Satisfactory Measles, Mumps, Rubella and Varicella Seroprevalence in Adult Refugees in Western Europe – But Don´t Forget the Kids

Alexandra Jablonka[1,2,*], Christine Happle[3,4,*], Ulrike Grote[5], Benjamin Thomas Schleenvoigt[6], Annika Hampel[7], Reinhold Ernst Schmidt[1,2], Georg MN Behrens[1,2,8]

[1]Department of Clinical Immunology and Rheumatology, Hannover Medical School, Hannover, Germany

[2]German Center for Infection Research

[3]Department of Pediatrics, Neonatology and Allergology, Hannover Medical School, Hannover, Germany

[4]German Center for Lung Research

[5]Department of Hematology and Oncology, Hannover Medical School, Hannover, Germany

[6]Center for Infectious Diseases and Infection Control, Jena University Hospital, Jena, Germany

[7]Department for Anaesthesiology and Surgical Intensive Care Medicine, Hospital Wolfsburg, Wolfsburg, Germany

[8]Niedersachsen Network on Neuroinfectiology

[*] contributed equally

The final publication is available at http://link.springer.com/article/10.1007/s00063-016-0203-7

Corresponding author:

Dr. med. Alexandra Jablonka
Department of Clinical Immunology and Rheumatology
Hannover Medical School
Carl-Neuberg-Straße 1
D - 30625 Hannover
Tel: +49 511 532 5337
Fax: +49 511 532 5324
jablonka.alexandra@mh-hannover.de

Running title

Current MMRV seroprevalence in refugees in Germany in 2015

Abbreviations

EU: European Union, IgG: immunoglobulin G, MMRV: mumps/measles/rubella/varicella, VPD: vaccine preventable diseases

Authorship contributions

Christine Happle and Alexandra Jablonka contributed equally to this work.

Participated in research design: Alexandra Jablonka, Georg MN Behrens, Annika Hampel, Ulrike Grote, Reinhold RE Schmidt

Conducted collection and analyses of samples: Routine clinical care

Data processing: Annika Hampel, Benjamin Schleenvoigt

Performed data analysis: Alexandra Jablonka, Christine Happle, Ulrike Grote

Wrote or contributed to writing of the manuscript: All authors

Conflict of interest statement

None to specify

Funding: not applicable.

Abstract

Purpose: The current extent of migration poses emerging socio-economic and humanitarian challenges. Little is known on vaccination rates in migrants entering Europe, and proper guidelines for serological testing and vaccination of refugees are pending. We aimed at improving this situation.

Methods: We conducted seroprevalence analyses for measles, mumps, rubella and varicella (MMRV) in 678 refugees coming to Germany during the current crisis.

Results: The mean age of refugees was 28.8±11.4 years, and 76.1% of subjects were male. Overall IgG seronegativity was 7.4% for measles, 10.2% for mumps, 2.2% for rubella, and 3.3% for varicella. Seropositivity rates were age-dependent with considerably low values in children. For example, overall MMR immunity was 90.9%, but only 73.1% of minor aged refugees displayed complete seroprevalence against all three diseases, and only 68.9% of children and adolescents were completely MMRV immune.

Conclusion: Our initial data set suggests overall satisfactory MMRV immunity in adult migrants coming to Europe, but the observed low MMRV seroprevalences in refugee children support thorough and prompt vaccination of young migrants entering Europe. Taken together, our data set underlines the urgent need to improve and validate vaccination guidelines for refugee care in the current crisis.

Key words

Vaccination, Refugees, Measles, Mumps, Rubella, Varicella

Background

Currently, the European continent faces the largest extent of migration since world war two. From Syria alone, about four million people have emigrated since beginning of the crisis in 2011 and have seeked asylum in neighboring regions or the European union [1]. Especially amongst young children, the collapse of immunization programs in their country of origin has led to outbreaks of life-threatening vaccine preventable diseases such as polio [2] and measles, which affected more than 10.000 children in Syria in 2014 [1]. The vast majority of refugees have no access to regular health or routine vaccination services [3]. Refugees and displaced persons are particularly susceptible to communicable diseases due to overcrowding, physical and psychological stress, malnutrition, and poor water and sanitation supply during their escape [4, 5]. Insufficient protection from communicable diseases and poor vaccination threaten migrant health as well as global efforts to eradicate vaccine preventable diseases [6].

The current extent of migration from the Middle East and Northern Africa poses new and emerging socio-economic and humanitarian challenges [7], and although millions of refugees now live in refugee camps in the Middle East, Turkey, and EU countries [6] comprehensive and uniform national or European immunization guidelines for displaced populations are pending. Little is known on vaccination rates in migrants entering Europe, and health care professionals struggle whether to advocate for instant vaccination or first serological testing of refugees with uncertain previous immunization status. Also, nation or European wide attempts to harmonize vaccination regimens in migrating children have so far not been successful and there is a lack of information on communicable disease seroprevalence and vaccination rates especially in young refugees. To address this issue, we conducted serum analyses for IgG against measles, mumps, rubella and varicella (MMRV) in 678 refugees seeking shelter in six northern German refugee centers in the summer of 2015. While our analysis demonstrates an overall satisfactory vaccination rate amongst adult refugees in Europe, it raises concern with regard to a comparably low seroprevalence against MMRV in children and adolescents of migrating families.

Methods

2.1 **Study population and serum collection**

A total of n=801 refugees presented to the outpatient clinics of six German refugee centers in Northern Germany in August 2015. N= 678 patients reported uncertain or insufficient vaccination history (2 x MMR vaccine) when they had started their migration and had no history of prior vaccination against MMRV in Germany or in other countries during their migration. They were therefore tested for measles, mumps, rubella and varicella antibodies prior to immunization as routine care. All patients were offered consecutive immunization if necessary based on IgG status. Informed consent was obtained from all patients and parents for underaged refugees prior to testing. No age group was excluded from the cross-sectional sample collection.

2.2 **Serological analyses**

Serum levels of IgG against measles, mumps, and rubella were assessed in each patient, and varicella IgG levels were assessed whenever enough serum material was available. IgG levels were analyzed by Enzyme Linked Immunosorbant Assay (EIA) according to the manufacturer´s recommendations in a diagnostic laboratory certified for routine serological testing according to DIN EN ISO 15189:2014. Threshold values regarded as protective immune statues were as follows: >150 mIU/ml for measles, >10 IU/ml for rubella, >50 mIU/ml for varicella, and titre >1:230 for mumps.

2.3 **Data analysis**

Information on individual age, gender and serological analyses was implemented into an electronic database and a two-pass verification step by an independent team member was performed to avoid typing errors and inconsistencies. In 14 patients, no information on gender and in 43 patients, no information on age was collected. The data was collected in routine clinical care. All data was anonymized before being transferred to analysis for age and gender specific seroprevalences.

2.4 **Statistics**

Statistical analyses were processed using SPSS version 23.0 or Graphpad Prism version 5.02. Calculation of MMRV seroprevalence was performed according to above mentioned cut off criteria. 95% confidence intervals (95% CI) for prevalences were estimated by bootstrapping (simple, 1000 computations). For age comparison of MMR seroprevalences, one way Anova with Bonferroni correction was performed, and p values below 0.05 were considered significant.

2.5 **Ethics**

The Institutional Review Board of Hannover Medical School approved this analysis (# 2972-2015). All patient information was anonymized and de-identified prior to analysis.

Results

The mean age of refugees was 28.8±11.4 years (range 3-76 years), and 76.1% of subjects were male. Figure 1 illustrates age and gender distribution of the cohort. In each age group, more sera from male than female subjects were obtained. In all individuals (n=678, 100%) serological screening for IgG against MMR was performed, and in 574/678 cases (84.7%), enough serum for varicella IgG detection was obtained.

Table 1 contains data on serological testing for the four analyzed vaccine preventable diseases in age and gender specific subgroups of the cohort. As illustrated in Figure 2A, 7.4% [95% CI 5.5-9.6] of screened samples were negative for measles IgG. Of note, an age-dependent decline of seronegativity was observed with the highest rate for IgG seronegativity against measles in subjects below the age of 18 years (17.3%; 95% CI 7.7-26.9). Subjects from 35 – 49 years had a significantly lower seronegativity rate of 2.6% [95% CI 0-6.1], whereas complete seropositivity occurred in subjects above the age of 50 years. A similar pattern was observed for IgG against varicella (overall seronegativity 3.3% [95% CI 1.9-4.9]), where underage subjects displayed a frequency of 8.9% [95% CI 2.2-17.8] seronegative samples, and all subjects above 50 years were seropositive (Fig. 2D). Mumps and rubella seronegativity occurred in 10.2% [95% CI 8.0-12.5] and 2.2% [95% CI 1.2-3.4] of subjects, respectively (Fig. 2B, C). Of note, individuals in the highest age group showed complete seropositivity against all four vaccine preventable diseases. Incomplete measles rubella (MR) seroprevalence occurred in 9.1% [95% CI 6.9-12] of subjects, incomplete MMR status in 18.1%, [95% CI 15-20.9] and incomplete MMRV status in 20% [95% CI 17.1-23.3] of all refugees, and in each analysis the highest rate of incomplete seroprevalence was observed in children and adolescents (Figure 2 E-F). Taken together, 91% of all refugees were tested positive for IgG against measles and rubella, and 80% of subjects had complete seroprevalence for MMRV.

As shown in Figure 3A, none of the MMRV screened samples were negative for all four vaccine preventable diseases. Only 3.0% [95% CI 1.7-4.5] of refugees were seropositive for just two out of four IgG types, 17.1% [95% CI 14-20] for three out of four, and the greatest proportion of subjects (80.0% [95% CI 76.7-82.9]) displayed seroprevalence for all four screened diseases (Fig. 3A).

In the data set for MMR screening per individual, a similar pattern emerged (Fig. 3B), with only 1.6% [95% CI 0.7-2.7] of MMR screened samples testing positive for one of the three disease specific IgGs (mainly against rubella with 63.6%, data not shown). 16.5% [95% CI 13.6-19.3] of subjects were seropositive for only two vaccine preventable diseases, and the vast majority of individuals (81.9%, [95% CI 79.1-85]) displayed complete seroprevalence for all three IgG types. Also in the screening for mumps and rubella, the vast majority of tested samples displayed combined seroprevalence against mumps and rubella [90.9 % CI 88.8-93.1] (Fig. 3C).

When we further analyzed incomplete MMR seropositivity in age-specific subgroups of our cohort, we observed the least satisfactory serological status in the youngest subjects, with a significantly lower mean age in refugees testing positive for only one or only two disease specific IgG types compared to the significantly higher age of subjects with full MMR seroprevalence (Fig. 3D). With regard to measles and rubella, 90.9% [95% CI 88.8-93.1] of all refugees were immune to both diseases, 8.7% [95% CI 6.6-10.6] were immune to only one of the two and only 0.4% [95% CI 0-1] were seronegative for both diseases (Fig. 2E).

Finally, to further characterize the youngest subcohort of our study population, we analyzed age distribution and seronegativity for measles in all children under 18. The mean age of minors in our cohort was 14.1 years (n=52, range 3 - 17 years, Fig. 4A). When analyzing for age-specific seroprevalence of anti-measles IgG in this subcohort, highest rates of seronegativity occurred in the youngest group (33·3% in children aged 3-9 years [95% CI 11·1 - 66·7]). Comparably high rates of seronegativity were also found in older children and adolescents: 8·3% [95% CI 0 - 25%] in children aged 10-15 years and 16.1% [95% CI 3·2-32·3] in adolescents aged 16-17 years (Fig. 4B).

When analysing all children aged 12 years and younger, we found varicella seroprevalence of 100% (n=7/7 analyzed samples, data not shown), whereas children aged 13-17 years showed seronegativity in 10.5% [95% CI 2.6-21.1].

Discussion

To our knowledge, we here present the first comprehensive data set on MMRV seroprevalence in a large cohort of refugees in Western Europe in the current crisis. Overall, we observed a satisfactory rate of protective immunity against MMRV in the analyzed population with an IgG seroprevalence of 92.6% for measles, 89.7% for mumps, 97.8% for rubella, and 96.7% for varicella.

Even though 90.9% immunity to measles and rubella in this refugee population is not alarming, it is well below the threshold of 95% necessary to meet the WHO goal of measles and rubella elimination in Europe [8, 9]. Although exact vaccination regimens for MMRV vary internationally, prevention of these communicable diseases is clearly favored globally. Measles is a highly contagious virus causing maculopapular rash and conjunctivitis, fever, and respiratory symptoms. Common complications range from otitis media to pneumonia and meningitis. Post infectious encephalitis occurs in about 1/1,000 cases, and subsclerosing panencephalitis, a slowly progressive and fatal degenerative brain disease affects around 1/10,000 post-measles patients [10, 11]. In pre-vaccination times, >90% of the population had contracted measles by the age of ten [12]. Mumps causes parotitis and orchitis in children and adults, and complications include meningitis and infertility in males. Before standardized vaccination, >90% of the population were mumps seropostitive [13, 14]. Rubella usually causes mild symptoms including rash, upper respiratory tract infection and fever, but infection during pregnancy is associated with severe birth defects or miscarriage [15]. Primary aim of rubella vaccination is to avoid teratogenic effects, and the WHO has set a goal to eliminate measles and congenital rubella syndrome by 2015 [13]. Varicella is highly contagious and usually causes respiratory tract symptoms with chickenpox rash and fever. Secondary activation may cause shingles or disseminated varicella in immunocompromised patients. Severe complications of varicella infections include pneumonia and meningitis and can have health economic impact [16]. Moreover, infection of pregnant women can cause preterm birth and severe morbidity in mothers and newborns [17].

After introduction of guidelines promoting population wide MMRV vaccination in Western countries, hospitalization rates and mortality due to varicella infections dropped dramatically [16, 18, 19]. In Germany, as in most European countries, MMRV vaccination is not mandatory but generally

recommended for all children. In Western Germany, measles vaccination was introduced in 1973, followed by measles plus mumps vaccination in 1976, and full MMR vaccination in the early 1980s [12]. Today, the German Standing Committee of Vaccination (STIKO) recommends MMRV immunization in all immunocompetent kids starting in month 11-14, and vaccination should be completed by the age of two years. Adolescents or young adults with no or insufficient vaccination status should get MMR immunized whenever possible [20].

Recently, representative national sampling yielded an overall MMR IgG seroprevalence of 76.8% in German children and adolescents between 1 and 17 years [12]. Compared to this, the rate of 73.1% seronegative underage refugees in our cohort is lower but not alarming. However, when further deciphering MMRV immunity in the young subcohort, we found the lowest seroprevalence of IgG against measles in children below the age of ten (66.7% seropositivity). This is a considerably lower immunity compared to German children between three and ten years, as in this age group MMR seroprevalence is reported to be above 80% [12]. Of note, also a frequency of 20% incomplete MMR immunity in German children is unsatisfactory and may threaten herd immunity to these communicable diseases.

However, the observed low MMR immunity in migrating children is particularly concerning. 51% of the 19.5 million refugees currently on the move worldwide are below the age of 18 years [21]. Migrating children are especially susceptible to communicable diseases due to physical and psychological stress, exposure to overcrowded tracks and refugee centres, and limited opportunities for personal space, hygiene and health care [3-5, 7]. In regions of crisis, such as Syria, where a once highly functional health care system has deteriorated to one of the poorest in the world within years, life-threatening vaccine preventable diseases such as polio and measles re-emerge and MMR vaccines were recently mixed up with atracurium, a muscle relaxant, leading to multiple deaths [1], limited or no resources exist to ensure proper vaccination of the youngest.

The issue of a special need for organized and focused care for children of migrating families is of increasing importance [21, 22]. After the first large extent of refugees that enter Europe in 2015/2016,

family members, especially women and children, are expected to follow in the upcoming years. Especially with regards to underage refugees, standardized national and European guidelines for vaccination should be promptly updated in order to assure proper MMRV immunization [23].

Currently, health care professionals caring for refugees struggle whether to immediately vaccinate migrants with unclear vaccination status or to first conduct serological testing and specifically vaccinate only individuals with insufficient immunity. With regard to MMRV, current guidelines in Germany recommend to vaccinate refugees with unclear immunization status born after 1970 with one dose of MMR. Children without documented or unclear vaccination status should receive full standard vaccination including MMRV for children 12 years and younger. Women of fertile age should receive two MMR doses and fertile women planning to become pregnant should receive two doses of MMRV vaccination [20]. The WHO states that "refugees, asylum-seekers and migrants […] should be vaccinated according to these countries' routine vaccination schedules." [24] The authors of this paper generally support these guidelines, as they consider too much vaccination better than vaccination gaps and these guidelines assure proper vaccination of refugee children. Accordingly, German national guidelines recommend serology should not be used to guide individual vaccination decisions, and asylum seekers should not be serologically tested prior to vaccination. Moreover, serology guided vaccination against measles in asylum seekers in Germany during an outbreak was recently reported to be twice as expensive as mass vaccination without prior serological testing [4].

Of note varicella vaccination is, at least in Germany, currently recommended only for refugees, who are 12 years or younger [20]. The present data set, however, supports the notion that children between 13 and 17 years should be considered to be included into this recommendation, as at least in our cohort they displayed a seronegativity rate above 10%. To draw thorough conclusions, though, the validity of our data set needs to be confirmed in a larger cohort.

Another problem in Europe are inconsistent refugee vaccination guidelines that significantly differ in-between countries and, at least in Germany, also from one federal state to another. Guidelines from German health officials are only recommendations, and each of the 16 federal German states needs to

translate these guidelines into actual refugee health care while taking individual federal legislations and financing challenges into account. The WHO, UNHCR and UNICEF just published a joint technical guidance paper for vaccination of refugees in the WHO European Region [24, 25], but as of today there is no German, let alone European standard in action.

Our analyses cannot differentiate between IgG due to sufficient vaccination or post-infection status. Our data on 80% concordance of MMR seroprevalence in individuals may suggest post-vaccination status, however, for example seroprevalence against mumps and measles may be >90% even in an unvaccinated adult population [12, 14]. The raise in seroprevalence with age could also suggest natural contagion rather than thorough immunization regime, as standard WHO recommendations call for immunization in early childhood [26] and MMR seropositivity rates wane with time from last immunization [12]. Furthermore, till today no definite threshold level of IgG has been determined that distinguishes susceptible from non-susceptible subjects.

Another limitation of our analysis may lie in the nature of our cohort that consisted of refugees presenting to the outpatient department of their refugee centre for general check-up or in need of medical care. Although seroprevalence screening was only conducted in those stating they had had no prior vaccination in Germany or Europe during their travel, this approach still poses the risk to positively select refugees that have a lower threshold to participate in the migration healthcare system and as such have higher vaccination probability than the general population. Obviously, vaccination campaigns were conducted in multiple camps in Europe and Germany and we cannot exclude that some refugees had been vaccinated during their travel shortly before our testing. These factors could have led to increased MMRV seroprevalences in our cohort compared to the general, newly arriving refugee population in Europe.

Also, we could not link subject specific information on nationality with seroprevalence results in our cohort. All subjects were recruited without selection for nationality at six large refugee centers in Northern Germany. In these centers, as in the rest of Europe, the vast majority of refugees in August 2015 stem from the Middle East and the Balkan region. Thus, we believe our data set represents a

valid sampling of the general population of refugees currently entering Western Europe. This notion is further supported by the finding of a mean age of 28.8 years in our cohort, with 67.1% of the subjects being male. This reflects pan-European statistics that state the largest proportion of asylum applicants are males aged 18–34 [27]. To further confirm the validity of our results, however, we next aim at analyzing sera from a large cohort of refugees in Western Europe with nationality specific subgroups. In the future, such studies will facilitate specific risk assessment and vaccination regimens, especially for children from the Middle East and the Balkan region.

The WHO recently stated that the current population movement is a challenge for refugees and migrants as well as for the receiving population [6]. Adequate protection of migrants from vaccine preventable diseases is not only central in preserving the refugees´ health but is also fundamental for protecting host communities. A key factor for this is the proper implementation and adaptation of sensible standards in refugee health care and vaccination. We hope our data set may contribute to the future development of such standards.

References

1. Cousins S. Syrian crisis: health experts say more can be done. Lancet **2015**; 385:931-4.

2. Eichner M, Brockmann SO. Polio emergence in Syria and Israel endangers Europe. Lancet **2013**; 382:1777.

3. Lam E, McCarthy A, Brennan M. Vaccine-preventable diseases in humanitarian emergencies among refugee and internally-displaced populations. Human Vaccines & Immunotherapeutics **2015**; 11:2627-36.

4. Takla A, Barth A, Siedler A, Stocker P, Wichmann O, Delere Y. Measles outbreak in an asylum-seekers' shelter in Germany: comparison of the implemented with a hypothetical containment strategy. Epidemiology and Infection **2012**; 140:1589-98.

5. Kouadio IK, Koffi AK, Attoh-Toure H, Kamigaki T, Oshitani H. Outbreak of measles and rubella in refugee transit camps. Epidemiology and infection **2009**; 137:1593-601.

6. Jakab Z. Population movement is a challenge for refugees and migrants as well as for the receiving population. http://www.euro.who.int/en/health-topics/health-determinants/migration-and-health/news/news/2015/09/population-movement-is-a-challenge-for-refugees-and-migrants-as-well-as-for-the-receiving-population. Accessed March 2nd 2016.

7. Nicolai T, Fuchs O, von Mutius E. Caring for the Wave of Refugees in Munich. The New England Journal of Medicine **2015**; 373:1593-5.

8. WHO 2010. Renewed commitment to elimination of measles and rubella and prevention of congenital rubella syndrome by 2015 and Sustained support for polio-free status in the WHO European Region. Regional Committee for Europe Sixtieth session Moscow **2010**; 13–16 September 2010.

9. WHO 2014. European Vaccine Action Plan http://www.euro.who.int/__data/assets/pdf_file/0007/255679/WHO_EVAP_UK_v30_WEB.xpdf. Accessed March 2nd 2016.

10. WHO position on measles vaccines. Vaccine **2009**; 27:7219-21.

11. Bojinova VS, Dimova PS, Belopitova LD, et al. Clinical and epidemiological characteristics of subacute sclerosing panencephalitis in Bulgaria during the past 25 years (1978-2002). European Journal of Paediatric Neurology **2004**; 8:89-94.

12. Poethko-Muller C, Mankertz A. Seroprevalence of measles-, mumps- and rubella-specific IgG antibodies in German children and adolescents and predictors for seronegativity. PloS one **2012**; 7:e42867.

13. WHO 2007. W. Rubella Vaccines: WHO position paper. Releve epidemiologique hebdomadaire / Section d'hygiene du Secretariat de la Societe des Nations = Weekly epidemiological record / Health Section of the Secretariat of the League of Nations **2007**; 86:301-16.

14. WHO 2007. Mumps virus vaccines. Releve epidemiologique hebdomadaire / Section d'hygiene du Secretariat de la Societe des Nations = Weekly epidemiological record / Health Section of the Secretariat of the League of Nations **2007**; 82:51-60.

15. Enders G, Nickerl-Pacher U, Miller E, Cradock-Watson JE. Outcome of confirmed periconceptional maternal rubella. Lancet **1988**; 1:1445-7.

16. Dinleyici EC, Kurugol Z, Turel O, et al. The epidemiology and economic impact of varicella-related hospitalizations in Turkey from 2008 to 2010: a nationwide survey during the pre-vaccine era (VARICOMP study). European Journal of Pediatrics **2012**; 171:817-25.

17. McKendrick MW, Lau J, Alston S, Bremner J. VZV infection in pregnancy: a retrospective review over 5 years in Sheffield and discussion on the potential utilisation of varicella vaccine in prevention. The Journal of Infection **2007**; 55:64-7.

18. van Hoek AJ, Melegaro A, Zagheni E, Edmunds WJ, Gay N. Modelling the impact of a combined varicella and zoster vaccination programme on the epidemiology of varicella zoster virus in England. Vaccine **2011**; 29:2411-20.

19. Siedler A, Dettmann M. Hospitalization with varicella and shingles before and after introduction of childhood varicella vaccination in Germany. Human Vaccines & Immunotherapeutics **2014**; 10:3594-600.

20. Robert Koch Institute/ RKI Germany 2015. Empfehlungen der Ständigen Impfkommission (STIKO) am Robert Koch-Institut/Stand: August 2015. Epidemiol Bull RKI **2015**; 34:327-62.

21. Adapting to migration as a planetary force. Lancet **2015**; 386:1013.

22. Modi N WB, Taylor S. Standing up for refugees. Lancet **2015**; 386:1939.

23. Cilleruelo MJ, de Ory F, Ruiz-Contreras J, et al. Internationally adopted children: what vaccines should they receive? Vaccine **2008**; 26:5784-90.

24. WHO/UNICEF/UNHCR 2015. Joint technical guidance: general principles of vaccination of refugees, asylum-seekers and migrants in the WHO European Region. **2015**.

25. Robert Koch Institute/ RKI Germany 2015. Konzept zur Umsetzung frühzeitiger Impfungen bei Asylsuchenden nach Ankunft in Deutschland. Epidemiol Bull RKI **2015**:439-48.

26. WHO 2015. WHO Factsheet Measles. **2015**;

27. European Commission http://ec.europa.eu/eurostat/statistics-explained/index.php/Asylum_statistics#Asylum_applicants. Eurostat **2015**. Accessed March 2nd 2016.