HUMAN VACCINES & IMMUNOTHERAPEUTICS
2022, VOL. 18, NO. 1, e1938492 (9 pages)
https://doi.org/10.1080/21645515.2021.1938492

Taylor & Francis
Taylor & Francis Group

RESEARCH PAPER

OPEN ACCESS Check for updates

The intent of students to vaccinate is influenced by cultural factors, peer network, and knowledge about vaccines

Laura Chinenye Ilogu[a], Olga Lugovska[a], Ivo Vojtek[b], Anna Prugnola[b], Andrea Callegaro[b], Sara Mazzilli[c], and Pierre Van Damme[d]

[a]Département Biologie, Faculté des Sciences et Techniques, Université Claude Bernard Lyon 1, Villeurbanne, France; [b]GSK, Wavre, Belgium; [c]Department of Translational Research and New Technologies in Medicine and Surgery, University of Pisa, Pisa, Italy; [d]University of Antwerp, Antwerp, Belgium

ABSTRACT

Young adults are the future vaccine decision-makers as parents or health-care professionals. To understand their attitudes and behaviors toward vaccination, we conducted a cross-sectional survey of 2079 students attending the University of Antwerp, Belgium and the University of Pisa, Italy. Principal component analysis was used to investigate associations between survey responses and the intent to vaccinate. Vaccination knowledge, attitudes, and behaviors among university students in Italy and Belgium were high. However, only one-half of respondents displayed an intent to vaccinate. High levels of knowledge, positive attitudes, and confidence in vaccines were positively associated with age, higher level of study, being a medical student, a recent vaccination experience, and not knowing trusted persons who did not believe in vaccines. Country of origin was highly correlated with the survey responses and was clustered with lifestyle, family, and data source variables, suggesting a strong modifying effect of culture and family attitudes on how vaccines are perceived in this age-group. Recent meningococcal vaccination campaigns and public discussions around mandatory vaccination in Italy may have influenced these results. We show that the intent to vaccinate was correlated with two main clusters of variables linked to culture (country, family, lifestyle), and to scholarship (knowledge, attitudes, data source) that together influence the behavior of students with respect to vaccination. Our study reinforces previous findings that knowledge about vaccines is key to shaping attitudes and behaviors, but also shows that cultural and lifestyle factors are another platform that could be leveraged in promoting vaccination among young people.

ARTICLE HISTORY
Received 28 January 2021
Revised 11 May 2021
Accepted 29 May 2021

KEYWORDS
Vaccination; vaccine; student; survey; qualitative research; vaccine hesitancy

Introduction

Vaccines are a high-value public health intervention that prevent 2–3 million child deaths annually.[1] Nonetheless, immunization programs face substantial ongoing challenges in achieving target coverage rates, and outbreaks of preventable diseases continue to be widely reported.[2] The persistent measles outbreaks in Europe since 2016 accentuate the drawbacks of suboptimal vaccination coverage levels in the region, where 78% of reported cases occur in non-vaccinated individuals.[3] In 2019, only four countries in Europe had measles vaccine coverage of 95% of more, which is the level needed to interrupt disease transmission.[3] Health experts have attributed outbreaks of vaccine-preventable diseases to increasing vaccine hesitancy behaviors and negative attitudes toward vaccination, suggesting that vaccination coverage rates are in part a reflection of individual vaccination attitudes and behaviors.[4–6] One theory is that individuals will adopt protective vaccination behaviors when they perceive they are at risk.[7] In many cases, however, the necessity of vaccination is questioned due to lack of awareness of the disease, poor knowledge about its potential consequences, and a perception of low disease susceptibility.[8–10] Further, the success of vaccination programs has encouraged complacency about diseases that most individuals have never experienced or heard little about.[7,11]

Vaccination behaviors can be influenced by beliefs in the safety and protective action of the vaccine as well as the perceived benefits of getting vaccinated.[7] These beliefs can become distorted by unsubstantiated misinformation about the risks posed by vaccination.[12] Since health-care providers (HCPs) are the most commonly accessed resource for vaccine-related information,[13] interactions with health professionals are important determinants of vaccination consent and adherence.[7] As with other health behaviors, social norms and networks exert powerful influences on vaccination attitudes and behaviors, and individuals may align their vaccination decisions with those of their family members and members of their social network.[14] This explains why negative attitudes toward vaccination sometimes cluster geographically.[15]

While many studies examine parental knowledge, beliefs, and attitude toward vaccination, perceptions and behaviors toward vaccination in young adults remain less well described, with the exception of several published studies focusing on specific vaccinations such as HPV and influenza.[10,16,17] Young adults, however, represent the population of future parents who will take vaccination decisions for their own

CONTACT Ivo Vojtek ivo.x.vojtek@gsk.com GSK, Rue Fleming 2, Wavre B-1300, Belgium
Supplemental data for this article can be accessed on the publisher's website at https://doi.org/10.1080/21645515.2021.1938492.

children. Young adults are also future HCPs who will communicate vaccine benefits and counsel individuals who express doubt about vaccines.

The primary objective of this study was to investigate attitudes and behaviors toward vaccination among students at the University of Antwerp, Belgium and the University of Pisa, Italy. We also aimed to examine vaccination behaviors of students studying in medical and non-medical disciplines in order to understand if educational background was predictive of positive vaccination attitudes. Describing the relationship among these different factors can provide new insights on factors that influence vaccine acceptance and suggest possible behavioral interventional strategies to address public confidence in vaccines.

Methods

Study setting and population

The data for this cross-sectional study were collected between April and July 2018. Study participants were students attending different faculties at the University of Antwerp, Belgium and the University of Pisa, Italy. The University of Pisa has about 50.000 students across 20 departments, whereas the University of Antwerp educates 20.000 students across 9 departments. In order to achieve 95% confidence level and 5% margin of error, the adequate sample size should be at least 759 (377 per the Belgian and 382 respondents per the Italian site).[18] Considering the particular interest of recruiting a sufficient number of medical students to evaluate their responses versus the non-medical group, the recruitment was stopped when 800 medical students completed the survey, in order to compensate for any potential incomplete answers. Respondents were recruited through an invitation link to the study questionnaire posted to online student groups and university noticeboards. The questionnaire was administered anonymously and required an average of 15 minutes to complete. The survey remained open for at least 1 month due to the slow recruitment rate.

In order to explore the effectiveness of an alternative recruitment strategy, students attending the University of Antwerp campus were additionally invited by a researcher during their break-out periods to attend face-to-face focus groups of 5–10 run by a single interviewer. The focus groups were run on a single day during a visit by OL to the University of Antwerp campus who approached and recruited students individually. Interviews were conducted concurrently with the on-line survey.

The study was approved by the research institutions participating in this study.

Questionnaire design

The self-administered questionnaire consisted of 30 items and was designed based on findings from previous studies and relevant literature.[5,19–21] The Health Belief Model underpinned the construction of the survey questions, as this has proven to be particularly effective in understanding vaccination attitudes and predicting vaccination behaviors.[21,22] The questionnaire was divided into five sections:

(1) Baseline questions recorded age, gender, area, level of study, lifestyle, timing of the most recent vaccination, and age of the next vaccination and were answered using multiple choice or free text. An additional question was asked if *among the people I trust, there are some that do not believe in vaccination* and was answered using a 5-point Likert scale (strongly agree, agree, neutral, disagree, strongly disagree) in the on-line survey, and a binary option (agree or disagree) during the face-to-face interviews, with responses combined into a composite variable for the analysis.
(2) Vaccine knowledge questions were designed based on empirical vaccine-related information relating to the public health benefits of vaccination. The six questions were scored on a 5-point Likert scale (strongly agree, agree, neutral, disagree, strongly disagree) and the responses categorized into 'correct answer' versus 'incorrect answer' (including neutral or no response). A score of "1" was given for each correct answer and "0" for incorrect or unknown answer.[23] The total possible knowledge score for each respondent ranged from 0 to 6.
(3) Attitude toward vaccination questions is designed to assess how participants perceived benefits, barriers, and influencers of vaccination. The six questions (3 pro and 3 contra-trait) were scored items on a 5-point Likert scale (from 1 "strongly disagree" to 5 "strongly agree") and reverse coding was applied for statements that were negatively worded.[5] A total attitude score ranging from 6 to 30 points was calculated per respondent.
(4) Vaccine confidence questions included three items adapted from the vaccine confidence scale developed by Heidi Larson.[24] The questions were scored items on a 5-point Likert scale from 1 "strongly disagree" to 5 "strongly agree" and a total confidence score ranging from 3 to 15 points was calculated per respondent.
(5) Sources of vaccine-related information which was assessed using a single multiple choice item were modified from a similar survey conducted by Jones.[25]

The final questionnaire was validated in the focus groups and the data collected have been included into the data analysis indicating the data source.

Data analysis

Descriptive statistics were used to analyze sample characteristics. Chi-square tests were performed to examine differences in survey responses for all singular items of the vaccine knowledge questionnaire, attitudes toward vaccination scale and vaccine confidence scale. Analysis of variance (ANOVA) or independent sample t test was used to examine the association between categorical predictors (gender, faculty, age) and continuous variables (vaccine knowledge, vaccine confidence, and attitudes toward vaccination).

The intent to vaccinate was determined as 1 = Yes or 0 = No if either of the following questions were answered a*t what age is my next vaccination?* or w*hat is the next vaccine that you plan to receive?* Principal component analysis (PCA) was performed to explain the intent to vaccinate using the other variables collected, where

logit(Pr(intent to vaccinate)) = alpha+beta1*PC1+ beta2*PC2+ beta3*PC3+ other demographic variables

All analyses were performed using the statistical program SPSS Statistics for Windows v25 (SPSS v25, IBM Corp., Armonk, NY, USA).

Results

A total of 2079 participants completed the survey of whom 321 participated in face-to-face interviews. The sample included 873 medical students and 1206 students from other faculties. The principal characteristics of the study group are shown in Table 1. The majority of respondents (63.2%) were students in Italy and 36.8% attended university in Belgium. A total of 21.6% of respondents reported that they had trusted contacts who did not believe in vaccination.

Knowledge and perception of vaccination

Overall, knowledge and perception of the benefits of vaccination were high (Table 2). More than 90% of respondents provided correct responses to questions about herd immunity, the protective benefit of vaccination, relevance of vaccines across all ages, while a somewhat lower proportion (83.3%) understood the contribution of vaccination to small pox elimination in Europe.

The mean correct response over the six questions among respondents was 5.51 (91.8%). Knowledge was significantly higher among respondents in Italy (mean correct response 5.72/6, 95.3%) than participants in Belgium (5.14, 85.7%); $p < .001$ (Table 3). Students of medicine scored significantly higher (5.78, 96.3%) compared to non-medical students (5.31, 88.5%); $p < .001$.

Attitudes toward vaccination

In total, 94.1% of respondents believed that getting vaccinated was a moral responsibility to protect others (Table 4). However, 8.2% felt vaccines should no longer be necessary for diseases that have become uncommon. The majority of respondents (68.8%) disagreed with the assumption that vaccination is promoted by the pharmaceutical industries for profit reasons. 86.4% expressed their willingness to acquire more information regarding their recommended vaccines.

The mean total value of young adults' attitudes regarding vaccination was 23.29 (77.6%) on the 30-point scale. Medical students differed significantly in all attitudes compared to non-medical students (total score 23.75, 79.2% versus 22.95, 76.5%); $p < .001$. Participants with trusted contacts against vaccines had significantly lower mean attitude scores (22.61, 75.4% versus 23.68, 78.9%; $p < .001$).

Level of vaccine confidence

In total, 93.4% of respondents considered vaccines to have an acceptable safety profile, 87.7% considered that vaccines are important to them, and 95.6% believed that vaccines are effective (Table 5). Only 2.3% of respondents disagreed that vaccines are safe, and 2.2% disagreed that vaccines are effective.

The mean vaccine confidence score among all respondents was 13.20 on the 15-point scale (88%). Older and medical students were significantly more confident about vaccination than the younger and non-medical respondents (Table 3). A recent history of vaccination was another positive factor contributing to vaccine confidence. Interestingly, participants

Table 1. Characteristics of the survey respondents.

	N = 2079	%	*p*-Value
Country			
Italy	1313	63.2	<0.001
Belgium	766	36.8	
Gender			
Male	591	28.4	0.337
Female	1485	71.4	
Prefer not to say	3	0.1	
Faculty			
Medical Science	873	42.0	<0.001
Non-medical Science	1206	58.0	
Age Range			
18–20 years	470	22.6	<0.001
21–24 years	1026	49.4	
≥25 years	583	28.0	
Study level			
Bachelor	886	42.6	<0.001
Master	1134	54.5	
Doctorate	59	2.8	
Knowing someone opposed to vaccination			
No	1193	57.4	<0.001
Neutral	438	21.0	
Yes	448	21.6	

Table 2. Knowledge and perception of vaccines among respondents.

Statement	Response	Medical (N = 873)	Non-medical (N = 1206)	Total (N = 2079)	*p*-Value
Q1 – Small pox and Polio in Europe have been eliminated because of vaccination	Correct answer	n (%)	n (%)	n (%)	$p < .001$
	Incorrect answer	808 (92.8)	922 (76.5)	1730 (83.3)	
		63 (7.2)	283 (23.5)	346 (16.7)	
Q2 – I believe vaccines are only relevant for children	Correct answer	846 (97.0)	1125 (93.8)	1971 (95.1)	$p < .001$
	Incorrect answer	26 (3.0)	75 (6.3)	101 (4.9)	
Q3 – More people should be vaccinated against diseases so that outbreaks of diseases do not occur	Correct answer	842 (96.6)	1026 (85.4)	1868 (90.1)	$p < .001$
	Incorrect answer	30 (3.4)	176 (14.6)	206 (9.9)	
Q4 – Vaccines can protect me against diseases that are quite dangerous	Correct answer	860 (98.6)	1150 (95.6)	2010 (96.8)	$p < .01$
	Incorrect answer	13 (1.5)	53 (4.4)	66 (3.2)	
Q5 – A good diet and a healthy lifestyle can keep me healthy, so I do not need vaccines	Correct answer	847 (97.1)	1115 (92.7)	1962 (94.6)	$p < .001$
	Incorrect answer	25 (2.9)	88 (7.3)	113 (5.4)	
Q6 – Not having my vaccinations may increase the risk that I get infected	Correct answer	840 (96.2)	1071(88.4)	1911(92.0)	$p < .001$
	Incorrect answer	33 (19.8)	134 (11.1)	167 (8.0)	

Table 3. Relationship between level of vaccine knowledge, attitude toward vaccination and vaccine confidence.

Variables	Vaccine knowledge mean (SD)	Attitude mean (SD)	Confidence mean (SD)
Country			
Italy	5.72 (0.6) ***	23.91 (2.8)***	13.65 (2.0)
Belgium	5.14 (1.2)	22.22 (2.6)	12.43 (2.1)
Gender			
Male	5.53 (0.8)	23.05 (3.0)	13.36 (2.0)
Female	5.50 (0.9)	23.38 (3.0)	13.14 (2.1)
Unknown	5.51 (0.9)	23.29 (2.8)	13.20 (2.1)
Faculty of Study			
Medical	5.78 (0.6)***	23.75 (2.5)***	13.90 (1.7)***
Non-Medical	5.31 (1.0)	22.95 (3.0)	12.70 (2.2)
Age Range			
18–20 years	5.26 (1.0)	22.66 (3.1)	12.54 (2.3)
21–24 years	5.55 (0.8)	23.37 (3.0)	13.28 (2.1)
≥25 years	5.64 (0.8)***	23.64 (2.6)***	13.60 (1.8)***
Study Level			
Bachelor	5.31 (1.0)	22.94 (3.1)	13.11 (2.2)
Master	5.66 (0.7)***	23.59 (2.5)***	13.94 (1.7)***
Doctorate	5.56 (0.8)	22.73 (4.0)	13.63 (2.8)
Vaccination History			
within last year	5.62 (0.8)***	23.68 (2.8)***	13.48 (2.1)***
<5 years ago	5.54 (0.8)	23.28 (2.6)	13.33 (2.0)
5–10 years ago	5.43 (0.9)	23.14 (2.6)	13.00 (2.6)
>10 years ago	5.41 (1.0)	23.10 (3.6)	12.33 (2.0)
Can't remember	5.14 (1.2)	22.23 (3.1)	12.92 (2.7)
Knowing someone opposed to vaccination			13.59 (1.8)***
No	5.62 (0.7)***	23.68 (2.4)***	12.81 (2.0)
Neutral	5.39 (1.1)	22.95 (2.9)	12.57 (2.5)
Yes	5.35 (1.1)	22.61 (3.3)	

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4. Attitude toward vaccination among respondents.

Statement	Response	Medical (N = 873)	Non-medical (N = 1206)	Total (N = 2079)	*p*-Value
		n (%)	n (%)	n (%)	
Q1 – I don't believe that all or some of the vaccines are still needed because the disease they protect against is already disappeared	Strongly agree	14 (1.6)	22 (1.8)	36 (1.7)	$p < .001$
	Agree	51 (5.8)	84 (7.0)	135 (6.5)	
	Neutral	89 (10.2)	212 (17.6)	301 (14.5)	
	Disagree	291 (33.3)	462 (38.3)	753 (36.2)	
	Strongly disagree	428 (49.0)	425 (35.3)	853 (41.0)	
Q2 – I feel that I do not have enough information about vaccines	Strongly agree	28 (3.2)	88 (7.3)	116 (5.6)	$p < .001$
	Agree	145 (16.6)	347 (28.8)	492 (23.7)	
	Neutral	172 (19.7)	353 (29.3)	525 (25.3)	
	Disagree	311 (35.7)	283 (23.5)	594 (28.6)	
	Strongly disagree	216 (24.8)	134 (11.1)	350 (16.9)	
Q3 – Pharmaceutical companies only promote vaccines to make money	Strongly agree	9 (1.0)	44 (3.7)	53 (2.6)	$p < .001$
	Agree	36 (4.1)	106 (8.8)	142 (6.8)	
	Neutral	134 (15.4)	315 (26.2)	449 (21.6)	
	Disagree	298 (34.2)	424 (35.2)	722 (34.8)	
	Strongly disagree	395 (45.3)	314 (26.1)	709 (34.2)	
Q4 – I need to be vaccinated to also protect others	Strongly agree	636 (72.9)	602 (50.0)	1238 (59.6)	$p < .001$
	Agree	222 (25.4)	497 (41.2)	719 (34.6)	
	Neutral	3 (0.3)	57 (4.7)	60 (2.9)	
	Disagree	2 (0.2)	28 (2.3)	30 (1.4)	
	Strongly disagree	10 (1.1)	21 (1.7)	30 (1.5)	
Q5 – I would like to know which vaccines I should have as an adult	Strongly agree	364 (41.7)	473 (39.3)	837 (40.3)	p = .023
	Agree	378 (43.3)	582 (48.4)	960 (46.2)	
	Neutral	102 (11.7)	98 (8.1)	200 (9.6)	
	Disagree	15 (1.7)	29 (2.4)	44 (2.1)	
	Strongly disagree	14 (1.6)	21 (1.7)	35 (1.7)	
Q6 – I know where I can get my vaccination	Strongly agree	354 (40.5)	301 (25.0)	655 (31.5)	$p < .001$
	Agree	327 (37.5)	528 (43.9)	855 (41.2)	
	Neutral	114 (13.1)	182 (15.1)	296 (14.3)	
	Disagree	57 (6.5)	159 (13.2)	216 (10.4)	
	Strongly disagree	21 (2.4)	34 (2.8)	55 (2.6)	

with trusted contacts who were opposed to vaccination were significantly less confident in the safety and effectiveness of vaccines compared to those who reported they did not, showing the influence of the attitudes of their peers. The influence of the environment on vaccine confidence was further highlighted through the primary component analysis below.

Table 5. Level of vaccine confidence among respondents.

Statement		Medical (N = 873)	Non-medical (N = 1206)	Total (N = 2079)	*p*-Value
		n (%)	n (%)	n (%)	
Q1 – In general, I think vaccines have an acceptable safety profile	Strongly agree	557 (63.9)	459 (38.1)	1016 (48.9)	$p < .001$
	Agree	293 (33.6)	630 (52.3)	923 (44.5)	
	Neutral	13 (1.5)	78 (6.5)	91 (4.4)	
	Disagree	3 (0.3)	17 (6.5)	20 (1.0)	
	Strongly disagree	5 (0.6)	21 (1.7)	26 (1.3)	
Q2 – in general, vaccines are important to me	Strongly agree	604 (69.2)	490 (40.8)	1094 (52.7)	$p < .001$
	Agree	226 (25.4)	506 (42.1)	732 (35.3)	
	Neutral	35 (4.0)	147 (12.2)	182 (8.8)	
	Disagree	2 (0.2)	30 (2.5)	32(1.5)	
	Strongly disagree	6 (0.7)	29 (2.4)	35 (1.7)	
Q3 – In general, I think vaccines are effective	Strongly agree	633 (72.5)	545 (45.6)	1178 (57.0)	$p < .001$
	Agree	226 (25.9)	573 (47.9)	797 (38.6)	
	Neutral	6 (0.7)	41 (3.4)	47 (2.3)	
	Disagree	2 (0.2)	18 (1.5)	20 (1.0)	
	Strongly disagree	6 (0.7)	19 (1.6)	25 (1.2)	

Intent to vaccinate

Respondents demonstrated a high level of awareness with respect to their vaccination history. The majority of the respondents could recall the last time they were vaccinated and only 7.3% (n = 151) could not remember when they had their last vaccination; 82.8% (n = 125) of these were non-medical students (Table 6). In total, 67.7% (n = 1407) reported to have received at least one vaccine within the last 5 years, and 6.0% (n = 125) received their last vaccination more than 10 years ago. Of the 634 (30.5%) participants who had received any vaccination in the previous year, 48.1% (n = 305) were within the age range of 21–24 years, 51.3% (n = 325) were medical students, and 62.8% (n = 398) were students of the Italian university.

Almost one-half of respondents (49.2%, n = 1023) indicated that they had either "no idea" or "no intention" to receive their next recommended vaccine and 72.6% (n = 743) of these respondents were non-medical students (Table 7). More females (75.9%, n = 801) than males 24.1% (n = 255) were aware of their next vaccination ($p < .001$). Compared to Belgium respondents, a significantly higher percentage of participants in Italy reported to know about/or intended to receive their next recommended vaccine (25.0% vs 75.0%; $p < .001$). Those who had been vaccinated recently were more likely to be aware of their future vaccination; among the 1056 respondents who intended to receive their next vaccine, 72.9% (n = 770) had their most recent vaccination less than 5 years ago, while 16.6% (n = 174) had received their last vaccination between 5 and 10 years ago. Only 5.9% (n = 62) of the respondents who had not been vaccinated in last 10 years reported to be aware of their next recommended vaccine.

PCA on score data summarized two main components, PC1 and PC2, with PC1 explaining 17% of the variation (Figure 1). Country of origin and vaccine importance (in opposite directions reflecting the scoring convention) were the most significant determinants of the intent to vaccinate (Figure 1). The country of origin was correlated with lifestyle, family, and data-source factors, whereas vaccine importance was correlated with knowledge and attitude. Age was correlated more with knowledge than with lifestyle or data source. Social media, friends, gender, and level of fitness were not significant. The intent to vaccinate was significantly associated with age, gender, and PC1 (Table 8). The intent to vaccinate was also impacted by Datasource, with scores for vaccine knowledge and attitude

Table 6. Vaccination history among respondents.

Variables	Time since the last vaccination				
	Within last year	<5 years ago	5–10 years ago	>10 years ago	Cannot remember
	n (%)	n (%)	n (%)	n (%)	n (%)
Country					
Italy	398 (62.8)	500 (64.7)	222 (56.1)	111 (88.8)	82 (50.6)
Belgium	236 (37.2)	273 (35.3)	174 (43.9)	14 (11.2)	69 (45.7)
Total	634 (100)	773 (100)	396 (100)	125 (100)	151 (100)
Faculty					
Medical	325 (51.3)	349 (45.1)	124 (31.3)	49 (39.2)	26 (17.2)
Non – Medical	309 (48.7)	424 (54.9)	272 (68.7)	76 (60.8)	125 (82.8)
Total	634 (100)	773 (100)	396 (100)	125 (100)	151 (100)
Gender					
Male	181 (28.5)	244 (31.6)	91 (23.0)	24 (19.2)	51 (33.8)
Female	453 (71.5)	529 (68.4)	303 (76.5)	101 (80.8)	99 (65.6)
Prefer not to say	-	-	2 (0.5)	-	1 (0.7)
Total	634 (100)	773 (100)	396 (100)	125 100)	151 (100)
Age range					
18–20	121 (19.1)	208 (26.9)	90 (22.7)	7 (5.6)	44 (29.1)
21 – 24	305 (48.1)	375 (48.5)	231 (58.3)	46 (36.8)	69 (45.7)
25 +	208 (32.8)	190 (24.6)	75 (18.9)	72 (57.6)	38 (25.2)
Total	634 (100)	773 (100)	396 (100)	125 (100)	151 (100)

Table 7. Intent to vaccinate.

Variables	Plan to receive a next vaccine	No idea/no intent to receive next vaccination
	n (%)	n (%)
Period since last vaccination		
Within last year	399 (37.9)	235 (23.0)
<5 years	371 (35.1)	402 (39.3)
5–10 years	174 (16.5)	222 (21.7)
>10 years	62 (5.9)	63 (6.2)
Can't remember	50 (4.7)	101 (9.9)
Total	1056 (100)	1023 (100)
Gender		
Male	255 (24.1)	336 (32.8)
Female	801 (75.9)	684 (66.9)
Prefer not to say	-	3 (0.3)
Total	1056 (100)	1023 (100)
Faculty		
Medical	593 (56.2)	280 (27.4)
Non-Medical	463 (43.8)	743 (72.6)
Total	1056 (100)	1023 (100)
Country		
Italy	792 (75.0)	521 (50.9)
Belgium	264 (25.0)	502 (49.1)
Total	1056 (100)	1023 (100)

tending to be more positive in the face-to-face meetings than the online survey. There was a significant association between the intent to vaccinate and vaccination knowledge and attitude scores, and with HCP or public health websites as the data source (Figure 2).

Discussion

We collected detailed data on the knowledge, attitudes, and behaviors toward vaccinations among a sample of university students, and linked these results to action on vaccination. Our results indicate that knowledge about vaccines was high among the student respondents, and that the majority held positive attitudes to vaccination and considered them to be safe and effective. High levels of knowledge, positive attitudes, and confidence in vaccines were positively associated with age, higher level of study, being a medical student, a recent vaccination experience, and not knowing trusted persons who did not believe in vaccines. These results are consistent with other

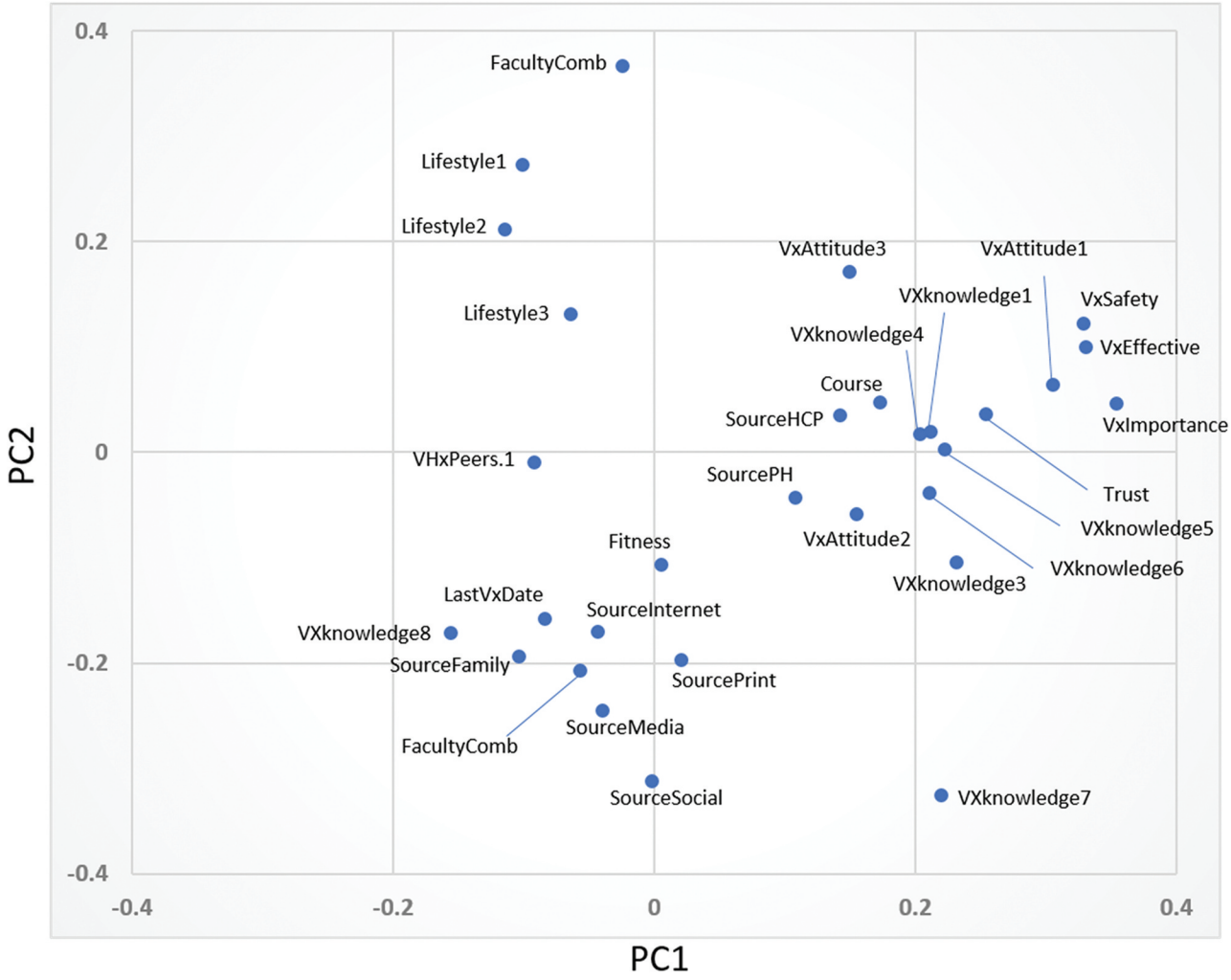

Figure 1. Principal component analysis. Results of principal component analysis reveals correlation of intent to vaccinate (Vxplan) as outcome variable with primary components measured in the survey. A positive correlation is observed with variables representing education (knowledge, school, courses) on the left side of the figure. There is also an association of intent of vaccinate with the group of parameters related to local culture (country, family and lifestyle).

Table 8. PCA regression.

	Estimate	Standard error	Z value	Pr (z)
(Intercept)	0.0196	0.1316	0.15	0.8815
PC1	0.2505	0.0352	7.11	0.0000
PC2	0.0950	0.0525	1.81	0.0705
PC3	−0.0642	0.0486	−1.32	0.1864
Data source	−0.4238	0.2254	−1.88	0.0601
Country	−0.3441	0.2274	−1.51	0.1303
Gender	−0.4643	0.1222	−3.80	0.0001
Age	0.3187	0.0848	3.76	0.0002

Primary Component Analysis shows that intent to vaccinate is significantly associated to Age, gender, and Country (PC1, the most important factor). PC1 is furthermore correlated with a number of lifestyle factors. The composed influence of these factors underlines the role of environment plays in vaccine confidence.

studies that have demonstrated higher confidence in vaccines among medical students,[5,9] the positive influenza of past vaccine administration on the intention to receive future vaccinations,[19,23] and the negative influence of trusted persons who hold negative opinions about vaccination.[5,9]

Uniquely, we assessed the intent to vaccinate among university students by constructing a dependent variable (planned vaccination) based on whether students knew when their next vaccination was due, or if they knew what their next vaccination should be. As might be expected, the intent to vaccinate was correlated with vaccine knowledge, attitudes, and being a medical student. However, age, female gender, and using public health websites and HCPs as sources of information about vaccines were also correlated with intent to vaccinate. The self-reported role of social media as a source of information was low. We observed that industry-sponsored vaccine awareness was not perceived overly negatively, and a generally strong willingness of students to learn more about vaccines recommended for them.

Country of origin was highly correlated with the survey responses and was clustered with lifestyle, family, and data source variables, suggesting a strong modifying effect of culture and family attitudes on how vaccines are perceived in this age-group. In the region of Tuscany where the University of Pisa is located, there was an increase in meningococcal meningitis cases including cases in young adults, with some deaths, which prompted distribution of free meningococcal vaccine in 2017 for all university students.[26] Additionally, from 2017 the Italian government adopted measures to enforce a legal obligation on parents to vaccinated their children.[27] As a result of the ensuing public debate, vaccinations were the focus of media attention in Italy for several months. The vaccine intervention and public discussion explain why most of the students who had received a vaccine within the last year were from the Italian university, and could have contributed to differences in

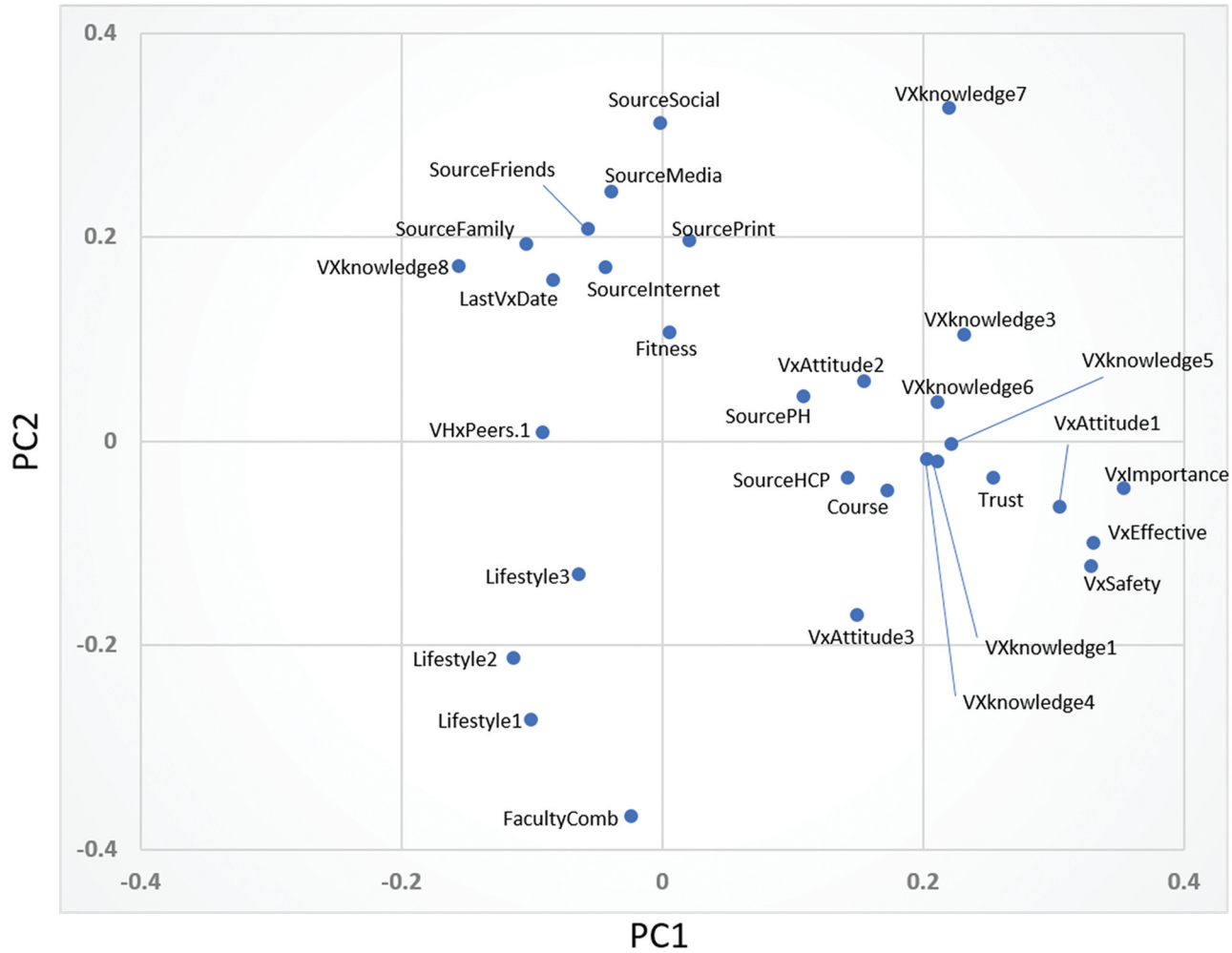

Figure 2. PCA loadings used for the PCA regression (excluding demographic variables). PCA regression showed that variability of primary component 1 was mainly associated with knowledge about vaccination.

vaccine knowledge, attitude, confidence, and intent to vaccinate observed between the respondents from the Italian university and the Belgian university.[23] Promotion of vaccination by the Belgian government has, on the other hand, been systematic, but without such major spikes in public debate, perhaps except for the occasional measles outbreak in the years before the study. Positive associations between vaccine knowledge and attitudes to vaccination have been shown previously in other studies.[5,9,23,28]

We observed that vaccine knowledge, attitudes, and confidence, as well as the intent to vaccinate, were all influenced by age, with higher scores in older students, even though the age-groups studied were narrow (18–20, 21–24, and ≥25 years). The effect of age on vaccine attitudes appears to be conflicting, with some studies reporting improved confidence with increasing age while other suggesting the reverse.[24,29] Medical students receive training in vaccinology later rather than earlier in their course, and in our study older respondents in Italy may be more likely to have been involved in the meningococcal public health campaign the year prior to the survey. Both factors could have contributed to the observed association between age and vaccine knowledge, attitudes, and confidence.

Our study is potentially limited by an over-representation of female respondents, in whom vaccine confidence has been reported to be higher than males,[20] and the potential for response bias toward students more interested in this subject who might be more motivated to complete an on-line survey. The study was performed at one university in Belgium, where medical students undergo a specific vaccinology module in their third year, and Italy, which may not be representative of the entire student population in both countries. Finally, we observed a general trend of more positive responses among participants inn face-to-face interviews than in online surveys, although the small number of students who participated in face-to-face interviews precludes further analysis.

In conclusion, we found that vaccination attitudes and behaviors among students at University of Pisa, Italy and those of University of Antwerp, Belgium are positive. Only around one-half of respondents were aware of their next vaccination or displayed an intent to vaccinate, showing an ongoing need for vaccine education in this age-group. We show that the intent to vaccinate is correlated with two main clusters of variables linked to culture (country, family, lifestyle), and to scholarship (knowledge, attitudes, data source) that together influence the behavior of students with respect to vaccination. Our study reinforces previous findings that knowledge about vaccines is key to shaping attitudes and behaviors, but also shows that cultural and lifestyle factors as well as peer networks are another platform that could be leveraged in promoting vaccination among young people.

Acknowledgments

The authors thank Pier-Luigi Lopalco for his contribution to the study. The authors would like to thank Business & Decision Life Sciences platform for editorial assistance and manuscript coordination, on behalf of GSK. Carole Desiron coordinated manuscript development and editorial support. Joanne Wolter (independent on behalf of GSK) provided medical writing support.

Author contributions

All authors had full access to all the data in the study and took responsibility for the integrity of the data and the accuracy of the data analysis. All authors participated in the development of this manuscript, reviewed, and approved the final manuscript.

Disclosure of potential conflicts of interest

IV, AP, and AC are employed by GSK group of companies and do not have any non-financial relationships and activities to declare. IV also hold shares in the GSK group of companies.

Funding

GlaxoSmithKline Biologicals SA funded this study and was involved in all stages of study conduct, including analysis of the data. GlaxoSmithKline Biologicals SA also covered all costs associated with the development and publication of this manuscript.

ORCID

Sara Mazzilli http://orcid.org/0000-0002-7989-0661

References

1. World Health Organization. WHO guidelines for the treatment of Neisseria gonorrhoeae. World Health Organization; 2016.
2. Centers for Disease Control and Prevention (CDC). Antibiotic resistance threats in the United States, 2019. Atlanta (GA): U.S. Department of Health and Human Services, CDC; 2019.
3. European Centre for Disease Prevention and Control (ECDC). Gonorrhoea. Annual epidemiological report for 2017. Stockholm: ECDC; 2019.
4. Larson HJ, Clarke RM, Jarrett C, Eckersberger E, Levine Z, Schulz WS, Paterson P. Measuring trust in vaccination: a systematic review. Hum Vaccin Immunother. 2018;14(7):1599–609. doi:10.1080/21645515.2018.1459252.
5. Cvjetkovic SJ, Jeremic VL, Tiosavljevic DV. Knowledge and attitudes toward vaccination: a survey of Serbian students. J Infect Public Health. 2017;10(5):649–56. doi:10.1016/j.jiph.2017.05.008.
6. Corben P, Leask J. To close the childhood immunization gap, we need a richer understanding of parents' decision-making. Hum Vaccin Immunother. 2016;12(12):3168–76. doi:10.1080/21645515.2016.1221553.
7. Brewer NT, Chapman GB, Rothman AJ, Leask J, Kempe A. Increasing vaccination: putting psychological science into action. Psychol Sci Public Interest. 2017;18(3):149–207. doi:10.1177/1529100618760521.
8. Vojtek I, Dieussaert I, Doherty TM, Franck V, Hanssens L, Miller J, Bekkat-Berkani R, Kandeil W, Prado-Cohrs D, Vyse A. Maternal immunization: where are we now and how to move forward? Ann Med. 2018;50(3):193–208. doi:10.1080/07853890.2017.1421320.
9. Zarobkiewicz MK, Zimecka A, Zuzak T, Cieslak D, Rolinski J, Grywalska E; Vaccination among Polish university students. Knowledge, beliefs and anti-vaccination attitudes. Hum Vaccin Immunother. 2017;13(11):2654–58. doi:10.1080/21645515.2017.1365994.
10. Wang LD, Lam WWT, Fielding R. Determinants of human papillomavirus vaccination uptake among adolescent girls: a theory-based longitudinal study among Hong Kong Chinese parents. Prev Med. 2017;102:24–30. doi:10.1016/j.ypmed.2017.06.021.
11. Hardt K, Schmidt-Ott R, Glismann S, Adegbola RA, Meurice F. Sustaining vaccine confidence in the 21st century. Vaccines. 2013;1:204–24. doi:10.3390/vaccines1030204.

12. Salmon DA, Dudley MZ, Glanz JM, Omer SB. Vaccine hesitancy: causes, consequences, and a call to action. Vaccine. 2015;33(Suppl 4):D66–71. doi:10.1016/j.vaccine.2015.09.035.
13. Costa-Pinto J, Willaby HW, Leask J, Wood N, Marshall H, Danchin M. Vaccine discussions with parents: the experience of Australian paediatricians. J Paediatr Child Health. 2017;53 (9):855–61. doi:10.1111/jpc.13587.
14. Larson HJ, Wilson R, Hanley S, Parys A, Paterson P. Tracking the global spread of vaccine sentiments: the global response to Japan's suspension of its HPV vaccine recommendation. Hum Vaccin Immunother. 2014;10(9):2543–50. doi:10.4161/21645515.2014.969618.
15. Beard FH, Hull BP, Leask J, Dey A, McIntyre PB. Trends and patterns in vaccination objection, Australia, 2002-2013. Med J Aust. 2016;204(7):275. doi:10.5694/mja15.01226.
16. Hilton S, Patterson C, Smith E, Bedford H, Hunt K. Teenagers' understandings of and attitudes towards vaccines and vaccine-preventable diseases: a qualitative study. Vaccine. 2013;31 (22):2543–50. doi:10.1016/j.vaccine.2013.04.023.
17. Lehmann BA, Ruiter RA, Wicker S, Chapman G, Kok G. Medical students' attitude towards influenza vaccination. BMC Infect Dis. 2015;15:185. doi:10.1186/s12879-015-0929-5.
18. Taherdoost H Determining Sample Size; How to Calculate Survey Sample Size; 2017.
19. Landowska K, Waller J, Bedford H, Rockliffe L, Forster AS. Influences on university students' intention to receive recommended vaccines: a cross-sectional survey. BMJ Open. 2017;7(7): e016544. doi:10.1136/bmjopen-2017-016544.
20. Wang B, Giles L, Afzali HHA, Clarke M, Ratcliffe J, Chen G, Marshall H. Adolescent confidence in immunisation: assessing and comparing attitudes of adolescents and adults. Vaccine. 2016;34(46):5595–603. doi:10.1016/j.vaccine.2016.09.040.
21. Carolan K, Verran J, Crossley M, Redfern J, Whitton N, Amos M. Impact of educational interventions on adolescent attitudes and knowledge regarding vaccination: a pilot study. PloS One. 2018;13 (1):e0190984. doi:10.1371/journal.pone.0190984.
22. Kim J. Relationship of health beliefs with information sources and HPV vaccine acceptance among young adults in Korea. Int J Environ Res Public Health. 2018;15:4. doi:10.3390/ijerph15040673.
23. Pelullo CP, Di Giuseppe G. Vaccinations among Italian adolescents: knowledge, attitude and behavior. Hum Vaccin Immunother. 2018;14(7):1566–72. doi:10.1080/21645515.2017.1421877.
24. Larson HJ, De Figueiredo A, Xiahong Z, Schulz WS, Verger P, Johnston IG, Cook AR, Jones NS. The state of vaccine confidence 2016: global insights through a 67-country survey. EBioMedicine. 2016;12:295–301. doi:10.1016/j.ebiom.2016.08.042.
25. Jones AM, Omer SB, Bednarczyk RA, Halsey NA, Moulton LH, Salmon DA. Parents' source of vaccine information and impact on vaccine attitudes, beliefs, and nonmedical exemptions. Adv Prev Med. 2012;2012:932741. doi:10.1155/2012/932741.
26. Hill MG, Menon S, Smith S, Zhang H, Tong X, Browne PC. Screening for chlamydia and gonorrhea cervicitis and implications for pregnancy outcome. Are we testing and treating at the right time? J Reprod Med. 2015;60:301–08.
27. Medina TM, Hill DA. Preterm premature rupture of membranes: diagnosis and management. Am Fam Physician. 2006;73:659–64.
28. Pelly LP, Pierrynowski Macdougall DM, Halperin BA, Strang RA, Bowles SK, Baxendale DM, McNeil SA. THE VAXED PROJECT: an assessment of immunization education in Canadian health professional programs. BMC Med Educ. 2010;10:86. doi:10.1186/1472-6920-10-86.
29. Brown AL, Sperandio M, Turssi CP, Leite RMA, Berton VF, Succi RM, Larson H, Napimoga MH. Vaccine confidence and hesitancy in Brazil. Cad Saude Publica. 2018;34(9):e00011618. doi:10.1590/0102-311X00011618.