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Public Acceptance of Guidance and Regulations for Space Flight Participation

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Abstract

Space flight participants are not professional astronauts and not subject to the rules and guidance covering space flight crewmembers. Ordinal logistic regression of survey data was utilized to explore public acceptance of current medical screening recommendations and regulations for safety risk and implied liability for civil space flight participation. Independent variables constituted participant demographic representations while dependent variables represented current Federal Aviation Administration guidance and regulations. Odds ratios were derived based on the demographic categories to interpret likelihood of acceptance for the criteria.

Significant likely acceptance of guidance and regulations was found for five of twelve demographic variables influencing public acceptance of one or more areas of guidance and regulations: age, household size, marital status, employment status, and employment class. Increases in age and household size, never married, employed full-time, and self-employed exhibited significance in increased likelihood of acceptance of one or more areas of the guidance and regulations for space flight participation. Findings are intended to inform government regulators and commercial space industries on what guidance and regulations the different demographics of the public are willing to accept.

Keywords: acceptance, demographics, space flight participant, space tourism

Introduction

Commercial space flight participation is of current public interest, spurred by recent milestones and publicized events. In acknowledging the term *space flight participant*, Weibel (2020) makes a succinct argument that "tourism is passive, while space flight participants see themselves as explorers—active, productive, willing to experience danger for the greater good, and helping to create an intensely believed-in future that will benefit humankind" (p. 10). Prior studies have researched public demand, consumer volumetrics, and financial possibilities (Musselman & Hampton, 2020). Public acceptance research itself had previously focused on novel technological advances analyzed via technology acceptance modeling, theory of planned behavior, and user experience modeling. Utilization of ordinal logistic regression (OLR) presents a unique and innovative approach to quantitatively investigate public acceptance of medical screening guidance, safety risk, and implied liability regulations to gauge the viability and marketability of public access to space. In addressing

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its budgetary limitations, the National Aeronautics and Space Administration (NASA) noted the desirability of a "continuous U.S. human presence in low-Earth orbit (LEO)—both with government astronauts and private citizens—in order to support the utilization of space by U.S. citizens, companies, academia, and international partners and to maintain a permanent American foothold on the nearest part of the space frontier" (NASA, 2019, p. 1).

Commercial space tourism is seen as a steppingstone to the eventual colonization of the space environment. Title 14-Aeronautics and Space, Code of Federal Regulations (14 CFR) is devoted to the commercial space launch industry, detailing requirements for space flight participation safety risk and implied liability. The Federal Aviation Administration (FAA) published *Guidance for Medical Screening of Commercial Aerospace Passengers*, recommending space flight participants file a personal medical screening questionnaire, receive a physical exam, and undergo medical laboratory testing (Antuñano et al., 2006). Current FAA medical screening guidance is nonbinding with general recommendations based on suborbital or orbital flight, and the gravitational load induced upon participants. FAA medical screening recommendations are as follows (Antuñano et al., 2006):

- Suborbital aerospace flight passengers should complete a simple questionnaire about their medical history but are not required to undergo a physical examination or complete medical laboratory testing.
- Orbital space flight passengers should complete a comprehensive medical history questionnaire, physical exam, and medical laboratory tests. They should also complete an abbreviated preflight medical interview and physical examination within two weeks of departure.

Statement of the Problem

There is currently no quantitative research concerning public acceptance of existing guidance and regulations for space flight participation. For the purpose of this research, *acceptance* refers to a level of agreement or sentiment of support for a variable under study. It has been projected that there will be progressive growth in commercial space travel as the industry matures (Beard & Starzyk, 2002; Chang, 2017; Springer, 2012). Spector (2020) noted "further research is required to understand the relationship between demographics and space travel intentions" (p. 505).

Research Questions

This study surveyed acceptance of current space flight participant guidance and regulations regarding medical screening, safety risks, and implied liabilities and assessed how these perceptions may differ based on targeted demographic variables. This research examined the following exploratory questions:

- What demographic factors significantly influence public acceptance of safety risks, liability, and medical screening for space flight participation?
- How do these demographic factors affect public acceptance of the safety risks, liability, and medical screening for space flight participation?

Limitations and Assumptions

FAA guidance for medical screening only addresses orbital and suborbital space flight. The population of respondents was assumed to be at least moderately interested in space tourism, the major sciences, and current space events. Use of an online survey tool assumes participants were honest in their demographic representation. As there was no tangible or intangible motive connected with responding in any particular way, respondents were implicitly expected to provide their true responses.

Methodology

Research Method Selection

A survey research design was determined to be the most optimal due to the need to gather a large number of broad representations in a short amount of time (Vogt et al., 2012). Independent variables (demographics) were drawn from U.S. Census Bureau data, while dependent variables (acceptance of medical screening, safety risk, and implied liability) were drawn directly from 14 CFR part 460 and FAA medical screening guidance. The demographic variables utilized and characteristics are summarized in Table 1.

Population/Sample

This research utilized a cross-sectional approach over a three-week period. Demographic characteristics were compared against the U.S. Census Bureau's (2021) QuickFacts, which provided current government-conducted census attributes to ascertain if the sample's demographic characteristics were representative of the general population. Demographic variables were examined relative to acceptance of requirements and recommendations for space flight participation within a randomized sampling frame of U.S. residents aged 18 years or older as supplied by SurveyMonkey web services Audience panelists. SurveyMonkey Audience allows for participant targeting per specified demographic inputs. SurveyMonkey notifies Audience panelists that they match criteria for selected research and are invited to participate (SurveyMonkey, 2018).

Table 1
Dependent demographic variable characteristics.

Variable name	Level of measurement	Response type
Sex	Categorical	Binary
Age	Continuous-ratio	Numerical (18–99+)
Marital status	Categorical	Multiple choice
Race	Categorical	Multiple choice
Region	Categorical	Multiple choice
Highest level of education achieved	Categorical	Multiple choice
Household size	Continuous-ratio	Numerical (1–9+)
Number of children	Continuous-ratio	Numerical (1–4+)
Employment status	Categorical	Multiple choice
Income	Continuous-ratio	Numerical ($0–$250,000+ annually)
Work sector	Categorical	Multiple choice
Class of employment	Categorical	Multiple choice

Demographic survey representations collected within the calculated sample size were checked against U.S. Census Bureau (2021) QuickFacts data for proximal generalizability of percentages. The sample reflected a 95% confidence interval with a 5% margin of error. According to the U.S. Census Bureau (2021), there are currently 255,200,383 U.S. residents aged 18 years or older. Cochran's sample size formula (Glen, 2021), shown in Equation (1), enumerated the target sample size of 385 participants:

$$n_0 = \frac{Z^2 \times pq}{\varepsilon^2} \qquad (1)$$

The sample was linked by demographic percentages, a form of demographic balancing, as drawn from the available pool of SurveyMonkey Audience panelists to reflect the broader demographic representation of the U.S. population. This allowed for flexibility in gathering a convenience sample without strict adherence to pure quota ratios.

An e-mail to prospective SurveyMonkey Audience participants provided a link to the survey instrument. Participants electing to take part were presented with an electronic consent form and instructions on how to complete the questionnaire. Participants affirmed if they were U.S. residents and at least 18 years of age, and were then presented with questions to gather demographic information before utilizing 7-point Likert scale responses regarding acceptance of space flight participation medical screening, safety risk, and implied liability.

Institutional Review Board

Embry-Riddle Aeronautical University guidelines were adhered to before conducting the online survey. Institutional Review Board application processes were reviewed, and final approval granted. Informed consent was utilized, and voluntary participation noted by way of participants accepting the consent parameters. No unique participant identifiers were catalogued ensuring anonymity of participants.

The research collected participants' demographic information and their acceptance ratings of specific criteria. Care was taken in question design to mitigate any distress or discomfort to participants while engaging the questionnaire. Participants had the opportunity to discontinue at any time. No physical, psychological, financial, or any other type of harm to participants could be reasonably anticipated in this research and no direct interaction with the participants was likely.

Measurement Instrument

OLR was determined to be feasible as Cochran's sample size formula prescribed a minimum of 385 participants for analysis. Independent demographic variables utilized were continuous or categorical. The dependent acceptance variables utilized Likert scale ordinal numbers. Flexibility in utilizing Likert items and scales allows for composite response formulation and variable scoring methods (Boone & Boone, 2012). A 7-point Likert scale was utilized with observations scored via the degree of agreement to disagreement by the following indicators: (1) *strongly disagree*, (2) *disagree*, (3) *somewhat disagree*, (4) *neither agree nor disagree*, (5) *somewhat agree*, (6) *agree*, and (7) *strongly agree*.

Continuous-ratio independent variables constitute survey participants' age, household size, number of children, and income. Categorical independent variables captured participants' sex, marital status, race, highest level of education achieved, region, employment status, work sector, and class of employment. Survey respondents were asked to respond to the statements listed below, as reflected in current FAA guidance and regulations, using a 7-point Likert scale which served as ordinally ranked dependent variables:

Liability

- Space flight participants must execute a reciprocal waiver of claims with the FAA/DOT. The reciprocal waiver of claims is an official acknowledgment by the space flight operator, crew members, and space flight participant to hold each other harmless (absolves all parties of any liability) from bodily injury or property damage sustained, resulting from space flight and launch activities, regardless of fault.

Safety Risk

- Space flight participants must be made aware of the known hazards and risks that could result in serious injury, death, disability, or total/partial loss of physical and mental function.
- Space flight participants must be made aware that there are unknown hazards.
- The operator must inform space flight participants that the U.S. Government does not certify launch/reentry vehicles as safe for carrying crewmembers or space flight participants.
- Space flight participants must be informed of the safety records (i.e., accidents and incidents) of all private and U.S. Government launch/reentry vehicles.
- Space flight participants must be given the opportunity to ask questions.

Medical Screening

- Space flight participants must fill out and file a medical history questionnaire to disclose any pre-existing medical conditions, history of illness or surgeries, and current medications which may result in death or injury during space flight or compromise the health and safety of other participants.
- The medical history questionnaire will also record participant height, weight, and blood pressure.
- Space flight participants must undertake general medical tests which will assess overall physical health, urinalysis, hearing, and vision screening.
- An electrocardiogram (EKG) will be required to record participants' heart electrical activity and give an overview of cardiac health.

Data Analysis Approach

Descriptive statistics were analyzed from IBM SPSS output to include the measures of central tendency (mean, median, and mode) and measures of variability (standard deviation) for independent variables, and acceptance of the dependent variables. OLR is an extension of logistic regression modeling by which probabilities are ascertained by examination of the dependent variables (Adejumo & Adetunji, 2013). OLR analysis was determined to be the most advantageous for this research because of the use of ranked interval Likert response units, categorical and continuous independent variables.

Independent variables are used in OLR to predict the acceptance factors by demographics as the formula of the odds ratio will form a regression model, as shown in Equation (2):

$$Log\,1/(Y-1) = b_0 + b_1X_1 + b_2X_2 + b_3X_3 \ldots b_nX_n \qquad (2)$$

Coefficients are used to calculate cumulative predictive probability odds from the logistic regression model for each case. The odds ratio for a variable utilized in OLR represents a change in the odds per one-unit increase in that variable, holding all other variables constant (Fagerland & Hosmer, 2016).

Model fitting information demonstrates if the model improves the ability to predict the outcome, showing how well the model fits the data. It is statistically significant when $p < 0.001$. The goodness-of-fit statistic is interpreted in terms of non-failure to reject the null results when the output is less than 0.05. Pseudo R-square measures calculate the continuous outcome variables such that the model explains a specified percentage of the variance in the dependent variable. The test of parallel lines analyzes the proportional odds assumptions by testing the null results that the odds for each explanatory variable are consistent across different thresholds of the outcome variable and is not statistically significant when less than 0.05. Parameter estimates calculate the log-odds ratios. To determine the odds ratio from the log-odds ratio, one must exponentiate the variable estimate value by the location variable in a parameter estimates table to derive the necessary odds ratio and upper and lower 95% confidence intervals (Lund & Lund, 2018).

The test of parallel lines utilizes the -2 log likelihood statistic to compare the fitted location model to a varying location parameters model and binomial logistic regression by demonstrating significance in differences within the test of parallel lines table to determine if the model is a good fit. To determine if independent variables have statistically significant effects on the dependent variables, the p values are examined to see if they are less than the significance level and thus provide enough evidence to reject the null results (Garson, 2014).

Four assumptions must be conditionally satisfied for OLR analysis. The first assumption is that the dependent variables are measurable at the ordinal level by way of ranking, such as utilized in Likert response ratings. The second assumption constitutes the need for independent variables be continuous, interval, ratio, or categorical (Adejumo & Adetunji, 2013). This assumption is satisfied by demographic variable inputs being treated as continuous-ratio or categorical.

The third assumption is that no multicollinearity exists between categorical independent variables. Multicollinearity is tested through logistic regression where coefficients for tolerance and variance inflation factors (VIFs) can be analyzed to ascertain if two or more independent variables are highly correlated.

The final assumption regards the assumption of proportional odds and involves odds ratio testing each independent

Table 2
Comparison of survey participants demographics and U.S. Census Bureau data.

	Survey participant median value	Survey participant SD	U.S. Census Bureau median value
Age (in years)	45.00	16.923	38.50
Household size (number of occupants including participant)	2.00	1.566	2.62
Number of children residing with participant	0.00	1.139	0.56
Annual income (in U.S. dollars)	60,000	54,814	62,843

Note. $n = 607$ for survey participants; median values for U.S. Census Bureau from U.S. Census Bureau (2021) *QuickFacts*. Retrieved from https://www.census.gov/quickfacts/fact/table/US/PST045218

variable to ensure an identical effect is apparent at each cumulative split of the ordinal dependent variable. An odds ratio gives the change in odds for a unit increase in continuous and categorical predictor variables. Another interpretation is that odds ratio denotes the constant effect of a predictor variable on the chances that one outcome will occur. IBM SPSS tests this in a full likelihood ratio test which compares the fitted location model to a model with varying location parameters and separate binomial logistic regressions on cumulative dichotomous dependent variables (Lund & Lund, 2018). The proportional odds assumption presumes that odds ratios are the same across categories, derived by exponentiating the coefficients. Multinomial logistic regression then estimates a separate binary logistic regression model for each dummy variable generated in the third assumption for conducting OLR. The result is $Y - 1$ binary logistic regression models. Each one defines the effect of the predictor variables on the probability of success in that category compared to the reference category (Grace-Martin, 2021). As each model has its own intercept and regression coefficients, the predictor variables can demonstrate a differing effect for each category.

Reliability was checked by examination of Cronbach's alpha for internal consistency of the dependent variables. Content validity is assured as survey statements are drawn directly from 14 CFR and FAA medical guidance (Antuñano et al., 2006). Criterion validity was assessed by the test of parallel lines which compares the proportional odds model to a model with varying location parameters, which are supposed to be similar across response categories. The goodness-of-fit statistic also assessed validity by factoring if the sample data represent the expectations of the actual population. OLR odds ratio exponents of the demographic categories allow for comparative predictive analysis regarding the acceptance of the criteria. External validity was ensured as survey participant demographic characteristics were compared to current U.S. Census Bureau (2021) QuickFacts database for parity and general representativeness.

Results

A total of 650 survey responses were collected over three weeks. Incomplete and nonqualifying respondents who failed to meet screening requirements were removed resulting in 607 useable response sets remaining for further analysis (296 males, 311 females, mean age = 46.25, SD = 16.924).). Survey respondents and U.S. Census Bureau differences in collected continuous variable data are noted in Table 2.

Independent categorical variables compared the percentages and frequencies of survey participants with U.S. Census Bureau values. As shown in Table 3, the percentages represented parity such that generalizability of the results for the U.S. population was inferred.

The acceptance question *space flight participants must be made aware that there are unknown hazards* received the highest mean at 6.0. The acceptance question *requiring space flight participants execute a reciprocal waiver of claims* received the lowest mean score at 4.74. No other dependent variable mean responses ranked below a 5.00 score. Standard deviations for all ranged from 1.423 to 1.75.

Each acceptance question was analyzed utilizing OLR, polytomous universal modeling (PLUM), and general linear (GENLIN) models to interpret the effects of the independent variables on dependent variables. Categorical independent variable odds ratios were utilized to interpret the likelihood of acceptance on singular dependent variables. Odds ratios and their significance indicate whether the effect was more likely, less likely, or there was no effect on acceptance of the dependent variable. Continuous variables (e.g., age, measured in full years) interpret how a single unit increase or decrease in that variable (e.g., a one-year increase or decrease in age) associates with the odds ratio of the dependent variable having a higher or lower value.

Because the models utilized many categorical independent variables and categories, covariate patterns generated warnings in SPSS output that there were 3636 (85.7%) cells with zero frequencies. Comparison of individual odds ratios in GENLIN and PLUM model output identified identical odds ratios per each model. However, the assumption of proportional odds was not readily apparent, as assessed by full likelihood ratio tests comparing the fit of proportional odds location models to models with varying location parameters. For example, in the PLUM assessment for the first dependent variable regarding *execution of a reciprocal waiver of claims*, $x^2(225) = 364.749$, $p < 0.001$.

Table 3
Survey participant versus U.S. Census Bureau demographic percentages.

Independent variables		**Survey respondent frequency**	**Survey respondent %**	**U.S. Census Bureau %**
Race	White	468	77.1	76.3
	Black/African American	49	8.1	13.4
	American Indian/Native Alaskan	8	1.3	1.3
	Asian	52	8.6	5.9
	Pacific Islander/Native Hawaiian	5	0.8	0.2
	Two or more races	25	4.1	2.8
Sex	Male	296	48.8	49.2
	Female	311	51.2	50.8
Highest level of education achieved	Less than 8th grade (no diploma)	5	0.8	0.8
	9th–12th grade (no diploma)	5	0.8	0.8
	High school diploma or equivalent	78	12.9	21.5
	Some college (no associates or 4-year degree)	134	22.1	17.2
	Associate degree	67	11.0	6.4
	Bachelor degree	194	32.0	15.0
	Master degree	85	14.0	6.3
	Professional degree (such as DDS or JD)	26	4.3	1.5
	Doctorate (such as PhD or EdD)	13	2.1	1.0
Marital status	Never married	184	30.3	46.0
	Married	319	52.6	38.8
	Divorced	64	10.5	9.0
	Separated	11	1.8	1.5
	Widowed	29	4.8	4.6
U.S. region	Northeast	119	19.6	17.8
	Midwest	140	23.1	21.8
	South	213	35.1	38.5
	West	135	22.2	21.8
Employment status	Full time	328	54.0	60.6
	Part time	102	16.8	13.4
	Not working	177	29.2	22.4
Class of employment	Not applicable/not working	161	26.5	0.0
	Employee of a private company	236	38.9	80.0
	Self-employed	76	12.5	5.8
	Private not-for-profit	36	5.9	0.2
	Local/state/federal employee	98	16.1	14.0
Work sector	Not applicable/not working	147	24.2	0.0
	Agriculture and related industries	11	1.8	1.5
	Mining	3	0.5	0.4
	Construction	26	4.3	4.9
	Manufacturing	34	5.6	7.9
	Wholesale trade	8	1.3	3.7
	Retail trade	49	8.1	9.7
	Transportation and utilities	18	3.0	4.0
	Information	25	4.1	1.7
	Financial activities	24	4.0	5.7
	Professional and business services	31	5.1	13.2
	Education and health services	105	17.3	15.1
	Leisure and hospitality	16	2.6	8.7
	Other services	72	11.9	4.9
	Government worker	38	6.3	14.2

Note. Data derived from U.S. Census Bureau (2021) and U.S. Bureau of Labor Statistics (2021).

This result was similarly displayed across the remaining nine dependent variables' output. It is important to note that while the assumption of proportional odds is an indicator of accuracy, it can be sensitive to outliers, volume of data, volume of response categories, and similarities between response categories (Garson, 2014). Nevertheless, the output demonstrates a degree of predictive quality and quantifies numerical relationships between variables.

Lacking readily apparent proportional odds, an examination of proportional odds was conducted via separate binomial logistic regressions which compared and contrasted proportionality of odds by the categorical splits between variable responses. Some variables demonstrated issues with odds ratios as the cumulative splits fell outside subjective determinations to violate the assumption of proportional odds. Odds ratios should not differ significantly at each different categorical threshold; therefore, the assumption of proportional odds for certain variables was not tenable. Continuous independent variables all met the assumption of proportional odds within the test for multicollinearity as they were not highly correlated.

The goodness-of-fit statistic indicates how well the model fits the data based on how well the data are predicted by the model and corresponds to the data actually collected (Field, 2014). The deviance goodness-of-fit statistic indicated that the model was a good fit to the observed data for the question pertaining to *space flight participants must execute a reciprocal waiver of claims with the FAA/DOT*: $x^2(3585) = 2141.79$, $p = 1.000$. At issue with the deviance significance statistic is perfect model representation ($p = 1.000$). This condition is prevalent when there are many cells with zero frequencies and small expected frequencies, as is the case with the SPSS statistical model output (Lund & Lund, 2018).

The likelihood ratio test looks at the change in model fit when comparing a full model to an intercept-only model by examining the difference in the -2 log likelihood between them as an x^2 distribution with degrees of freedom equal to the difference in the number of parameters (Lund & Lund, 2018). The final model demonstrated statistical significance in predicting dependent variables over and above the intercept-only model, $X^2(45) = 78.645$ to 119.060, $p < 0.001$, except for the dependent variable involving *space flight participants must execute a reciprocal waiver of claims with the FAA/DOT* which had a $p > 0.001$. Pseudo R-square Nagelkerke output calculated the continuous outcome variables such that the model explains 11.8% to 19.0% of the variance in the dependent variables. Pseudo R-square Cox and Snell output similarly explains 11.5% to 17.8% of variance in the dependent variables.

Cronbach's alpha was utilized to test reliability of the survey instrument. This was appropriate to the research as the dependent variables utilized Likert scale responses. Internal consistency of the survey instrument was favorable at $a = 0.934$.

The test of parallel lines, which is a key determinate for the assumption of proportional odds, compares model fit between two differing cumulative odds models. The proportional odds model is listed as a "null hypothesis" and a cumulative odds model without the proportional odds assumption is listed as "general," where the slope coefficients are allowed to differ for each cumulative logit (Lund & Lund, 2018). In each instance, the results indicated that differences between the two models were large and statistically significant ($p < 0.05$), which warranted interpreting the proportionality of odds utilizing separate binomial logistic regressions on cumulative dichotomous dependent variables to affirm validity. Comparisons of the odds ratios were fragmented between the dichotomous categorical splits. While there were proportional odds ratios between certain categories, they were few in number per the dependent variables. These findings do, however, indicate the best demographic variable factors to determine acceptance among guidance and regulations for space flight participation.

A linear regression test for collinearity diagnostics was run to check for multicollinearity. As demonstrated in Table 4, tolerance values were greater than 0.1 (the lowest is 0.401), and VIF values were less than 10, indicating no collinearity within the data set.

Cumulative odds OLR with proportional odds were run to determine the effect of independent demographic variables on dependent Likert-scale ordinal variables. Odds ratios greater than 1.000 suggest an increased likelihood of acceptance of the dependent variable as values on the independent variable increase. Odds ratios less than 1.000 suggest a decrease in likelihood of acceptance with increases in the independent variable. Odds ratios equal to 1.000 suggest there will be no predictive change in likelihood of being in a higher value as the values on the independent variable increase. In the following paragraphs, only outputs

Table 4
Test for multicollinearity.

Coefficient collinearity statistics		
Independent variable	**Tolerance**	**VIF**
The race you identify with is:	0.950	1.053
The sex you identify as is:	0.903	1.108
What is the highest level of education you have completed?	0.795	1.258
Your current age is:	0.685	1.460
Your marital status is:	0.778	1.286
What is your household size (number of occupants including yourself in your home)?	0.401	2.491
How many children reside with you?	0.412	2.430
In which region of the United States do you reside?	0.979	1.021
What is your employment status?	0.512	1.952
What is your class of employment?	0.600	1.668
What is your work sector?	0.480	2.083
What is your annual income?	0.741	1.350

that presented categories of significant findings ($p \leq 0.05$) and increased likelihood of acceptance (odds ratios greater than 1.000) are presented.

Liability

Regarding *space flight participants must execute a reciprocal waiver of claims with the FAA/DOT*, deviance goodness-of-fit statistic indicated that the model was a good fit to the observed data, $x^2(3585) = 2141.791$, $p = 1.000$. Per the likelihood ratio test, the final model predicted the dependent variable over and above the intercept-only model, $x^2(45) = 74.152$, $p < 0.004$. An increase in household size was associated with an increase in the odds of acceptance, with an odds ratio of 1.180, 95% CI [1.015, 1.371], Wald $x^2(1) = 4.644$, $p = 0.031$. Per this dependent variable, the more people that reside with a potential space flight participant, the more likely they will accept this regulatory requirement.

Safety Risks

Regarding the question *space flight participants must be made aware of the known hazards…*, deviance goodness-of-fit statistic indicated that the model was a good fit to the observed data, $x^2(3585) = 1574.167$, $p = 1.000$. The likelihood ratio test indicated the final model predicted the dependent variable over and above the intercept-only model, $x^2(45) = 109.224$, $p < 0.001$. In the instance of this dependent variable, there were no categories that indicated greater likelihood of acceptance (odds ratio greater than 1.000) and demonstrated significance ($p < 0.050$). While the model demonstrated a good fit to the data provided, there were no discernable categories of significance which contributed to likely acceptance of this dependent variable.

For the dependent variable *space flight participants must be made aware that there are unknown hazards*, deviance goodness-of-fit statistic indicated that the model was a good fit to the observed data, $x^2(3585) = 1544.393$, $p = 1.000$. The likelihood ratio test indicated the final model predicted the dependent variable over and above the intercept-only model, $x^2(45) = 81.247$, $p < 0.001$. The odds of category marital status never married being more likely to accept this dependent variable was 2.349, 95% CI [0.999, 5.522] times that of the reference category marital status widowed, a statistically significant effect, Wald $x^2(1) = 3.833$, $p = 0.050$. An increase in age (expressed in years) was associated with an increase in the odds acceptance, with an odds ratio of 1.012, 95% CI [1.000, 1.025], Wald $x^2(1) = 3.828$, $p = 0.050$. For this dependent variable, those potential space flight participants most likely to accept this regulatory requirement will not have been married. Likewise, as participant age increases, the likelihood of acceptance is also expected to increase.

Regarding *the operator must inform space flight participants that the U.S. Government does not certify launch/reentry vehicles as safe for carrying crewmembers or space flight participants*, deviance goodness-of-fit statistic indicated that the model was a good fit to the observed data, $x^2(3585) = 1736.557$, $p = 1.000$. The likelihood ratio test indicated the final model predicted the dependent variable over and above the intercept-only model, $x^2(45) = 98.149$, $p < 0.001$. An increase in age (expressed in years) was associated with an increase in the odds acceptance, with an odds ratio of 1.017, 95% CI [1.005, 1.030], Wald $x^2(1) = 7.858$, $p = 0.005$. Regarding this dependent variable, the older a potential spaceflight participant is, the more likely they are to accept this regulatory requirement.

Model fit of *space flight participants must be informed of the safety records…* as reflected by deviance goodness-of-fit statistic indicated that the model was a good fit to the observed data, $x^2(3585) = 1672.723$, $p = 1.000$. The likelihood ratio test indicated the final model predicted the dependent variable over and above the intercept-only model, $x^2(45) = 88.252$, $p < 0.001$. The odds of category employment status full time being more likely to accept this dependent variable was 2.625, 95% CI [1.112, 6.199] times that of the reference category employment status not working, a statistically significant effect, Wald $x^2(1) = 4.849$, $p = 0.028$. This dependent variable demonstrates that spaceflight participants that have full-time employment status are most likely to accept this regulatory requirement over other employment status categories.

Regarding *space flight participants must be given the opportunity to ask the space flight operator questions*, deviance goodness-of-fit statistic indicated that the model was a good fit to the observed data, $x^2(3585) = 1573.326$, $p = 1.000$. The likelihood ratio test indicated the final model predicted the dependent variable over and above the intercept-only model, $x^2(45) = 119.060$, $p < 0.001$. An increase in age (expressed in years) was associated with an increase in the odds acceptance, with an odds ratio of 1.017, 95% CI [1.004, 1.029], Wald $x^2(1) = 6.997$, $p = 0.008$. Per this dependent variable, increase in potential space flight participant age is a key factor to consider regarding likelihood of acceptance.

Medical Screening

Per *space flight participants must fill out and file a medical history questionnaire…*, the deviance goodness-of-fit statistic indicated that the model was a good fit to the observed data, $x^2(3585) = 1606.960$, $p = 1.000$. The likelihood ratio test indicated the final model predicted the dependent variable over and above the intercept-only model, $x^2(45) = 78.645$, $p < 0.001$. The odds of category employment class self-employed being more likely to accept this dependent variable was 2.712, 95% CI [1.353, 5.435] times that of the reference category employment class local/state/federal employee, a statistically significant effect, Wald $x^2(1) = 7.908$, $p = 0.005$. This dependent variable

Table 5
Summary of significant findings.

Ranked order: likelihood of acceptance	Odds ratio	Demographic variable	Dependent variable
1	2.712	Self-employed	Medical history questionnaire
2	2.625	Full-time employment	Informed of safety records
3	2.388	Full-time employment	General medical tests
4	2.349	Never married	Aware there are unknown hazards
5	1.180	Household size	Execute waiver of claims
6a	1.017	Age	Launch vehicle certification
6b	1.017	Age	Opportunity to ask questions
7	1.012	Age	Aware there are unknown hazards

Note. There was no significant likely acceptance found for the following dependent variables: made aware of known hazards, provide height, weight, and blood pressure, and electrocardiogram (EKG) required.

demonstrates that potential space flight participants who are self-employed are more likely to accept this guidance over others in the same category.

Model fit of *space flight participants will be required to provide their height, weight, and blood pressure in their medical history questionnaire* per the deviance goodness-of-fit statistic indicated that the model was a good fit to the observed data, $x^2(3585) = 1656.650$, $p = 1.000$. The likelihood ratio test indicated the final model predicted the dependent variable over and above the intercept-only model, $x^2(45) = 111.187$, $p < 0.001$. In the instance of this dependent variable, there were no demographic categories that indicated greater likelihood of acceptance (odds ratio greater than 1.000) and demonstrated significance ($p < 0.050$).

Regarding the question *space flight participants must undertake general medical tests which will assess overall physical health, urinalysis, hearing, and vision screening*, deviance goodness-of-fit statistic indicated that the model was a good fit to the observed data, $x^2(3585) = 1660.622$, $p = 1.000$. The likelihood ratio test indicated the final model predicted the dependent variable over and above the intercept-only model, $x^2(45) = 89.451$, $p < 0.001$. The odds of category employment status full time being more likely to accept this dependent variable was 2.388, 95% CI [1.018, 5.598] times that of the reference category employment status not working, a statistically significant effect, Wald $x^2(1) = 4.008$, $p = 0.045$. For this dependent variable, potential space flight participants that are currently employed full time are more likely to accept this guidance than others in the same category.

Model fit of the final question regarding *an electrocardiogram (EKG) will be required to record the participant's heart electrical activity and give an overview of cardiac health* per the deviance goodness-of-fit statistic indicated that the model was a good fit to the observed data, $x^2(3585) = 1676.374$, $p = 1.000$. The likelihood ratio test indicated the final model predicted the dependent variable over and above the intercept-only model, $x^2(45) = 92.656$, $p < 0.001$. In the instance of this dependent variable, there were no categories that indicated greater likelihood of acceptance (odds ratio greater than 1.000) and demonstrated significance ($p < 0.050$).

A rank ordering of the odds ratios, demographic variables, and the corresponding dependent variables are shown in Table 5. It should be noted that the demographic "age" ranked the lowest with it being tied for sixth position. The remainder of the demographic variables and associated odds ratios indicate the most likely acceptance factors for space flight participation guidance and regulations.

Discussion

This research represents an innovative union of survey instrumentation and quantitative analysis to explore significant public acceptance of current medical screening guidance, safety risks, and implied liability regulations for space flight participation. Utilization of demographic categories to predict odds ratios for acceptance factorization is a unique and novel approach to assess potential populations inclined to partake in commercial space flight.

The answer to the first research question was determined by identifying those demographic variable categories of significance with increased likeliness odds ratios for acceptance of the dependent variable (i.e., regulations or guidance). While three of the dependent variables had no significant odds ratios associated with acceptance, the remainder demonstrated specific acceptance effects relative to demographics for various space flight participation guidance and regulations. The second research question was answered by inferences drawn from the OLR output and statistical assumptions. Acceptance of the dependent variables depends upon interpretation of the results in a broader context as applied to the general population.

The demographic variable pertaining to *space flight participants must execute a reciprocal waiver of claims with the FAA/DOT* showed that per a one-unit increase in household size, participants would exhibit a 1.180 odds ratio increase in acceptance of this guidance. As a significant finding over other categories, it demonstrates the importance of larger households' likelihood to accept this guidance for space flight participation. There may be a correlation between either a household with many children, multigenerational housing situation, or having many non-family residents in one domicile that increases likely acceptance of this dependent variable.

Significant odds ratio output regarding *space flight participants must be made aware that there are unknown hazards* was found with those of a marital status category of never having been married with an odds ratio of 2.349. A one-unit increase in age also demonstrated an acceptance effect on this dependent variable with an odds ratio of 1.012. These differences in the ratios show that while both are significant factors for acceptance of this guidance, those that have never married demonstrate a substantial increase in likelihood for acceptance. Alone or in combination, these two demographic categories demonstrate acceptance of this guidance greater than other categories.

The dependent variable regarding *operator must inform space flight participants that the U.S. Government does not certify launch/reentry vehicles* showed that per a one-unit increase in age, a 1.017 odds ratio was associated with acceptance of this guidance. Increase in age was also a factor in likely acceptance of the dependent variable *space flight participants must be given the opportunity to ask the space flight operator questions* with a 1.017 odds ratio as well. This demonstrates that as the population becomes more mature, acceptance of these regulations for space flight participation is likely to increase.

Regarding acceptance of the guidance *space flight participants must be informed of the safety records*, survey participants who had full-time employment status were likely to be more accepting than other categories with a 2.625 odds ratio. Full-time employment status was also a key to likely acceptance of *space flight participants must undertake general medical tests*, as a 2.388 odds ratio was presented in the output. This demonstrates that job security and steady income are key contributors to acceptance of these dependent variables.

A significant odds ratio for likely acceptance of *space flight participants must fill out and file a medical history questionnaire* was found with those who were self-employed. The odds ratio of acceptance was 2.712, demonstrating that survey participants who were independent and confident in their workplace employment class were more likely to accept this guidance to partake in space flight.

The three dependent variables which had no significant odds ratios for likely acceptance relative to demographic variables included *space flight participants must be made aware of the known hazards*, *will be required to provide their height, weight, and blood pressure in their medical history questionnaire*, and *an electrocardiogram (EKG) will be required to record the participant's heart electrical activity*. The lack of significant likely acceptance of these dependent variables indicates that the population has no particular regard for the acceptability of these guidance and regulations. Significant likely acceptance of dependent variables for space flight participation medical screening guidance, safety risk, and liability regulations could be found in demographics which aligned with increases in age and household size, those who never married, full-time employed and those self-employed.

The findings revealed specific factors that industry and regulators can focus on to increase overall public acceptance of the requirements and recommendations for spaceflight participants as construed in current regulations and guidance. The commercial space tourism industry could utilize the findings in this research to align their marketing towards those members of the public who have demographics more likely to accept current guidance and regulations for space flight participation. The findings indicate that the marketing efforts should generally focus on individuals who are older, single, and employed. Regulators and policymakers can utilize the findings to expand acceptability to broader demographic representations by considering amendments to regulations and revisions to the guidance that were less likely to be accepted by specific demographic groups, which was generally marked by individuals who are less educated (bachelor degree or below), Asian or Pacific Islander/Native Hawaiian, reside with multiple children, and inhabitants of the Midwest or Southern regions of the United States.

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