Health Sciences & Disease
The Journal of Medicine and Biomedical Sciences

Original Article

Magnitude and Associated Factors with Measles Among General Population in Mongolia: Evidence from National Health Surveys 2015-2016

Ampleur et Facteurs Associés à la Rougeole dans la Population Générale en Mongolie : Données Probantes Tirées des Enquêtes Nationales sur la Santé 2015-2016

Ghislain Gnimbar Poda [1,2], Nyamtsatsral Batmunkh[3]

1.Ministry of Health, Ouagadougou, Burkina Faso;
2.University of Ouagadougou, Burkina Faso
3.Ministry of Health in Mongolia

Corresponding author
Dr Ghislain Gnimbar Poda, PhD
Ministry of Health, University of Ouagadougou, Public Health Department , Burkina Faso
Email: podaghis@yahoo.fr

Keywords: Measles, confirmed case, mortality, vaccination, Mongolia.

Mots clés : Rougeole, cas confirmé, mortalité, vaccination, Mongolie.

ABSTRACT

Background. Despite the availability of vaccine, measles remains a great challenge public health across the world. This study assessed the magnitude of measles outbreak and identify the associated factors of confirmed case health outcome in Mongolia. **Methods.** This study is a cross sectional survey using 2015-2016 data collected by the National Center for Communicable Diseases and the Ministry of Health in Mongolia. The study population was 3,787 confirmed cases of measles. **Results.** Out of 3787 subjects, 62.6% of subjects were aged under 6 years old, 50.6% were males, 80.4 % of subjects came from Ulaanbaatar (the capital city of Mongolia) and 69.3% were unemployed. In terms of clinical characteristics, almost all the subjects (98 % and above) experienced fever and rash; 62.5% experienced cough and around one-quarter had coryza and red eyes. Subjects from other cities or rural areas (OR=1.32, 95% CI: 1.12-1.57), unemployed (OR=1.44, 95%CI: 1.14-181) who had fever OR=2.22; 95% CI: 1.25-3.95) had rash (OR=2.16; 95% CI 1.14-4.89), had cough (OR=1.63; 95% CI: 1.42-1.87), had coryza (OR=4.46; 95%CI: 3.79-5.26), had red eyes (OR=2.2195% CI: 1.91-2.56) and with measles PCR positive (OR=2.28, 95% CI: 1.98-2.61) were more likely of being under negative health outcome compared to the reference groups. **Conclusion.** Higher prevalence of measles was observed in children aged under 6 years and adults aged 18 years and above. The risk of measles was higher among the cases with clinical symptoms. More intervention programs, including children and adult's vaccination should be done to attenuate measles illness and reduce transmission.

RÉSUMÉ

Introduction. Malgré la disponibilité du vaccin, la rougeole reste un grand défi de santé publique dans le monde. Cette étude a évalué l'ampleur de l'épidémie de rougeole et identifié les facteurs associés à l'évolution de la santé des cas confirmés en Mongolie. **Méthodes**. Cette étude est une enquête transversale utilisant les données 2015-2016 collectées par le Centre national des maladies transmissibles et le ministère de la Santé de Mongolie. La population étudiée comptait 3 787 cas confirmés de rougeole. **Résultats**. Sur 3 787 sujets, 62,6 % étaient âgés de moins de 6 ans, 50,6 % étaient des hommes, 80,4 % des sujets venaient d'Oulan-Bator (la capitale de la Mongolie) et 69,3 % étaient au chômage. En termes de caractéristiques cliniques, presque tous les sujets (98 % et plus) ont présenté de la fièvre et des éruptions cutanées ; 62,5 % avaient de la toux et environ un quart avaient un coryza et des yeux rouges. Sujets originaires d'autres villes ou zones rurales (OR=1,32, IC 95 % : 1,12-1,57), chômeurs (OR=1,44, IC 95 % : 1,14-181) qui avaient de la fièvre OR=2,22 ; IC à 95 % : 1,25-3,95) avait une éruption cutanée (OR=2,16 ; IC à 95 % 1,14-4,89), avait de la toux (OR=1,63 ; IC à 95 % : 1,42-1,87), avait un coryza (OR=4,46 ; IC à 95 % : 3,79-5,26), avaient les yeux rouges (OR=2,2195 %, IC : 1,91-2,56) et avec une PCR positive pour la rougeole (OR=2,28, 95 % IC : 1,98-2,61) étaient plus susceptibles d'avoir un résultat de santé négatif par rapport aux groupes de référence.. **Conclusion**. Une prévalence plus élevée de la rougeole a été observée chez les enfants âgés de moins de 6 ans et les adultes âgés de 18 ans et plus. Le risque de rougeole était plus élevé parmi les cas présentant des symptômes cliniques. Davantage de programmes d'intervention, notamment la vaccination des enfants et des adultes, devraient être mis en œuvre pour atténuer la rougeole et réduire la transmission.

HIGHLIGHTS OF THE STUDY

What is already known on this topic

Measles remains a great challenge public health across the world.

What question this study addressed

To assess the magnitude of measles outbreak and identify the associated factors of confirmed case health outcome in Mongolia.

What this study adds to our knowledge

Higher prevalence of measles was observed in children aged between 1 and 5 years old, adults aged 18 years and above and in the capital city. The risk of measles was higher among the cases with clinical symptoms such as fever, cough, and coryza, red eyes.

How this is relevant to practice, policy or further research.

More intervention programs including children and adult's vaccination should be done to attenuate measles illness and reduce transmission.

INTRODUCTION

Despite the availability of safe and cost-effective vaccine, measles remains a great challenge public health across the world. Measles is one of the most infectious diseases and can cause serious illness, lifelong complications, and death [1,2]. Measles have been targeted for eradication given the favorable biologic characteristic that humans are the only reservoir [3]; however, due to social and political factors and high transmissibility, elimination has been achieved in very few areas of the world [4, 5]. Measles outbreaks continue to occur, and failure to vaccinate has been identified as the primary cause [6]. In the Southeast Asia region, 31,000 measles deaths were reported in 2013, representing the second highest mortality rate globally6. In the western pacific region including Mongolia, 78,000 measles cases were reported in 2014 and around 31,000 confirmed cases of rash onset in 2016 [7].

Although significant progress was made toward measles elimination in Mongolia, much more effort and intervention programs including innovative strategies in reaching populations at high risk living in the areas with poor access to vaccination services as suggested by a previous study [8] still need for the effective management of measles. In Mongolia, 23,888 confirmed and suspected cases of measles were reported in the first four months of 2016 [9]. In addition, the WHO-Western Pacific Region reported that 3,560 confirmed cases of rash onset were recorded at the end of 20167. Besides, previous studies done in different part of Mongolia have not assessed the associated factors of measles in the general population. A study done in 2011 was focused on the diagnosis and the magnitude of the mumps outbreak [10]. Another study done was aimed to investigate on Measles outbreak after a Post-Honeymoon Period in Mongolia [11]. Therefore, it is important to determine the magnitude of measles outbreak related to the age group, geographic position and identify the associated factors of confirmed case health outcome in Mongolia.

METHODS

Study design and setting

This study design is a cross sectional survey using 2015-2016 data collected by the National center of Communicable Diseases and the Ministry of Health in Mongolia. This study included health outcome as outcome variable defined by recovery or no from measles, and socio-demographic characteristics and the health assessment of participants as independent variables.

Participants

This study used the data collected from 2015 to 2016 among the general population by the National Center for Communicable Diseases and the Ministry of Health in Mongolia. Around 21,695 and 27,557 subjects were recorded in 2015 and 2016 respectively, and the sample size after excluding subjects with the uncertain and negative diagnosis was 3,787. The participants for this study were 3,787 measles confirmed cases living in Mongolia (Figure 1)

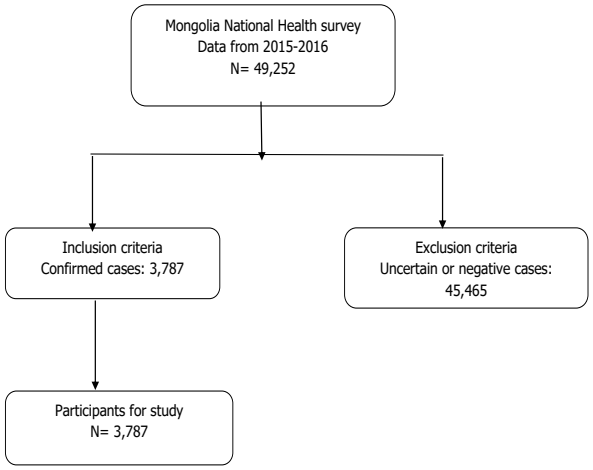

Figure 1. Sampling flow chart and sample size for the study

Data collection

This study used the data collected by the National Center for Communicable Diseases (NCCD) with the collaboration of the Ministry of health in Mongolia. Briefly, the data were collected by using a questionnaire in each city of Mongolia and sent to the NCCD. The data included participant's socio-demographics characteristics (age, gender, profession, location or address), health assessment (fever yes/no; cough yes/no, coryza yes/no, conjunctivitis yes/no, admission at hospital yes/no) and health status outcome (Recovery or not from measles IgM positive)

Anti-measles IgM serologic testing for measles was done using participant's blood. Laboratory confirmation of cases of measles is a vital aspect of surveillance at all stages of control programs because clinical diagnosis is unreliable [12].

Ethical considerations

The protocol for this study was reviewed and approved by the Mongolia National Ethics Committees for Health Research. An informed consent statement was read to the respondent at the beginning of the personal interview, and it was emphasized that participation was voluntary. The authors did not seek further ethical clearance because the data were completely anonymous.

Data analysis

The statistical analysis was performed using SPSS 22 (SPSS Inc., Chicago IL, USA). Chi-square test was performed to describe the distribution of variables regarding measles status. Logistic regression analysis was used to determine the potentials risk factors associated with health outcome in Mongolia. The P value less than 0.05 will be considered significant.

RESULTS

Participants' socio demographics and clinical characteristics

Out of 3787 subjects aged between 1 and 61 years old, 62.6% of subjects were aged between 1 and 5 years old, 50.6% were males, 80.4 % of subjects came from Ulaanbaatar (the capital city of Mongolia) and 69.3% were unemployed. In terms of clinical characteristics, almost all the subjects (98.4% and 99.2%) experienced fever and rash. More than half (62.5%) reported that they experienced coughing and around one-quarter (22.4% and 26.2%) reported that they had coryza and red eyes. The subject's socio demographics and clinical characteristics are described in table 1.

The chi-square results showed that age, city, profession rash, cough, coryza, red eyes, admission at hospital and measles PCR were significantly associated with health outcomes such as being recovery or not from measles diseases at P<0.001.

Risk factors for negative health outcome or not recovery from Measles

Subjects from others cities or rural areas (OR=1.32, 95% CI: 1.12-1.57, P=0.001), unemployed (OR=1.44, 95%CI: 1.14-181, P=0.03) who had fever OR=2.22; 95% CI : 1.25-3.95, P= 0.006) had rash (OR=2.16; 95% CI 1.14-4.89, P=0.003) , had cough (OR=1.63; 95% CI : 1.42-1.87, P<0.001) , had coryza (OR=4.46; 95%CI: 3.79-5.26, P<0.001), had red eyes (OR=2.2195% CI : 1.91-2.56, P<0.001) and with measles PCR positive (OR=2.28, 95% CI : 1.98-2.61, P<0.001) were more likely of being under negative health outcome compared to the reference groups.

Table 1 Distribution of participants socio demographics and clinical characteristics by health outcomes

Characteristics	Total n=3787	Recovery n=1542	No recovery n=2245	P-value
Demographics characteristics				
Age (years)				<0.001
1-5	2372 (62.6)	870 (56.4)	1502 (66.9)	
6-17	281 (7.4)	102 (6.6)	179 (7.9)	
18 & more	1134 (29.9)	570 (37.0)	564 (25.1)	
Sex				0.59
Female	1869 (49.4)	753 (48.8)	1116 (49.7)	
Male	1918 (50.6)	789 (51.2)	1129 (50.3)	
Family Member				0.38
1-5	3236 (85.5)	1327 (86.1)	1909 (85.0)	
6-12	551 (14.5)	215 (13.9)	336 (15.0)	
Cities				<0.001
Ulaanbaatar	3046 (80.4)	1284 (83.3)	1762 (78.5)	
Others	741 (19.6)	258 (16.7)	483 (21.5)	
Profession				<0.001
Unemployed	2624 (69.3)	953 (61.8)	1671 (74.4)	
Students	837 (22.1)	442 (28.7)	395 (17.6)	
Workers	326 (8.6)	147 (9.5)	179 (8.0)	
Clinical information				
Fever				0.14
Yes	3727 (98.4)	1512 (98.1)	2215 (98.7)	
No	60 (1.6)	30 (1.9)	30 (1.3)	
Rash				<0.001
Yes	3757 (99.2)	1541 (99.9)	2216 (98.7)	
No	30 (0.8)	1 (0.1)	29 91.3)	
Cough				<0.001
Yes	2366 (62.5)	1067 (69.2)	1299 (57.9)	
No	1421 (37.5)	475 (30.8)	946 (42.1)	
Coryza				<0.001
Yes	847 (22.4)	580 (37.6)	267 (11.9)	
No	2940 (77.6)	962 (62.4)	1978 (88.1)	
Red eyes				<0.001
Yes	993 (26.2)	547 (35.5)	446 (19.9)	
No	2794 (73.8)	995 (64.5)	1799 (80.1)	
Admission at hospital				<0.001
Yes	2174 (57.4)	814 (52.8)	1359 (60.5)	
No	1614 (42.6)	728 (47.2)	886 (39.5)	
Measles PCR				<0.001
Positive	2222 (58.7)	1082 (70.2)	1140 (50.8)	
Negative	1565 (41.3)	460 (29.8)	1105 (49.2)	

Table 2 Associated factors with the negative health outcome as not recovery.

Characteristics	OR	95% CI	P-value
Age (years)			<0.001
1-5	1.00		
6 & more	0.64	(0.56-0.73)	
Sex			0.59
Female	1.00		
Male	0.96	(0.84-1.09)	
Family Member			0.38
1-5	1.00		
6-12	1.08	(0.90-1.30)	
Cities			0.001
Ulaanbaatar	1.00		
Others	1.32	(1.12-1.57)	
Profession	1.00		
Workers	0.73	(0.56-0.94)	0.01
Students Unemployed	1.44	(1.14-1.81)	0.03
Fever			0.006
No	1.00		
Yes	2.22	(1.25-3.95)	
Rash			0.003
No	1.00		
Yes	2.16	(1.14-4.89)	
Cough			<0.001
No	1.00		
Yes	1.63	(1.42-1.87)	
Coryza			<0.001
No	1.00		
Yes	4.46	(3.79-5.26)	
Red eyes			<0.001
No	1.00		
Yes	2.21	(1.91-2.56)	
Admission at hospital			<0.001
No	1.00		
Yes	0.73	(0.63-0.83)	
Measles PCR			<0.001
Negative	1.00		
Positive	2.28	(1.98-2.61)	

While older subjects (OR=0.64; 95% CI: 0.56-0.73, P<0.001), students (OR=0.73, 95%CI: 0.56-0.94, P=0.01) and those admitted at hospital (OR=0.73, 95% CI: 0.63-0.83, P<0.001) were less likely of being under negative health outcome or no recovery from measles. The potential risk factors of negative health outcome are summarized in Table 2

DISCUSSION

This study pointed out that the prevalence of measles was high in children aged between 1 and 5 years old. A similarity was observed in a previous study done in Pakistan in where they reported that based on various age groups, the prevalence of anti-measles IgG antibodies was 75.35 % in children aged between 1 and 6 years old [13]. The prevalence was higher in this group of a population because of their vulnerability. A previous study was done in Mozambique among 85% (216 of 253) cases reported during a measles outbreak, reported that measles has been a major killer among vaccine-preventable diseases in children < 5 years of age in developing countries [14]. This study also observed a high prevalence in adults aged 18 years and above. The similarity was observed with a previous study done in China among the 280 cases in where they reported that 220 (77.6%) were ≥20-year-old adults [15]. This figure was also found in a study done among a total of 1708 and 2040 specimens sampled from Namibian pregnant women aged 15–44 years old who were included in the 2008 and 2010 National HIV Sentinel Survey. In both years, measles seropositivity was 87% [16]. The increased proportion of measles in adults could be explained by the low coverage of measles vaccine in the past decades in many countries including, Mongolia. Similar to Thailand, who experienced numerous measles outbreaks including adult communities such as university student dormitories, prisons, refugee camps, and military recruit camps. The overall measles seroprevalence was 78.5 %. The measles seroprevalence by province ranged from 59.6 % to 93.1 % [17]. In the present study, measles outbreak during 2015-2016 was more present in Ulaanbaatar (80.4%), the capital city of Mongolia. A similar figure was observed in a previous study done in Ireland in 2011, in where there was a large measles outbreak in Dublin. Nationally 285 cases were notified by the end of December 2011, and 250 (88%) were in the Dublin region [18]. The likely reason for this was Measles, Mumps, and Rubella vaccination uptake rates below 95%. The use of the geographical information system for the real-time digital mapping of cases could be one the best approach for better management of measles diseases in Mongolia.

In addition to the assessment of measles prevalence, this study highlighted several factors associated with measles mortality such as failed recovery from measles disease. Subjects' age, profession, location and clinical characteristics such as fever, rash, cough, coryza, admission at hospital and PCR confirmation were

identified as contributors' factors to affect the health outcome in this study. The present study found being young (1 to 5 years old) was a risk factor for measles mortality. Children are more vulnerable than adults to environmental risks because of several factors. Children's health problems resulting from exposure to biologically contaminated water, poor sanitation, indoor smoke, rampant disease vectors such as mosquitoes, inadequate food supply, and unsafe use of chemicals and waste disposal, rank among the highest environmental burden of disease worldwide [19]. Complication rates are higher in those <5 and >20 years old, although croup and otitis media are more common in those <2 years old and encephalitis in older children and adults [20]. Participants with fever, coryza, cough, red eyes and not admitted to the hospital were more likely of being under not recovery from measles. A previous study done in California reported that coughing, fever, conjunctivitis, coryza, and hospitalization affected health outcomes among measles patient [21]. Another study in Kenya (Africa) reported that children less than five years, patients who had a neurological complication and respiratory infection increased the risk of measles mortality [22] . This study reported also that the admission at the hospital was observed as a protective effect of being under worse health status. A similarity was observed in a study done in Bangladesh where they reported that patients who visited health facility increased the risk of measles compared to others admitted to the hospital23. In addition, the present study reported that being unemployed was a contributing factor while education was a protective factor for measles mortality. This situation could be explained by the fact that unemployed and illiterate are linked leading to poor household income and health status. A previous study done reported that not schooling was a risk factor for measles mortality [23].

This study has several strengths. To the best of our knowledge, this study is the first one using the National Center for Communicable Diseases and the Ministry of Health data in Mongolia data to determine the magnitude of measles outbreak related to the age group, geographic position and to also identify the associated factors of confirmed case health outcome in Mongolia. This study used a large population-based study. As a limitation, this study used a secondary data and the association between the risk factor(s) and the outcome or condition may change with time.

CONCLUSION

Measles is a real public concern in Mongolia. Higher prevalence of measles was observed in children aged between 1 and 5 years old, adults aged 18 years and above and in the capital city. The risk of measles was higher among the cases with clinical symptoms such as fever, cough, and coryza, red eyes. More intervention programs including children and adult's vaccination should be done to attenuate measles illness and reduce transmission. The findings of this study will guide the Ministry of Health in Mongolia to implement better health policies regarding the management of epidemiological diseases such measles, mumps, and rubella.

Competing interests

The authors declare no competing interest.

Financial Support

None of the authors received funding for this study.

Authors' contributions

NB & GGP conceived the study. GGP performed the statistical analyses and drafted the manuscript, tables and figures. All authors contributed to and approved the final version of the manuscript.

Acknowledgements

The authors are most grateful to the National Center for Communicable Diseases and the Ministry of Health in Mongolia for their assistance.

REFERENCES

1. World Health Organization. Media center. Measles: WHO; 2017a. Retrieved from http://www.who.int/mediacentre/factsheets/fs286/en / [cited 2017 March 14]
2. World Health Organization. Global Measles and Rubella: Strategic Plan, 2012-2020. Geneva, WHO, 2012. Available on http://apps.who.int/iris/bitstream/10665/44855/1/9789241503396_eng.pdf .
3. Black FL. Measles. In: Viral infections in humans: Epidemiology and control, Evans AS, Kaslow RA (Eds), Plenum Publishing, New York 1997. p.507.
4. Bellini WJ, Rota PA. Biological feasibility of measles eradication. Virus Res. 2011 Dec; 162(1-2):72-9.
5. Keegan R, Dabbagh A, Strebel PM, Cochi SL. Comparing measles with previous eradication programs: enabling and constraining factors. J Infect Dis. 2011 Jul;204 Suppl 1:S54-61. doi: 10.1093/infdis/jir119.
6. Patel MK, Gacic-Dobo M, Strebel PM, Dabbagh A, Mulders MN, Okwo-Bele JM, Dumolard L, Rota PA, Kretsinger K, Goodson JL. Progress Toward Regional Measles Elimination - Worldwide, 2000-2015. MMWR Morb Mortal Wkly Rep. 2016 Nov 11;65(44):1228-1233. doi: 10.15585/mmwr.mm6544a6.
7. World Health Organization, Western Pacific Region. Measles. Geneva , WHO, 2016. Available from http://iris.wpro.who.int/bitstream/handle/10665.1/13533/Measles-Rubella-Bulletin-2016-Vol-10-No-12.pdf?ua=1
8. Teleb N, Lebo E, Ahmed H, Hossam AR, El Sayed el T, Dabbagh A, Strebel P, Rota P, Alexander J; Centers for Disease Control and Prevention (CDC). Progress toward measles elimination--Eastern Mediterranean Region, 2008-2012. MMWR Morb Mortal Wkly Rep. 2014 Jun 13;63(23):511-5.
9. Mongolia Ministry of Health. Annual report, Ministry of Health: Ulaanbaatar, Mongolia, 2016
10. Munkhjargal I, Selenge J, Ambaselmaa A, Tuul R, Delgermaa P, Amarzaya S, Baigalmaa J, Byambajav B, Luo D. Investigation of a mumps outbreak in Mongolia, January to April 2011. Western Pac Surveillance Response J. 2012 Dec 12;3(4):53-8. doi: 10.5365/WPSAR.2012.3.3.007. Print 2012 Oct.
11. Rentsen T, Enkhtuya B, Nymadawa P, Kobune F, Suzuki K, Yoshida H, Hachiya M. Measles outbreak after a post-honeymoon period in Mongolia, 2001. Jpn J Infect Dis. 2007 Jul; 60(4):198-9.
12. Featherstone D, Brown D, Sanders R. Development of the global measles laboratory network. J Infect Dis 2003; 187: S264-9 doi: 10.1086/368054 pmid: 12721924.
13. Zahoor MA, Rasool MH, Waseem M, Aslam B, Zahoor MK, Saqalein M, Nawaz Z1, Sahar R1. Prevalence of measles in

vaccinated and non-vaccinated children. EXCLI J. 2015 Apr 1;14:504-7.
14. Mandomando I, Naniche D, Pasetti MF, Cuberos L, Sanz S, Vallès X, Sigauque B, Macete E, Nhalungo D, Kotloff KL, Levine MM, Alonso PL. Assessment of the epidemiology and burden of measles in Southern Mozambique. Am J Trop Med Hyg. 2011 Jul;85(1):146-51.
15. Ma C, Yan S, Su Q, Hao L, Tang S1, An Z1, He Y1, Fan G1, Rodewald L1, Wang H2. Measles transmission among adults with spread to children during an outbreak: Implications for measles elimination in China, 2014. Vaccine. 2016 Dec 12;34(51):6539-6544.
16. Cardemil CV, Jonas A, Beukes A, Anderson R, Rota PA, Bankamp B, Gary HE Jr2, Sawadogo S3, Patel SV3, Zeko S2, Muroua C2, Gaeb E5, Wannemuehler K6, Gerber S3, Goodson JL6. Measles immunity among pregnant women aged 15-44 years in Namibia, 2008 and 2010. Int J Infect Dis. 2016 Aug; 49:189-95.
17. Gonwong S, Chuenchitra T2, Khantapura P3, Islam D3, Mason CJ3. Measles susceptibility in young Thai men suggests need for young adult measles vaccination: a cross sectional study. BMC Public Health. 2016 Apr 11; 16:309. doi: 10.1186/s12889-016-2987-z.
18. Fitzpatrick G, Ward M, Ennis O, Johnson H, Cotter S, Carr MJ, O Riordan B, Waters A, Hassan J, Connell J, Hall W, Clarke A, Murphy H, Fitzgerald M. Use of a geographic information system to map cases of measles in real-time during an outbreak in Dublin, Ireland, 2011. Euro Surveill. 2012 Dec 6;17(49). pii: 20330.
19. World Health Organization: Children's environmental health. Geneva, 2017b. Available from http://www.who.int/ceh/risks/en/
20. Perry RT, Halsey NA. The clinical significance of measles: a review. J Infect Dis. 2004 May 1;189 Suppl 1:S4-16.
21. Zipprich J, Zahn M2, Harriman K1, Cherry JD3. Clinical Characteristics and Factors Associated With Measles Transmission in California. Open Forum Infect Dis. 2015 Dec 9;2(Suppl 1). pii: LB-4.
22. Mahamud A1, Burton A, Hassan M, Ahmed JA, Wagacha JB, Spiegel P, Haskew C, Eidex RB, Shetty S, Cookson S, Navarro-Colorado C, Goodson JL. Risk factors for measles mortality among hospitalized Somali refugees displaced by famine, Kenya, 2011. Clin Infect Dis. 2013 Oct;57(8):e160-6. doi: 10.1093/cid/cit442. Epub 2013 Jul 2.
23. Akramuzzaman SM, Cutts FT, Hossain MJ, Wahedi OK, Nahar N, Islam D, Shaha NC, Mahalanabis D. Measles vaccine effectiveness and risk factors for measles in Dhaka, Bangladesh. Bull World Health Organ. 2002;80(10):776-82.