


# BMJ Open Medical sharps in Portugal: a cross-sectional survey of disposal practices among the diabetic population

Ana Luísa Corte-Real ,<sup>1</sup> Leonor Luz Duarte,<sup>2</sup> Ana Luísa Teixeira,<sup>3</sup> Maria Vaz Cunha,<sup>4</sup> Catarina Calheno Rebelo,<sup>2</sup> Ana Correia de Azevedo,<sup>5</sup> João Mário Pinto,<sup>1</sup> Andreia Faria,<sup>5</sup> Sofia Sacramento,<sup>4</sup> Filipa Machado,<sup>4</sup> Daniel Martinho-Dias,<sup>6,7,8</sup> Tiago Taveira-Gomes<sup>6,8,9,10,11</sup>

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For numbered affiliations see end of article.

## Correspondence to

Dr Ana Luísa Corte-Real;  
anabcortereal@gmail.com

## ABSTRACT

**Objective** We aim to determine the disposal site for biohazardous materials resulting from diabetes surveillance and therapy.

**Design** Cross-sectional study.

**Setting** Five Portuguese primary care facilities.

**Participants** We randomly sampled diabetic patients representative of five primary care facilities. Inclusion criteria consisted in patients  $\geq 18$  years old with an active diagnosis of diabetes mellitus (DM). Patients unable to provide written informed consent were excluded.

**Outcome measure** Sociodemographic variables, diabetes duration, type of treatment, medical sharps disposal practices and whether adequate disposal information were provided.

**Results** A total of 1436 diabetics were included. Overall, 53.8% of diabetics conducted regular capillary glycaemia measurements, although 45.3% of them had no medical indication. Statistically significant predictors of adequate disposal were not having an active professional status ( $p=0.011$ ) and having a DM duration between 5 and 10 years ( $p=0.014$ ). Only being professionally inactive remained an independent predictor after multivariate logistic regression. Less than a fifth of patients on injectable therapy report having been advised by healthcare staff regarding sharps disposal. Over a fifth of the latter report having received wrong advice. The majority of diabetics dispose of biohazardous materials in unsorted household waste (68.1% of needles/devices with needles and 71.6% of lancets). Other incorrect disposal sites identified were recycling bins, toilet and home accumulation. Only 19.1% of the needles/devices with needles and 13.1% of the lancets were disposed of at healthcare facilities.

**Conclusions** Most diabetics have unsafe disposal practices for their biohazardous materials, mostly in unsorted household waste. We identified that being unemployed independently predicts adequate disposal of medical sharps and found evidence of low patient literacy on the topic, as well as poor patient education. Therefore, educating and raising awareness among healthcare professionals is crucial to address this public health issue.

## STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ Cross-sectional study concerning a large primary care randomised sample.
- ⇒ Sampling including outpatients from both rural and urban areas, from four different counties in the North of Portugal, which increases external validity towards the Portuguese diabetic population.
- ⇒ There is a non-negligible possibility of memory bias due to self-reported assessments, and of selection bias due to the exclusion of patients unable to go to the primary care unit.
- ⇒ Due to lack of previously validated questionnaires on the topic, the questionnaire applied was designed by the researchers and lacked formal validation.

## INTRODUCTION

About 422 million people around the world have diabetes mellitus (DM), and its prevalence has been increasing over the past decades.<sup>1</sup> DM is also a very common chronic disease in Portugal. In 2018, it was estimated that 13.6% of its population between the ages of 20 and 79 suffered from DM, representing more than 1 million individuals, with roughly 60 000 new diagnoses every year.<sup>2</sup>

Many of these patients, especially those who suffer from DM type 1, require daily use of medical sharps in order to control blood glucose levels and administer insulin, leading to the generation of a considerable amount of sharp waste within the household setting.<sup>3,4</sup> The most commonly used sharps for home treatment of DM are lancets, needles, reusable and disposable insulin or glucagon-like peptide-1 (GLP-1) analogues pens and insulin cartridges.<sup>4,5</sup>

According to the WHO, about 16 billion injections are administered worldwide every year, and many of these needles and syringes are improperly disposed of afterwards.<sup>6</sup> While medical sharps used and discarded in a hospital setting are considered biomedical



waste, and are strictly regulated, those used in household and community settings are included in municipal solid waste and disposed of accordingly.<sup>7,8</sup>

The undifferentiated elimination of these by-products of DM management at home not only leads to environmental pollution, but also represents a major threat to anyone who inadvertently handles ordinary household waste, such as workers at material recovery facilities, but also for landfill workers and those who collect waste from households.<sup>9,10</sup> Approximately 5.2 million people die every year worldwide due to diseases derived from the inadequate management of healthcare waste.<sup>11,12</sup> Improper disposal of sharps carries potential risk of propagation of some diseases, such as hepatitis B, C and HIV, to anyone who comes in contact with these sharps. This situation may become a serious public health problem as these diseases are chronic infections and often remain undetected for a long period of time.<sup>13</sup>

According to the Portuguese Diabetes Association, 650 000 sharps are used daily by Portuguese diabetic patients at their homes.<sup>14</sup> Although its importance, proper disposal of medical sharps is often neglected as a part of patient education on self-injection techniques, leading to potentially unsafe disposal methods.<sup>15</sup> There is practically no legislation, national guidelines or local municipal rules regarding disposal of home-generated sharps in Portugal. The Portuguese Manual for Children and Young Adults with DM type 1 states that sharps should be disposed of to a proper container, without further specifications.<sup>16</sup>

Some known barriers to safe disposal include lack of information about how and where to dispose, lack of proper advice by healthcare professionals, wrong perception that sharp disposal information is only meant for illegal drug users, and that using community sharp disposal services by patients may reveal their DM status.<sup>11,17,18</sup>

With the predicted increase in the prevalence of DM in the future, its subsequent biological waste will also increase. This issue is not exclusive to Portugal, as many other countries, including the USA and the UK, are also struggling to find solutions to this problem.<sup>10,18,19</sup>

Despite all the risks associated with sharps disposal, little evidence regarding patient education is available on this subject and no characterisation of the Portuguese reality has been conducted. Adequate information is needed to inform policy change and reinforcement.

The main purpose of this study was to determine the disposal site for biohazardous materials resulting from diabetes surveillance and therapy. We also intended to explore sociodemographic differences and identify potential independent predictors of adequate disposal, determine the proportion of non-insulin-treated diabetics who check their blood glucose, ascertain whether adequate education is currently being provided to patients on this topic and determine the occurrence of accidental pricks.

## METHODS

A cross-sectional approach was designed to target primary healthcare users. Eligible population included diabetic patients aged 18 years or over and with an active diagnosis of type 1 or type 2 DM. Physically disabled users or those with chronic pathology that conditioned their visit to the health unit to sign the informed consent were excluded. No further exclusion criteria was established.

We drew a list of all patients attending the five primary care facilities in the North of Portugal that participated in the study, who had an active diagnosis of diabetes, regardless of its type. All patients with an active code of T89 (insulin dependent diabetics) or T90 (non insulin dependent diabetes) from second edition of the International Classification of Primary Care 2 in MIM@UF (information and monitoring module of the functional units) administrative platform, as coded by their general practitioner, in these primary care facilities participating the study, were deemed eligible.

The sample size was defined for each primary care unit, with a 5% margin of error and 95% CI, using the Raosoft Sample Size Calculator program, yielding an overall required sample size of 1424 diabetic individuals. We then randomised the list of diabetic patients per primary care unit using the Microsoft Office Excel 2019 program, and sequentially contacted individuals until the sample size requirements were met. We randomly selected nearly 25% of diabetic patients per healthcare unit.

If contact was not feasible (eg, due to the lack of a telephone number in the national patient register [RNU] or after two unsuccessful contact attempts), the individual immediately following in the list was selected from the global patient list created.

The first five randomised patients per unit, comprising a total of 25 patients, were contacted for a pilot questionnaire application to ensure questions comprehension and adequacy. Changes on the questionnaire were conducted based on patient feedback and consisted mainly of adding options to closed questions on site of disposal. These patients were excluded from the following questionnaire application.

On recruitment, data collection took place between July 2020 and February 2021. A questionnaire (figure 1) was applied to all consenting individuals, either during a scheduled appointment in the primary healthcare unit, or by telephone. The results obtained were structured in a shared spreadsheet (Microsoft Office Excel 2019) between researchers and later exported to IBM SPSS V.26.0. Categorical variables are herein summarised as absolute and relative frequencies, while continuous variables are summarised with both central and dispersion measures according to their distribution type. Logistic regression with stepwise forward methodology was conducted with adequate disposal site as outcome variable and variables deemed by the researchers as potentially relevant as predictive variables.

The protocol for this study is available as a online supplemental file.

## SURVEY "WHAT IS THE DESTINATION OF OUR DIABETIC PATIENTS' NEEDLES AND LANCETS?"

By completing this survey, I declare that I have freely given my informed consent to participate in this research study.

Check the box corresponding to your answers with an X.

Demographic data:

- Gender:  Feminine  Masculine
- Age: \_\_\_\_ Years
- Education (for how many years did you attend school?)
  - 0 Years
  - 4 Years or less
  - 6 Years
  - 9 Years
  - 12 Years
  - More than 12 Years
- Professional situation:
  - Employed
  - Unemployed
  - Student
  - Retired

1. For how many years have you been a diabetic?

- Less than 5 Years
- 5-10 Years
- More than 10 Years

2. Are you on insulin treatment?

- Yes
- No

3. Are you being treated with other injectable diabetes' medications?

- Yes
- No

**IF YOU ANSWERED NO TO THE PREVIOUS TWO QUESTIONS GO TO QUESTION 6.**

4. If you are being treated with insulin or other injectable medications for diabetes, for how many years have you been on it?

- Less than 5 Years
- 5-10 Years
- More than 10 Years

5. Where do you usually deposit needles or needle devices after use?

- Domestic waste
- Recycling bin
- Hospital
- Health Center
- Pharmacy
- Toilet
- Other

Which? \_\_\_\_\_

6. At home, do you usually prick your finger to measure your blood glucose (blood sugar level)?

- Yes
- No

**IF YOU ANSWERED NO TO QUESTIONS 2, 3 AND 6 STOP THE SURVEY. THANK YOU FOR YOUR COOPERATION.**

7. Where do you usually deposit lancets (to prick your finger) after use?

- Domestic waste
- Recycling bin
- Hospital
- Health Center
- Pharmacy
- Toilet
- Other

Which? \_\_\_\_\_

8. Have you been informed of an appropriate place to waste needles, needle devices, or lancets (for finger pricks)?

- Yes
- No

**IF YOU ANSWERED NO TO QUESTION 8 GO TO QUESTION 11.**

9. You have been informed by whom?

- Family/friend
- Doctor
- Nurse
- Pharmacist
- Television
- Internet
- Other?

Which? \_\_\_\_\_

10. Which was the indicated location?

- Domestic waste
- Recycling bin
- Hospital
- Health Center
- Pharmacy
- Toilet
- Other

Which? \_\_\_\_\_

11. Has anyone accidentally been stung by one of your needles, needle devices, or lancets (to prick your finger) after you threw them away?

- Yes
- No

THANK YOU SO MUCH FOR YOUR COOPERATION.

**Figure 1** Questionnaire used in the study (online supplemental file 1).

**Table 1** Sociodemographic characteristics of participants

Variable	Total (n=1436) n (%)
Sex	
Female	692 (48.2)
Male	744 (51.8)
Age	
18–39	18 (1.3)
40–64	534 (37.2)
65–74	486 (33.8)
Over 75	398 (27.7)
Educational level	
Illiterate	2 (4.5)
4 years	903 (62.9)
6 years	171 (11.9)
9 years	148 (10.3)
12 years	90 (6.6)
University	152 (11.1)
Professional status	
Active	406 (28.3)
Unemployed	74 (5.2)
Retired	955 (66.5)
Background	
Urban	829 (57.7)
Rural	607 (42.3)

### Patient and public involvement

Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

### RESULTS

A total of 1436 diabetic patients responded to the questionnaires, either via telephone or in face-to-face appointments at their health unit, between July 2020 and February 2021. Questionnaires were applied by the researchers to 25.6% of the diabetic patients of the included health units. These 5 health units belong to 4 municipalities in the north of Portugal and serve a total of 71 762 patients, of whom 7.8% (5601) had an active diabetes diagnosis.

Sociodemographic variables are presented in [table 1](#). The majority of patients were male (51.8%), completed primary education (62.9%), were retired (66.5%) and belonged to the urban setting (57.7%). Information regarding diabetes characterisation can be found in [table 2](#). The majority of participants (52.5%, n=754) had a diabetes duration longer than 10 years, less than a fifth were insulin dependent (17.1%, n=245) while GLP-1 agonists were administered to a total of 42 (2.9%) diabetics.

Overall, most of the diabetic patients in the study sample conducted regular capillary glycaemia measurements

**Table 2** Disease and treatment characteristics of participants (n=1436)

Variable	Total (n=1436) n (%)
Diabetes duration	
<5 years	292 (20.3)
5–10 years	390 (27.2)
>10 years	754 (52.5)
Under injectable therapy	273 (19.0)
Insulin only	231 (16.1)
GLP-1 analogues only	28 (1.9)
Both GLP-1 analogues and insulin	14 (1.0)
Duration of injectable therapy	
<5 years	114 (8.0)
5–10 years	76 (5.3)
>10 years	83 (5.8)

GLP-1, glucagon-like peptide-1.

(n=773, 53.8%). Among insulin-treated patients, over 95% complied with the use of blood glucose test strips (non-compliance rate of 4.5%, n=11). Nonetheless, the use of medical sharps among non-insulin-treated patients, who therefore do not require regular glycaemia self monitoring, amount to nearly half of this subpopulation (45.3%, n=539).

Regarding disposal habits ([table 3](#)), the vast majority of diabetics dispose of biohazardous materials in unsorted household waste, more precisely 68.1% (n=186) of needles or devices with needles and 71.6% (n=554) of lancets. Only 19.1% (n=52) of the needles/devices with needles and 13.1% (n=104) of the lancets were disposed of at healthcare facilities, such as primary care, hospital or community pharmacy. Other incorrect disposal sites such as recycling bins (6.6% of needles and 6.5% of lancets), the toilet (0.4% of needles and 1.0% of lancets) or even accumulation at home (4.4% of needles and 2.8% of lancets) should also be mentioned.

Retired and unemployed people ([table 4](#)), as well as individuals with diabetes duration between 5 and 10 years, deliver significantly more needles/devices with needles in healthcare facilities (p=0.011; p=0.014, respectively).

**Table 3** Place where diabetics deposit biohazard materials

Disposal site	Needles	Lancets
	n (%)	n (%)
Primary care	7 (2.6)	8 (1.0)
Recycling deposit	18 (6.6)	50 (6.5)
Pharmacy	27 (9.9)	66 (8.5)
Hospital	18 (6.6)	30 (3.9)
Unsorted household waste	186 (68.1)	554 (71.6)
Toilet	1 (0.4)	8 (1.0)
Other	16 (5.9)	58 (7.5)

**Table 4** Relation of sociodemographic data with the place where biohazard materials are deposited (using the chi-squared test)

Sociodemographic data	Needles	Lancets
Sex	P=0.165	P=0.182
Age	P=0.343	P=0.394
Educational level ( $\geq 12$ years vs $< 12$ years)	P=0.620	P=0.687
Professional status	P=0.011	P=0.061

However, these findings do not stand statistical significance when the analysis is shifted towards lancets disposal ( $p=0.06$ ;  $p=0.195$ ). There is a tendency towards greater correct lancet disposal in rural health units ( $p=0.43$ ), although statistical significance has not been achieved in the case of needles ( $p=0.09$ ). In multivariable logistic regression with needle adequate disposal site as dependent variable, only being unemployed predicted adequate disposal habits, regarding both needles and lancets, (OR 4.98 (1.30–19.05),  $p=0.02$  and OR 3.21 (1.18–8.25),  $p=0.02$ , respectively), after adjusting for sex, age, education level and professional status. Likelihood of adequate disposal did not differ significantly between patients medically treated with insulin or other injectable therapies versus other patients ( $p=0.620$  for needles and  $p=0.620$  for lancets).

Approximately 6.5% of diabetics report having been provided information by a healthcare professional (ie, medical, nurse or pharmacy staff) on adequate medical sharps disposal. Among the diabetic population that has been prescribed either injectable therapy or insulin administration, this percentage rises to one fifth of patients (19.0%). The highest reported information provider was nursing staff (45.9%), followed by community pharmacy services (21.6%) and medical doctors (17.1%). Apart from the healthcare system, family and friends were a relevant reported information source (10.8%), while internet, television and other media were residual sources in this dataset ( $n=2$ ). Additionally, 22.3% of those allegedly informed by healthcare professionals, report have been advised to dispose of them in household waste.

In addition, there were reported a total of six accidental pricks in needles/devices with needles or lancets already used and discarded by diabetic patients (0.8% of medical sharps users).

## DISCUSSION

To the best of our knowledge, there was no data available about home disposal practices of medical sharps in the Portuguese diabetic population, as in many other countries.<sup>20</sup> We found clear evidence of inadequate disposal of medical sharps among these patients, findings that are corroborated by studies in the same scope conducted in other countries, which reported household

bin disposal of medical sharps ranging from 33% to 92%,<sup>3 7 8 10 13 15 17 18 21–28</sup> a common problem worldwide.<sup>9</sup> Our results show that over two-thirds of diabetic patients discard sharps directly into common household bins. Only 19.1% ( $n=52$ ) of needles/devices with needles and 13.1% ( $n=104$ ) of lancets were disposed of at healthcare facilities, that is, primary care, hospital or community pharmacy. Most of them, however, did not use suitable containers to hold their sharps, using plastic bags instead, most likely because these items were readily available and easy to find at their home. Some patients reported the deposit in recycling bins, some by flushing the toilet and others reported the accumulation of such materials at home in undifferentiated containers since they started using needles and lancets.

In addition to environmental concerns, this can be considered a health hazard, considering that accidental needle pricks carry the risk of transmission of infectious diseases among caregivers, healthcare workers during domiciliary appointments, other family members or even strangers. However, the number of accidents implying sharps reported here was low, most likely underestimated, mainly because patients only report accidents which they have knowledge or recall of. Other professionals, for instance waste and sanitation workers, are exposed to such risks daily, which amplifies the possibility of avoidable accidents.

Additionally, we found a clear overuse of medical sharps. We estimate medical sharps use among diabetics with no regular blood monitoring indication to be as high as 45.3% ( $n=539$ ). Besides, this shows that patients and, perhaps, even healthcare staff tend to overvalue glycaemia measurements in non-insulin dependent diabetics, which in these patients does not play an essential role on either treatment goals or prognosis.<sup>29</sup>

Alarmingly, as few as 6.5% of diabetics report having been provided with any sort of information on adequate disposal by a healthcare professional. When information was provided, the major informant was the nursing staff, probably due to their role on patient education in glucose monitoring. This lack of systematic information about the adequate disposal of these sharps can be explained by the absence of legislation on this matter, which limits health professionals' options regarding advice. The lack of safe disposal options in the community may also contribute to the high rate of erroneous advice by health professionals to dispose of it in the household waste (22.3%). Other studies have revealed rates of non-education of diabetic patients about correct medical sharps deposition practices ranging from 34% to 96.2%.<sup>7 8 10 13 18 22–24 26 27</sup> However, from the beginning of the therapeutic plan, it is necessary to provide education to patients and their families about the importance of proper disposal of sharps, not neglecting the education of healthcare professionals.<sup>20</sup> Even though educating patients might be challenging, a broad and improved knowledge on safe sharps disposal is required, as there is evidence that patients are more likely to dispose of sharps properly if advised by healthcare

providers, especially if there is ongoing support from the healthcare team.<sup>18 21 30</sup>

We identified other factors besides poor patient education that must be considered. Being unemployed was independently associated with having better disposal habits, which may be related to greater physical capability than retired status and having more time available than being professionally active, in order to be able to dislocate to a health facility that manages medical waste. Additionally, a DM duration between 5 and 10 years independently predicted an adequate disposal of medical sharps. The reason for this may be that lower DM duration can be associated with less knowledge of management options while longer DM duration may be associated with older and poorly educated patients. Curiously, we found no independent statistically significant association between degree of education and inadequate disposal practices, after adjusting for the above factors.

Appropriate disposal practices could help reduce the risks associated with community generated sharps. The US Food and Drug Administration recommends placing used needles and other sharps into a sharps disposal container to reduce the risk of needlestick injuries.<sup>20</sup> Options such as special municipal pick-up services for medical sharps, community drop-off centres, exchange or mail-back programmes, or at home needle destruction devices, in which needles are burnt or melt rendering it safe for disposal, are also reported from some countries, as the USA.<sup>22 31-33</sup> In Australia, a website has been created to guide patients in finding the location of safe disposal of sharps services, and smartphone-based applications have even been developed to make the services user-friendly.<sup>34</sup> According to our data, we believe that a system similar to the one implemented in the UK could prove useful. This includes sharps bins designed with a lid, obtained on prescription from the family doctor, general practitioner or pharmacist. When full, the box is collected for disposal by local administration services.<sup>35</sup> This would eliminate the need for the active dislocation by the diabetic patient to the healthcare facility. Another potentially viable system could be a disposal flow similar to that implemented in some Portuguese pharmacies to collect syringes from intravenous drug users, with proper safe containers and disposal circuits. Nonetheless, this would still require dislocation rendering it perhaps less effective.

As the Diabetes Technology Society Green Declaration stated, the solution for the sustainability and waste management of the diabetes devices used at home must integrate a group of stakeholders, including people with diabetes, healthcare professionals, device manufacturers, government and regulatory agencies and regional partnerships. Each one of these must take part in identifying and overcoming barriers that could not be overcome individually. The Diabetes Technology Society Green Declaration presents a group of tasks for said stakeholders, among which we note the need for: standardised methods for medical waste and sharps management established

by government entities, to provide incentives for manufacturers to partake in the initiatives and to promote research on how these materials are disposed of to define the current barriers that prevent proper waste disposal.<sup>36</sup>

Aligned with this last task, we bring new findings on this matter for the Portuguese population that increase the need for reflection among staff in the National Health System. Primary care services can be considered the ideal study setting for these patients as the majority is subject to regular follow-ups and management by their primary care physician and nursing team, and most information on their condition is provided in this setting. Another main strength of this study is the random sampling of patients from several primary care facilities located in both rural and urban areas, from a widespread geographical area (four different counties within North of Portugal), which may be representative of the North of Portugal diabetic population even though the family health units themselves were not randomised. Estimated prevalence of diabetes in the studied healthcare facilities was 7.8%, a mismatch to the previous national estimate of 13.6% diabetes prevalence in 2018.<sup>2</sup> This may be explained either by population differences or underdiagnosis in the North of Portugal. Lack of representativeness due to patient access limitations is unlikely as the Portuguese public health system provides universal health coverage.

Methodological concerns of this study include the possibility of information bias (ie, memory bias) with subsequent under or over-reporting by patients, since data collection relies on self-reported assessments; selection bias derived from the need to have an updated telephone number in the family health unit and the exclusion of dependent patients unable to go to primary care units; the lack of a formal validation of the questionnaire (only a pilot was conducted to ascertain that patients understood the implemented questions and introduced new options on closed questions); participating health units were not sampled as they were the researchers' working units, although they comprised both urban and rural settings which we believe may reduce the impact of the convenience sampling of the studied units in addition to the random sampling of patients. Despite these limitations, this study provided valuable local data on sharp handling and disposal in a community setting. Considering the increasing prevalence of DM, expanded studies with significant samples in broader geographic areas may be needed to more accurately depict sharp disposal practices of patients and its burden.

In conclusion, we found that most diabetics dispose of their biohazardous materials resulting from diabetes surveillance and therapy in unsorted household waste. In the era of the optimisation of household medical waste management and of the public discussion of the environmental effects of waste, management of DM treatment byproducts is mandatory, and deserves the attention of both the scientific community and the health authorities. In fact, with the increasing prevalence of DM, this problem can potentially give origin to an emerging global

crisis, demanding international efforts to be dealt with. The purpose of this investigation was to contribute to the solution, providing hard data on this topic in the current Portuguese reality and call for action for all stakeholders.

#### Author affiliations

- <sup>1</sup>Family Health Unit Joane, ACeS Ave-Famalicão, Joane, Famalicão, Portugal  
<sup>2</sup>Family Health Unit Oceanos, ACeS Matosinhos, Matosinhos, Portugal  
<sup>3</sup>Family Health Unit O Basto, ACeS Alto Ave, Cabeceiras de Basto, Portugal  
<sup>4</sup>Family Health Unit Ara de Trajano, ACeS Alto Ave, Caldas das Taipas, Guimarães, Portugal  
<sup>5</sup>Family Health Unit Famalicão I, ACeS Ave-Famalicão, Famalicão, Portugal  
<sup>6</sup>Department of Community Medicine, Information and Health Decision Sciences (MEDCIDS), Faculty of Medicine, University of Porto, Porto, Portugal  
<sup>7</sup>Family Health Unit Ao Encontro da Saúde, ACeS Santo Tirso Trofa, São Romão do Coronado, Trofa, Portugal  
<sup>8</sup>Center for Research in Health Technologies and Information Systems (CINTESIS), Porto, Portugal  
<sup>9</sup>Faculty of Medicine, University of Porto, Porto, Portugal  
<sup>10</sup>Faculty of Health Sciences, Fernando Pessoa University, Porto, Portugal  
<sup>11</sup>IINFACTS, Institute of Research and Advanced Training in Health Sciences and Technologies, CESPU, Gandra, Portugal

**Contributors** Conceived and designed the protocol: ALC-R, ALT, ACdA, MVC, LLD, CCR, TT-G. Conceived the database: ALC-R. Collected the data: ALC-R, ALT, ACdA, MVC, LLD, CCR, JMP, AF, FM, SS. Performed the statistical analysis: DM-D. Wrote the paper: ALC-R, ALT, ACdA, MVC, LLD, CCR, JMP, AF, FM, SS, DM-D, TT-G. Revising the article: ALC-R, ALT, LLD, JMP, AF, DM-D, MVC, TT-G. Guarantor: ALC-R.

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#### ORCID iD

Ana Luísa Corte-Real <http://orcid.org/0000-0003-1345-7213>

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