



Factors Associated with Willingness to be Vaccinated Against COVID-19 in a Large Convenience Sample

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Abstract

Willingness and reasons to be vaccinated against COVID-19 were examined among 26,324 respondents who completed a survey on willingness and questions related to *Confidence* in vaccine safety, *Complacency* about the disease, *Convenience* of vaccination, tendency to *Calculate* risks versus benefits, and *Concern* for protecting others. Willingness to be vaccinated differed by age ($p < 0.001$), by race and ethnicity ($p < 0.001$) and by level of education ($p < 0.001$). Willingness generally increased with age and education. Asians were most willing to be vaccinated, followed by non-Hispanic Whites, Hispanics, and non-Hispanic Blacks ($p < 0.001$). Occupational groups differed in willingness ($p < 0.001$). Retired and students were more willing than all others ($p < 0.001$) followed by disabled or unemployed, healthcare workers, and educators. First Responders were least willing to be vaccinated ($p < 0.001$) followed by construction, maintenance and landscaping, homemakers, housekeeping, cleaning and janitorial workers, and retail and food service. The strongest predictor of willingness was confidence with the safety of the vaccine ($r = 0.723$, $p < 0.001$), followed by concern with protecting others by being vaccinated ($r = 0.574$, $p < 0.001$), and believing COVID-19 was serious enough to merit vaccination ($r = 0.478$, $p < 0.001$). Using multiple regression, confidence in safety was the strongest predictor for all groups. Protecting others was strongest for 13 of 15 demographic groups and 8 of 11 occupational groups. College educated, non-Hispanic Whites, first responders, construction, maintenance and landscape workers, housekeeping, cleaning and janitorial workers all gave greater weight to complacency about the disease. These results can help in designing programs to combat vaccine hesitancy.

Keywords Vaccine · Vaccine hesitancy · Psychology · Attitudes

Introduction

Vaccine hesitancy has been defined by the World Health Organization as “the delay in the acceptance or refusal to vaccinate despite the availability of vaccine services.” [1] A number of factors have been linked to increased vaccine hesitancy. These include concerns about the safety and efficacy of a vaccine, which has been shown to be a factor among all races and ethnicities [2–5] and applies to healthcare workers as well the public [6]. A lack of concern about the seriousness of a disease also increases hesitancy [2, 7, 8]. Matters related to the ease of getting vaccinated, such as whether one has healthcare coverage is also a factor [4, 8]. Trust in the

system that promotes and administers the vaccine is also a factor, especially for American Blacks [2, 7]. With regard to COVID-19 vaccine, Reiter et al. [8] found Americans more willing to be vaccinated if they were worried about the disease, felt the vaccine was safe and effective, and if their healthcare provider recommended it. They were less willing if they were non-Hispanic Black. A recent study by Khubchandani et al. [9] found that Hispanics, as well as African Americans, showed higher COVID-19 vaccine hesitancy than Whites or Asians, as did those with less education and those who were not concerned about being infected.

Nguyen et al. [10] reported results of studies of changes in vaccine hesitancy between September and December 2020, dates which were pre-vaccine authorization and post-vaccine authorization, respectively, in the U.S. Intent to be vaccinated increased from 39.4 to 49.1%, and lack of intent decreased from 38.1 to 32.1%. The largest increase in intent occurred among adults 65 years and older. Lack of intent

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was highest among young adults, women, non-Hispanic Blacks, adults living in nonmetropolitan areas, adults with lower educational attainment, having lower income, or without health insurance.

Despite the fact that initial federal and California prioritization schemes for deciding who gets vaccinated first relied on occupational categories, such as healthcare providers, educators, first responders, or food and agriculture workers, few studies have specifically addressed various occupational groups to assess their vaccine hesitancy. Betsch [6] reported that healthcare workers' worry about safety of a vaccine outweighed concern for others when making decisions about vaccination. The motivation for employing the survey was to determine which demographic and occupational groups should be targeted by efforts to reduce COVID-19 vaccine hesitancy, and what factors related to COVID-19 vaccine hesitancy should be addressed by a campaign to increase vaccination rates. The survey research was designed to answer the following questions: 1. What is the level of vaccine hesitancy among different demographic and occupational groups across a large (population 3,175,130) Southern California county? 2. What concerns determine willingness to be vaccinated in each group?

Methods and Procedures

Sample

A convenience sample of 25,000 respondents was assembled by asking the 35 members of a county community vaccine taskforce to contact their constituents by email and request responses to the survey via the internet using SurveyMonkey™. In order to increase representation of low-income and minority respondents, a coalition of community clinics was contracted to provide approximately 1300 face-to-face or telephone interviews with clinic clients who did not have emails. The final number of respondents was 26,324. The survey was conducted during the months of October and November, 2020.

Survey

The Survey chosen was a short form of the 5-C Scale of Psychological Antecedents of Vaccination developed by Betsch et al. [11]. The 5C scale is based on a model developed by the SAGE Working Group on Vaccine Hesitancy [12] and work by Larson et al. [13] and especially the taxonomy for determining vaccine uptake described by Thompson et al. [14]. It measures agreement with five statements related to *Confidence* in the vaccine, *Complacency* about the disease, *Convenience* of getting vaccinated, whether one is a person who *Calculates* risks and benefits, and *Concern* for others

as a reason for getting vaccinated. Betsch et al. [11] studied the effectiveness and statistical characteristics of both the complete 15-item 5-C Scale and a Short Form, 5-item scale. The shorter, 5-item scale, with some modification, was used in our survey. The scale was available, online and in person, in 7 languages: English, Spanish, Farsi, Korean, Chinese, Vietnamese, and Khmer (Cambodian).

Following the format of Betsch et al., the survey asked five statements, each one related to one of the five areas of concerns about receiving a vaccine. Responses to each statement were on a 7-point scale from strongly disagree to strongly agree. Three statements, related to confidence, calculation and concern for others were scored positively, so that higher scores (agreement) meant less hesitancy and two items related to complacency and convenience, for which higher scores indicated more hesitancy, were reverse-scored in the statistical analyses. Willingness to be vaccinated was measured in terms of agreement on the 7-point scale with the statement: "If a vaccine is available, I plan to be vaccinated." Respondents also answered questions about age, gender, ethnicity, education, primary language, plus 11 occupational categories. The Complete survey is available from the senior author on request.

Analyses

Significant differences in willingness to be vaccinated related to differences in age, gender, ethnicity, education, primary language and occupation were assessed using one-way analyses of variance, employing Welch's ANOVA, as a protection against bias due to unequal sample sizes and non-homogeneity of variances. Games-Howell t-tests were used to compare individual means. All significance tests were two-tailed. Multiple linear regression was used to assess the strength of each of the 5-C questions in predicting willingness to be vaccinated within the overall sample and within each demographic and occupational group.

Results

Sample Composition

The demographic and occupational makeup of the sample is presented in Table 1. Women, non-Hispanic Whites, college educated, 35–54 year olds and those for whom English was their primary language were overrepresented compared to the county population, which, according to the 2010 census, is 39.8% non-Hispanic White, 33.7% Hispanic, and 17.7% is Asian, although only 1.5% is non-Hispanic Black. The over 75 population was underrepresented in our sample (2.9% vs. 5.3% in the county). More than half of the respondents were either office/technical/professional workers or in education.

Table 1 Number and percentage of respondents in demographic and occupational categories (N = 26,324)

Variable	Value	Frequency	Percent	Cumulative percent
Gender	Other	141	0.5	0.5
	Female	18,963	72.8	73.3
	Male	6957	26.7	100.0
Age	18–34 years	5350	20.5	20.5
	35–54 years	13,402	51.3	71.8
	55–74 years	6593	25.3	97.1
	75 and older	760	2.9	100.0
	Other	1368	5.3	5.3
Race/Ethnicity	Non-Hispanic White	13,313	51.6	56.9
	Hispanic	6533	25.3	82.2
	Non-Hispanic Black	265	1.0	83.2
	Asian	4335	16.8	100.0
Highest level of education	Less than high school	608	2.3	2.3
	High school diploma	1590	6.1	8.4
	Community College/some college	5801	22.3	30.7
	College degree (4-year)	8109	31.1	61.8
	Graduate degree	9942	38.2	100.0
Primary language	Other	544	2.1	2.1
	English	22,785	87.1	89.2
	Spanish	1694	6.5	95.7
	Vietnamese	585	2.2	97.9
	Farsi	100	0.4	98.3
	Chinese	343	1.3	99.6
	Cambodian/Khmer	107	0.4	100.0
	Other	2413	9.2	9.2
Occupation	Healthcare worker	2902	11.1	20.4
	First responder	810	3.1	23.5
	Retail/Food Services	894	3.4	26.9
	Education	6350	24.3	51.2
	Student	1474	5.6	56.9
	Construction/Maintenance/Landscape	358	1.4	58.2
	Office/Professional/Technical	6897	26.4	84.7
	Housekeeping/Cleaning/Janitorial	145	0.6	85.2
	Homemaker	1570	6.0	91.2
	Retired	1902	7.3	98.5
	Disabled/Unemployed	388	1.5	100.0

The sample was not representative of the total Orange County population, however the size of the sample allowed analysis of the responses of a number of demographic and occupational subgroups of interest.

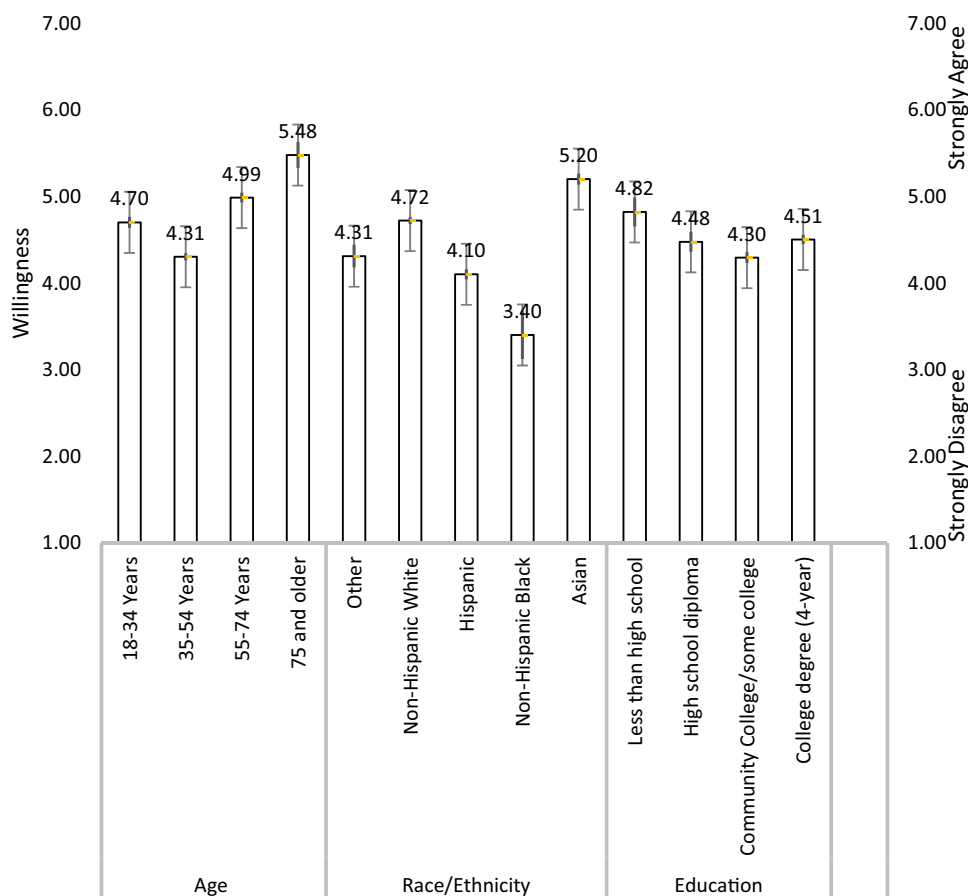
Demographic Group Differences

Due to unequal sample sizes and lack of homogeneity of variance, differences between groups were tested using Welch's ANOVA and follow-up multiple comparisons were tested for significance using the Games-Howell method. There were too few respondents in the "other" category of gender, and

males and females were compared using a t-test for samples with unequal variances.

Most of the groups had mean scores between 4 (neutral) and 5 (slightly agree) as shown in Fig. 1. Willingness to be vaccinated differed by age ($F(3, 3436.84) = 173.40$, $p < 0.001$). Willingness increased with age, with the exception that 18–34 year olds were more likely than 35–54 year olds to agree to be vaccinated (Fig. 1). Follow up comparisons with the Games-Howell statistic showed that all age groups differed significantly from one another ($p < 0.001$). Race/ethnicity also showed a significant effect on willingness to be vaccinated ($F(4, 1729.87) = 188.07$, $p < 0.001$).

Fig. 1 Willingness means and 95% confidence limits for age (n = 26,058), race/ethnicity (n = 25,765) and education (n = 26,003)



Asians were most likely to want to be vaccinated, followed by non-Hispanic Whites, then others, Hispanics, and non-Hispanic Blacks. All racial/ethnic groups differed significantly from one another ($p < 0.001$). Level of education also showed significant differences on willingness to be vaccinated ($F(4, 3463.96) = 56.47, p < 0.001$). Follow-up comparisons with the Games-Howell statistic showed that those with no high school diploma differed from those with a high school diploma ($p < 0.01$) and those with some college ($p < 0.001$). Those with a high school diploma differed from those with a graduate degree ($p < 0.01$). Those with some college differed from everyone ($p < 0.001$) except those with a high school diploma, and those with a 4-year degree differed from those with a graduate degree ($p < 0.001$). The most and least educated groups were most willing to be vaccinated. The number of respondents who had primary languages other than English was small enough in some cases to make the results only suggestive and they are not shown in Fig. 1. However, the overall Welch's ANOVA was significant ($F(6, 618.38) = 64.86, p < 0.001$). Those who spoke languages other than English or Spanish didn't differ significantly from one another, and all were more willing to be vaccinated than those who spoke English or Spanish ($p < 0.001$), which didn't differ from each other. Not shown

in Fig. 1, males were more willing to be vaccinated than females, ($t(12,963) = -20.73, p < 0.001$).

Occupational Group Differences

The mean of mean scores across all the occupations was 4.57, which corresponded to an answer halfway between neutral and slightly agreeing to be vaccinated. Figure 2 shows that retired persons and students were the most willing to be vaccinated, followed by disabled or unemployed, other, healthcare workers, office, professional and technical workers and educators. First responders were the least willing to be vaccinated followed by construction, maintenance and landscape workers, homemakers, housekeeping, cleaning and janitorial workers, and retail and food service workers.

The overall differences between occupational groups on willingness to be vaccinated were significant using Welch's ANOVA ($F(11, 2853.64) = 67.54, p < 0.001$). Paired comparisons using the Games-Howell statistic showed that retired persons were significantly more willing than all other occupations except students ($p < 0.001$), and students were more willing than all the rest of the groups ($p < 0.001$; disabled and unemployed, $p < 0.005$). Disabled

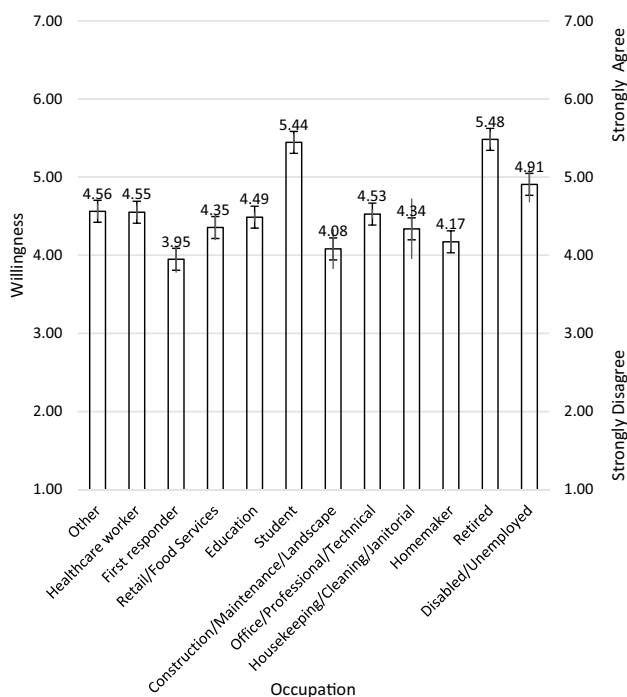


Fig. 2 Willingness means and 95% confidence limits for Occupational Groups (n = 26,050)

and unemployed were more willing than first responders ($p < 0.001$), retail and food service workers ($p < 0.05$), educators ($p < 0.05$), construction, maintenance and landscape workers ($p < 0.001$) and homemakers ($p < 0.001$). Healthcare workers were significantly more willing than first responders ($p < 0.001$), construction, maintenance and landscape workers ($p < 0.05$) and homemakers ($p < 0.001$). Educators and office and technical or professional workers were significantly more willing than first responders ($p < 0.001$) and homemakers ($p < 0.001$). First Responders were less willing to be vaccinated than everyone ($p < 0.001$; retail/food service $p < 0.05$) except housekeeping, cleaning and janitorial workers, homemakers, and construction, maintenance and

landscape workers. Construction, maintenance and landscape, retail and food service, housekeeping, cleaning and janitorial, and homemakers did not differ significantly from one another.

Prediction of Willingness to be Vaccinated

Every factor from the 5-C measure significantly predicted willingness to be vaccinated, with the highest correlations being with confidence with the safety of the vaccine ($r = 0.723$, $p < 0.001$), concern with protecting others by being vaccinated ($r = 0.574$, $p < 0.001$), and believing COVID-19 was serious enough to merit vaccination ($r = 0.478$, $p < 0.001$). The relationship with convenience of being vaccinated ($r = 0.214$, $p < 0.001$) and calculating the pros and cons of vaccination ($r = -0.038$, $p < 0.01$) were lower, and the latter relationship was negative.

Following Norman [15] and Sullivan and Artino [16] we treated our 7-item Likert scale as a continuous variable and used a stepwise multiple regression model employing all five 5-C factors to predict agreement with the willingness to be vaccinated question. Table 2 shows the results of the step-wise multiple regression analysis of the relationship of five factors to willingness to be vaccinated. The R^2 was highly significant.

For the sample as a whole, confidence in the safety of the vaccine was the strongest predictor of willingness to be vaccinated, followed by concern for protecting others and whether or not one believed that COVID-19 was serious enough to warrant vaccination. Multicollinearity was not a factor according to the variance inflation factor (VIF).

Separate multiple regressions were carried out for each demographic and occupation group. All were significant at the < 0.001 level. Confidence in the safety of the vaccine was the strongest predictor for every group. Concern for protecting others was the second strongest predictor for 13 of 15 demographic groups and 8 of 11 occupational groups (excluding “other”). Non-Hispanic Whites, those with 4 year

Table 2 Multiple regression: 5-C factors on willingness to be vaccinated: all respondents (n = 25,855)

R	R square	Adjusted R square	Std. error of the estimate	R square change	F change	df1	df2	Sig. F change
0.763	0.582	0.582	1.555	0.582	7190.577	5	25,853	<0.001

Multiple regression weights for each 5-C factor in predicting willingness to be vaccinated

Variable	B	Std. error	Beta	t	Signif	Partial correlation	Collinearity VIF
Constant	-0.416	0.056		-7.436	<0.001		
Confidence	0.621	0.006	0.549	108.746	<0.001	0.560	1.424
Complacency	0.178	0.006	0.150	31.159	<0.001	0.190	1.091
Convenience	0.014	0.006	0.009	2.138	<0.05	0.013	1.036
Calculation	-0.049	0.006	-0.034	-8.223	<0.001	-0.051	1.733
Concern	0.240	0.007	0.191	36.165	<0.001	0.219	1.577

college degrees, first responders, construction, maintenance and landscape workers and housekeeping, cleaning and janitorial workers all gave greater weight to whether COVID-19 was a serious enough disease to merit vaccination than to concern for protecting others by being vaccinated. Neither convenience of getting vaccinated nor whether one calculated the pros and cons of getting vaccinated was a strong predictor of willingness to be vaccinated. In all cases in which calculation was a significant predictor, the correlation with willingness was negative.

Discussion

Males and non-Hispanic White or Asian respondents were more willing to be vaccinated than females or Hispanic or non-Hispanic Black respondents. Older respondents were more willing to be vaccinated than younger, except that those age 18–34 were more willing than those age 35–54, perhaps because of the large number of students in the younger group (24% compared to 1.1%). The most and least educated groups were most willing to be vaccinated. English as a second language was not associated with greater hesitancy in those whose primary language was Farsi or any of a number of Asian languages.

The low vaccine hesitancy among Hispanics and non-Hispanic Blacks found in this study is important and alarming, especially in the Southwestern US, which has a high Hispanic population and where COVID-19 infection and death rates are higher than for other racial/ethnic groups. Andrafsky and Goldman [17] projected that life expectancy at birth in Hispanics and Blacks in the U.S. decreased as a result of COVID-19 by 3.05 and 2.10 years, respectively, compared to 0.68 years for Whites. Chen et al. [18] reported that, since the pandemic started, in California, excess mortality has been highest among older adults, males, Black and Latino residents, and those without a college degree. Comparing March through April to May through August of 2020, Hispanics and those without a high school degree had the greatest increase in excess deaths. Hispanic excess deaths increased from 16/million to 51/million during this period. That Hispanic and non-Hispanic Blacks were the least willing to be vaccinated among racial/ethnic groups in our study compounds the problem of their vulnerability to the disease.

Vaccine hesitancy has been well studied among health-care workers [6], but there are fewer data available on vaccine hesitancy in other occupational groups, and the present findings provide some insight into a number of occupational sectors, some of which have been given priority in terms of receiving vaccines in the U.S. (e.g., educators, first responders, food service workers). In general, with the exception of first responders, those “white collar” occupations requiring

more education, such as educators, office and professional or technical workers, and healthcare workers were more willing to be vaccinated than those “blue collar” occupations requiring less education, such as housekeeping, cleaning and janitorial, retail and food workers, and homemakers. First responders were an exception, where 74% of them had 4 year or graduate college degrees, yet they were the least willing to be vaccinated of any occupational group, despite being given priority for vaccination in California and many other states.

Willingness to be vaccinated was related most strongly to concerns about the safety of the vaccine across all demographic and occupational groups, and to a lesser extent, with protecting others by being vaccinated and to the question of whether COVID-19 is a serious disease. It was not highly related to convenience of being vaccinated or to whether one said they calculated the risks versus benefits of being vaccinated.

Since carrying out this survey, COVID-19 vaccines have become available. In California, vaccine rates have lagged for Hispanics and Blacks, compared to non-Hispanic Whites and Asians, most recently with rates for Hispanics and Blacks at about half their level of representation in the state’s population [19]. The survey was administered prior to any COVID-19 vaccine being available, and the research of Nguyen [10] showed that vaccine hesitancy within the US declined in December, after the first vaccines were authorized for emergency use. With increasing evidence of the safety of vaccines, it is likely that hesitancy declined among our respondents after the introduction of the vaccines.

The survey that is the basis for this study was carried out as part of an activity by a community vaccine taskforce and the results have provided insights used in the development of approaches to reducing vaccine hesitancy in the local county, particularly directed toward under-vaccinated populations such as Hispanics, food service workers and first responders, all of whom were among the most hesitant in our survey.

Conclusions

Willingness to be vaccinated against COVID-19 varied significantly by gender, age, race/ethnicity, and level of education as well as by occupation. Being Hispanic, non-Hispanic Black, younger, female, first responders or blue collar workers was associated with less willingness to be vaccinated. Nevertheless, some of the same concerns were related willingness to be vaccinated across all groups. Confidence in the safety and efficacy of the vaccine, concern for protecting others and belief in the seriousness of the disease were all associated with greater willingness to be vaccinated. Some of the least willing occupational groups in this study, i.e., first responders and construction, maintenance and

landscape workers and housekeeping, cleaning and janitorial workers, had less belief in the seriousness of the disease. These results provide suggestions about which demographic and occupational groups need to be targeted in efforts to reduce vaccine hesitancy and provide some direction on what issues need to be addressed for each group.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.1007/s10900-021-00987-0>.

Author Contributions All authors participated in the design of the study. CD, AP and C Condon participated in data collection, and data analysis. CD, JQ, KK, and DD participated in implementation of the survey. CD wrote the draft of the paper and all authors, including CC, participated in editing it.

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Declarations

Conflict of interest All the authors declared that they have no conflict of interest.

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