

Epidemiology of laboratory-confirmed mumps infections in South Africa, 2012-2017: a cross-sectional study

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Abstract

Background Data on the burden of mumps in South Africa are limited and the epidemiology of mumps in this setting is not well understood. We present findings of analysis of mumps data in South Africa from 2012 to 2017.

Methods This cross-sectional study included secondary data on laboratory-confirmed mumps infections from 2012 to 2017, archived at the South African National Health Laboratory Services' data repository as well as from four private laboratories. Mumps-specific immunoglobulin M (IgM) and/or viral nucleic acid positive results represented acute infections. We used age-specific mid-year population estimates for each study year as denominators when calculating annual incidence. We calculated seasonality indices to determine seasonality of mumps infections.

Results Out of 48580 records obtained from the public and private sectors, 46713 (96.2%) were from the private sector. Over the study period, there were 7494 acute infections, 7085 (94.5%) of which were recorded in the private sector. Of these 7494 infections, 3924 (52.4%) occurred in males. The proportion of samples tested that were IgM positive was 18.6% (1058/5682) in 2012, 15% (1016/6790) in 2013, 15.8% (1280/8093) in 2014, 15.5% (1384/8944) in 2015, 13.1% (1260/9629) in 2016 and 15.8% (1496/9442) in 2017. The cumulative incidence rate per 100000 was highest in children between one and nine years throughout the study period. Infections tended to peak in the October-November months, which represents spring in our setting. Most infections occurred in Gauteng, Western Cape and KwaZulu-Natal and this was consistent throughout the study period.

Conclusion Mumps infections predominantly occurred in spring, affecting children below 10 years of age and individuals who were male. There were fewer tests performed in the public sector compared to the private sector. Since only laboratory data was analysed our results represent and underestimate of disease burden. Further studies that include clinical data are required to provide better estimates of disease burden in South Africa.

Background

Mumps is usually a childhood illness that mostly affects children aged 5–9 years although adolescents and adults can be infected (1). In the absence of a mumps-containing vaccine (MuCV), the annual incidence of mumps was estimated to be between 100–1000 cases/100 000 population (1). By the end of 2017, 122 countries worldwide had introduced the vaccine in their respective national immunization programmes, with the annual reported number of cases being 552 779 worldwide (2,3). However, there has been reported mumps outbreaks recently in previously adequately vaccinated populations (4–10).

In the African region, only four countries (Algeria, Libya, Egypt and Sao Tome and Principe) currently include MuCV in their vaccination program (11). In South Africa, MuCV is currently only available in the private sector in the form of the measles-mumps-rubella (MMR) vaccine (12,13). However, mumps is not a notifiable disease in the country, contributing to the sparse epidemiological data of the disease as well as the baseline incidence of mumps infections being known. This study aimed to describe the epidemiology of laboratory-confirmed mumps infection in South Africa between 2012 and 2017. The objectives included estimating the incidence of laboratory-confirmed mumps infections in South Africa during the study period, as well as determining whether the infections had any periodic fluctuations.

Methods

Study design and setting

This was a cross-sectional study using private and public health sector mumps data from January 2012 to December 2017. Public sector data were obtained from the data repository of the National Health Laboratory Service (NHLS). The NHLS is the largest diagnostic pathology service provider in South Africa and provides laboratory services to $\geq 80\%$ of the population through a network of over 260 laboratories throughout the country (14). Private sector data were obtained from four private laboratories (Ampath, Lancet, PathCare and Vermaak & Partners). Data included patient's demographic information as well as test results.

Operational definitions

Positive mumps-specific immunoglobulin M (IgM) and/or viral nucleic acid (NA) results represented acute infections. Results positive only for mumps-specific immunoglobulin G (IgG) represented previous exposure to mumps. Age-specific cumulative incidence rates were calculated using the number of acute infections per year as the numerator and the age-specific mid-year population estimates as denominators (15–20). Mid-year population estimates for 2012 were not available, therefore the average of estimates for 2011 and 2013 were used to calculate the 2012 age-specific estimates. Seasonality was determined by calculating seasonality indices.

Participants, sample size and sampling

All samples tested for mumps at the NHLS and the four private laboratories during the study period were included.

Data management and analysis

Stata statistical software version 15 (StataCorp. 2017. Stata Statistical Software: Release 15. College Station, TX: StataCorp LLC) was used for data cleaning and analysis.

Ethical considerations

Ethics approval for conducting this study was obtained from the Faculty of Health Sciences Research Ethics Committee of the University of Pretoria (ref. 539/2017). Institutional clearance was also obtained from the NHLS Academic Affairs, Research and Quality Assurance as well as the relevant ethics committees of the respective private laboratories.

Results

A total of 48 580 records were used in the analysis. Participant characteristics are summarized in Table 1. Of these records, 46 713 (96.2%) were from the private sector (fig 1). There were 186 (0.4%) records with missing information on age, 143 (0.3%) on gender, 15 993 (32.9%) on sample type and 15 175 (31.2%) on province. There were 26 640 (54.8%) records from samples collected from females. There were 10 279 samples from children ≤ 9 years, 9 583 (93.2%) of whom were from the private sector. Table 2 shows the types of the 32587 samples submitted to both health sectors over the study period. There were 20 279 (41.7%) specimens that were cerebrospinal fluid samples, and 12 144 (25.0%) that were blood samples (this includes samples labelled “blood” and “blood culture”). There were 16 959 (50.8%) samples from Gauteng Province, while the lowest number of samples came from the Eastern Cape, Northern Cape and Free State Provinces (343 (1%), 345 (1%) and 349 (1%) respectively).

Table 1: Characteristics of samples submitted for mumps testing, public and private sectors, 2012-2017, (n=48580)

Variable	Public Sector	Private Sector	Total
	Number (%)	Number (%)	
Gender			
Female	1046 (4)	25594 (96)	26 640
Male	788 (4)	21009 (96)	21 797
Age			
<1	139 (9)	1423 (91)	1 562
1-4	317 (7)	4080 (93)	4 397
5-9	240 (6)	4080 (94)	4 320
10-19	263 (4)	6061 (96)	6 324
20-29	299 (4)	7184 (96)	7 483
30-39	214 (2)	9866 (98)	10 080
>40	227 (2)	14001 (98)	14 228
Unknown	168 (90)	18 (10)	186
Province			
EC	71 (21)	272 (79)	343
FS	63 (18)	286 (82)	349
GP	933 (6)	16026 (94)	16 959
KZN	193 (2)	8116 (98)	8 309
LP	51 (6)	822 (94)	873
MP	114 (8)	1245 (92)	1 359
NW	67 (9)	663 (91)	730
NC	60 (17)	285 (83)	345
WC	315 (8)	3823 (92)	4 138

EC Eastern Cape; FS Free State; GP Gauteng; KZN KwaZulu Natal; LP Limpopo; MP Mpumalanga; NW North West; NC Northern Cape; WC Western Cape

Table 2: Specimen types of samples submitted for MuV testing in the public and private sectors, 2012-2017, (n= 32587)

Sample Type	Number (%)
CSF ^a	20279 (62,2)
Blood	10364 (31,8)
Blood Culture	1780 (5,5)
Swab ^b	69 (0,2)
Unknown ^c	38 (0,1)
CSF & Blood	25(<0,1)
Saliva/sputum	14 (<0,10)
Smear	11 (<0,1)
NPA ^d	3 (<0,1)
Amniotic Fluid	1 (<0,1)
Bone Marrow	1 (<0,1)
Stool	1 (<0,1)
Swab ^e & Blood	1 (<0,1)
Total	32587 (100)

^aCentral Nervous System; ^bIncludes ear, vaginal, nasal and throat swabs; ^cSamples codes recorded by the laboratories unknown; ^dNasopharyngeal Aspirate; ^eSource of swab not specified

Overall, there were 7494 infections recorded during the study period, 7085 (94.5%) of which were in the private sector (Fig 1). Most of these infections were recorded in 2017 (1496/7494; 20%), while the least number of infections occurred in 2013 (1016/7494; 13.6%). Most (3061/3198; 95.7%) of the infections were diagnosed from blood samples. Except for 2013, there has consistently been more infections amongst males. Most of the acute infections were recorded in the Gauteng, Western Cape and KwaZulu Natal provinces throughout the study period (fig 3). The cumulative incidence (per 100000) was highest in 2017 (2.7 cases/100 000 population), while it was lowest in 2013 (1.9 cases/100000 population). The incidence has been consistently high amongst children in the 1-4 and 5-9 year age groups (Fig 2). There was no major seasonal variation in infections across the months throughout the years when absolute numbers of infections were plotted, however, after calculating seasonality indices, infections tended to increase in the October-November months, with the indices being 1.3 respectively (Fig 4).

Figure 1. Number of laboratory-confirmed acute infections recorded in the public and private sectors amongst males and females, 2012-2017

Figure 2: Incidence per 100000 population of laboratory-confirmed mumps infections in the public and private sectors by age groups, 2012-2017

Figure 3: Absolute numbers of laboratory-confirmed acute infections recorded in the public and private sectors by province, 2012-2017

Figure 4: Absolute numbers of laboratory-confirmed acute infections recorded in the public and private sectors by month, 2012-2017

Discussion

In this paper, we report the number of tests positive for mumps in South Africa between 2012 to 2017. Most of these cases were reported by the private sector laboratories and occurred mostly in the 1–4 and 5–9 age groups. This age distribution is consistent with what has been reported in other countries during the pre-MuCV era, with most of the infections reported in children below 10 years of age (1). The mumps incidence in our setting was found to be lower than that reported in other countries in the pre-vaccine era throughout the study period, most likely reflecting under-reporting in the public sector. However, under-reporting in the public sector is expected since MuCV has not been introduced into the country's Extended Immunization Programme (EPI) and is also not under surveillance. However, the few positive results from the public sector may represent unidentified large outbreaks.

The recently reported resurgence of mumps infections has been found amongst adolescence and young adults in overcrowded and semi-closed settings such as communes, colleges and camps (8–10). In the United States (US), military recruits, a sub-population that has previously been associated with mumps outbreaks, were found not to be involved in the resurgence of mumps infections reported between 1998–2007 in the US (8). This was associated with the decision in 1991, to introduce the MMR vaccine amongst recruits irrespective of previous vaccination status. Although this finding could strengthen a case for booster doses in older age groups, particularly those at high risk such as college students, antibody titres have been found not to be durable, with titres returning to pre-MMR3 dose levels one year after vaccination in individuals between 18–24 years in a non-outbreak setting (19). A booster dose of the mumps vaccination is currently recommended only in the setting of an outbreak (9,10,21). Although protective antibody levels against mumps infections are not well-defined, suggested causes of the resurgence of infections have included waning immunity over time due to a lack of a durable T-cell mediated response, as well as antigenic differences between vaccine and circulating mumps strains, (1, 4, 7–10, 21–24). As such, the mismatch between vaccine and circulating mumps stains has also prompted the consideration of a polyvalent vaccine (1, 25)

In our study, most of the samples submitted for MuV testing were CSF and blood specimens. However, information on the clinical presentation of the patients from whom specimens were collected was not available. One study conducted in Gauteng Province in South Africa used CSF samples from patients who had clinical presentation of central nervous system disease (meningitis, encephalitis or other febrile illness with focal neurological signs) to determine the presence of MuV and to characterise the strains, if found (12). The study findings showed a low frequency of MuV-associated CNS disease [3/260 (1.2%)], and phylogenetic analysis of one detected strain showed that it was a Jeryl-Lynn or RIT4385 vaccine-like strain. A suggestion made by the authors was the establishing of a MuV surveillance programme in the country.

Our finding of a male predominance with regards to infections is similar to what has been reported in other studies (26, 27). This has been associated with immunological differences between males and females, where females have been shown to have a stronger T-helper1 cell (Th1) immune response, as well as having persistent and higher antibody levels compared to males (24, 28). Orchitis has been reported to be the most common complication of mumps infection, and this may also explain the male bias seen in the results (6). Males have also been found to have an increased risk of complications that occur less commonly following mumps infections such as mumps-associated meningitis and encephalitis (6, 28).

The seasonal pattern of mumps infections differs by country, with this difference attributed to variations in meteorological, environmental and seasonal exposure factors (29). Mumps virus survival and virulence has also been reported to be supported by increasing humidity and temperatures (29). In our study, we found that the infections tended to peak in the October-November months, which represents spring in South Africa. This is consistent with the seasonal pattern that has been found in other settings, even though the months representing spring in the Northern Hemisphere may differ (26, 27, 30, 31).

Although Gauteng, Western Cape and KwaZulu Natal were seemingly the most affected provinces, these regions were also over-represented in the analysis, with the highest number of samples having been obtained from these provinces. This spatial variation in the findings may also be due to the differential availability of laboratory services in these provinces compared to others in the country, as well as the fact that two of these provinces, Gauteng and Kwa-Zulu Natal, were the most populous provinces in the country throughout the study period.

A strength of our study is that we analysed data from both the public and private health sectors. However, our study also has several limitations. Firstly, missing data could not be accounted for and information on risk factors was not available since secondary data was analysed. Secondly, 50% of mumps infections present non-specifically or with respiratory symptoms, while 20–30% of infections are reportedly asymptomatic or have mild symptoms (1, 21). These cases may therefore not present at health facilities and would therefore not be included in the data reviewed. Therefore, cases of mumps infection in whom mumps was only diagnosed clinically without being investigated using laboratory testing would not have been accounted for in our study. Also, mumps was not a notifiable disease in South Africa at the time that this paper was written. Thus, case-based data that could have supplemented the laboratory-based data were not available. The above-mentioned limitations may also account for the small numbers of mumps test requests, particularly from the public health sector, where mumps infections are likely to be diagnosed based on clinical presentation rather than by laboratory testing. Thirdly, we were not able to comment on mumps-related complications in our setting because information on clinical presentation was not included in the analysed data. Increased age is associated with more severe disease in many childhood diseases, and in mumps infections, this increased risk occurs more commonly in males compared to females (10, 28) Fourthly, differential availability of laboratory services across the provinces may also have had an impact on the completeness of the analysed data. The estimates of acute infections presented may be an underestimation of the true burden of mumps disease and may explain why the cumulative incidence found in our study was lower than the incidence of ≥ 100 cases/100000 that has been reported in the pre-vaccine era in other settings.

Conclusion

Our results should that, in South Africa, mumps infections mostly affected children below 10 years of age, occurred in spring and predominantly affected males. Fewer tests were performed in the public compared to the private sector, which may have contributed to under-reporting of infections. Based on the study results, as well as the limitations presented, the true burden of mumps infection in our setting still needs to be investigated. Conducting further studies that include analysis of clinical data may provide further insight into disease burden in the country.

Abbreviations

CNS
Central Nervous System
EC
Eastern Cape Province
EPI
Extended Immunization Programme
FS
Free State Province
GP
Gauteng Province
IgG
immunoglobulin G
IgM
immunoglobulin M
KZN
KwaZulu Natal Province
LP

Limpopo Province
MMR
measles-mumps-rubella
MP
Mpumalanga Province
MuCV
mumps-containing vaccine
NA
nucleic acid
NC
Northern Cape Province
NHLS
National Health Laboratory Service
NPA
Nasopharyngeal Aspirate
NW
North West Province
US
United States of America
WC
Western Cape Province

Declarations

- *Ethics approval and consent to participate*

Ethics approval was obtained from the Faculty of Health Sciences Research Ethics Committee of the University of Pretoria (ref. 539/2017). Institutional clearances were also obtained from the NHLS Academic Affairs, Research and Quality Assurance (for the public health sector data) as well as the relevant ethics committees of the respective private laboratories (for private health sector data).

- *Consent for publication*

Not applicable

- *Availability of data and materials*

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request

- *Competing interests*

The authors declare that they have no competing interests

- *Funding*

No funding to declare

- *Authors' contributions*

All authors contributed to the conception of the study. MLS requested and acquired raw data from the NHLS data repository and private laboratories. All authors contributed towards analysis and interpretation of the data. All authors as well as Mrs Dorothy Southern and Dr Inez Rossouw reviewed the manuscript.

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Figures

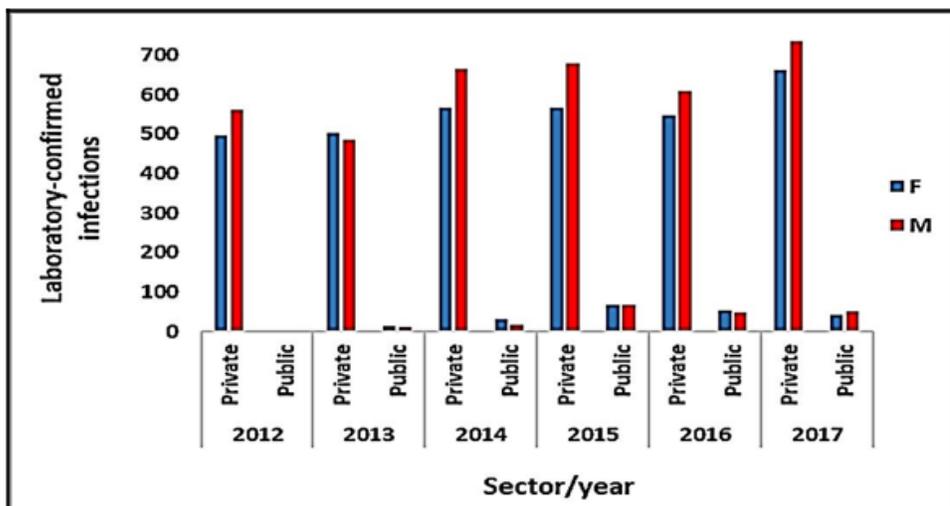


Figure 1

Number of laboratory-confirmed acute infections recorded in the public and private sectors amongst males and females, 2012-2017

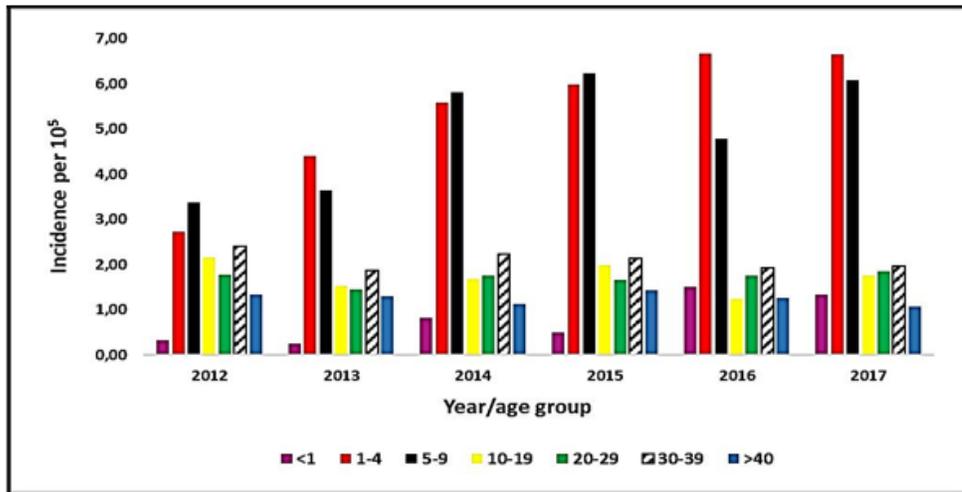


Figure 2

Incidence per 100000 population of laboratory-confirmed mumps infections in the public and private sectors by age groups, 2012-2017

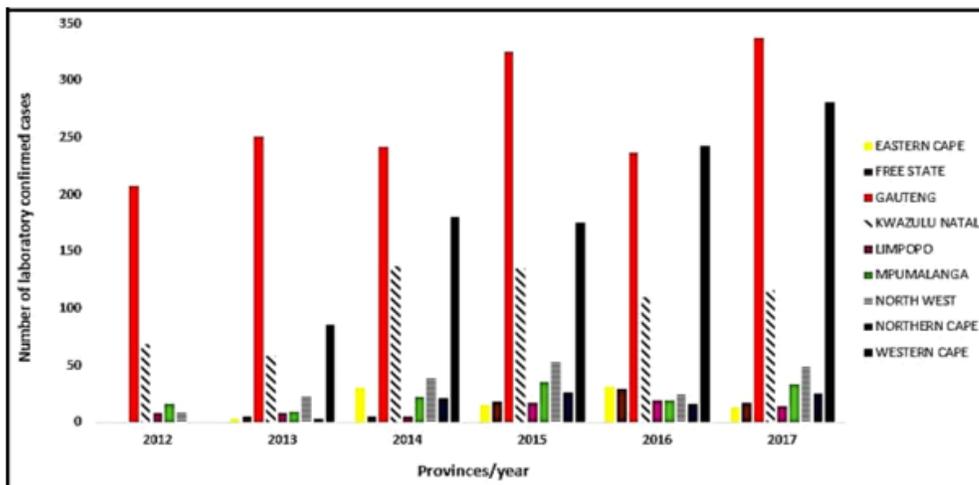


Figure 3

Absolute numbers of laboratory-confirmed acute infections recorded in the public and private sectors by province, 2012-2017

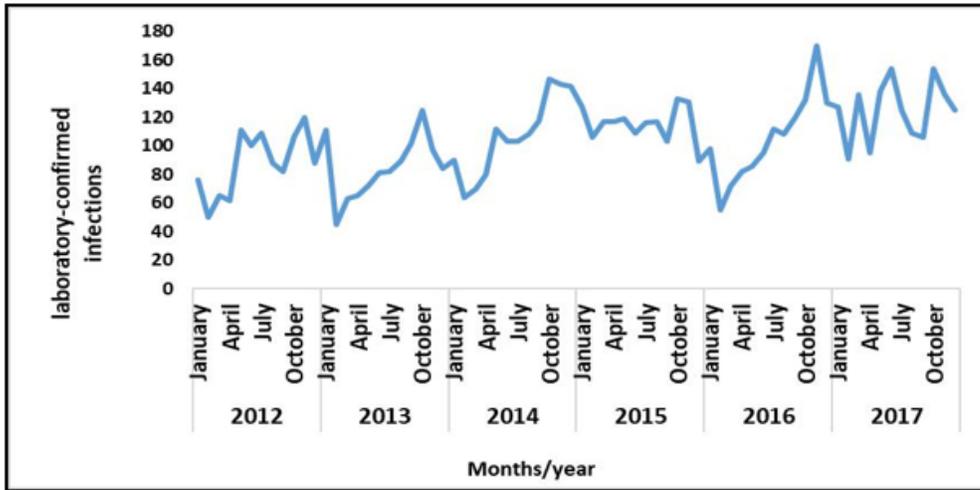


Figure 4

Absolute numbers of laboratory-confirmed acute infections recorded in the public and private sectors by month, 2012-2017