Building a population-based diabetes register: An Italian experience

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\textbf{A B S T R A C T}

Aims: To describe the methodology used to set up the Reggio Emilia (northern Italy) Diabetes Register. The prevalence estimates on December 31st, 2009 are also provided.

Methods: The Diabetes Register covers all residents in the Reggio Emilia province. The register was created by deterministic linkage of six routinely collected data sources through a definite algorithm able to ascertain cases and to distinguish type of diabetes and model of care: Hospital Discharge, Drug Dispensation, Biochemistry Laboratory, Disease-specific Exemption, Diabetes Outpatient Clinics, and Mortality databases. Using these data, we estimated crude prevalence on December 31st, 2009 by sex, age groups, and type of diabetes.

Results: There were 25,425 ascertained prevalent cases on December 31st, 2009. Drug Dispensation and Exemption databases made the greatest contribution to prevalence. Analyzing overlapping sources, more than 80% of cases were reported by at least two sources. Crude prevalence was 4.8% and 5.9% for the whole population and for people aged 18 years and over, respectively. Males accounted for 53.6%. Type 1 diabetes accounted for 3.8% of cases, while people with Type 2 diabetes were the overriding majority (91.2%), and Diabetes Outpatient Clinics treated 75.4% of people with Type 2 diabetes.

Conclusion: The Register is able to quantify the burden of disease, the first step in planning, implementing, and monitoring appropriate interventions. All data sources contributed to completeness and/or accuracy of the Register. Although all cases are identified by deterministic record linkage, manual revision and General Practitioner involvement are still necessary when information is insufficient or conflicting.

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1. Introduction

Diabetes is a major public health concern worldwide. In 2013, 392 million people had diabetes; by 2035 there will be 592 million [1]. Type 2 diabetes accounts for 95% of diagnosed cases and Type 1 diabetes for the remaining 5% [2]. The estimated prevalence for Italy was 7.9% in adults (20–79 years) in 2013, forecasted to increase to 9.8% for 2035 [1].

Diabetes is a chronic disease with a high impact on health systems. A study conducted in Emilia-Romagna region [3] found a per capita expenditure for diabetic patient 2.5 times higher than that for a non-diabetic citizen.

The impact is also relevant on individual health conditions due to possible long-term complications, such as retinopathy, nephropathy, peripheral and autonomic neuropathy, and increased incidence of atherosclerotic cardiovascular, peripheral arterial, and cerebrovascular disease [4–7].

To counteract the increase of Type 2 diabetes burden, WHO promotes a change in model of care, recommending the application of a patient-oriented chronic care model able to integrate management of disease into primary health care whenever feasible [8].

In light of this recommendation, the Italian Ministry of Health published guidelines in 2008 for shared care management of Type 2 diabetes [9], mainly directed to non-insulin-dependent diabetes patients and defined as the joint participation of primary care and specialised care (diabetes clinic), where the general practitioner (GP) is in charge of routine metabolic check-ups, if the blood glucose level is on target and no complications arise. The Emilia-Romagna region Health Authority updated its guidelines in 2009 [10]. In this framework, an information system is needed in order to evaluate the performance of the new model of care (i.e. shared care involving the GP) compared to specialised care (i.e. directly diabetes clinic care). Emilia-Romagna region guidelines encourage local health authorities to set up a diabetes register based on routinely collected health data. The advantages of this approach to setting up a disease-specific register include feasibility, accessibility, and low cost [11–17].

The aim of this paper is to describe the methodology used to set up the Reggio Emilia Diabetes Register, measuring the contribution of each source of information and estimating the diabetes prevalence on December 31st, 2009 in order to evaluate the algorithm reliability.

2. Materials and methods

2.1. Setting

Reggio Emilia is a province situated in Emilia-Romagna region, northern Italy. The health system is administered by the local health authorities; the province is divided into five health districts. The Diabetes Register covers the whole province population, i.e. the 525,267 residents on December 31st, 2009 [18].

The Diabetes Register uses WHO diabetes classification [19]: Type 1 diabetes; Type 2 diabetes; others specific types (i.e. genetic, drug- or chemical-induced, unknown), and no diabetes (i.e. gestational diabetes, IGT – impaired glucose tolerance, IFG – impaired fasting glycaemia).

In the Reggio Emilia province there are 7 Diabetes Outpatient Clinics able to provide specialised care for diabetes patients. Patients are referred to specialised centres by the GP, but the patient can chose to be seen only by the GP. When the patient with Type 2 diabetes accepts specialised care, diabetologist and GP decide together whether he needs to be followed directly by Diabetes Clinic or if he is eligible for shared care management. Thus three models of care are possible: GP only, Diabetes Clinic directly, and shared care management. The patients with Type1 diabetes are in charge of Diabetes Outpatient Clinics.

In the northern district of the Reggio Emilia province the shared care model of managing Type 2 diabetes has been in place since 1999. In 2005, the whole province adopted the first edition of the regional guidelines [20], which were updated in 2009 [10].

2.2. Sources

Data sources and criteria used to ascertain cases of diabetes and to assign type of diabetes and model of care are reported in Table 1.

2.2.1. Disease-specific Exemption database

This file contains the patients exempted to co-payment (d.m. 329/99 and subsequent amendments) [22]. The Italian National Health System provides universal health insurance to all the citizens. The implementation of the health system is through the regional health authorities which are organised into local health authorities. A small co-payment is made by subjects for outpatient care (diagnostic tests and specialised visits) and drugs, although exemption can be granted in case of specific diseases, including diabetes. In order to obtain the exemption, the diabetes patient must present to the local health authority a certificate issued by a diabetologist or other established documentation.

Exemption database uses the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM).

2.2.2. Hospital Discharge database

This file includes all resident discharges from any Italian hospital. There is one primary discharge diagnosis and up to fourteen secondary diagnoses, coded using ICD-9-CM.

2.2.3. Biochemistry Laboratory database

This file includes laboratory results of tests carried out in the provincial public health network, coded using internal classification.

2.2.4. Drug Dispensation databases

The files are two: the first is the Pharmacy Drug Dispensation database which contains information on drugs dispensed by pharmacies located in the province; the second one is the Direct Drug Dispensation database collecting information on drugs directly distributed by the health services (e.g. Diabetes Outpatient Clinic, hospitalisation Unit). Drugs are coded using anatomic therapeutic chemical (ATC) classification.
Table 1 - Sources and criteria used for case ascertainment, type of diabetes identification, and model of care definition.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Case ascertainment</th>
<th>Type of diabetes identification</th>
<th>Model of care definition (only for Type 2 diabetes)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disease-specific Exemption database</td>
<td>For starting year (2009): exemptions for diabetes (coded 013.250) valid in 2009 For following years: new exemption issued</td>
<td>No information</td>
<td>No information</td>
</tr>
<tr>
<td>Hospital Discharge database</td>
<td>At least one discharge in the reference year, excluded MDC 14(^b), with primary or secondary diagnosis of: 250.xx; 357.2x; 362.0x; 366.41; 648.0x</td>
<td>Type 1 diabetes if the discharge diagnosis code was 250.x1 or 250.x3. Type 2 diabetes if the discharge diagnosis code was 250.x2 or 250.x3. No information for remaining diagnosis codes</td>
<td>No information</td>
</tr>
<tr>
<td>Biochemistry Laboratory database</td>
<td>At least one glycated haemoglobin (HbA1c) test(^c) ≥6.5% (48 mmol/mol) in the reference year</td>
<td>No information</td>
<td>No information</td>
</tr>
<tr>
<td>Drug Dispensation databases</td>
<td>If Pharmacy Drug Dispensation database: at least two anti-diabetic(^d) drugs (insulin or oral hypoglycaemic) in the reference year. If Direct Drug Dispensation database: at least one anti-diabetic drug in the reference year</td>
<td>If oral hypoglycaemic drug (combined or not with insulin), Type 2 diabetes If only insulin, no information</td>
<td>No information</td>
</tr>
<tr>
<td>Diabetes Outpatients Clinics database</td>
<td>Patients are included in the file if they have diagnosis of diabetes</td>
<td>Diagnosis is in medical record</td>
<td>Shared care management is mentioned in medical record</td>
</tr>
<tr>
<td>Mortality register</td>
<td>For starting year (2009): the source cannot contribute with prevalent cases For following years: it will contribute with incident cases. Death in the reference year with cause of death between E10 and E14</td>
<td>If cause of death is E11, Type 2 diabetes</td>
<td>No information</td>
</tr>
</tbody>
</table>

* Type 1 diabetes patients were assigned to Diabetes Outpatient Clinic by default; the patients with “Other type” of diabetes were evaluated case by case.

\(a\) MDC14: “Pregnancy, Childbirth and Puerperium”, using major diagnostic category codification.

\(b\) The assay of HbA1c was performed using HPLC (high-performance liquid chromatography) methods calibrated to the DCCT (diabetes control and complications trial) reference, and standardised by the NGSP (national glycohemoglobin standardisation programme) [21]

\(c\) Anti-diabetic drug: insulin (ATC code = A10A*) and hypoglycaemic drug (ATC code = A10B*).

2.2.5. Diabetes Outpatient Clinics database

The file contains clinical, laboratory, pharmaceutical, and complications information about patients examined in clinics. The model of care in use (shared care or directly diabetes clinic care) is also indicated.

2.2.6. Mortality Register

This file contains all resident deaths by year of death, with cause of death coded using International Classification of Diseases, Tenth Revision (ICD-10).

2.3. Case ascertainment criteria

2.3.1. Ascertained cases

We took the diabetic patients recorded in the Disease-specific Exemption database; for Diabetes Outpatient Clinics database we verified whether the diagnosis of diabetes was reported, and for Biochemistry Laboratory database we used HbA1c value(s), and we selected the cases with value(s) ≥6.5% (48 mmol/mol), based on WHO criterion [23]. In order to decide whether to adopt “only one hospital discharge” as the criterion rather than “at least two” in the same year, we compared the proportion of cases also present in the Disease-specific Exemption database, as a proxy of criteria specificity and relative sensitivity. We repeated the procedure for Drug Dispensation databases.

Once the criteria were defined, we matched the sources with Reggio Emilia Population Register to include only people alive on December 31st, 2009.

Moreover, we excluded gestational diabetes patients, using Delivery Assistance Certificates database to identify the women for whom the time window between the reporting of diabetes date and the delivery date was less than ten months.
Later, we linked all sources using a unique identifier: the Diabetes Register includes all persons who were present in at least one of health data sources. According to the adopted prevalence definition, cases identified by the Mortality Register simultaneously entered in the register and exited for death. They did not therefore contribute to prevalence estimates, being only incident cases. Incidence estimates from this prevalence register will be available after at least 5 years of registration [24].

2.3.2. Suspected cases

The Diabetes Register also contains a list of people with only one anti-diabetic drug recorded in Pharmacy Drug Distribution database or with HbA1c value(s) between 6.0% (42 mmol/mol) and 6.4% (46 mmol/mol). If these two criteria were both present, the case was included as person with diabetes, otherwise the case was labelled “suspected”. The suspected cases are not included in the prevalence estimation. By updating the register annually, suspected cases may become certain cases if, in subsequent years, either one of the ascertainment criteria or the other suspected condition is met.

2.4. Type of diabetes identification criteria

Disease-specific Exemption and Biochemistry Laboratory databases do not provide information on diagnosis, while Drug Dispensation databases and Hospital Discharge database do so partially, and Diabetes Clinics database does entirely. When two or more sources gave different indications on diagnosis, a manual revision was done to resolve the disagreement. When the diagnosis was undefined and the case found was aged less than 19 years, Type 1 diabetes was assigned by default.

For the remaining cases without diagnosis, further investigation is ongoing, analyzing their hospitalisation history, contacting GP, or manually checking on the Data Warehouse, an electronic database that can be consulted on inpatient and outpatient clinical data.

2.5. Model of care identification criteria

For Type 2 diabetes, the only source able to distinguish between models of care provided is Diabetes Outpatient Clinic database. Therefore, if the case was present in this source, the model of care was defined. For remaining cases the model of care assigned was “GP only”.

The Type 1 diabetes was assigned to Diabetes Clinic by default. The cases classified as “Other types” were manually revised in order to define model of care adopted.

2.6. Data analysis

Relative sensitivity of each source was calculated as the proportion of cases reported by the specific source out of the total cases present in the register. The exclusive contribution of each source is reported. The overlap information by sources is depicted using Edward’s diagram with five sets.

The crude prevalence per 100 residents was calculated on December 31st, 2009 by gender and age groups and by type of diabetes and age groups. Prevalence trends were graphed using logarithm scale. Median age by sex and type of diabetes with confidence interval at 95% (95% CI) was calculated.

For Type 2 diabetes, the proportion of cases by model of care is reported. Furthermore, cases were classified by gender and type of diabetes.

The cases of diabetes ascertained only by Mortality Register were defined Death Certificate Only. As in cancer registries [25], the proportion of these cases could become an indicator of registration quality, quantifying the number of cases not recorded by the other sources when the patient was alive. We present this indicator, although it is not yet established as a standard for prevalence registers.

Individual records were managed with a specific software; data analysis was performed using Stata IC 11.0 (Stata Corporation, College Station, TX, USA).

2.7. Ethical approval

The setting up of the Diabetes Register was mandated by regional Health Authority in 2009 [26] and a 2012 Italian law authorised setting up a disease register [27]. The Register treats information with extreme confidentiality and the protocols for data acquisition and management have been established according to the Italian data protection act [28]. All the analyses are performed after anonymization of individual records.

The register can provide, upon duly reasoned request, aggregated but non-personalized data for research or health planning purposes. Individual data can be provided only after the approval of the Ethics Committee.

3. Results

3.1. Validation of sources and criteria

There were 25,425 ascertained cases of diabetes on December 31st, 2009 (Diabetes Register accessed on November 28th, 2012).

The Hospital Discharge databases show for the two distinct criteria (i.e. “at least two discharges” and “only one discharge”) the same proportion of cases reported also by Disease-specific Exemption databases (68.3% and 68.4% respectively), while the second criterion had a sensitivity three-fold higher (3.1% and 9.1% respectively). These results led us to favour the criterion “only one discharge” in the algorithm used to ascertain the cases.

The “only one dispensation” criterion applied to the Direct Drug Dispensation database matched 70.7% of cases also reported by Disease-specific Exemption database, while the same criterion for Pharmacy Drug Dispensation database matched 64.6% of cases, despite their having almost the same sensitivity (1.3% and 1.4%, respectively). This difference led us to consider one dispensation derived from the Direct Drug Dispensation database as a validation criterion, while for Pharmacy Drug Dispensation database, there had to be at least two dispensations in the reference year.
There were 23 cases initially identified only by Mortality Register. Further investigation confirmed diagnosis of diabetes in 18 cases, and not diabetes in 1. For the remaining 4 cases, no additional information was found, and they were defined as Death Certificate Only (0.016% out of the total cases).

Cases identified only by one of the two weaker criteria (i.e. “only one hospital discharge”, or “only one drug dispensation” if database was Direct Drug Dispensation) were further evaluated: of 107 patients with only a hospital discharge (0.4% of total cases), 87 (81.3%) were confirmed through clinical investigation of medical records. Of the 31 patients with only one drug dispensation in the year from Direct Drug Dispensation database (0.1%), 27 were confirmed (87.1%).

There were some cases (n = 30) initially defined as suspected cases because they had only one drug dispensed by the pharmacy which then became ascertained cases after manual revision validating their status of diabetic patient.

The Drug Dispensation and Exemption databases made the greatest contribution to prevalence, followed by Biochemistry Laboratory and Diabetes Clinics, while the contribution of Hospital Discharge was quite a bit less (Table 2). Furthermore, Biochemistry Laboratory and Drug Dispensation databases had the highest percentages of cases reported only by these sources.

Analyzing sources overlapping (Fig. 1), 1147 cases (4.5% of the total) were recorded in five sources, 7950 (31.3%) in four, 7308 (28.7%) in three, 4509 (17.7%) in two, and there were 4511 cases meeting only one criterion, representing 17.7% of the total.

There were 2033 suspected cases and 85.3% (1736) of total cases were characterised by an HbA1c value between 6.0% and 6.4% (42 mmol/mol and 46 mmol/mol); the remaining had only one drug dispensation in Pharmacy Drug Dispensation database.

Table 2 - Distribution by sources/criteria of cases with diabetes on December 31st, 2009. Reggio Emilia province.

<table>
<thead>
<tr>
<th>Sources/criteria</th>
<th>Total</th>
<th>Shared cases</th>
<th>%</th>
<th>Cases met only by source</th>
<th>%</th>
<th>Sensitivity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exemptions for diabetes</td>
<td>18,597</td>
<td>17,704</td>
<td>69.6</td>
<td>893</td>
<td>3.5</td>
<td>73.1</td>
</tr>
<tr>
<td>At least one hospital discharge</td>
<td>3097</td>
<td>2976</td>
<td>11.7</td>
<td>121</td>
<td>0.5</td>
<td>12.2</td>
</tr>
<tr>
<td>Drug dispensation</td>
<td>19,047</td>
<td>17,428</td>
<td>68.5</td>
<td>1619</td>
<td>6.4</td>
<td>74.9</td>
</tr>
<tr>
<td>HbA1c test &gt;6.5% (48 mmol/mol)</td>
<td>16,402</td>
<td>14,768</td>
<td>58.1</td>
<td>1634</td>
<td>6.4</td>
<td>64.5</td>
</tr>
<tr>
<td>In charge of diabetes clinic</td>
<td>15,845</td>
<td>15,601</td>
<td>61.4</td>
<td>244</td>
<td>1.0</td>
<td>62.4</td>
</tr>
</tbody>
</table>

* Shared cases are those captured by at least one of the other sources as well.

b The sensitivity was calculated as proportion of cases identified by source and total ascertained cases (N = 25,425). It is also the sum of percentage of shared cases and percentage of cases identified only by the source.

c For drug dispensation, criterion is dependent on database: if Direct Drug Dispensation database at least one anti-diabetic drug in the year; in case of Pharmacy Drug Dispensation database there must be at least two anti-diabetic drugs in the year.

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Fig. 1 – Overlapping sources for identification of diabetes cases represented with Edward’s diagram five sets.
Table 3 – Prevalence of diabetes by sex and type of diabetes on December 31st, 2009. Reggio Emilia province.

<table>
<thead>
<tr>
<th>Type</th>
<th>Male</th>
<th>Female</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
<td>N</td>
</tr>
<tr>
<td>Type 2 diabetes</td>
<td>12,527</td>
<td>91.9</td>
<td>4.8</td>
</tr>
<tr>
<td>Type 1 diabetes</td>
<td>503</td>
<td>3.7</td>
<td>0.2</td>
</tr>
<tr>
<td>Other</td>
<td>49</td>
<td>0.4</td>
<td>0.0</td>
</tr>
<tr>
<td>Missing</td>
<td>558</td>
<td>4.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Total</td>
<td>13,637</td>
<td>100.0</td>
<td>5.3</td>
</tr>
</tbody>
</table>

*Other type: e.g. genetic, drug- or chemical-induced, unknown.

After the deterministic linkage by sources, there were approximately 5000 cases without identification of type of diabetes. In order to reduce this number, we are currently seeking information in other sources. When we wrote the manuscript, the type of diabetes in about 4.6% (1180) cases was still undefined (Table 3). Among patients whose diagnosis was not yet defined, 75.6% (893) were identified only by Laboratory source (HbA1c criterion).

Among patient with Type 2 diabetes, 51.6% (11,973) were directly followed by Diabetes Outpatient Clinics, 23.8% (5525) were in shared care, and 24.6% (5697) were seen only by GP.

3.2. Prevalence of diabetes and clinical characteristics

Crude prevalence on December 31st, 2009 was 4.8% and 5.9% for the whole population and for people aged 18 years and over, respectively. Males are more represented (53.6%) (Fig. 2 and Table 3), and median age was 71.5 years (95% CI: 71.2–71.8) for females and 67.4 years (95% CI: 67.2–67.7) for males.

Classification by type of diabetes shows an overriding majority of Type 2 diabetes. Median age was 43.0 years (95% CI: 41.6–44.7) for Type 1 diabetes and 69.7 years (95% CI: 69.5–69.8) for Type 2 diabetes.

Fig. 2 – Crude prevalence on December 31st, 2009 by sex and age groups and by type of diabetes and age groups. Reggio Emilia province. “Missing” are “type of diabetes not (yet) defined” (N = 1180); cases classified as “Other type” of diabetes (N = 93) has not been included in the graph.
4. Discussion

4.1. Data sources and diabetes criteria

All the considered data sources made a meaningful contribution to setting up the Diabetes Register, and, with exception of Mortality Register, each of them captured cases not otherwise identified. Moreover, the combination of these sources is original compared to the other registers cited in literature. Disease-specific Exemption, Drug Dispensation, and Hospital Discharge sources are listed in regional guideline documents [10]. These sources are used (partially and/or in combination with others) in other diabetes registers [11-17,24]. Using HbA1c value(s) increases algorithm power since this makes possible the adoption of WHO diabetes definition, as others have done [17,29,30]. Diabetes Clinics data are used in the DARTS study [14], in the Swedish Register [15], in the London study [16], and in Umbria Diabetes Register [31]. Moreover, it is the only source able to distinguish between models of care.

Criteria for Hospital Discharge database and Drug Dispensation databases were defined through a validation process based on relative sensitivity and on comparison with Disease-specific Exemption database, i.e. a proxy of specificity.

Most of suspected cases were identified HbA1c value(s) between 6.0% and 6.4% (42 mmol/mol and 46 mmol/mol). This criterion has shown to have a low sensitivity for isolated impaired glucose tolerance (i-IGT) in the general population [32], suggesting that the group of suspected cases in our register represents only a fraction of pre-diabetes and i-IGT. It will be interesting to quantify how many of these cases will turn into ascertained cases in the next few years. Nevertheless, this subgroup of individuals defines a population at high risk of developing diabetes [30] or with undiagnosed diabetes for whom primary prevention strategies involving GPs should be developed [30].

Our algorithm was able to identify type of diabetes for ~80% of all patients. The remaining cases have to be revised using other sources of information (e.g. GP, hospitalisation history, and/or clinic data). Most of the patients still with undefined diagnosis were identified only by HbA1c value(s), often less than 7.0% (53 mmol/mol). Thus they were likely new-onset cases of Type 2 diabetes and were seen by their GP and following only a specific diet or were still lacking a diagnosis of diabetes.

The Diabetes Outpatient Clinics database is a key source for identifying model of care. The next step would be to contact GPs in order to verify whether they have in their care the patients allocated to “GP only” group. Indeed, some of these patients may be undiagnosed or lost to follow up by Diabetes Outpatient Clinics and not in the care of the GP at all.

4.2. Prevalence of diabetes

The estimation of the diabetes prevalence on December 31st, 2009 had as its primary aim to evaluate the reliability of the algorithm.

The crude prevalence from our register ranks just between those from surveys and those deriving from routinely collected health data sources, both estimated for the same geographical area.

The comparison with other prevalence estimates through health data sources suggests that our algorithm achieves a higher sensitivity than the others do. In fact we estimated a higher prevalence than two studies based on routinely collected health databases in our region: one for [35] Reggio Emilia residents aged 18 years and over equal to 4.6% (unpublished data), which is lower than prevalence register for the same age (5.9%); another recent study [36] estimates the prevalence in Emilia-Romagna Region for population aged 16 years and over equal to 4.9% (95% CI: 4.9–5.0), compared to 5.7% in our register.

Moreover, our prevalence estimate are only slightly lower than those obtained by population based surveys, suggesting that the fraction of diabetes patients not accessing the health service and thus not traceable, at least not by the sources take into account, is small (about 5% of people with diabetes and 0.2% of the population). In fact, the Passi survey found the prevalence for people aged 18–69 years equal to 3.9% (95% CI: 2.3–5.5) in 2009, in the Reggio Emilia province [33], while for the same age class, the prevalence estimated by diabetes register was 3.7%; the National Health Interview found 5.0% of prevalence for the whole population [34] in 2009, while the register estimated a prevalence of 4.8%.

The percentage of Type 1 diabetes is smaller than that estimated for USA [2] (3.8% vs ~5%). It is likely that some cases of Type 1 diabetes are currently included in “not (yet) defined” group. Also, the algorithm may have underestimated Type 1 diabetes: subjects taking hypoglycaemic drugs were assigned to the Type 2 diabetes, when manual revision found (rare) cases of Type 1 diabetes also assuming hypoglycaemic drug, accordingly to literature [37].

Distribution by sex and age is consistent with cited surveys [33,34]. The decreasing prevalence in the elderly population is likely due to the diabetic patient over-mortality, as reported in literature [38].

4.3. Strengths and limitations

The Reggio Emilia Diabetes Register is population-based, is able to capture cases, and to identify type of diabetes and model of care. The register combines in an original way different sources of data and we have indirect evidence that it achieves good coverage of people with diabetes.

Deterministic linkage between sources alone is not enough to identify type of diagnosis; manual electronic medical record revision and GP involvement are still necessary. However, both practices improve register quality and promote healthcare professional networks. Efforts will be made to simplify and standardise this kind of verifications.

The register is able to quantify the burden of disease, a piece of information fundamental to planning, implementing, and monitoring appropriate interventions. The next step will be to produce process and outcome indicators to evaluate differences between models of care adopted [10]. Moreover, we plan to conduct studies in order to investigate the relationship between diabetes and other pathologies or conditions, considering diabetes both as an outcome and/or exposure (i.e. diabetes and cancer, diabetes and postoperative risk, diabetes and immigrant condition).
Conflict of interest

The authors declare that they have no conflict of interest.

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