Conflicts of interest: None declared.

Key points

- The study found a substantial effect of shared familial environment in the development of early respiratory infections but, for some of these, genes also matter.
- For pneumonia and wheezy bronchitis, parental smoking was suggested to account for a relevant proportion of the shared environment reinforcing the importance of public health campaigns.
- Susceptibility genes for these infections may be more easily detectable in children not exposed to passive smoking.

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Short Report

Surveillance of imported hospital requiring malaria in Portugal: can it be improved?

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Although eradicated in Portugal, malaria keeps taking its toll on travellers and migrants from endemic countries. Completeness of hospital requiring malaria notification in Portugal 2000–11 was estimated, using two-source capture–recapture method. Data sources were: national surveillance database of notifiable diseases and the national database of the Diagnosis-Related Groups resulting from National Health Service (NHS) hospital episodes. The completeness of notification was 21,2% for all malaria cases and 26,5% for malaria deaths, indicating significant underreporting and urging for complementary data source in surveillance, for disease burden estimates and retrospective monitoring, namely hospital episodes statistics.

Introduction

Migration to and from Portuguese speaking African and Asian countries and global increase in international travel keeps imported malaria in the national public health agenda. Malaria notification, included in the mandatory National Notifiable Diseases Surveillance system, is liable to non-quantified underreporting.[1,2]

Underreporting leads to disease burden underestimation, compromising surveillance performance and the mounting of appropriate public health responses.[3] This includes pre- and post-travel health care preparedness and resurgence risk awareness, determined by malaria importation, vector *Anopheles atroparvus* receptivity and malariogenic potential in Portugal.

Statutory notification in Portugal is since 2014 evolving towards an electronic reporting system.[4] However, in practice, it remains a clinician-based notification system. Laboratories are still not involved nor are hospital episodes statistics (HESs).

This study aims to estimate completeness of hospital requiring malaria notification in Portugal from 2000–11, using capture-recapture method (CRM), as a baseline study prior to this structural change, and propose HES as a complementary surveillance data source.

Methods

Data source and study design

Retrospective study on malaria hospitalizations was based on the National Notifiable Disease Surveillance (NNDS) Database and the National Database of the Diagnosis-Related Groups (DRG) [National Health Service (NHS) HES]. Data were anonymous.

The DRG Database includes all NHS hospitalizations. The NNDS Database includes all cases of disease that have been notified by physicians (private, public, and military healthcare establishments).

Consecutive malaria hospitalizations and notifications were obtained from 2000 to 2011, using international classification disease 9 clinical modification (ICD-9 CM) all codes 084∗ (malaria) and 647.4 (malaria in the mother classifiable elsewhere, but complicating pregnancy, childbirth or the puerperium), for DRG database, and the ICD-10, codes B50-B54, for NNDS Database.

In the period under study, 2422 malaria hospitalizations were obtained from DRG Database and 606 malaria-hospitalized cases were obtained from NNDS Database out of a total of 662 notified cases.

Duplicate records in the DRG database, due to readmission or transference between hospitals, were removed. Gender and date of birth were used as identity proxy markers. Resulting records were manually checked for coherence, by two separate investigators, regarding hospitalization dates, hospital and residence details, before final removal. This was done in order to assess the number of notifications that should have arisen due to hospitalization events. Therefore, 2262 hospitalized cases were retained for linkage purposes.

Both databases were linked using date of birth and gender as identity proxy markers. The matched records found were manually checked for coherence by two separate investigators, regarding all equivalent variables in both databases and in case of doubt consensus was sought. The resulting 479 matched records were considered as 'notified HES patients'.

Completeness

Searching cases that were both in NNDS and DRG databases assessed the completeness of notification relative to hospital register data. The formula $a/b*100$ was used, where (a) is the number of cases present in both databases and (b) is the number of cases in the DRG database.

Using two-source CRM completeness relative to the estimated total number of hospitalized cases was assessed.[5,6] CRM is applied to overlapping incomplete and independent data sources and has been increasingly used for assessing completeness of surveillance systems.[5–7] It estimates the number of total cases, including the ones not registered, on the basis of the available information, considering that the maximum likelihood estimator (MLE) for the real number of cases is: $N=(a+b)*(a+c)/a$, where (a) is the number of cases in both registers and (b) and (c) are the number of cases in only one of the registers.[7] Subsequently, completeness of notification, of hospital episodes and overall completeness was calculated as the number of notified cases, the number of cases in DRG database and both of them divided by the total number of cases, as estimated by CRM. The 95% CI for the estimated total number of cases and completeness were calculated. The same methodology was done regarding malaria deaths.

Results

Completeness of notification relative to hospitalized patients in NHS hospitals (Table 1):

The overall notification completeness was 21.2% (95% CI 19.5–22.9). From 2004 to 2011 it ranged from 23.5 to 27.9% per year (total 24.7%). Overall death notification completeness was 26.5% (95% CI 14.1–39.0).

Completeness relative to estimated total number of cases (CRM) (Table 1):

the estimated total number of malaria cases and malaria deaths were 2862 (95% CI 2258–2966) and 83 (95% CI 58–108), respectively. The completeness of notification was 21.2% (95% CI 19.7–22.7), HES completeness was 79% (95% CI 77.5–80.0) and the overall completeness, considering both data sources together, 83.5% (95% CI 82.1–84.8). For malaria deaths, the completeness of notification was 26.5% (95% CI 17.0–36.0), HES completeness 59.0% (95% CI 48.5–69.6) and the overall completeness, considering both data sources together, 69.8% (95% CI 60.0–79.7).

Discussion

This study confirms the number of imported malaria cases and deaths in Portugal are much higher than notified. From 2000 to 2011, completeness of notification for malaria requiring hospitalization, using CRM, was 21.2% for all cases and 26.4% for deaths, denoting a less than satisfactory performance of the malaria surveillance methodology. In similar CRM studies in Europe, physician notification completeness was 35.5–40% and laboratorial notification 56–69.1%, positive predictive value for malaria assumed to be high.[6,8,9] High completeness is essential for surveillance for accurate estimates of disease burden and adequate strategic planning.

NHS HES (DRG database) can be a valuable source for retrospectively assessing and monitoring malaria hospitalizations, these representing the most severe illness spectrum. The advantage is that these data are systematically collected and standardized, albeit not done for epidemiological purposes. Thus, it provides timely nationwide data that would be otherwise unfeasible or logistically cumbersome to obtain, enabling a comprehensive addition to the surveillance system.

In this study, in comparison to the notification system performance, HES completeness was nearly four times higher (79%) and it increased to 83.5% when both data sources were considered together. Likewise, considering deaths only, HES completeness was more than twice higher (56.3%) and it increased to 67.8% when both data sources were considered together.

HES as health data source and the CRM on surveillance assessment have been used elsewhere.[6,8–10] By definition, laboratorial confirmation is required for malaria diagnosis. The database states diagnosis, coded by specifically trained medical coders (doctors), but does not include laboratorial results. Regular audits are carried out to assess the coding process. Crosschecking of diagnosis and laboratory is logistically unfeasible. Despite increasingly used, probably because they provide a readily available global picture, data on DRG data validity are scarce. Two source CRM basic assumptions were observed[7]: (i) source independency, as clinical notification is independent of the DRG database; (ii) matching of the individuals from both sources was laborious but completely achieved through a linkage algorithm manually revised; still, future assessments could benefit from the introduction of common personal identifiers; (iii) same probability to be ascertained as case; (iv) closed study population, since it is unlikely that one would travel abroad while with acute malaria.

Portugal is implementing the electronic notification of infectious diseases; therefore improvements in reporting performance are expected.[4] Nonetheless, it currently remains a clinician based only notification. As such, it is essential to acknowledge and address the constraints leading to underreporting, namely providing education

Table 1 Malaria Hospitalizations in Portugal 2000–11

	Year	Hospitalizations (HES)[a]	Hospitalized patients (HES)[b]	Bed days[c]	Notifications (NNDS)[d]	Notified HES patients[E]	Completeness of notification relative to HES % (95% CI)[f]	Number of unobserved cases (CRM)[g]	Estimate total number of cases (CRM) % (95% CI)[h]	Completeness of notification (CRM) % (95% CI) [9]	Completeness of HES (CRM) % (95% CI) [10]	Overall completeness (CRM) % (95% CI) [11]
All cases	2000	314	294	2602	52	32	10.9 (7.3–14.4)	164	478 (381–575)	10.9 (8.1–13.7)	61.5 (57.1–65.9)	65.7 (61.4–70.0)
	2001	280	253	2246	66	41	16.2 (11.7–20.7)	129	407 (337–478)	16.2 (12.6–19.8)	62.2 (57.5–66.9)	68.3 (63.8–72.8)
	2002	266	246	2207	77	63	25.6 (20.2–31.1)	41	301 (273–328)	25.6 (20.7–30.5)	81.7 (77.4–86.1)	86.4 (82.5–90.3)
	2003	231	215	1590	43	33	15.3 (10.5–20.2)	55	280 (238–323)	15.3 (11.1–19.6)	76.8 (71.8–81.7)	80.4 (75.7–85.0)
	2004	177	165	1447	50	42	25.5 (18.8 –32.1)	23	196 (176–217)	25.5 (19.4–31.6)	84.2 (79.0–89.3)	88.3 (83.8–92.8)
	2005	166	153	1166	43	37	24.2 (17.4–31.0)	19	178 (159–196)	24.2 (17.9–30.4)	86.0 (80.8–91.0)	89.3 (84.8–93.9)
	2006	132	129	1039	40	36	27.9 (20.2–35.6)	10	143 (131–156)	28.0 (20.6–35.3)	90.2 (85.3-95.1)	93.0 (88.8-97.2)
	2007	151	139	1418	41	36	25.9 (18.6–33.2)	14	158 (143–174)	26.0 (19.1–32.8)	88.0 (82.9-93.0)	91.1 (86.7–95.6)
	2008	156	151	1381	40	36	23.8 (17.0–30.6)	13	168 (153–183)	23.8 (17.4–30.3)	89.9 (85.3–94.4)	92.3 (88.2–96.3)
	2009	130	121	1105	37	30	24.8 (17.1–32.5)	21	149 (129–169)	24.8 (17.9–31.8)	81.2 (74.9–87.5)	85.9 (80.3–91.5)
	2010	179	170	1647	50	40	23.5 (17.2–29.9)	33	213 (187–238)	23.5 (17.8–29.2)	79.8 (74.4–85.2)	84.5 879.6–89.4)
	2011	240	226	2241	67	53	23.5 (17.9–29.0)	46	286 (255–316)	23.4 (18.5–28.3)	79.0 (74.3–83.7)	83.9 (79.7–88.2)
	Total	**2422**	**2262**	**20 089**	**606**	**479**	**21.2 (19.5–22.9)**	**473**	**2862 (2258–2966)**	**21.2(19.7–22.7)**	**79.0 (77.5—0.0)**	**83.5 (82.1–84.8)**
Deaths	**Total**	**49**	**49**	**1288**	**22**	**13**	**26.5 (14.1–39.0)**	**25**	**83 (58–108)**	**26.5 (17.0–36.0)**	**59.0 (48.5–69.6)**	**69.8 (60.0–79.7)**

Completeness of notification relative to HESs and completeness of notification, hospital episodes statistics and overall completeness relative to the estimated total number of malaria cases by the CRM.

[a]Number of malaria hospitalizations or hospital admissions (DRG database), [b]Number of malaria hospitalized patients, after removal of duplicate records (DRG database), [c]Sum of in hospital length of stay (days), [d]Number of hospitalized malaria cases (Statutory notification or NNDS database), [e]Hospitalieed malaria cases (patients) in the DRG database that were notified to the NNDS database, [f]Completeness of notification relative to hospital episodes (hospitalized patients in DRG database) = Notified HES patients/Hospitalized patients ∗ 100, [g]Number of unobserved cases, as estimated by CRM = (Cases only in the DRG database ∗ Cases only in NNDS database)/Cases in both databases, [h]Estimated total number of malaria cases, as estimated by CRM (MLE), [i]Completeness of Notification, as estimated by CRM = Notified cases/Estimated total number of malaria cases∗100, [j]Completeness of HES (DRG hospitalizations), as estimated by CRM = Hospitalized patients/ Estimated total number of malaria cases∗100, [k]Overall completeness, as estimated by CRM = (Cases only in the DRG database + Cases only in NNDS database + Cases in both databases)/Estimated total number of malaria cases∗100.

and feedback to relevant health care workers on the importance of the notification process. It is urgent to include laboratorial-based notification and consider the feasibility of evolving towards automated capture from HES, electronic medical records, laboratories and hospital antimalarial spending. Otherwise, gains in timeliness but not in completeness and data quality will result. Moreover, to ensure that a surveillance system is performing efficiently, evaluation should be made regularly. Studies like this one may provide a baseline for comparing the effectiveness of the notification system in future.

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Conflicts of interest: None declared

Key points

- Hospital requiring malaria notification completeness was 21.2% from 2000 to 2011 in Portugal.
- Therefore, relying only on notification data will result in incorrect disease burden estimates and subsequent oriented public health planning.
- Significant improvement in disease burden estimates will occur if NHS hospital episodes statistics are included in surveillance system for retrospectively assessing and monitoring malaria in addition to statutory notification.
- NHS hospital episodes will remain a valuable additional and complementary data source for systematic surveillance even in case of improvements in the current surveillance performance.

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