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Seroprevalence of Measles and Rubella Antibodies and the Effects of Health Education in High School Students Evaluated Using Antibody Titer Measurements

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The Japanese Ministry of Health, Labour, and Welfare has set a goal of zero cases of measles by 2012 and has adopted initiatives towards its elimination. However, it remains necessary to improve the understanding of immunization by Japanese people. This study assessed the seroprevalence of measles and rubella antibodies in high school students and analyzed the effects of health education related to infection and immunity. In 2008 and 2010, 1,155 students attending S high school in G prefecture, Japan, attended a health education class titled, "Basics about infection and the immune system". Measles and/or rubella antibody titers were measured in 563 consenting students. An identical survey of five questions was administered before and after the class and the changes in knowledge were assessed in all 1,155 students. In this study, the seroprevalence of measles and rubella antibodies was 83.5% and 80.4%, respectively. In an analysis of the responses to the survey administered to 1,155 students before and after attending the health education class, the mean total score increased from 3.38 points to 4.29 points for the five questions (perfect score = 5 points) (p<0.0001). Mean scores were then calculated for students whose antibody titers were not measured, students whose antibody titers were measured, and a control group. The mean score increased to 4.58 points after the class in the students whose antibody titers were measured; however, the degree of increase was smaller in the students whose antibody titers were not measured (4.10 points) and the control group (3.88 points).

The results of this study suggest that the seroprevalence in high school students is insufficient to eliminate measles and rubella, and the health education is effective for improving understanding about infection and immunity.

Keywords: seroprevalence, measles and rubella antibodies, health education, effects of education, high school students

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1. Introduction

Measles is highly contagious and more than 90% of people without measles antibody who are exposed to the virus become infected. Vaccinations are an effective means of eradicating measles. The World Health Organization (WHO)'s index for measles eradication requires achieving and maintaining at least 95% population immunity to measles and second dose immunization coverage of at least 95% (IDSC, 2007a; IDSC, 2007b; IDSC, 2009). The WHO has also set a target of eliminating measles from the entire Western Pacific region (including Japan) by 2012 (WHO/UNICEF, 2010; IDSC, 2007c). In countries that have already eliminated measles (McQuillan et al., 2007), the measles vaccine is reported to have successful results. After the measles vaccine was introduced in the United States in 1963, the disease was reportedly eliminated in the country by 2000 (McQuillan et al., 2007; Baker et al., 2003).

An actual cohort study carried out from 1999-2004 showed that measles seropositivity in the overall population was 95.9% (McQuillan et al., 2007). A second shot of vaccine is administered in other developed countries, many of which have eradicated the disease (WHO, 2009). Japan also introduced routine immunization with two shots of the measles and rubella vaccine starting in 2006 (Health, Labour and Welfare Statistics Association, 2011). Japan is taking various initiatives toward measles eradication, such as devising various guidelines and educational materials aimed at eradication (IDSC, 2007b; IDSC, 2003; Sunagawa et al., 2008). Despite these efforts, the measles antibody prevalence rate in Japan in 2008 was reported to be 73.0% (IDSC, 2009), far below the target of 95% or higher.

In order to increase seroprevalence, it is necessary to provide education on how to improve the immunization rate. Such education can be delivered in homes, schools, and regional communities (Inoue et al., 2007).

In other countries, initiatives related to immunization programs have proved successful (Lamabadusuriya 1993; Kishore et al., 2008; Ratnam et al., 1996), and evaluation indicators for immunization (Kolbe , 1989) have been specified in school health promotion programs. In Japan, there are no specific immunization programs at schools as in other countries, and health education is conducted through overall educational activities such as healthcare learning and the physical education course on "health education" (Sakuma et al., 2008; Momose et al., 2009).

Previous studies on measures for controlling measles infections and other diseases have focused on adults and mothers (Takahashi et al., 2009; Khaled et al., 2010; Fernandez et al., 2011; Simiyu et al., 2003; Siddiqi et al., 2010). Takahashi et al. (2009) reported that there are few opportunities for children to learn about infectious diseases and the importance of immunization before university or college, resulting in a low level of awareness in university or college students on these points. Research examining university and college students in other countries has also shown the importance of education about vaccination and the need for disseminating accurate information about vaccinations to students (Khaled et al., 2010). In addition, reports have also pointed out the importance of education for mothers to improve their understanding about vaccinations (Fernandez et al., 2011; Simiyu et al., 2003; Siddiqi et al., 2010). Although there are many reports of previous studies on health education as a measure to prevent infectious diseases (Ijichi et al., 2008; Nakagawa et al., 2008; Yasutake et al., 2006; Yoshida et al., 2007; Ito et al., 2009; Terajima et al., 2009; Ichinohe et al., 2011), few of these studies have focused on high school students and hardly any have examined the effects of measles and rubella health education on this demographic. From these studies, it appears that health education on infections related to measles and other diseases is not specifically carried out as a part of compulsory and secondary school education. The lack of knowledge about measles by mothers and other adults and the need for platforms to provide health education pose significant challenges (Kaneko, 2009).

Controlling infectious diseases and taking measures towards that aim are important challenges in schools, and health education is essential. In G Prefecture, Japan, there were 218 reports of measles infections in 2007, one of the largest outbreaks since 1997-98 (Trend research report on the infectious disease generation of Gunma Prefecture, 2007). Seven students at S high school were infected with measles and there was concern about the disease spreading throughout the school. The purpose of this study was to measure measles and rubella antibody titers in this group of high school students to determine the antibody prevalence rates and analyze the effectiveness of health education related to the prevention of infectious diseases.

2. Methods

2.1. Participants

Participants were 1,155 students (504 males [43.6%], 651 females [56.4%]) attending S high school in G prefecture (681 grade 10, 11, and 12 students in 2008; and 240 grade 10 and 234 grade 11 students in 2010) who attended a health education class about infectious diseases and immunity **(Table 1)**. All students were administered surveys about the basics on infection and the immune system before and after attending the health education class. Grade 10, 11, and 12 students in 2008 and grade 10 students in 2010 (a total of 921 students) were offered measles and rubella antibody titer assessment and analyses

Table 1 Participant attributes

Year	Grade	Enrollment (n = 1,155)	Tested group (n=563)	Untested group (n=358)	Control group (n=234)
		No. of students (%)	No. of students (%)	No. of students (%)	No. of students (%)
2008	10	241 (100)	158 (65.0)	83 (34.4)	0
	11	233 (100)	116 (49.8)	117 (50.2)	0
	12	207 (100)	72 (34.8)	135 (65.2)	0
2010	10	240 (100)	217 (90.4)	23 (9.6)	0
	11	0	0	0	234 (100)

were made for students who requested them. Grade 11 students in 2010 (234 students) were not asked to participate in antibody titer measurements and were used as the control group **(Table 1)**.

2.2. Measles and rubella antibody titer measurement

Antibody titers were measured in 563 students (self-selected from among 921 grade 10, 11, and 12 students in 2008 and grade 10 students in 2010) who requested measles tests and 547 students who requested rubella tests. All 547 students for whom rubella antibody titer measurement was performed also underwent measles antibody titer measurement. In this study, students who had measles or rubella antibody titers measured formed the tested group and 358 students who were not measured formed the untested group.

Blood samples (about 7 ml of venous blood) were taken for measuring antibody titers and centrifuged at 1,600 g for 10 min at 4℃. Measles and rubella antibody titer measurements were conducted by SRL Inc. (Tokyo, Japan). The titers of measles IgG antibody were measured using particle agglutination assays and the titers of rubella antibody were measured using hemagglutination inhibition tests.

Results for measles were considered to be negative if the antibody titer was <16, false-positive if the titer was 16-128, and positive if the titer was ≥128. For rubella, antibody titer <8 was negative.

Written measurement results were given to the participants with instructions on how to interpret the results.

2.3. Health education related to infectious disease

Health education on the basic principles of infection and immunity was given to 1,155 students attending S high school. The contents of the lesson are shown in **(Table 2)**. The lesson for each class was 40 minutes long. Lessons were conducted in lecture format by a teacher in charge of health education at schools. Using the textbook "Health Education" (Takaishi et al., 2007), lectures covered basic knowledge of infectious diseases and prevention **(Table 2)**. After a 40-minute lecture, questions were asked and a questionnaire survey was conducted during summarization of the lecture.

2.4. Surveys

Surveys consisted of the following five questions, which could be answered with either 'Yes' (I know), 'A little' (I know a little), or 'No' (I don't/didn't know).

Q1: Do you know the words "antigen" and "antibody"?
Q2: Do you know what an antibody titer is?
Q3: Do you know how your body's immune system works?
Q4: Do you know that it is important to have antibodies to prevent infectious diseases?
Q5: Do you know that people with low levels of antibodies need a vaccination?

Contents regarding infectious diseases and immunization were investigated based on the textbook "Health Education" (Tanaka et al., 2011; Motokawa et al., 2010; Shiokawa et al., 2011), and question items were created based on the Ministry of Education, Culture, Sports, Science and Technology's educational guidelines for high schools (Ministry of Education, Culture, Sports, Science and Technology, 1999).

In 2008, the first survey (before the education) was given in August. After the survey, students could choose to have their antibody titers measured. The

Table 2 Educational content

Point	Details
(1) What is biological defense?	Living organisms have a biological defense system that prevents foreign substances from invading the body and removes foreign substances that have invaded the body.
(2) What is the immune system?	Bacteria, viruses, and other pathogens enter the bodies of living organisms and cancer cells and other foreign substances are produced within the body. The body has mechanisms for maintaining homeostasis that involve recognizing foreign substances as non-self and removing them from the body. This system of mechanisms is called the immune system.
(3) Cells and organs that make up the immune system	Immunity is achieved in the body by the lymph system. Structures that make up the lymph system include the thymus gland, spleen, lymph nodes, and lymph vessels. These structures have many immune cells that give the body humoral immunity and cellular immunity.
(4) Humoral immune system	The immune system that is responsible for antibodies is called the humoral immune system. In this system, foreign substances that invade the body are recognized as antigens and are removed from the body by the activity of antibodies produced by B cells. Antigens and antibodies bind together in a specific way called an antigen-antibody reaction. Antibodies are made from proteins called immunoglobulins.
(5) How the humoral immune system works	When non-self substances invade the body as antigens, they are carried through lymph vessels to lymph nodes where they are engulfed by macrophages and dendritic cells. If a body has been infected by a pathogen, it often does not become sick the next time the same pathogen invades the body. This is because immune memory cells immediately begin proliferating and differentiating into antibody-producing cells, producing a large number of antibodies.
(6) What is a vaccine?	There is a method for preventing infectious diseases that involves injecting weak pathogens or detoxified toxins into the body as antigens, causing the body to produce antibodies. The antigen used is called a vaccine.
(7) Vaccination (immunization) and titers	Acquired immunity means that a body that has once contracted a disease will remain immune to that disease for a long time. Vaccination (or immunization) is a method that uses this characteristic by injecting pathogens or products of pathogens into the body to artificially acquire immunity, preventing future infections. To check whether a body is immune to a pathogen, we usually check the level of antibodies in a blood test. The antibody level in blood is called the antibody titer.

health education was given in late August, during which the results of antibody titer measurement were given to students in the tested group. The second survey (after the education) was given in September 2008. In 2010, the first survey (before the education) was given in August. After the survey, only grade 10 students could choose to have their antibody titers measured. The health education was given in late August, during which the results of antibody titer measurement were given to the tested group of grade 10 students. The second survey (after the education) was given in September 2010.

2.5. Statistical analysis

SAS JMP software, version 8.0.2 (SAS Institute Inc., Cary, NC, USA), was used for statistical analysis. Cochran-Mantel-Haenszel tests were used to compare the results from the 1,155 students before versus after the health education. Pearson's chi-squared tests were used to compare changes in understanding from before to after the education in the tested, untested, and control groups.

2.6. Ethical considerations

This study was approved by the Epidemiologic Research Ethics Committee of Gunma University Faculty of Medicine (Approved August 4, 2008; approval number 20-11). Informed consent was obtained from all participants and the parents or guardians of the students in this study.

3. Results

3.1. Seroprevalence of measles and rubella antibodies

Measles antibody titers were measured in 563 of 921 students, of which 470 students (83.5%) were positive, 64 students (11.4%) were false positive, and 29 students (5.2%) were negative. Rubella antibody titers were measured in 547 of 921 students, of which 440 students (80.4%) were positive and 107 students (19.6%) were negative **(Table 3)**. Vaccination was recommended to all students who were negative for measles or rubella antibodies, and a vaccination rate of 100% was subsequently achieved.

3.2. Antibody prevalence rate

The overall seroprevalence of measles IgG antibody was 83.5%, which is higher than the national mean for Japan (73.0%) (IDSC, 2009), but lower than the mean for G Prefecture (93.3%) (Nagai et al., 2008). The seroprevalence of rubella antibody was 80.4%, which is lower than both the national mean (87.6%) (IDSC, 2003) and the mean for G Prefecture (84.4%) (Trend research report on the infectious disease generation of Gunma Prefecture, 2007; Nagai et al., 2008) **(Table 3)**.

3.3. Effects of health education

To evaluate the trends for the entire survey, each survey question answer was given a score of either 1 point for 'Yes' or 'A little' or 0 points for 'No.' The sum of the points from Questions 1 to 5 was calculated to give an overall score (maximum 5 points). The mean score for all 1,155 students was 3.38 points before the education and increased 4.29 points after the education (Table 4). The total number of students who scored 0 was 58 (5.0%) before the lesson; following the education, this decreased to 33 (2.9%) students **(Table 4)**. The mean score was then calculated for each group and the degree of increase was evaluated. All groups showed a significant increase in score. The overall mean score increased 1.14 points from 3.44 points before the education to 4.58 points after the education in the tested group. The degree of increase was smaller in the other groups, with the score increasing from 3.38 points to 4.10 points in the untested group and from 3.24 points to 3.88 points in the control group **(Table 4)**.

Table 3 Seroprevalence of measles and rubella antibodies

	No. of students (%)				Antibody seropositivity (%)		
	Participants	Negative	False positive*1	Positive	S High School	Japan	G Prefecture
Measles	563	29 (5.2)	64 (11.4)	470 (83.5)	83.5	73	93.3
Rubella	547	107 (19.6)	—	440 (80.4)	80.4	87.6	84.4

*1 No false positive results for rubella diagnosis

Table 4 Questionnaire results on the effects of the health education

	All students		Tested group (n=563)		Untested group (n=358)		Control group (n=234)	
Score[*1]	Before the education No. of students (%)	After the education No. of students (%)	Before the education (%)	After the education (%)	Before the education (%)	After the education (%)	Before the education (%)	After the education (%)
0	58 (5.0)	33 (2.9)	17 (3.0)	7 (1.2)	27 (7.5)	19 (5.3)	14 (6.0)	7 (3.0)
1	19 (1.7)	12 (1.0)	6 (1.1)	2 (0.4)	7 (2.0)	8 (2.2)	6 (2.5)	2 (0.8)
2	167 (14.5)	63 (5.5)	72 (12.8)	13 (2.3)	49 (13.7)	21 (5.9)	46 (19.7)	29 (12.4)
3	301 (26.1)	96 (8.3)	167 (29.6)	28 (5.0)	83 (23.2)	36 (10.0)	51 (21.8)	32 (13.7)
4	402 (34.8)	227 (19.7)	219 (38.9)	99 (17.6)	104 (29.0)	60 (16.8)	79 (33.8)	68 (29.1)
5	208 (18.0)	724 (62.7)	82 (14.6)	414 (73.5)	88 (24.6)	214 (59.8)	38 (16.2)	96 (41.0)
Total	1,155 (100)	1,155 (100)	563 (100)	563 (100)	358 (100)	358 (100)	234 (100)	234 (100)
Average score	**3.38**	**4.29**	**3.44**	**4.58**	**3.38**	**4.10**	**3.24**	**3.88**
p-value[*2]	<0.0001		<0.0001		<0.0001		0.0006	

[*1] Each survey question answer was given a score of either 1 point for 'Yes' or 'A little' or 0 points for 'No.'
The sum of the points from questions 1 to 5 was calculated to give an overall score (maximum 5 points).
[*2] Cochran-Mantel-Haenszel test

No significant difference between sex was observed.

3.4. Questionnaire on the effects of health education: Effects of health education by question

We evaluated the effects of health education from five questions designed to test knowledge of basic principles of infection and the immune system. Compared to before the education, the proportion of students in the tested group who answered 'Yes' (I know) increased significantly for all questions after the education (p<0.0001) **(Table 5)**. In the untested group, the proportion answering 'Yes' increased, but the degree of increase was smaller than that for the tested group (p<0.0001). The increase in the proportion of students who responded 'Yes' after the lesson was even smaller in the control group than in the untested group, with no difference observed for responses to Question 2. A large increase in the level

Table 5 Effect of health education on each question of the questionnaire

Total n=1,155

	Tested group (n=563)				Untested group (n=358)				Control group (n=234)			
	Before lesson (%)	After lesson (%)	Difference	p-value[*1]	Before lesson (%)	After lesson (%)	Difference	p-value[*1]	Before lesson (%)	After lesson (%)	Difference	p-value[*1]
Q1: Do you know the words antigen and antibody?				<0.0001				<0.0001				<0.0001
Yes	149 (26.5)	382 (67.9)	+41.4		108 (30.2)	194 (54.2)	+24.0		52 (22.2)	61 (26.1)	+3.9	
A little	238 (42.3)	151 (26.8)	-15.5		128 (35.8)	109 (30.5)	-5.3		89 (38.0)	117 (50.0)	+12.0	
No	176 (31.3)	30 (5.3)	-25.9		122 (34.1)	55 (15.4)	-18.7		93 (39.7)	56 (23.9)	-15.8	
Q2: Do you know what an antibody titer is?				<0.0001				<0.0001				0.0783
Yes	17 (3.0)	229 (40.7)	+37.7		30 (8.4)	105 (29.3)	+20.9		5 (2.1)	18 (7.7)	+5.6	
A little	75 (13.3)	216 (38.4)	+25.1		72 (20.1)	123 (34.4)	-14.3		39 (16.7)	84 (35.9)	+19.2	
No	471 (83.7)	118 (21.0)	-62.7		256 (71.5)	130 (36.3)	-35.2		190 (81.2)	132 (56.4)	-24.8	
Q3: Do you know how your body's immune system works?				<0.0001				<0.0001				<0.0001
Yes	88 (15.6)	264 (46.9)	+31.3		71 (19.8)	132 (36.9)	+17.0		26 (11.1)	46 (19.7)	+8.6	
A little	326 (57.9)	242 (43.0)	-14.9		167 (46.7)	148 (41.3)	-5.3		128 (54.7)	138 (59.0)	+4.3	
No	149 (26.5)	57 (10.1)	-16.4		120 (33.5)	78 (21.8)	-11.7		80 (34.2)	50 (21.4)	-12.8	
Q4: Do you know that it is important to have antibodies to prevent infection?				<0.0001				<0.0001				0.0005
Yes	316 (56.1)	417 (74.1)	+17.9		171 (47.8)	206 (57.5)	+9.8		111 (47.4)	121 (51.7)	+4.3	
A little	209 (37.1)	126 (22.4)	-14.7		146 (40.8)	122 (34.1)	-6.7		97 (41.5)	101 (43.2)	+1.7	
No	38 (6.8)	20 (3.6)	-3.2		41 (11.5)	30 (8.4)	-3.1		26 (11.1)	12 (5.1)	-6.0	
Q5: Do you know that people with low levels of antibodies need a vaccination?				0.0019				<0.0001				<0.0001
Yes	356 (63.2)	469 (83.3)	+20.1		194 (54.2)	233 (65.1)	+10.9		120 (51.3)	147 (62.8)	+11.5	
A little	169 (30.0)	82 (14.6)	-15.5		125 (34.9)	96 (26.8)	-8.1		89 (38.0)	75 (32.1)	-5.9	
No	38 (6.8)	12 (2.1)	-4.6		39 (10.9)	29 (8.1)	-2.8		25 (10.7)	12 (5.1)	-5.6	

[*1] Pearson's chi-squared test

of understanding was observed in the tested group while small increases were observed in the untested and control groups **(Table 5)**.

3.5. Increase in understanding of health education according to antibody level measurement

As the survey results indicated that the lesson was effective overall, changes in the level of understanding in each group were evaluated. An increase of one or more steps (from 'No' to 'A little,' from 'A little' to 'Yes,' or from 'No' to 'Yes') was classified as an 'improvement.' The proportion of improvement for question 1 was 56.3% in the measured group, 38.8% in the unmeasured group, and 32.1% in the control group, with significant differences observed between the measured group and unmeasured group and between the measured group and control group.

No significant difference was observed between the unmeasured group and the control group. The same trends were observed for questions 2 and 3, but there were no significant differences between groups for questions 4 and 5 **(Table 6)**.

In the group of students that underwent antibody titer measurement, 563 students underwent measles antibody titer measurement while 547 underwent rubella antibody titer measurement. All students who underwent rubella antibody titer measurement also underwent measles antibody titer measurement. Statistical analysis of the rubella antibody titer measurement group showed more similar results as the measles antibody titer measurement group.

4. Discussion

The World Health Organization's index for measles eradication requires achieving and maintaining at least 95% population immunity. However, the

Table 6 Understanding of health education by antibody titer measurement testing groups

n=1,155

		No. of students	Improvement[*1] n (%)	Risk difference[*2] %	Risk difference[*3] %	Risk difference[*4] %	95% CI %	p-value[*5]
Q1	Tested group	563	317 (56.3)	17.5			11.0-24.0	<0.0001
	Untested group	358	139 (38.8)		24.2		17.0-31.5	<0.0001
	Control group	234	75 (32.1)			6.7	1.1-14.6	0.0934
Q2	Tested group	563	404 (71.7)	23.4			17.1-29.8	<0.0001
	Untested group	358	173 (48.3)		37.1		30.0-44.3	<0.0001
	Control group	234	81 (34.6)			13.7	5.7-21.7	0.001
Q3	Tested group	563	259 (46.0)	11.1			5.1-17.5	0.0009
	Untested group	358	125 (34.9)		14.4		7.1-21.6	0.0002
	Control group	234	74 (31.6)			3.3	-11.0-4.4	0.4071
Q4	Tested group	563	174 (30.9)	5.5			-0.4-11.4	0.0730
	Untested group	358	91 (25.4)		5.3		-1.5-12.0	0.1372
	Control group	234	60 (25.6)			0.2	-6.9-7.4	0.9517
Q5	Tested group	563	163 (29.0)	4.1			-1.7-9.9	0.1745
	Untested group	358	89 (24.9)		2.1		-4.8-8.8	0.5628
	Control group	234	63 (26.9)			2.0	-5.2-9.3	0.5743

[*1] Improvement: Change from 'No' to 'A little,' 'A little' to 'Yes,' or 'No' to 'Yes' from before to after a health education lesson
[*2] Difference between the tested group and the untested group
[*3] Difference between the tested group and the control group
[*4] Difference between the untested group and the control group
[*5] Pearson's chi-squared test

nationwide seroprevalence of measles antibody in Japan was reported to be 73.0% in 2008, which is below the target of ≥95%. The seroprevalence of measles antibody in the present study was also insufficient, at 83.5%. The fact that Japan has a low seroprevalence of measles antibody despite being a developed country may be attributed to the following reason. During the five-year period between 1990 and 1994, the combined measles-rubella vaccine (MR vaccine) was mandatory, but many individuals were vaccinated only once. Because some individuals were unable to acquire immunity through vaccination, or did not receive a vaccination, the seroprevalence was low (Higo et al., 2008). In the US, mandatory vaccination (Baker et al., 2003) is performed upon entering school, but no similar program has been implemented in Japan.

In this study, health education on the basic principles of infection and immunity was given as a part of school health curriculum and the effectiveness of the education was evaluated. One possible reason for the greater increase in the untested group compared to the control group is that the students in the untested group were present during the explanation of the antibody titer measurement results to tested students, which may have improved their understanding.

In the control group, understanding about antibody titers was particularly low among survey questions **(Table 5)**, with 56.4% of students answering 'No' (I don't know) after the health education. It is possible that their understanding on this point was not improved after the education because they did not have the results of the antibody test seroprevalence on hand when listening to the explanation of antibody titers in the class. Regarding changes in the level of understanding for each group, the proportion of improvements was largest for Questions 1 to 3 (30% or higher), with significant differences in the amount of improvement between the tested and untested groups and between the tested and control groups **(Table 6)**. About half of the students in all groups answered 'Yes' (I know) to Questions 4 and 5 before the education, suggesting that they may have already understood these principles well at the start of the study.

In this study, measles and rubella antibodies were measured to evaluate the effects of health education. Students' knowledge of their own measles and rubella antibody titer levels motivated them to be vaccinated or to learn more about vaccination. Therefore, such measurements should be part of methods of health education and the base of their healthy life in future.

A survey assessing knowledge about immunizations in 310 Egyptian university students found that 43.3% of students knew little about the topic, suggesting the need for health education (Khaled et al., 2010). In Japan, previous studies have also suggested the importance of health education (Yasutake et al., 2006; Yoshida et al., 2007).

A survey about the level of awareness concerning measles and other diseases in university students found that half of the students had lost or had not checked their records kept in the maternal and child health handbook and they had a poor understanding about infection and awareness concerning immunizations. Including education about infection and immunity in the regular curriculum has been proposed as a method for promoting accurate understanding in students (Takahashi, et al., 2009). Health education was conducted only once in the present study, so a future issue is to investigate whether scores increase after health education is repeated multiple times.

Another study examining the effects of education aimed at controlling infection reported positive effects on understanding by incorporating risk prediction training into the educational content (Ito et al., 2009). According to these previous studies, improving health education related to infection and immunity is an important challenge. In the present study, understanding was raised by giving en masse health education in a health class for each grade. Many past studies have suggested a lack of understanding about measles, a disease that can be prevented by immunization (Schmitt et al., 2003; Zurayk et al., 1987; Brown, 2009; Tokuda et al., 2010). Regarding the effect of health education seen from overall survey results in the present study, while the number of students scoring 0 dropped from 58 students (5.0%) to 33 students (2.9%), the next challenge entails considering how to increase the knowledge and understanding of students whose level of understanding remains low.

In a study by Siddiqi et al. about vaccinations (Siddiqi et al., 2010), education to mothers and regional health education had an impact on immunization coverage, indicating the importance of health education in the home and in regional community settings. By giving lessons about infection in elementary, junior high, and high schools, students receiving the lessons may understand the importance of immunization by the time they reach adulthood and become parents, leading to an increase in immunization coverage.

The educational guidelines for high schools state that the objectives of health education are "to deepen the understanding of health and safety in personal and social lives and to nurture the qualities and abilities for appropriately managing and improving one's own health throughout life" (The Course of Study for Upper Secondary School, Ministry of Education, Culture, Sports, Science and Technology 1999). The application of antibody titer measurement results, which promote actions for preventing infectious diseases, to health education in the present study was thought to have enabled achievement of part of the objective.

5. Limitations of the present study

The assumed population in the present study consisted of students who attended a school at which students generally achieve average results on standardized tests completed by all public high school students in Japan. Subjects were given the measurement results as feedback. The results showed that students who requested antibody titer measurement had a higher educational effect, indicating that these students had a high health awareness and a certain level of interest or concern in infectious diseases. Therefore, it was considered difficult to determine whether these students had a high educational effect as a result of antibody titer measurement or their educational effect increased because they already had a high awareness of infectious diseases.

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References

Baker CJ, Baltimore RS, Bocchini JA, et al. (2003). State Immunization Requirements for School Attendance. In: Pickering LK ,eds. Red Book: 2003 Report of the Committee on Infectious Diseases. 26th ed. Elk Grove Village, IL: American Academy of Pediatrics: 809.

Brown LR. (2009). Vaccination-knowledge and attitudes of school children. Irish Medical Journal 102: 45-47.

Fernandez R, Rammohan A, Awofeso N. (2011). Correlates of first dose of measles vaccination delivery and uptake in Indonesia. Asian Pacific Journal Tropical Medicine 4: 140-5.

Health, Labour and Welfare Statistics Association. (2011). Journal of Health and Welfare Statistics: 150-151 (in Japanese).

Higo A, Fujii K, Sato Y, et al. (2008). Trends in the immune status for measles in Japanease younger generation, 2002-2006.Campus Health 45: 59-62 (in Japanese).

Infectious Disease Surveillance Center.(2003).Rubella, Japan, 1999-2002. Infectious Agents Surveillance Report 24:53-54 Available at: http://idsc.nih.go.jp/iasr/24/277/tpc277-j.html (in Japanese) Accessed: August, 2011

Infectious Disease Surveillance Center.(2007a). Measles Japan, 2006-2007. Infectious Agents Surveillance Report 28:239-240 Available at: http://idsc.nih.go.jp/iasr/28/331/tpc331-j.html (in Japanese) Accessed: September, 2011

Infectious Disease Surveillance Center.(2007b). Measles elimination plan and future countermeasures in Japan as of August 2007— MHLW. Infectious Agents Surveillance Report 28:260-261 Available at: http://idsc.nih.go.jp/iasr/28/331/dj331d.html (in Japanese) Accessed: September, 2011

Infectious Disease Surveillance Center.(2007c). Countermeasures toward measles elimination in 2012— WHO Western Pacific Regional Office. Infectious Agents Surveillance Report 28:261-262 Available at: http://idsc.nih.go.jp/iasr/28/331/dj331e.html (in Japanese) Accessed: August, 2011

Infectious Disease Surveillance Center.(2009). Measles in Japan, 2008. Infectious Agents Surveillance Report 30:29-30 Available at: http://idsc.nih.go.jp/iasr/30/348/tpc348-j.html (in Japanese) Accessed: September, 2011

Ichinohe S, Ogawa T. (2011). Study of measles history, vaccination, antibody status, and vaccination effectiveness for school teachers. The Journal of Japanese Medical Association 85: 263-267 (in Japanese).

Ijichi S, Kawamura Y, Nagata M, et al. (2008). Measles cases in Kagoshima University 2007 the significance of appropriate clinical decision for infection control on campus. PR Health Science Journal 45: 177-182 (in Japanese).

Inoue M, Shinjo M, Kato N, et al. (2007). High school students'knowledge of vaccination. The Journal of Child Health 66: 638-643 (in Japanese).

Ito K, Hanioka Y, Minehira H. (2009). Effectiveness of safety training before returning to work from maternity leave, concerning to raise awareness about medical safety. Japanese Journal of Occupational Medicine and Traumatology 57: 293-296 (in Japanese).

Kaneko M. (2009). Medical education. School Health Infectious Disease. Keio University Press 678: 56-65 (in Japanese).

Khaled M. Abd Elaziz, Sahar M. Sabbour, Sahar A. Dewedar. (2010). A measles and rubella (MR) catch-up vaccination campaign in an Egyptian University: Vaccine uptake and knowledge and attitudes of students. Vaccine 28: 7563-7568.

Kolbe LJ. (1989). Indicators for Planning and Monitoring School

Health Program. In: Kar SB, eds. Health Promotion Indicators and Actions. Springer Publishing Co. New York: 221-248.
Kishore PV, Palaian S, Paudel R, et al. (2008). Why treat? Better prevent: about immunization. Kathmandu University Medical Journal 6: 122-127.
Lamabadusuriya SP. (1993). Improving child survival through immunization. Ceylon Medical Journal 38: 170-171.
Ministry of Education, Culture, Sports, Science and Technology (MEXT).(1999).The Course of Study for Upper Secondary School. 90-97. (in Japanese)
Momose I, Maluoka R, Nakade Y. (2009). Health education for high school students of peer education-exercise and nutrition. Bulletin of Tenshi College 9; 33-42 (in Japanese).
McQuillan GM, Kruszon-Moran D, Hyde TB, et al. (2007). Seroprevalence of measles antibody in the US population, 1999-2004. Journal Infectious Diseases 196: 1459-1464.
Motokawa T, Tanimoto E, Akasaka K, et al. (2010). Revised BiologyⅡ, 65-68, Keirinkan,Tokyo (in Japanese).
Nakagawa K, Hatta F, Sumi M, et al. (2008). Evaluation of strategies against 2007 outbreak of measles in Ritsumeikan University. Campus Health 45: 227-232 (in Japanese).
Nagai A, Suzuki T, Siobara M, et al. (2008). Gunma epidemiological surveillance of vaccine-preventable diseases, An annual report of Gunma Prefectural Institute of Public Health and Environmental Sciences.41: 70-73 (in Japanese).
Ratnam S, West R, Gadag V, et al. (1996). Immunity against measles in school-aged children: Implications for measles revaccination strategies. Can Journal Public Health 87: 407-10.
Sakuma H, Takahashi H. (2008) .Assesment of the effects of health instruction on the cultivation of cognitive skills-examination of descriptions in the field of sex and the self-management skill. (2008) Japanese Journal of School Health 50; 175-185 (in Japanese).
Schmitt HJ, Booy R, Weil-Olivier C, et al. (2003). Child vaccination policies in Europe a report from the summits of independent European vaccination experts. Lancet Infect Diseases 3: 103-108.
Shiokawa K, Nakamura T, Matumoto T, et al. (2011). Revised High School BiologyⅡ, 58-66, Suukennsyuppan, Tokyo (in Japanese).
Sunagawa T, Shimada T, Ueno-Yamamoto K, et al. (2008). Progress toward Measles Elimination --- Japan, 1999--2008. MMWR 57: 1049-1052.
Simiyu DE, Wafula EM, Nduati RW. (2003) .Mothers' knowledge, attitudes and practices regarding acute respiratory infections in children in Baringo District, Kenya. East African Medical Journal 80: 303-307.
Siddiqi N, Siddiqi AE, Nisar N, et al. (2010). Mothers' knowledge about EPI and its relation with age-appropriate vaccination of infants in peri-urban Karachi. Journal Pak Medical Association 60: 940.
Takahashi K, Yasuda T, Yamaguchi M, et al. (2009). Measures against an outbreak of five vaccine-preventable infectious diseases, What can be now conducted in universities. PR Health Science Journal 46: 93-99 (in Japanese).
Terajima T, Takemura T, Maezawa K, et al. (2009). Educational effect of handwashing for pharmacy students in pre-clinical pharmacy practice. The Journal of the Japanese Society of Environmental Infections 24: 425-431 (in Japanese).
Tokuda K, Ikarashi M, Yamamoto KU, et al. (2010). A high school measles outbreak--control measures and vaccine efficacy. The Journal of the Japanese Association for Infectious Diseases 84: 714-720.
Trend research report on the infectious disease generation of Gunma Prefecture. (2007). Gunma Prefectural Institute of Public Health and Environmental Sciences: 44-45. (in Japanese).
Takaishi M, Suzuki S, Watou M, et al. (2007). The Latest Health and Physical Education. 32-33, Taisyuukansyoten,Tokyo (in Japanese).
Tanaka R, Tanaka A, Konishi K, et al. (2011). Revised BiologyⅡ,121-130, Daiichigakusyuusya,Tokyo (in Japanese).
World Health Organization (WHO).(2009). Global elimination of measles. EXECUTIVE BOARD 125th Session Provisional agenda item 5.1.
World Health Organization WHO/UNICEF.(2010). WHO/UNICEF Joint Statement: Global Plan for Reducing Measles Mortality 2006-2010. (http://www.who.int/immunization_delivery/adc/measles/Measles%20Global%20Plan_Eng.pdf).
Yasutake S, Kuramoto M, Matsuura Y, et al. (2006). An investigation on the development of a new system of health education on life and sex for pupils in cooperation with the community health staff. J of the Faculty of Health and Welfare 6: 83-90 (in Japanese).
Yoshida N, Tsumura N, Toyomasu K, et al. (2007). Antibody titers against measles, rubella, mumps and varicella-zoster viruses in medical students. The Journal of Occupational Health 49: 21-26 (in Japanese).
Zurayk H, Halabi S, Deeb M. (1987). Measures of social class based on education for use in health studies in developing countries. Journal Epidemiology Community Health 41: 173-179.

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