lack of motivation, effective communication skills knowledge of guidelines or locally available interventions),
3. the health care team (for example, lack of communication between different members of a health care team), and
4. the organisation of health care (for example, lack of disease registers, individual care plans or financial incentives and lack of guidelines relevant to sub-populations such as the elderly or ethnic minorities).

Communication between primary and secondary care can be improved using information technology such as the Scottish Care Information diabetes system which provides an electronic patient record of variables related to diabetes care [162]. In collaboration with partners from other countries, this system has been developed further to allow comparison of outcomes between countries as part of the EUropean Best Information through Regional Outcomes in

Diabetes (EUBIROD) project (http://www.eubirod.eu/) which has also highlighted major differences in approaches to data protection between countries [163].

5.2. *Management*

The management of co-morbid conditions among people with diabetes is becoming increasingly important as a consequence of increasing prevalence of multi-morbidity. However, guidelines for managing diabetes are frequently based on findings of randomised controlled trials in which people with co-morbidities are under-represented [164] and therefore may not be appropriate for all patients. As a consequence, clinical judgement is required in identifying treatment targets that are suitable for individual patients including the management of multi-morbidity [165,166]. Initiatives such as case management are a possible approach to counteract the fragmented care for patients with multiple diseases. Such programmes attempt to combine various evidence-based treatment protocols and to co-ordinate care with tailoring to individual patients' preferences.

5.3. *Costs*

Estimating the costs of diabetes to individuals and society is difficult, but estimates suggest that diabetes was responsible for 10% of total health expenditure in Europe for 2010 [167]. Regional data from Scotland estimated that 12% of in-patient expenditure in 2005–2007 was diabetes-related [168]. The limited available data suggests that the largest components of costs to health services are the management of complications (even though these costs are likely to be under-estimated) and prescribed drugs. Although prevention of diabetes is likely to be cost-effective, rolling out programmes that have been found to be effective in trial settings for use in normal clinical practice has not been widely achieved. Furthermore, although it is widely believed that disease management programmes reduce health expenditure, a recent review showed that evidence for this claim remains inconclusive [169]. Nevertheless, disease management programmes are increasingly implemented in health systems worldwide. To support evidence-based decision-making in this field, well-designed economic evaluations are required. In addition, it would be helpful to compare the cost-effectiveness of various approaches to secondary and tertiary prevention of diabetes across countries in order to inform best practice in comparable countries.

In conclusion, conventional models of care for chronic diseases are not sustainable given increasing prevalence of diabetes and multi-morbidity in Europe and constraints on resources. Over the coming decades, it is essential that cost-effective approaches are developed to managing care differently including greater emphasis on self-management, novel care-delivery mechanisms and integrated care for people with multi-morbidity.

6. Conclusion

There is a wide variation of diabetes prevalence in EUR. Age, obesity, physical activity, nutrition, and genetic predisposition all influence diabetes prevalence. There are large differences in distribution of these risk factors at the population level in the Europe Region. The effect of these lifestyle factors on risk of diabetes and how they interact with each other and with genetic factors may also differ in various populations. Furthermore, regional differences in prevalence have been related to socioeconomic deprivation which needs to be considered in future studies. Finally, there is growing evidence that smoking behaviour (including secondhand smoking) and psychosocial factors as well as exposure to environmental pollutants contribute to diabetes development. In light of the growing prevalence of diabetes and environmental pollution these modifiable risk factors could be tackled to reduce incidence of type 2 diabetes in Europe.

Although micro- and macrovascular disorders are responsible for most of the morbidity and mortality associated with diabetes, there is a lack of good quality epidemiological studies on diabetic complications and on diabetes-related mortality in Europe. Diabetes management is a major challenge to health care services in the European countries. There is often a lack of co-ordination between different components and professional groups within health systems. Improved networking practices of health professionals and other stakeholders in combination with empowerment of people with diabetes and continuous quality monitoring needs to be further developed in Europe.

Conflicts of Interest

The authors declare that they have no conflict of interest.

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