Clinical Medicine

Knowledge and Attitudes toward Vaccination in Croatian Adolescents, the Influence of the Internet

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Abstract

Objective – The aim of the study was to assess the knowledge and attitudes toward vaccination among Croatian high school students and to investigate influence of internet and social networks on the reported knowledge and attitudes. **Materials and Methods** – A convenient sample of 1012 adolescents aged 17 to 19 years was included in the study. Data regarding sociodemographic factors, habits of informing oneself regarding the health status, vaccination and vaccines and knowledge of and attitudes toward vaccination were collected. **Results** – The study showed that Croatian adolescents most often obtained information regarding vaccination from the internet, although they reported health professionals to be the most reliable source. Adolescents reported poor knowledge about vaccination. Better knowledge was reported by adolescents who inform themselves about vaccination through scientific literature or school teachers than those who use the internet and social contacts. Results showed that the negative attitude toward vaccination was associated with the internet as the source of information, female gender and poor knowledge about vaccination. **Conclusion** – Adolescent mostly get information about vaccination on the internet as the easiest accessible source. Efforts should be made to make relevant sources of information more available to adolescents since good knowledge correlates with positive attitude toward vaccination.

Key Words: Vaccination ▪ Knowledge ▪ Attitudes ▪ Adolescents ▪ Internet.

Introduction

In the 2019, the World Health Organization included vaccine hesitancy among ten threats to global health. Vaccine hesitancy is the reluctance or refusal to get vaccinated despite the availability of vaccines that threatens to interfere with the progress made in controlling vaccine-preventable diseases (1, 2). Although vaccines proved to be extremely useful in shaping our future and health, the reasons for vaccination hesitancy are multiple. The most common barriers to vaccination are lack of education and information about the vaccine, and attitudes of adolescents, parents and providers toward vaccination

(3, 4). A recent review showed that the main reasons for vaccine hesitancy among adolescents were lack of information and concerns about side-effects (2). Research also found the internet to be associated with the mistrust regarding vaccines (5).

Internet has become an important part of life of adolescents and their main means of obtaining and processing information. More than 90% of youth regularly use the internet in USA and EU (6, 7). The development of social networks allowed the worldwide interconnection of internet users. The most common social networks nowadays have billions of interconnected users: for example, Facebook has

2.7 billion of monthly active users, which is little less than 30% of global population and makes it the greatest social network in the world (8-10). The X, formerly known as Twitter, had 187 million of active users in 2021. The Instagram has around 1 billion users, most of them being between 18 and 34 years old. The TikTok has about 689 million active users worldwide (8, 10).

According to the annual Digital News Report of Reuters Institute for 2020, 92% of Croatian population used the internet. In the period from 2017 to 2020, the use of personal computers for the internet access decreased from 72% to 65%, while the use of mobile phones increased from 64% to 78%. Furthermore, in the same period, 88% of Croatian population read the news online, 76% watched television, 55% read newspapers, while 36% read news using social networks. Leading social network in Croatia is the Facebook, where 55% of participants follows news (11). In the period from 2018 to 2021, the number of Facebook users in Croatia increased to 2.3. million, and 65% are younger than 35 (10). More than 75% of youth in Europe use the internet to search health topics. Despite educational possibilities, the internet might have a negative influence by spreading incorrect information about vaccination (6).

Vaccination is a major component of adolescent primary healthcare, but adolescent vaccination rates are lower than childhood ones (2, 4). Research related to adolescents' knowledge and attitudes toward vaccination is scarce (2, 7, 12) and mostly associated with specific vaccines such as human papilloma virus vaccine (HPV) (2, 7,13-16) or meningococcal vaccine (17). Vaccination coverage in Croatia is relatively high for mandatory vaccines such as Measles- Mumps- Rubella vaccine (MMR) or Diphtheria-Tetanus-Pertussis vaccine (DTP). For example, in 2021, MMR coverage was 89.3%, and ranged from 68.1% in Dubrovnik-Neretva County to 96.6% in Krapina-Zagorje County. In 2021, DTP coverage was 92.1%, and ranged from 76.8% in Dubrovnik-Neretva County to 98.0% in Bjelovar-Bilogora County (18).

Understanding the attitudes associated with vaccine hesitancy enables prediction of vaccination behavior and development of public health interventions for achieving higher vaccination coverage (19). A recent systematic review concluded that further studies are needed to investigate adolescents' understanding of vaccines and their access to vaccine information using digital media (7).

Therefore, the aim of the study was to determine the knowledge and attitudes about vaccination among high school students in Croatia, and to investigate the association of the internet and social networks with those attitudes and knowledge.

Methods

Subjects

The study was cross-sectional and was conducted in the period from March to April of 2021. The study included a convenient sample of 1012 high school students attending third and fourth grades in two Croatian Counties, Varaždin and Bjelovar-Bilogora in the northwestern part of Croatia, which have above average vaccine uptake in population. In 2021, Varaždin County had MMR and DTP coverage of 94.3% and 94.8% respectively, while Bjelovar-Bilogora County had MMR and DTP coverage of 93.5% and 98.0% respectively (18). The ethical approval was obtained from the Ethical Committee of the Faculty of Medicine Osijek at the Josip Juraj Strossmayer University of Osijek. Third-grade high school students in Croatian education system are aged 17 to 18 years, while fourth-grade high school students are aged 18 to 19 years. An informed consent was obtained from adult-aged students or from parents/guardians of underage students willing to participate.

Measures

Due to COVID-19 lockdown measures the participants completed an online questionnaire on the Google Forms platform. The questionnaire was used to collect data regarding sociodemographic factors, habits of internet and social network use, habits of informing oneself about health and vaccination, attitudes toward vaccination and

knowledge about vaccination. Sociodemographic data included age, sex, type of high school, duration of education and the place of education. Habits of internet and social network use, habits of obtaining information regarding health and vaccination were determined using questions with 5-point Likert scale answers. Knowledge about vaccination and vaccines was determined using 12 statements that had to be answered with "correct" or "incorrect". The attitudes toward vaccination were determined using 5 closed-ended questions and by using the Vaccination Attitudes Examination (VAX) scale (19). Higher score in VAX scale presents negative attitude toward vaccination (19). The VAX scale has been found to be short, simple, reliable and associated with vaccination behaviors and intentions (19).

Statistical Analysis

Normality of the data distribution was tested with the Kolmogorov-Smirnov test. Categorical data were presented using absolute and relative frequencies. Differences in categorical variables were tested using χ^2-test. Differences in numerical variables between two independent groups were tested using Mann-Whitney U test, and between three or more groups by using Kruskal Wallis test. Spearman's correlation coefficient was calculated to test the correlation between the knowledge about vaccination and the attitudes toward vaccination in the studied population. All P values were two-sided. The level of statistical significance was set at α = 0.05. All statistical analyses were run in IBM SPSS Statistical Package, version 22.0 (SPSS Inc., Chicago, IL, USA).

Results

Demographic data are presented in Table 1.

A total of 1012 high school students participated in the study, 716 (70.8%) were females. The median age of the participants was 17.0 (interquartile range 17.0–18.0) years. Social networks were used often or consistently by 17.9% of adolescents

Table 1. Demographics of Study Participants	
Demographic data	N (%)
Gender	
Boys	296 (29.2)
Girls	716 (70.8)
Age	
17	518 (51.2)
18	455 (45.0)
19	39 (3.9)
Type of high school	
Grammar school	260 (25.7)
Vocational school	751 (74.2)
Art school	1 (0.1)
Duration of high school education	
Three years	151 (14.9)
Four years	727 (71.8)
Five years	134 (13.2)
County of education	
Bjelovar-Bilogora	329 (32.5)
Varaždin	683 (67.5)
Total	1012 (100)

in order to inform themselves about their health or health status, while 24.0% did so occasionally or consistently to acquire information about vaccination and vaccines. Only 26.7% of adolescents often or consistently double check information obtained on the internet or social networks that are related to health status by using relevant sources of information. Half of the adolescents (50.9%) reported that they can often or consistently differentiate correct and incorrect information regarding vaccination and vaccines obtained on the internet or social networks (Table 2).

According to gender, girls used social networks more often than boys to inform themselves about their health or health status (Mann-Whitney U test, P=0.003), and they, more often than boys, double checked information obtained on the internet or social networks that were related to health status by using relevant sources of information (Mann-Whitney U test, P=0.002). Boys more often reported that they could differentiate correct and

incorrect information regarding vaccination and vaccines obtained on the internet and social networks (Mann-Whitney U test, P=0.004) (Table 3).

The participants most often obtained information on vaccination from the internet (39.2%), followed by family/relatives/neighbors (35.2%) and scientific literature/school teachers (25.6%). There was no difference with regard to gender (χ^2-test, P=0.210) (Table 4).

The importance of different sources of information regarding vaccination is presented in Table 5.

The most important source of information reported by the adolescents were healthcare professionals (28.0%), internet and social networks (25.5%), medical literature (21.6%) and family and friends (21.1%). As the least important source of information regarding vaccination, adolescents reported daily newspapers and magazines (45.0%). The internet was reported as the most important source of information regarding vaccination by 9.7% of adolescents and as the least important source of information by the 16.6% of adolescents.

Table 2. Habits of Informing Oneself regarding Health Status, Vaccination and Vaccines

Adolescents' habits	N (%)					
	Never	Rarely	Sometimes	Often	Consistently	Total
Do you inform yourself using social networks about your health or health status?	166 (16.4)	234 (23.1)	430 (42.5)	132 (13.0)	50 (4.9)	1012 (100)
Do you inform yourself using social networks about vaccination and vaccines?	408 (40.3)	362 (35.8)	210 (20.8)	0	32 (3.2)	1012 (100)
I double check information from the internet/social networks regarding health status using relevant sources	200 (19.8)	213 (21.0)	329 (32.5)	179 (17.7)	91 (9.0)	1012 (100)
I can differentiate correct and incorrect information regarding vaccination and vaccines obtained on the internet/social networks	96 (9.5)	89 (8.8)	312 (30.8)	337 (33.3)	178 (17.6)	1012 (100)

Table 3. Habits of Informing Oneself regarding Health Status, Vaccination and Vaccines with Regard to Gender

Adolescents' habits	Median (Interquartile range)			P*
	Boys	Girls	Total	
Do you inform yourself using social networks about your health or health status?	2 (2-3)	3 (2-3)	3 (2-3)	0.003
Do you inform yourself using social networks about vaccination and vaccines?	2 (1-3)	2 (1-2)	2 (1-2)	0.252
I double check information from the internet/social networks regarding health status using relevant sources	2 (1-3)	3 (2-4)	3 (2-4)	0.002
I can differentiate correct and incorrect information regarding vaccination and vaccines obtained on the internet/social networks	4 (3-)	3 (3-4)	4 (3-4)	0.004

*Mann-Whitney U test.

Table 4. The Most Common Source of Information Regarding Vaccination

Source of information	N (%)			P*
	Boys	Girls	Total	
Family/relatives/neighbors	93 (31.4)	263 (36.7)	356 (35.2)	
Scientific literature/school teachers	76 (25.7)	183 (25.6)	259 (25.6)	0.210
Internet/blogs/social networks	127 (42.9)	270 (37.7)	397 (39.2)	
Total	296 (100)	716 (100)	1012 (100)	

*χ^2-test.

Table 5. The Level of Importance of Different Sources of Information about Vaccination

Source of information	N (%)					Total
	1	2	3	4	5	
Television/radio	73 (7.2)	163 (16.1)	353 (34.9)	262 (25.9)	161 (15.9)	1012 (100)
Scientific literature	379 (37.5)	162 (16.0)	163 (16.1)	149 (14.7)	159 (15.7)	1012 (100)
Medical books	385 (38.0)	133 (13.1)	147 (14.5)	128 (12.6)	219 (21.6)	1012 (100)
Healthcare professionals	157 (15.5)	122 (12.1)	194 (19.2)	256 (25.3)	283 (28.0)	1012 (100)
Public health institutions	201 (19.9)	136 (13.4)	216 (21.3)	253 (25.0)	206 (20.4)	1012 (100)
Internet	168 (16.6)	279 (27.6)	314 (31.0)	153 (15.1)	98 (9.7)	1012 (100)
Family and friends	56 (5.5)	114 (11.3)	329 (32.5)	299 (29.5)	214 (21.1)	1012 (100)
School lectures/seminars	161 (15.9)	146 (14.4)	277 (27.4)	273 (27.0)	155 (15.3)	1012 (100)
Magazines	455 (45.0)	260 (25.7)	222 (21.9)	60 (5.9)	15 (1.5)	1012 (100)
Social networks	126 (12.5)	206 (20.4)	327 (32.3)	193 (19.1)	160 (15.8)	1012 (100)

Social networks were reported as the most important source of information regarding vaccination by 15.8%, and as the least important source by the 12.5% of adolescents.

According to gender, girls, more than boys, preferred the information gathered from the scientific literature (Mann-Whitney U test, P=0.004), medical books (Mann-Whitney U test, P<0.001), healthcare professionals (Mann-Whitney U test, P<0.001), public health institutions (Mann-Whitney U test, P<0.001) and school lectures/seminars (Mann-Whitney U test, P<0.001) as a source of

information about vaccination. The internet, social networks, television/radio and family and friends were similarly important to both genders (Table 6).

Self-assessment of knowledge regarding vaccination and vaccines is presented in Table 7. Sufficient knowledge was reported by 33.9% of participants, good knowledge by 27.3% and very good knowledge by 12.3%. Girls reported higher self-assessment scores of knowledge regarding vaccination than boys (χ^2-test, P=0.012).

Knowledge about vaccination and vaccines obtained in the study is presented in Table 8.

The best knowledge was reported for the following statements: 92.9% of adolescents knew that the statement "vaccines are 100% efficient" is incorrect; 73.9% of the adolescents knew that the

Table 6. The Importance of Different Sources of Information about Vaccination with Regard to Gender

Source of information	Median (Interquartile range)			P*
	Boys	Girls	Total	
Television/radio	3 (3-4)	3 (3-4)	3 (3-4)	0.392
Scientific literature	2 (1-3)	3 (1-4)	2 (1-4)	0.004
Medical books	1 (1-4)	3 (1-4)	2 (1-4)	<0.001
Healthcare professionals	3 (2-4)	4 (3-5)	4 (2-5)	<0.001
Public health institutions	2 (1-4)	3 (2-4)	3 (2-4)	<0.001
Internet	3 (2-4)	3 (2-3)	3 (2-3)	0.931
Family and friends	3 (3-4)	4 (3-4)	4 (3-4)	0.154
School lectures/seminars	2 (2-)	3 (2-4)	3 (2-4)	0.001
Magazines	1 (1-3)	2 (1-3)	2 (1-3)	0.100
Social networks	3 (2-4)	3 (2-4)	3 (2-4)	0.232

*Mann-Whitney U test.

Table 7. Self-Assessment of Knowledge about Vaccination and Vaccines with Regard to Gender

Self-assessment of ones' knowledge	N (%)			P*
	Boys	Girls	Total	
Cannot assess	43 (14.5)	101 (14.1)	144 (14.2)	
Insufficient	40 (13.5)	84 (11.7)	124 (12.3)	
Sufficient	84 (28.4)	259 (36.2)	343 (33.9)	0.012
Good	78 (26.4)	198 (27.7)	276 (27.3)	
Very good	51 (17.2)	74 (10.3)	125 (12.4)	
Total	296 (100)	716 (100)	1012 (100)	-

*χ^2-test

Table 8. Knowledge about Vaccination and Vaccines

Statements	N (%)		
	Incorrect	Correct	Total
Vaccination as a protection from viral diseases was first applied by English doctor Edward Jenner	428 (42.3)	584 (57.7)*	1012 (100)
Vaccination can be done using attenuated or dead causative agent	455 (45.0)	557 (55.0)*	1012 (100)
Vaccination can prevent diseases	264 (26.1)	748 (73.9)*	1012 (100)
Autism is an adverse reaction to vaccination	725 (71.6)*	287 (28.4)	1012 (100)
Polyvalent vaccines contain several serotypes of one causative agent	417 (41.2)	595 (58.8)*	1012 (100)
Administration of several vaccines at once increases the risk of side-effects and can overload the immune system	198(19.6)*	814 (80.4)	1012 (100)
Vaccination is the biggest medical achievement of the 20th century	405 (40.0)	607 (60.0)*	1012 (100)
Vaccines are 100% effective	940 (92.9)*	72 (7.1)	1012 (100)
High uptake of vaccination in the population is important, even for diseases that appear to be eradicated in Croatia	453 (44.8)	559 (55.2)*	1012 (100)
Vaccination produces only individual protection/immunity	431 (42.6)	581 (57.4)	1012 (100)
There is no need for vaccination against diseases that appear to be eradicated in a specific area	627 (42.0)*	385 (38.0)	1012 (100)
Vaccination increases the risk of autoimmune diseases	492 (48.6)*	520 (51.4)	1012 (100)

*Correct answer.

Table 9. Correct Answers about Vaccination and Vaccines with Regard to the Source of Information Used

Statements	Median (Interquartile range)				P*
	Family, relatives, neighbors	Scientific literature, school, teachers	Internet (blogs, social networks)	Total	
Number of correct answers	7 (6 – 8)	8 (6 – 9)	7 (6 – 8)	7 (6 – 8)	<0.001

*Kruskal-Wallis test.

statement "vaccination can prevent diseases" was correct; 71.6% of adolescents knew that the statement "autism is an adverse reaction to the vaccine" is incorrect. Most of the correct answers were in the range between 6 and 8 out of 12, and were reported by 57.3% of the participants. The median number of correct answers was 7, range 2 to 12. Significantly higher number of correct answers were given by participants who got informed through scientific literature or school teachers (Kruskal Wallis test, P<0.001) than those who got their information on the internet or from social contacts (Table 9).

Knowledge about vaccination with regard to the source of information used is presented in Table 10. Participants who rely on scientific literature or school teachers for information on immunization performed better on the questions about attenuated or inactivated viral vaccines (χ^2-test, P=0.021),

prevention of diseases using vaccination (χ^2-test, P=0.004), and the need for continuing immunization against diseases that appear to be eradicated (χ^2-test, P=0.032) than adolescents who inform themselves using internet or family/relatives/neighbors. Adolescents who inform themselves using internet reported poorer knowledge about vaccination and the risk of autoimmune diseases (χ^2-test, P=0.020) than adolescents that inform themselves using science literature/school teachers or family/relatives/neighbors.

Attitudes of the students toward vaccination are presented in Table 11.

Only 21.0% of the adolescents felt that vaccination is necessary in order to prevent diseases, 12.4% thought that vaccination is unnecessary, 13.8% thought that vaccination is harmful due to side-effects, 10.3% found themselves not enough

Statements	N (%)				P*
	Family, relatives, neighbors	Scientific literature, school, teachers	Internet (blogs, social networks)	Total	
Vaccination as a protection from viral diseases was first applied by English doctor Edward Jenner	203 (57.0)	158 (61.0)	223 (56.2)	584 (57.7)	0.490
Vaccination can be done using attenuated or dead causative agent	188 (52.8)	162 (62.5)	207 (52.1)	557 (55.0)	0.021
Vaccination can prevent diseases	246 (69.1)	210 (81.1)	292 (73.6)	748 (73.9)	0.004
Autism is an adverse reaction to vaccination	240 (67.4)	192 (74.1)	293 (73.8)	725 (71.6)	0.090
Polyvalent vaccines contain several serotypes of one causative agent	193 (54.2)	165 (63.7)	237 (59.7)	595 (58.8)	0.060
Administration of several vaccines at once increases the risk of side-effects and can overload the immune system	64 (18.0)	55 (21.2)	79 (19.9)	198 (19.6)	0.590
Vaccination is the biggest medical achievement of the 20th century	215 (60.4)	164 (63.3)	228 (57.4)	607 (60.0)	0.320
Vaccines are 100% effective	331 (93.0)	238 (91.9)	371 (93.5)	940 (92.9)	0.750
High uptake of vaccination in the population is important, even for diseases that appear to be eradicated in Croatia	198 (55.6)	147 (56.8)	214 (53.9)	559 (55.2)	0.760
Vaccination produces only individual protection/ immunity	154 (43.3)	107 (41.3)	170 (42.8)	431 (42.6)	0.880
There is no need for vaccination against diseases that appear to be eradicated in a specific area	212 (59.6)	178 (68.7)	237 (59.7)	627 (62.0)	0.032
Vaccination increases the risk of autoimmune diseases	190 (53.4)	130 (50.2)	172 (43.3)	492 (48.6)	0.020

Table 10. Distribution of Correct Answers with Regard to the Source of Information Used

*χ^2-test

informed about vaccination and 42.5% had neither positive nor negative attitude toward vaccination. The reasons given for the negative attitude toward vaccination were complications after vaccination (23.4%), risk/benefit ratio (21.6%) and the belief that vaccination has no effect (9.4%). Most of the adolescents (76.6%) felt that vaccination should be a matter of choice, 10.4% felt that vaccination should be mandatory and 13.0% had no opinion regarding mandatory vaccination. A sizeable number of participants (43.4%) felt that pharmaceutical companies extract the greatest benefit from vaccination, followed by community (25.4%), government (23.0%) and doctors (8.2%). Most (57.3%) reported that the vaccination rate would decrease if vaccination became non-mandatory, 35.9% reported that the vaccination coverage would not change, and 6.8% thought that this would increase vaccination acceptance (Table 11).

Significant differences in the attitudes toward vaccination were found based on different sources of information regarding vaccination (Table 11). Participants who use internet to get their information on vaccination, found vaccination significantly more often unnecessary and harmful (χ^2-test, P<0.001), ineffective and with of increased risk/benefit ratio (χ^2-test, P<0.001). They also felt that vaccination should be non-mandatory (χ^2-test, P=0.041), and that the pharmaceutical companies and the government extract financial benefit from the vaccination (χ^2-test, P=0.023). On the other hand, participants who use scientific literature and school teachers to inform themselves on immunization tended to maintain a positive attitude toward vaccination, support mandatory vaccination and feel that the community benefited from the vaccination.

The median VAX scale score was 50.0 (interquartile range 43.0-59.0). Female participants had

Gender	VAX scale total	
	Median (Interquartile range)	P[*]
Boys	48.00 (41.00-58.00)	0.001
Girls	50.00 (43.00-59.00)	

Table 12. Attitudes towards Vaccination in the Croatian Adolescent Population Measured by VAX Scale according to Gender

[*]Mann-Whitney U test.

more negative attitudes toward vaccination (Mann-Whitney U test, P=0.001) (Table 12).

There was a positive correlation between poor knowledge and more negative attitudes toward vaccination in the studied population (P<0.001; rs=0.260).

Discussion

The study revealed that around a quarter of adolescents used internet or social networks to inform themselves about vaccination and vaccines and double check the obtained information. Half of the participants reported that they could differentiate between correct and incorrect information obtained on the internet. Female adolescents used social networks more often than males to obtain information regarding their health status and more often double-checked information. More male adolescents reported to be able to differentiate between correct and incorrect information than females. In this study the proportion of adolescents who sought health information on the internet was similar to the results of the EU Kids Online 2020 survey from 19 countries that investigated digital habits of children. This survey revealed that Croatian high school students spent significant time online, with 76.8% of them having social network profile and 16.9% of them searched for health information online (20). It is necessary to become aware that adolescents are not only passively highly exposed to, but also intentionally seek healthcare information on the internet (7).

This study revealed that adolescents most often obtained information regarding vaccination by using the internet. However, when self-assessing the importance of different sources of information regarding vaccination, the highest number of adolescents reported healthcare professionals as the most important source of information. The second most important source were public health institutions, medical books, and family and friends. This study confirms what was earlier established in a recent systematic review (2).

However, medical sources of information were not the ones that adolescents used most. The reason for this might be that the healthcare professionals, public health institutions and medical literature are not as easily accessible as sources such as internet and social networks (2) or family and friends. Generation Z (born between late 1990s and early 2010s) uses internet as the preferred main source of information compared to older generations X and Y (21). They largely rely on smartphones to instantly connect and roam through the cyberspace. Searching the internet for health information is more convenient and easier than consulting a health professional or reading medical literature, especially for adolescents (6). Other studies also found adolescents mostly acquiring information regarding vaccination on the internet (16). However, some studies came out with opposite results (12), especially when specific vaccinations were investigated: HPV (13) and meningococcus (17).

Furthermore, some research showed that even medical students preferred social networks to official health websites (6). The imposing availability of the internet and the information gained online are fueling the efforts to adjust educational material and teaching process to this generation (22-24). Also, efforts are needed to make healthcare professionals more available for communicating and promoting vaccination (25, 26). In a recent study conducted among Croatian medical doctors who participated in the vaccination program it became evident that the process of communication with individual people was often based on the very elaborate categorizations of clients based on previous experience, which lead to prioritizing and a communication breakup when dealing with so called "problematic individuals" not inclined

to vaccination (27). In such circumstances medical doctors found themselves in a delicate situation where a fine balance between time-consuming communication with patients and the demands for maintaining satisfying vaccination uptake was needed. This study further explained that this situation arose from the social roles conflict, which was embedded in wider social values and expectations, especially within the social context of the declining trust in the medical profession and science in general. Addressing communication issues in the doctor's office alone is insufficient. To enhance immunization outcomes, it is crucial to tackle the underlying social forces contributing to trust deficiencies (27). Furthermore, health professionals should contribute to public health promotion and education by participating in creating and editing of health-related web-pages (6).

Family, relatives and neighbors were the second most commonly used source of information in this study, but they might not be reliable since other research found that parents also used internet and social networks as the source of information regarding vaccination and vaccines (28,29). One Croatian study of parents' attitudes and knowledge about vaccination found that 51.3% used online media, 63.8% used internet portals and 49% used internet forums as a source of information. Internet portals were the most important source of information regarding vaccination for 23.2% of the parents (30). A recent systematic review of HPV vaccination revealed that the source of information is critical in creating a positive attitude toward vaccination, where a reliable source provides balanced and understandable scientific information needed for well-informed decisions (15).

In this study, adolescents' self-assessment showed that they were confident of their knowledge of vaccination and vaccines. Also, females self-assessed their knowledge regarding vaccination superior to males. However, other research found adolescents feeling not enough informed about vaccination and willing to gain more information (6). Despite confident self-assessment, the presented knowledge was not accordingly high, with a median of 7 out of the possible 12 correct answers. Several studies also showed that adolescents often had limited knowledge about vaccines and vaccine-preventable diseases (7, 12, 14, 17). Better knowledge was found among adolescents who informed themselves through scientific literature and school teachers than among those who used the internet and social contacts, but discordant results were also seen (13). Several studies found better knowledge among adolescents who informed themselves from healthcare professionals (12-14, 17), which highlights the importance of reliable sources of information.

This study revealed rather negative attitudes toward vaccination and vaccines among high school students. Only 21.0% of the adolescents reported positive attitude. Most of them (76.6%) felt that vaccination should not be mandatory and only 25.4% reported that the community reaped the most advantages from the vaccination. Negative attitude toward vaccination was associated with the internet as the source of information. Adolescents who informed themselves using scientific literature or school teachers tended to have a positive attitude to mandatory vaccination and vaccination in general. Results of other studies are not unanimous on these questions: negative attitudes may be associated with getting health information online (19), but the internet can also exert a positive influence (13).

The VAX scale from this study showed that female adolescents had more negative attitude toward vaccination, in line with other research (17), but some authors found the opposite (2). The correlation was determined between poor knowledge and negative attitudes, which is similar to previous research (2).

This research was not without limitations. Considering the fact that this study used a convenient sample of adolescents from two Croatian counties (out of a total of 21 counties), the obtained results should be interpreted with caution because the study sample might not be representative for all adolescents in Croatia. Therefore, further research should include adolescents from different parts of the country. However, this study

provides valuable information regarding the knowledge and attitudes toward vaccination in Croatian adolescents, especially in relation to internet as a source of knowledge and a significant factor that shapes their attitudes toward vaccination, which is highly important in the context of successful combat against anti-vaccination movements within the society.

Conclusion

The present study reports poor knowledge and predominantly negative attitudes toward vaccination and vaccines among high school students in northwestern Croatia. The study revealed that the adolescents preferred using easily accessible sources of information regarding the vaccination (internet, social contacts) to the more relevant ones (scientific literature, school teachers, medical professionals) despite being aware of the difference. We can hypothesize on the reasons why adolescents dwelling on the internet do not browse scientific literature or web-pages relevant to the evidence-based knowledge on immunization, it may be that these scientific websites are not adolescent-friendly. Efforts should be made to make relevant sources of information, such as health professionals and public health institutions, more available to adolescents since good knowledge correlated with a positive attitude toward vaccination. Health promotion in adolescents is important as they form the future social base of the society and number 1.2 billion worldwide (6). A good insight into adolescents' specific needs and their understanding of disease and disease prevention is necessary to adapt vaccination strategies for this population subgroup. Public health initiatives specifically tailored for adolescents are essential to successfully address the observed negative indicators. Following some positive examples from other countries, public health authorities should use the internet to involve adolescents in health promotion programs (6). Fostering positive attitudes and enhancing adolescents' knowledge about vaccination are vital prerequisites for achieving targeted vaccination coverage and effectively countering anti-vaccination sentiments within the broader society. The approaches toward improving motivations of all generations toward immunization need to be reevaluated.

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Supplementari Material

Questionnaire

Please answer to the following questions.				
How old are you?				
a) 17 yrs		b) 18 yrs		c) 19 yrs
What is your gender?				
Female			Male	
What type of high school do you attend?				
Grammar school		Vocational school		Art school
4. How many grades does your high school have?				
Three		Four		Five
What is your county?				
Varaždin			Bjelovar–bilogora	
Do you inform yourself using social networks about your health or health status?				
Consistently	Often	Sometimes	Rarely	Never
Do you inform yourself using social networks about vaccination and vaccines?				
Consistently	Often	Sometimes	Rarely	Never
I double check information from the internet/social networks regarding health status by using relevant sources				
Consistently	Often	Sometimes	Rarely	Never
I can differentiate correct and incorrect information regarding vaccination and vaccines obtained on the internet/social networks.				
Consistently	Often	Sometimes	Rarely	Never
The most common source of information regarding vaccination I obtain from				
Family/relatives	Neighbors	Scientific literature	School teachers	Internet (blogs, social networks)
Please mark the level of importance of different sources of information about vaccination (bigger number means higher importance)				
Television/radio 1 2 3 4 5	Scientific literature 1 2 3 4 5	Medical books 1 2 3 4 5	Healthcare professionals 1 2 3 4 5	Public health institutions 1 2 3 4 5
Internet 1 2 3 4 5	Family and friends 1 2 3 4 5	School lectures/ seminars 1 2 3 4 5	Magazines 1 2 3 4 5	Social networks 1 2 3 4 5
Please self-assess your knowledge about vaccination and vaccines				
Very good	Good	Sufficient	Insufficient	Cannot assess
Knowledge about vaccination and vaccines				
Please mark the following statements as correct or incorrect				
Vaccination as a protection from viral diseases was first applied by English doctor Edward Jenner				CORRECT / INCORRECT
Vaccination can be done using attenuated or dead causative agent				CORRECT / INCORRECT
Vaccination can prevent diseases				CORRECT / INCORRECT
Autism is an adverse reaction to vaccination				CORRECT / INCORRECT
Polyvalent vaccines contain several serotypes of one causative agent				CORRECT/INCORRECT
Administration of several vaccines at once increases the risk of side-effects and can overload the immune system				CORRECT / INCORRECT
Vaccination is the biggest medical achievement of the 20th century				CORRECT/ INCORRECT

Vaccines are 100% effective				CORRECT/INCORRECT
High uptake of vaccination in the population is important, even for diseases that appear to be eradicated in Croatia CORRECT/INCORRECT				
Vaccination produces only individual protection/immunity				CORRECT/INCORRECT
There is no need for vaccination against diseases that appear to be eradicated in a specific area				CORRECT/INCORRECT
Vaccination increases the risk of autoimmune diseases				CORRECT/INCORRECT

Attitudes toward vaccination

Which sentence best describes your attitude toward vaccination?

Vaccination is necessary in order to prevent diseases	Vaccination is totally unnecessary	Vaccination is harmful due to side-effects caused by the vaccines	I have no positive nor negative attitude toward vaccination	I do not have enough information about vaccination

If you are against vaccination, what is the most correct reason?

Complications after vaccination	Vaccines are ineffective	Harms surpass the benefits	I do not have negative attitude toward vaccination	Other

Do you agree that the vaccination should be mandatory?

Yes, vaccination should be mandatory.	No, everyone should decide for themselves about vaccination	I do not know; I do not have an opinion

Who benefits the most from the vaccination?

Community, family, children	Doctors	Government	Pharmaceutical companies that produce vaccine

How would non-mandatory vaccination effect vaccine coverage in the population?

Vaccine coverage would not change significantly	Vaccine coverage would decrease in the population	Vaccine coverage would increase in the population