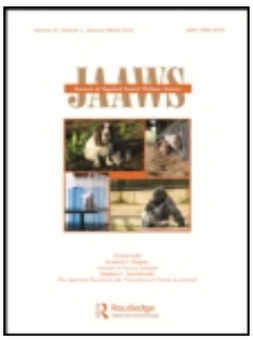

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Analysis of Dog Adoption Success and Failure Using Surveys With Vignettes

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ABSTRACT

Adoption success of dogs who serve as companion animals was analyzed via surveys with vignettes. The researchers administered surveys with vignettes to animal shelter employees, veterinarians, and other animal-care professionals in Eastern North Carolina. Logistic and linear regression analyses were used to identify variables that were perceived to influence adoption success. Dog size, personality, behavior, and level of obedience training were found to be significant perceived influencers of adoption success. Prospective caregiver characteristics such as gender and level of activity were shown to be perceived as significant. Guidance on the practical use of the logistic regression model is provided, and limitations of the study are described.

KEYWORDS

Companion animals; dog adoption; dog relinquishment; survey; vignettes; statistical models

Each year, millions of companion animals enter shelters in the United States. According to the American Society for the Prevention of Cruelty to Animals (ASPCA), nearly 4 million of these nonhuman animals are dogs. Of these dogs, approximately one third are adopted by new caregivers, one third are returned to their original caregivers, and one third are euthanized (ASPCA, n.d.). Of the dog adoptions, approximately 15% to 20% are unsuccessful (Diesel, Pfeiffer, & Brodbelt, 2008; Neidhart & Boyd, 2002). Our objective in this study was to identify dog and potential caregiver characteristics that are perceived by animal welfare practitioners (e.g., veterinarians, veterinarian staff, animal shelter employees, etc.) to be significant predictors of adoption success or failure. Our focus was on characteristics that are identifiable at the time of the adoption. For example, we included characteristics such as the observed behavior of the dog. This characteristic would likely be known by adoption employees. We did not include whether the new caregiver observed poor behavior, as this would be observed after the adoption had taken place.

This focus on characteristics that are known at the time of adoption potentially allows for an immediate assessment of adoption success probability as a prospective caregiver considers adoption of a particular dog. This type of assessment would be of considerable value to adoption personnel, as it may allow for matching prospective caregivers with dogs in such a way as to maximize adoption success probability. We conclude by giving guidance on selecting an appropriate success probability threshold. Potential dog adoptions with predicted success probabilities lower than the threshold may prompt adoption personnel to provide recommendations to the prospective caregivers. The limitations of this study are also described.

We began with an examination of the relevant animal adoption literature. Pertinent literature typically resides in one of two streams. In one stream, adoption successes and failures are considered. In this literature, adoptions are tracked from the time of adoption through a specified period of time, typically 6 months after adoption. The characteristics of dogs and caregivers for both successful and unsuccessful adoptions are then collected and analyzed. In the other prevalent stream of literature, dogs are studied upon caregiver relinquishment to animal shelters. Dog and caregiver characteristics are then

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evaluated to identify characteristics that may be typical in the case of relinquishment. Characteristics of dogs who were not relinquished and of the caregivers of these unrelinquished dogs are not included in these studies. In our work in this article, the adoption success stream of literature is more closely aligned with our objectives. However, both literature streams are valuable for identifying characteristics for inclusion in our study.

A study by Kidd, Kidd, and George (1992) is among the early studies of dog adoption success and failure. In this research, the authors surveyed companion-animal adopters in San Francisco, CA, 6 months after adoption. The authors concluded that adopters having children in the home and having or previously having had companion animals influenced adoption success. Having children in the home was found to negatively influence adoption success due to improper expectations placed on both the animal and the children. Having or having had companion animals in the home was found to positively influence adoption success. Men were also found to reject adopted companions at a higher rate than women.

In 2005, Diesel et al. (2008) examined the success of dog adoptions at 14 adoption centers in the United Kingdom. The caregivers of 4,500 adopted dogs from the centers were sent and responded to a questionnaire 6 months after adoption. The purpose of the questionnaire was to determine whether the caregivers still had the dogs. If the caregivers had relinquished ownership of the dogs, they were asked about their reason(s) for relinquishment. The researchers included 93 variables in their analysis. Of these, 40 were found, via univariate logistic regression, to be significant or weakly significant ($p \leq .10$) predictors of adoption success. Variables that were found to be significant or weakly significant predictors included dog age; dog size; information from the previous dog caregiver related to the duration owned and care; dog behavior (including with other companion animals and with children); and information regarding behavior, care, and other factors reported by the new caregiver. Most of the variables (26 of 40) were related to characteristics and other observations that were made after the dog was adopted.

Diesel et al. (2008) also conducted a multivariate logistic regression analysis using the significant and weakly significant variables from their univariate models. They noted that medium- (10–25 kg) and large-sized (>25 kg) dogs were almost twice as likely to have unsuccessful adoptions compared with small (<10 kg) dogs. Behavioral issues (reported by the new caregiver) were a primary driver of adoption failure, with aggression toward humans increasing the likelihood for an adoption failure by more than a factor of 10. Caregivers having young children was also shown to be a significant predictor of adoption failure.

Several studies have also been used to examine factors that led to dog adoptions; however, the authors did not consider the ultimate success of the adoptions. In work by Siettou, Fraser, and Fraser (2014), the researchers indicated that dog age, size, appearance (pedigree and coat length), and behavior (toward children, toward other companion animals, and amount of training) were significant factors that predicted whether a dog would be adopted. Diesel, Smith, and Pfeiffer (2007) performed a similar analysis related to the length of time a dog would wait to be adopted and found similar characteristics to be significant predictors. Other studies that support these characteristics as being important include Lepper, Kass, and Hart (2002), Normando et al. (2006), and Posage, Bartlett, and Thomas (1998).

There are a number of articles in the literature related to the relinquishment of dogs. For example, Coe et al. (2014) provided a thorough review of the state of the animal relinquishment literature. Earlier studies include work by Arkow and Dow (1984). They studied dog relinquishments at 13 shelters in the United States and indicated that companion-animal behavior issues, particularly those related to other companion animals and children, were drivers that led to animal adoption failures. Salman et al. (1998) confirmed these results in a separate study of 12 shelters in the United States and also noted that the majority of relinquished animals had not been exposed to obedience training prior to adoption. Shore (2005) studied 78 animal adopters in the Midwestern United States who experienced failed adoptions and noted that adoptions often failed due to behavioral issues related to children and other companion animals. Diesel, Brodbelt, and Pfeiffer (2010) examined the characteristics of 2,806 dogs who had been relinquished by their caregivers in the United Kingdom. Behavioral issues including attention-seeking behavior by the dogs toward their caregivers were cited as significant factors that led to relinquishment.

From our review of the literature, a common theme emerges. There are several variables that are consistently described in the literature as potential contributors to adoption failure or dog relinquishment. Variables of particular interest include those related to dog behavior, dog age, and dog size. We incorporated these and other variables into our work.

Materials and methods

We selected the use of surveys with vignettes as our data collection tool. A vignette study is an experimental approach used to survey respondent perceptions related to a specific combination of researcher-determined variables. These variables are typically presented via "a short, carefully constructed description of a person, object, or situation, representing a systematic combination of characteristics" (Atzmüller & Steiner, 2010, p. 128). Surveys with vignettes have been used in a variety of contexts. For example, several early studies used vignettes to examine the social status of urban families (Nosanchuk, 1972; Rossi, Sampson, Bose, Jasso, & Passel, 1974). More recent studies using vignettes have considered topics such as student cheating (Rettinger, Jordan, & Peschiera, 2004) and bioethics (Ulrich & Ratcliffe, 2007).

We chose to use vignettes for two primary reasons. First, the level of experimental control when using vignettes tends to be greater than when using a traditional survey. The abstraction and ambiguity that can be characteristic of a traditional survey is replaced by concrete and carefully constructed detail (Alexander & Becker, 1978). Second, animal shelters and dog adoption organizations in Eastern North Carolina do not typically maintain high-quality records of dog adoption successes and failures. What records may exist are not maintained in a standardized format and/or are not readily accessible, which makes it difficult to use historical adoption and relinquishment records for analysis.

Table 1 shows the 10 variables for this study from which the survey vignettes were constructed. A brief description of the variables (as provided to the survey takers) is also included. We selected

Table 1. Survey variables and descriptions.

Variable	Levels and description
Dog size	Small (less than 20 lb)
	Medium (20–60 lb)
	Large (more than 60 lb)
Dog age	Juvenile (younger than 2 years old)
	Adult (2–6 years old)
	Old (older than 6 years old)
Dog personality	Shy (reserved or nervous in the company of people and/or other animals)
	Confident (self-assured, readily accepts human leadership that is firm/consistent)
	Outgoing (friendly, sociable, and desires social interaction and human attention)
Dog handling	Submissive (accepts and yields to authority)
	Compliant (inconsistent in behavior to agree and obey)
	Resistant (refuses to comply with authority)
Dog obedience	No obedience training (knows no commands)
	Some obedience training (knows basic commands)
	Advanced obedience training (knows commands beyond basic commands)
Gender of caregiver	Male
	Female
Will leave dog alone	Rarely
	Sometimes
	Often
Children in home	Yes
	No
Other companion animals in the home	Yes
	No
Caregiver activity level	Inactive (rarely exercises)
	Somewhat active (exercises several days per week)
	Very active (exercises daily or nearly daily)

Mary has adopted a small, adult dog. The dog has an outgoing personality, is resistant when handled, and has received advanced obedience training.
Mary's work schedule ensures that the dog will often be alone.
Mary has no children and does not have other pets.
Mary is a somewhat active individual who goes on occasional walks or runs.

Do you believe that this adoption will be successful? (Circle One) Yes No

How likely is the adoption to be successful? (0 to 100).
Write your number in the box to the right. [ ]

Figure 1. Sample survey vignette and survey questions.

variables for inclusion in the survey that were prevalent in the literature and that could potentially be assessed at the time of adoption. Additionally, we asked for the survey respondents to indicate their gender and job description.

An Excel spreadsheet tool was designed to create the random values of the variables and to stitch the values into a coherent series of vignettes.

Each respondent was then asked whether they believed the adoption depicted in the vignette would be successful. A response was forced by presenting the respondent with two choices: "Yes" and "No." The respondents were then asked to assign an adoption success score from 0 (indicating unsuccessful) to 100 (indicating successful) to indicate how likely it would be that the adoption depicted in the vignette would be successful. Figure 1 shows a sample survey vignette created by the Excel tool.

A total of 102 surveys, each with 8 randomly generated vignettes, were distributed to employees at animal shelters, animal adoption agencies, veterinary facilities, and other animal-care facilities in eastern North Carolina. Facilities were chosen at random. Surveys were then distributed to all available employees at each facility. Of the distributed surveys, 50 surveys were completed and returned for a survey return rate of 49%. The vignette evaluations from each survey were entered into a spreadsheet for analysis. Of the 400 vignettes evaluated by survey respondents, 25 were discarded because the respondent either left the questions unanswered or chose to assign nonsensical evaluations to their vignettes. For example, one respondent whose responses were discarded assigned adoption success scores of 100 to each of the vignettes presented to him or her but then indicated that several of these vignettes would not result in a successful adoption. This data cleaning left 375 vignette evaluations in the final data set for analysis.

We used the survey responses to then develop a series of models to predict adoption success and adoption success scores. The first models that we built were univariate logistic regression models to predict adoption success and univariate linear regression models to predict adoption success scores. Additionally, we evaluated interaction terms between the variables. Variables and interaction terms in these models with p values $\leq .10$ (significant or weakly significant) were then added to the first multivariate models (referred to as Model 1 for adoption success and Model 1b for adoption success scores). Stepwise regression with backward elimination was then utilized to remove variables and improve the Akaike information criterion (AIC; Akaike, 1974) values of the models. The resulting models are referred to as Model 2 for adoption success and Model 2b for adoption success scores. We also built multivariate logistic and linear regression models with all of the variables (Models 3 and 3b) and then used stepwise regression with backward elimination to improve the AIC values of the models (resulting in Models 4 and 4b).

The best of the multivariate logistic regression models was subjected to the Hosmer Lemeshow goodness-of-fit test (Hosmer & Lemeshow, 2013). A receiver-operating characteristic (ROC) curve for the best model was constructed, and the area under the curve (AUC) was calculated. In the Discussion section, we describe the selection of an appropriate probability threshold value and the implications of such selection for model accuracy, sensitivity, and specificity.

The adjusted R-squared statistic was used to evaluate the goodness of fit for the linear regression models. We also constructed logistic and linear regression models to assess the impact of survey respondent

characteristics (gender and job description) on both adoption success and the adoption success score. All analyses were conducted with the *R* statistical computing software (R Core Team, 2013).

Results

Descriptive statistics

Of the 375 vignettes presented to and evaluated by the survey respondents, 316 were identified by the respondents as likely to be successful adoptions. Therefore, the adoption success rate from the vignettes was 84.3% (failure rate of 15.7%). Figure 2 shows the distribution of adoption success scores for the 375 vignettes. The mean adoption success score was 71.4 with a median score of 75.0. The distribution of scores is negatively skewed. The mean adoption success score for adoptions classified as successes was 78.6, and for adoptions classified as failures, the mean score was 33.1.

Logistic regression models

In the Materials and Methods section, we described the development of logistic regression models to predict adoption success. A univariate logistic regression model for each variable and 4 multivariate models were constructed. From the 10 univariate models constructed, six variables were shown to be significant or weakly significant predictors of adoption success. No interaction terms were shown to be significant. Table 2 shows the variables that were found to be significant or weakly significant ($p < .10$) in the univariate models.

The significant and weakly significant variables from Table 2 were then placed in a multivariate model (Model 1). Stepwise regression with backward elimination was then used to generate Model 2. As noted in the Materials and Methods section, all variables were used and then stepwise regression with backward elimination was applied to generate Models 3 and 4, respectively. Table 3 shows which

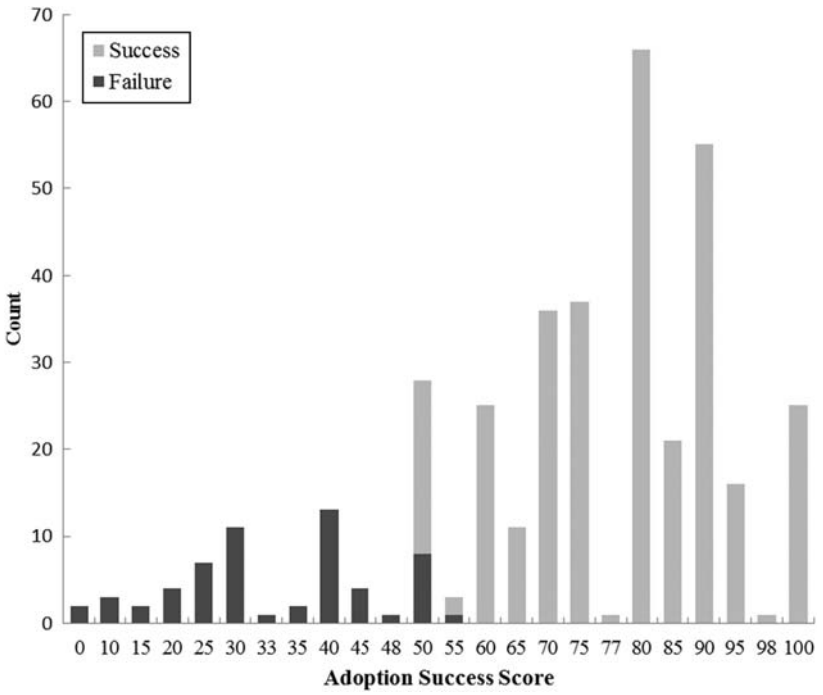

Figure 2. Distribution of adoption success scores.

Table 2. Summary of variable significance for univariate logistic regression models for adoption success.

Variable name and levels	Odds ratio	95% confidence interval for odds ratio	*p* value
Dog age			
Juvenile	1.00		
Adult	0.37	[0.16, 0.80]	.02
Old	0.91	[0.38, 2.10]	.84
Dog size			
Small	1.00		
Medium	0.96	[0.49, 1.88]	.90
Large	0.83	[0.42, 1.66]	.60
Dog personality			
Shy	1.00		
Confident	1.28	[0.67, 2.43]	.45
Outgoing	1.70	[0.81, 3.64]	.17
Dog behavior when handled			
Submissive	1.00		
Compliant	1.97	[0.85, 5.14]	.13
Resistant	0.60	[0.33, 1.09]	.09
Dog obedience training			
None	1.00		
Some	1.77	[0.91, 3.48]	.09
Advanced	1.25	[0.63, 2.51]	.53
Caregiver gender			
Female	1.00		
Male	1.76	[0.99, 3.24]	.06
How often dog is left alone			
Rarely	1.00		
Sometimes	0.90	[0.42, 1.86]	.77
Often	0.41	[0.20, 0.83]	.01
Caregiver has children			
No	1.00		
Yes	0.68	[0.39, 1.19]	.18
Caregiver has other companion animals			
No	1.00		
Yes	0.92	[0.52, 1.65]	.78
Caregiver level of activity			
Inactive	1.00		
Somewhat active	1.93	[1.00, 3.75]	.04
Very active	1.88	[0.94, 3.85]	.08

Note. Underlined text indicates the variable is significant or weakly significant at $p < .10$.

variables were significant or weakly significant ($p < .10$) in the multivariate models. Note that this table does not indicate which variables were included in the models, only which variables were ultimately found to be significant. AIC values for the models are also presented.

The best of the multivariate models (in terms of AIC) was Model 4. Table 4 shows the results (odds ratios, confidence intervals for the odds ratios, and *p* values of the model variables) of the logistic

Table 3. Summary of variable significance and Akaike information criterion (AIC) values for multivariate logistic regression models for adoption success.

Variable	Model 1	Model 2	Model 3	Model 4
Dog size			X	X
Dog age				
Dog personality			X	X
Dog behavior when handled	X	X	X	X
Dog obedience training		X		X
Caregiver gender			X	X
How often dog is left alone	X	X	X	X
Caregiver has children			X	X
Caregiver has companion animals				X
Caregiver activity level			X	X
Model AIC =	318.3	311.8	306.5	303.1

Note. X indicates the variable is significant or weakly significant at $p < .10$.

Table 4. Results of multivariate logistic regression analysis (Model 4).

Variable name and levels	Odds ratio	95% confidence interval for odds ratio	*p* value
Dog size			
Small	1.00		
Medium	0.27	[0.08, 0.74]	.02
Large	0.21	[0.07, 0.57]	<.01
Dog personality			
Shy	1.00		
Confident	6.70	[2.01, 25.88]	<.01
Outgoing	6.33	[2.14, 21.00]	<.01
Dog behavior when handled			
Submissive	1.00		
Compliant	3.12	[1.03, 10.15]	.05
Resistant	0.26	[0.08, 0.72]	.02
Dog obedience training			
None	1.00		
Some	2.83	[1.04, 7.82]	.04
Advanced	1.96	[0.73, 5.56]	.19
Caregiver gender			
Female	1.00		
Male	2.00	[0.92, 4.48]	.08
How often dog is left alone			
Rarely	1.00		
Sometimes	1.40	[0.37, 5.51]	.62
Often	0.16	[0.05, 0.47]	<.01
Caregiver has children			
No	1.00		
Yes	0.39	[0.16, 0.97]	.03
Caregiver has other companion animals			
No	1.00		
Yes	0.52	[0.23, 1.16]	.11
Caregiver level of activity			
Inactive	1.00		
Somewhat active	0.72	[0.28, 1.85]	.49
Very active	2.76	[1.06, 7.50]	.04

regression analysis for this model. This model had an AIC of 306.5. The Hosmer Lemeshow goodness-of-fit test for this model did not indicate a lack of fit ($p = .13$), and the ROC curve for this model (see Figure 3) had an AUC value of 0.80.

Linear regression models

Univariate linear regression models for each variable were also developed to predict the adoption success score. Table 5 shows which of the variables in these univariate models were found to be significant or weakly significant ($p < .10$). The significant and weakly significant variables in Table 5 were then used to construct a multivariate linear regression model (Model 1b) and stepwise regression with backward elimination to develop an additional multivariate model (Model 2b). A multivariate model with all variables (Model 3b) was constructed. Stepwise regression with backward elimination was applied to this model to generate a new model (Model 4b). Table 6 shows the significant and weakly significant variables in the multivariate models. An adjusted *R*-squared value for each of these models is also presented. As with the logistic regression models, Table 6 shows only the significant and weakly significant variables and does not indicate all of the variables that were included in each model.

Models 3b and 4b were found to be the best multivariate linear regression models to predict adoption success scores. Both models featured the same significant variables and the same adjusted *R*-squared values. The stepwise regression with backward elimination removed the insignificant dog-age variable from Model 3b to generate Model 4b. Table 7 shows the regression coefficients, confidence intervals for the regression coefficients, and *p* values for the variables for Model 4b.

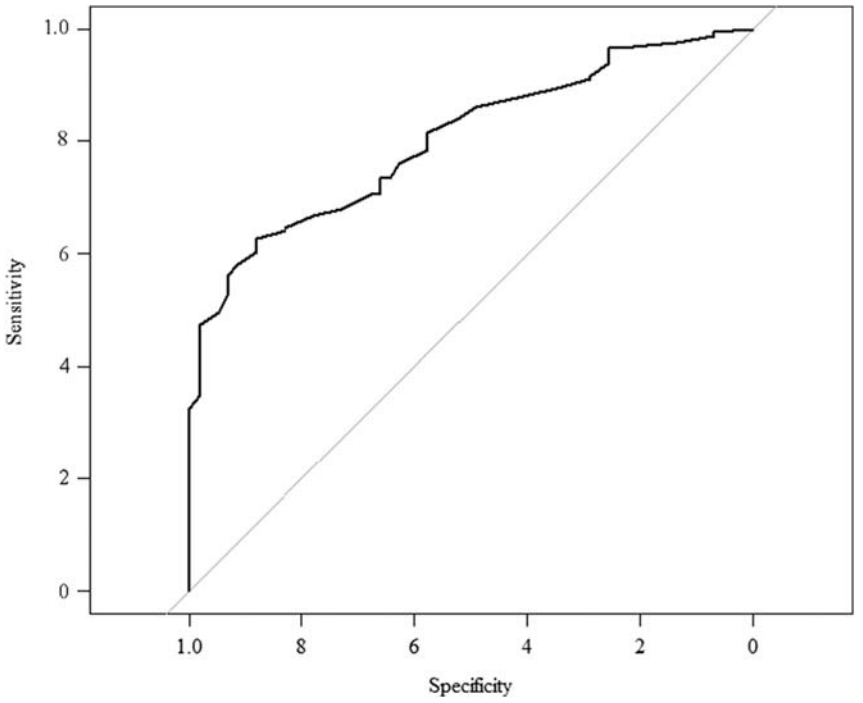

Figure 3. Receiver-operating characteristic curve for Model 4.

Other models

Logistic and linear regression models were also developed to determine if survey respondent characteristics (gender and job description) impacted adoption success and the adoption success scores. When holding all other variables constant, there was no significant effect from either gender or job description on adoption success or the adoption success scores.

Discussion

We analyze the results of the multivariate logistic and linear regression models (Models 4 and 4b) and discuss the implications of these models. We also describe the selection of a probability threshold for the logistic regression model. In addition, we suggest how such a threshold could be used by dog adoption personnel to target some prospective adoptions for additional scrutiny.

The odds ratios from the logistic regression analysis in Table 4 indicate the effect on the odds of adoption success for the various levels of each variable in Model 4. Odds ratio values that are less than 1 for a particular level indicate that level is perceived to reduce the odds of a successful adoption. Likewise, odds ratios greater than 1 suggest a perception of an enhanced likelihood of adoption success.

As expected, dog characteristics related to behavior and size were perceived to have the greatest impact on the odds of adoption success. For example, the odds of a successful adoption increase by more than sixfold for a dog who is confident or outgoing versus a dog with a shy personality. Likewise, a dog who is compliant when handled is 3 times more likely to be successfully adopted than a dog who is submissive. A submissive dog is nearly 4 times more likely to have a successful adoption than a dog who is considered resistant to handling. Dogs with at least some obedience training were significantly more likely to be in a successful adoption. In addition, medium- and large-sized dogs were approximately 4 times less likely to be in a successful adoption than were small dogs.

Table 5. Summary of variable significance for univariate linear regression models for adoption success score.

Variable name and levels	Coefficient	95% confidence interval for coefficient	*p* value
Dog age			
Juvenile	0.00		
Adult	−7.26	[−12.98, −1.53]	.01
Old	0.68	[−4.87, 6.22]	.81
Dog size			
Small	0.00		
Medium	−0.48	[−5.62, 4.66]	.85
Large	1.40	[−3.97, 6.77]	.61
Dog personality			
Shy	0.00		
Confident	−1.21	[−6.36, 3.93]	.64
Outgoing	2.07	[−3.56, 7.69]	.47
Dog behavior when handled			
Submissive	0.00		
Compliant	3.09	[−2.36, 8.55]	.27
Resistant	−7.07	[−11.95, −2.19]	<.01
Dog obedience training			
None	0.00		
Some	4.71	[−0.45, 9.87]	.07
Advanced	6.61	[1.01, 12.20]	.02
Caregiver gender			
Female	0.00		
Male	4.42	[0.09, 8.75]	.04
How often dog is left alone			
Rarely	0.00		
Sometimes	−5.08	[−10.07, −0.09]	.04
Often	−12.98	[−18.39, −7.58]	<.01
Caregiver has children			
No	0.00		
Yes	−3.76	[−8.06, 0.54]	.09
Caregiver has other companion animals			
No	0.00		
Yes	−2.46	[−6.92, 1.99]	.28
Caregiver level of activity			
Inactive	0.00		
Somewhat active	5.95	[0.78, 11.13]	.02
Very active	6.45	[0.94, 11.95]	.02

Note. Underlined text indicates the variable is significant or weakly significant at $p < .10$.

Male caregivers were perceived to be twice as likely to have a successful adoption as female caregivers, although the *p* value for this variable is slightly greater than .05. Interestingly, this stands in contrast to the finding from Kidd et al. (1992). A caregiver who leaves the adopted dog alone often was perceived to experience a reduced likelihood for a successful adoption. A similar effect was perceived

Table 6. Summary of variable significance and adjusted *R*-squared values for multivariate linear regression models for adoption success.

Variable	Model 1B	Model 2B	Model 3B	Model 4B
Dog size			X	X
Dog age				
Dog personality			X	X
Dog behavior when handled	X	X	X	X
Dog obedience training	X	X	X	X
Caregiver gender				
How often dog is left alone	X	X	X	X
Caregiver has children	X	X	X	X
Caregiver has other companion animals			X	X
Caregiver activity level	X	X	X	X
Model adjusted R-squared =	.13	.14	.19	.19

Note. X indicates the variable is significant or weakly significant at $p < .10$.

Table 7. Results of multivariate linear regression analysis for Model 4b.

Variable name and levels	Coefficient	95% confidence interval for coefficient	*p* value
Dog size			
Small	0.00		
Medium	−8.23	[−13.889, −2.57]	<.01
Large	−8.83	[−14.83, −2.81]	<.01
Dog personality			
Shy	0.00		
Confident	17.53	[10.23, 24.83]	<.01
Outgoing	16.53	[0.35, 23.70]	<.01
Dog behavior when handled			
Submissive	0.00		
Compliant	10.72	[4.30, 17.13]	<.01
Resistant	−6.70	[−12.53, −0.88]	.02
Dog obedience training			
None	0.00		
Some	5.61	[−0.39, 11.61]	.07
Advanced	11.39	[5.11, 17.66]	<.01
Caregiver gender			
Female	0.00		
Male	4.49	[−0.35, 9.33]	.07
How often dog is left alone			
Rarely	0.00		
Sometimes	−5.27	[−12.84, 2.30]	.17
Often	−21.40	[−28.36]	<.01
Caregiver has children			
No	0.00		
Yes	−6.90	[−11.60, −2.19]	<.01
Caregiver has other companion animals			
No	0.00		
Yes	−6.21	[−11.22, −1.19]	.02
Caregiver level of activity			
Inactive	0.00		
Somewhat active	−0.35	[−6.38, 5.67]	.91
Very active	12.22	[6.11, 18.33]	<.01

for caregivers with children. Lastly, caregivers who are very active were perceived to be almost 3 times more likely to experience a successful adoption than an inactive caregiver.

The accuracy, sensitivity, and specificity of Model 4b (the best logistic regression model in this work) are highly dependent on the selection of an appropriate threshold value (T). We used the ROC curve from Model 4 (Figure 3) and Table 8 (which shows how accuracy, sensitivity, and specificity vary with T) to guide the selection of an appropriate value for T. Potential adoptions with a model-predicted success probability less than T would be classified as unsuccessful. Adoptions with success probabilities greater than T would be classified as successful. However, before selecting a value of T, we had to

Table 8. Variation of accuracy, sensitivity, and specificity for threshold values, *T*.

Threshold (*T*)	Accuracy	Sensitivity	Specificity
.0	.84	1.00	.00
.1	.85	.99	.01
.2	.85	.99	.01
.3	.85	.99	.01
.4	.85	.99	.01
.5	.85	.99	.01
.6	.85	.97	.03
.7	.83	.94	.06
.8	.79	.84	.16
.9	.54	.45	.55
1.0	.16	.00	1.00

Table 9. Hypothetical evaluation of prospective caregiver and dog matching.

Variable	Example 1	Example 2	Example 3
Dog size	Large	Small	Small
Dog personality	Confident	Shy	Outgoing
Dog behavior when handled	Compliant	Submissive	Resistant
Dog obedience training	Some	None	Some
Caregiver gender	Male	Male	Female
How often dog is left alone	Sometimes	Often	Often
Caregiver has children	No	Yes	Yes
Caregiver has other companion animals	No	No	Yes
Caregiver level of activity	Somewhat	Somewhat	Very active
Probability of adoption success	.99	.36	.72
Adoption success score	91.40	45.34	62.65

consider which of the classification quality metrics (accuracy, sensitivity, or specificity) was most appropriate for this work.

We argue that a dog adoption classification model with good specificity is preferable to a model with either good accuracy or sensitivity. A model with high specificity may tend to overclassify results as negative (unsuccessful adoptions in our case). The alternative is a model with high sensitivity in which results are overclassified as positive (successful adoptions in our case). From Table 8, we note that a threshold value of $T = .90$ leads to a model accuracy of .54, sensitivity of .45, and specificity of .55. With this value of T, any potential dog adoption with a model-calculated success probability less than .90 was classified as "unsuccessful." By potentially overclassifying such adoptions as unsuccessful, an adoption agency could target these potential adoptions for action to improve the likelihood for adoption success. For example, prospective caregivers could be steered toward a dog who might have a higher likelihood of adoption success. Prospective caregivers could also be made aware of available resources such as dog obedience classes.

The best of the linear regression models (Model 4b) to predict adoption success scores largely agreed with the results of Model 4. Dog size was shown to significantly influence the adoption success score. Medium- and large-sized dogs were found to decrease the success score. Dog personality and behavior were also significant. A dog with a better personality or with better behavior increases the success score, while a dog with a poor personality or poor behavior drives the score downward. Having some obedience training improves the adoption success score. Often leaving a dog alone results in the largest change in the predicted success score with a score decrease of greater than 21. As in Model 4, an adoptive caregiver with children or other companion animals resulted in decreased success scores. Similarly, caregiver level of activity was significant in that when the caregiver was very active, the adoption success score was likely to increase.

Table 9 shows the application of Models 4 and 4b to three hypothetical prospective caregiver/dog combinations. Of these combinations, Examples 2 and 3 have adoption success probabilities that fall below a threshold of $T = .90$. If this is an acceptable threshold, it may be in the interest of the dog adoption agency, as noted earlier, to suggest alternative dogs or obedience training. For example, if the dog in Example 2 receives some obedience training, the probability of the adoption being a success is projected to improve from .36 to .61.

Study limitations

Before implementing the models introduced in this article, it may be useful to consider the potential limitations associated with this work. First, the work was based upon a relatively small sample size derived from a relatively small geographic area. A natural extension of this work would be to increase the number of survey respondents and to obtain respondents from a broad geographic area. Second, one potentially negative aspect of the use of surveys with vignettes is that it is often impractical to

present each survey respondent with each of the possible combinations of variables (Alexander & Becker, 1978). For this project, there were 17,496 unique vignettes or combinations of variables. It would be impossible to present all of these vignettes to each survey respondent and to expect each respondent to carefully read each vignette and answer a series of questions. Therefore, we opted to present each respondent with a set of 8 randomly generated vignettes.

Third, the work was based on the perceptions of animal welfare professionals of hypothetical dog and caregiver characteristics. Although this approach allowed for relatively tight experimental control, it did introduce several potential limitations to the work. Had characteristics from actual dogs and caregivers been presented to the respondents, it then would have been possible to track the adoption of the dog to determine how well the perceptions of the respondent aligned with reality. For example, if the respondent suggested that an adoption was very likely to be successful, did the actual adoption ultimately end up being a success? An avenue of future related work would be to utilize real dog adoptions and present these adoptions to respondents for evaluation. The models presented in this work could then be tested and the results could be evaluated.

Finally, it is possible that the animal welfare professionals who were survey respondents for this work could possess various biases that would potentially influence their responses. For example, a respondent could be overly optimistic that adoptions will be successful due to lack of experience with adoptions or due to an inherent desire to see adoptions succeed. Future work should carefully consider the characteristics of the animal welfare professionals (e.g., amount of training, length of employment, etc.) used as survey respondents. The respondents should be evaluated to determine whether biases exist and what impact such biases may have on perceptions of adoption success.

Conclusions

We described a survey with a vignettes-based approach to the study of dog adoption success and failure. We built a series of logistic and linear regression models to predict adoption success. Variables related to dog size, dog behavior, and several prospective caregiver characteristics were found to be influential when predicting adoption success. We then discussed the selection of a probability threshold for the classification of adoptions as successes or failures. We recommend the use of a high-probability threshold (close to 1) to be conservative and overclassify adoptions as potentially unsuccessful.

A goal of our future work in this area is to develop a decision support tool that would be provided to personnel working with prospective dog adoptions. Such a tool would likely be coupled with a questionnaire to ascertain prospective caregiver characteristics and a professional evaluation of dog characteristics. The tool would then enable matching of prospective caregivers with dogs available for adoption with an objective to maximize the probability of adoption success. Limitations of the work and opportunities for future work were described.

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