DEPARTMENT OF ECONOMICS
JOHANNES KEPLER UNIVERSITY OF LINZ

Gender and Competition:

Evidence from Jumping Competitions

by

René BÖHEIM
Mario LACKNER

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Johannes Kepler University of Linz
Department of Economics
Altenberger Strasse 69
A-4040 Linz - Auhof, Austria
www.econ.jku.at

Mario.Lackner@jku.at
phone +43 (0)732 2468 -5145, -9679 (fax)

Gender and Competition: Evidence from Jumping Competitions *

René Böheim
University of Linz

Mario Lackner
University of Linz

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Abstract

We analyze if female athletes differ from male athletes in their competitive behavior, using data from high jump and pole vault competitions. We estimate if female athletes use risky strategies as often as male athletes and whether or nor their returns to risky strategies differ. Returns to risky strategies are identified via an instrumental variable approach where we use other athletes' declarations as instruments for individual risk taking. We find that women use risky strategies less often than men, although their returns are significantly greater than men's. We also find that women's returns to risky strategies do not differ between relatively low and relatively high risk situations, whereas male athletes' returns decrease in the level of risk. Our results show considerable differences between male and female professional athletes which are likely to be a lower bound of overall gender differences in risk-taking behavior.

JEL Classification: J16, D81.
Keywords: Competition, gender differences, risk preferences

*Department of Economics, Johannes Kepler University Linz, Austria. Corresponding author: Mario Lackner, Johannes Kepler University of Linz, Department of Economics, Altenbergerstr. 69, 4040 Linz, Austria. Ph.: +43 732 2468 5145, fax:+43 732 2468 9679, Mario.Lackner@jku.at. René Böheim, Rene.Boeheim@jku.at, is also affiliated with the Austrian Institute of Economic Research (Vienna), the Austrian Center for Labor Economics and the Analysis of the Welfare State (Linz), CESifo (Munich), IZA (Bonn), and NBER (Cambridge, MA). We are grateful to Eddy Bekkers, Franz Hackl, Rudolf Winter-Ebmer, Christine Zulehner, Martina Zweimüller, and seminar participants in Linz for their valuable comments. Clemens Kozmich and David Steingress provided excellent research assistance.

1 Introduction

Men and women work in different occupations (e.g., Blau and Kahn (2000)), have different probabilities of holding an executive position (e.g., Malmendier and Tate (2009)), and a large body of evidence indicates that they earn different wages for the same jobs (e.g., Bertrand (2010)). The explanations for these differences are highly contested. The standard economic approach suggests that they are caused by specialization and preferences, or because of (statistical) discrimination by employers. Others, for example, Croson and Gneezy (2009), stress that differences in risk aversion, overconfidence or differential responses to incentives cause observed differences between men and women in our societies.

The analysis of the differences in risk-taking associated with competitiveness between the sexes has a strong experimental background, both in the laboratory and in the field. Eckel and Grossman (2008) and Croson and Gneezy (2009) provide surveys on experiments which investigate differences between the genders in their risk taking. The evidence suggests that women are more risk averse than men. Niederle and Vesterlund (2009) suggest that women, at least in the laboratory, "fail to compete" (p1099) and that preferences to compete are "not fully innate". However, results from laboratory may depend on the contextual environment of the experiment. Self-selection of participants into experiments, within-group heterogeneity in traits associated with risk aversion, and comparability of indicators for risk aversion across experiments may provide results that are not fully generalizable (Kamas and Preston, 2012). In addition, Booth and Nolen (2012) find that gender differences in risk aversion are sensitive to how preferences are elicited, suggesting that survey-based research might lead to misleading conclusions.

The second, much less developed, strand of the literature analyzes competitive behavior in the field. Of course, it is more difficult to measure risk taking and associated success outside designed experiments, which explains the scarcity of such studies. One area where this is possible are sporting competitions.[1] Dohmen, Falk, Huffman, Sunde, Schupp and Wagner (2011) show that differences in risk attitudes of men and women are relatively stable across different contexts, in particular for sports or career decisions.

We analyze the strategic risk-taking of athletes who compete in high jump or pole vault competitions. These competitions in the Olympic Games and other international championships have clear competitive settings where athletes are selected on their competitiveness and physical strength. The high jump and the pole vault are disciplines where the choice of a risky strategy, i.e., when athletes pass a height, is objectively verifiable. Passing a height is a risky strategy because athletes face a more difficult challenge at the next height. We analyze if female athletes use risky strategies as often as male athletes, controlling for changes in risk. In addition, we investigate gender-specific returns to risk-taking and estimate the causal effect of risk-taking on subsequent success. We employ an instrumental variable approach where we exploit the exogenous variation in the degree of competition over heights, caused by athletes' choices of different starting heights, to identify the consequences of strategic risk-taking for subsequent success.

Other research that aimed at identifying risk-taking behavior in sports competitions used definitions of risky strategies that relied on expert opinions. Paserman (2007) uses the percentage of "unforced" errors, i.e., errors due to bad judgment, so classified "by courtside statistics-keepers (usually amateur tennis players with a substantial amount of experience in both playing and watching tennis matches)" (p6). The indicator may however indicate both the ability of the player and the aggressiveness of the shot. In addition, differences between female and male players may merely reflect the gender composition of these judges. Gerdes and Gränsmark (2010) use "eight chess experts of different strengths" (p768) to rate the opening move of chess players as aggressive or solid, also relying on subjective interpretations.

[1] Gender differences in risk preferences and competitiveness in other areas, e.g. stock markets (Barber and Odean, 2001) or investment (Dwyer, Gilkeson and List, 2002) have been analyzed. Frick (2010) provides a detailed survey of the literature that focuses on sports.

Niederle and Vesterlund (2009) stress that gender differences that are found in sport competitions might be lower than in non-sport settings since elite athletes typically know their competitors and their relative performance. In addition, differences in risk taking appear to be smaller in single-sex competitions than in mixed-sex settings (Booth and Nolen, 2012). Previous research using sports competitions provide mixed results on the differences in competitiveness of men and women. For example, Frick (2010) finds that women's races in long distance and ultra marathon running were less competitive than men's. In contrast, Dreber, von Essen and Ranehill (2011) and Frick (2011) analyze gender differences in running competitions with experimental identification strategies and find no gender differences in competitiveness.

Our results show considerable differences in strategic risk taking between male and female athletes. Female athletes take too few risky decisions and could improve their outcomes by taking more risks. Because of the extremely competitive environment of professional sports competitions, and the single-sex setting, our estimates are likely to be a lower bound of gender differences in risk-taking behavior. Buser, Niederle and Oosterbeek (2012) show that competitiveness correlates with career choices and can explain a large part of the gender differences in educational choices.

2 Data

We collected data from 36 indoor and outdoor sports events, including Olympic Games, World Championships, and European Championships. These events consist of 252 competitions.[2] The data cover the high jump and the pole vault, including competitions in the pentathlon, the heptathlon, and the decathlon. In total, our data cover 2,904 competition histories of 958 individual athletes from 83 nations. All data were downloaded from `http://www.todor66.com/athletics/index.html,` as well as various individual event

[2] We count jumping competitions in combined disciplines such as the pentathlon, the heptathlon, and the decathlon that are held in two separate groups as separate competitions.

web pages. We obtained information on the competitions, the heights, and competitors. All contests in our data are single-sex competitions on the highest international level of competition.[3]

The high jump is an athletic event in which athletes jump over a horizontal bar placed at measured heights. The International Association of Athletics Federations (IAAF) is the international governing body and specifies the rules for competitions (IAAF, 2011). Before a competition, the judges announce the starting height and the increases. Subsequently, all athletes state their starting height at which they want to enter the competition. Athletes who decide not to attempt the first heights are "sitting out" until the bar is raised to their previously announced starting height.

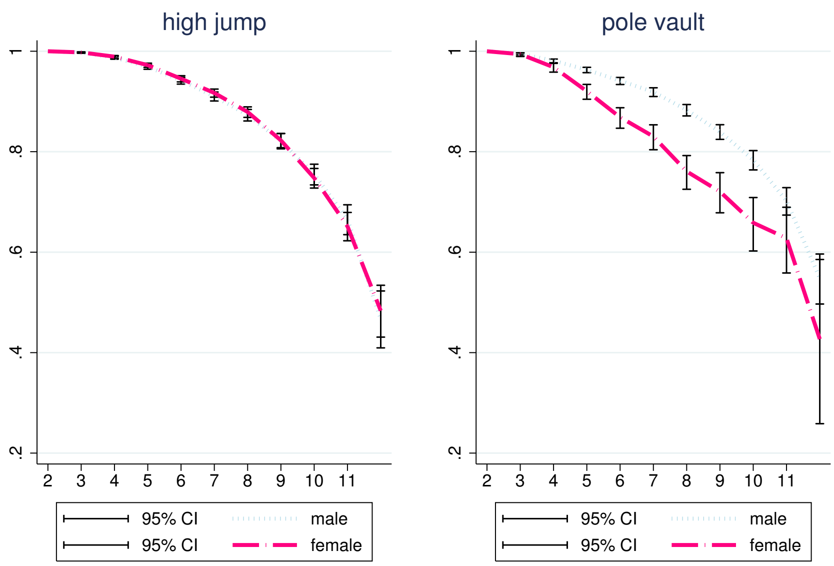
Each athlete has three attempts in jumping over the bar at a given height. If at least two athletes succeed in jumping over the starting height, or athletes are sitting out, the bar is raised. At each attempt, athletes may behave strategically by choosing to defer their remaining attempts to the next higher height, termed a "pass". If the athlete defers one attempt, s/he has only this single attempt at the next height. Should the athlete choose to defer one or more attempts to the next height, s/he is not allowed to lower the bar after a failed attempt at the next height. An athlete is disqualified after three consecutively failed attempts, not counting passes. The athlete who succeeded in jumping over the highest height wins. In the case of a tie, the athlete with the fewest failed attempts at that height is declared the winner. Should this result in another tie, the athlete who had fewer failed attempts among all previous jumps is declared the winner. If this results in another tie, a play-off is held. The pole vault is almost identical to the high jump, however, athletes propel themselves over the bar by means of a flexible pole.

An observation in our data is a single attempt by athlete i at height increase t and at attempt j. Each competition is characterized by a starting height and a predefined height progression. We focus therefore on height increases, counting the starting height as $t = 1$,

[3] Men and women differ in the achieved heights, for example, the current high jump (pole vault) world record is 2.45m (6.14m) for men and 2.09m (5.06m) for women. Weisfeld (1986) reports that women appear to provide less effort in mixed-sex competitions.

rather absolute heights in meters. For each observation, we can potentially observe one of three possible events, clearing the height (O), a failure (X) or a pass (-). On average, athletes compete up to the sixth height increase and there are a maximum of 18 height increases in our data. Figure 1 presents survival curves for female and male athletes for the high jump and the pole vault. Male and female athletes have similar survival rates in high jump competitions. However, their survival differs in pole vault competitions. The survival curves show that female athletes drop out of pole vault competitions slightly earlier than men. Pole vault competitions for women were only as recently as 2000 included in the Olympic Games, making it a relatively young sport for female athletes, which could account for these differences (Dupuy, 2012).

Figure 1: Survival of athletes in high jump and pole vault competitions.

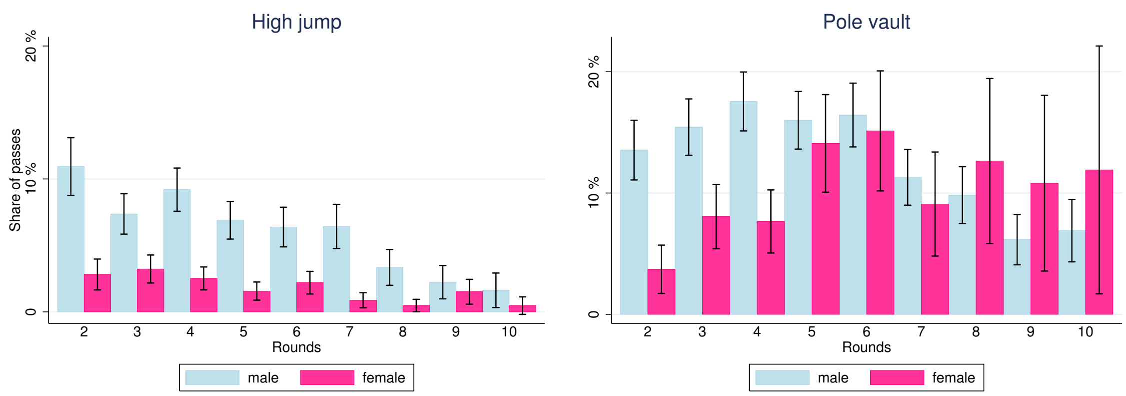


Notes: Survival graphs with 95 % confidence intervals for high jump and pole vault competitions, by sex.

In general, an athlete needs to exert effort when attempting to clear a certain height. This effort costs energy and athletes tire from providing effort. Each attempt carries some risk of injury, which may increase in the number of attempts as the athlete tires. A pass might therefore be interpreted as a way to preserve stamina and health while lowering the overall number of attempts. A pass, however, is also a risky strategy because it makes the next attempt indisputably more difficult as the bar will be raised.

Pre-competition passes are announced before the first athlete's attempt and cannot be based on the competitors' performances during the competition but indicate the athlete's evaluation of his or her ability. In contrast, an athlete who passes during the competition will probably form this decision not only on his or her confidence in jumping over the next height, but possibly also on the competitors' performances and strategies. An athlete's pass might be determined by her or his ability or physical constitution. For example, athletes who tire more quickly from providing effort than other athletes may choose to pass more often.

Figure 2: Frequency of passes, by sport and sex.



Notes: Share of all in-competition passes of all types of attempts (including clears and fails), by height increase, sex, and sport. Excludes pre-competition passes.

Figure 2 tabulates the share of in-competition passes by sport and sex. The Figure shows that female athletes pass less often than male athletes. While this could be a result of different attitudes towards risk, it could also be driven by differences in the distribution of abilities, if, for example, men are on average stronger than women but tire faster. We cannot observe the distribution of abilities directly. Because passes can be used strategically, we cannot conclude from the distributions of achieved heights that the distributions of abilities differ between male and female athletes.

We have therefore obtained data from 7 Olympic long jump competitions, 1984–2008, to investigate if the distributions of abilities differ for male and female athletes. We choose long jump competitions because observed outcomes are a clear indicator of the athletes' abilities. In the long jump, there is no strategic element similar to passes in the high jump. The long jump is not a simultaneous competition as e.g., distance running, where competitors might influence each other directly. Figure 3 plots the distribution of jumped distances for male and female athletes. While the achieved distances clearly differ between men and women, based on a variance-ratio test we cannot reject the null hypothesis that the variances of the jumped distances of male and female athletes are equal (p-value of 0.48 for a two-sided test). The long jump and the high jump have a long tradition in athletics—the pole vault became an Olympic discipline for women only in 2000—and we believe that differences in the propensity to pass between men and women are not due to underlying differences in their distribution of abilities.[4]

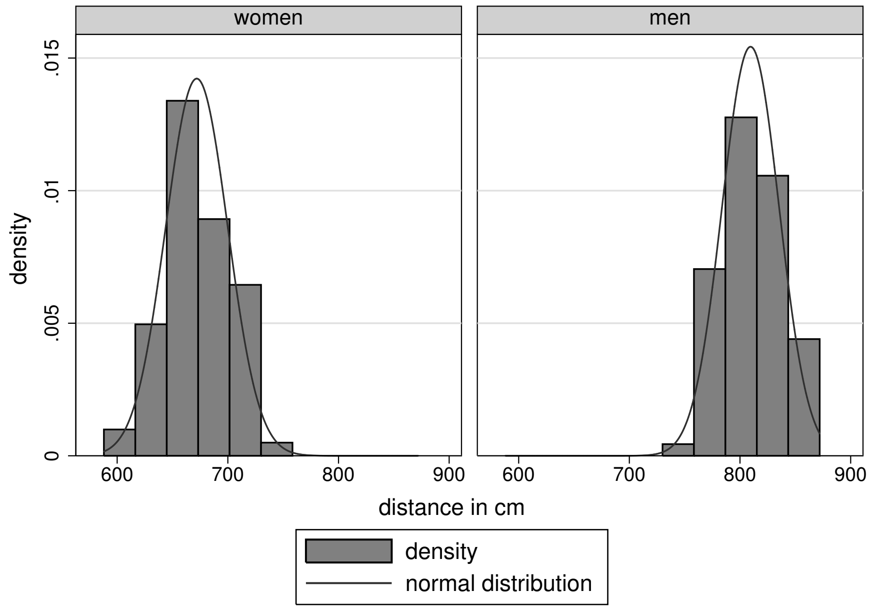
3 Do women pass as often as men do?

We analyze passes from the second height increase onwards, as passes at the starting height are indistinguishable from pre-competition passes. We restrict the analyzes to height increases up to 11 to have a consistent sample with the analyzes that follow below.[5]

[4] Any strategic decision could be influenced by coaches. Coaches could differ systematically for male and female athletes, for example, because coaches for male athletes are better paid or are more respected than coaches for female athletes, and differences in strategic choices might result from these systematic differences. Data on coaches are not available; however, average expenditures for outdoor track and field teams of all US colleges in 2011 indicate that total spending on male teams was slightly lower than for female teams (http://ope.ed.gov/athletics/index.aspx). Since we limit our analyses to the most competitive competitions worldwide, we consider it highly unlikely that systematic differences of coaches for male and female athletes are the reason for our findings.

[5] Our results are robust to the inclusion of all observations above height increase 11.

Figure 3: Distribution of distances in Olympic long jump competitions, by sex.



Notes: Data are from 7 Olympic long jump competitions, 1984–2008, 71 female and 80 male athletes. The means (standard deviations) are 672cm (28cm) for women and 809cm (26cm) for men. A variance-ratio test does not reject the equality of the variances of these two distributions, with F(70,79)=1.18 and a p-value of 0.48 (two-sided).

We estimate the following linear probability model to estimate the chances that an individual may pass:

$$\text{pass}_{itj} = \beta_0 + \beta_1 \cdot sex_i + \xi \cdot \mathbf{X}_{itj} + \varepsilon_{itj}, \tag{1}$$

where *pass* is a binary variable taking the value 1 if an athlete i chooses to pass at any given height t. The variable *sex* is equal to 1 if the athlete is female and 0 if male. The vector X contains a set of control variables, including the number of previous jumps, the number of previous fails, the number of competitors who are competing at the height, and fixed-effects for height and number of attempt, as well as sports and discipline fixed-effects. Table 1 presents the results from estimating the model. The results indicate that in all sports and disciplines women are about 4–6 percent less likely than men to pass.

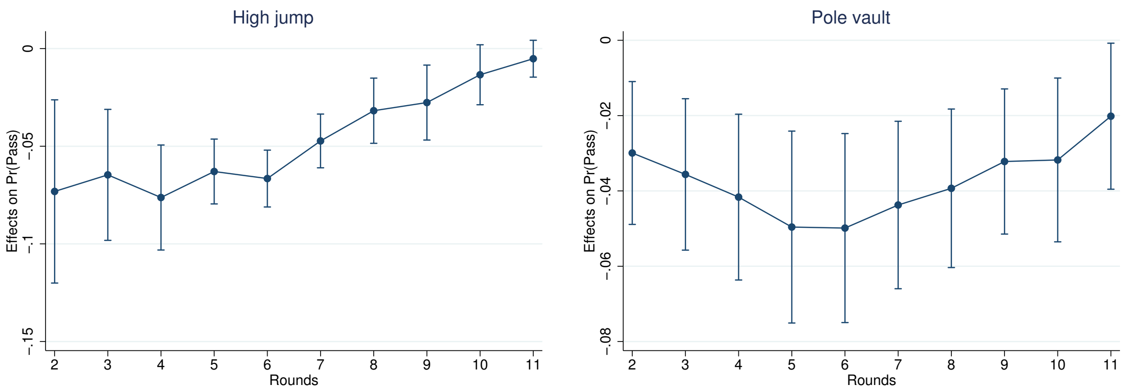
Table 1: Linear probability model—do female athletes pass as often as male athletes do?

	All sports		**High jump**		**Pole vault**		**HJ specialists**		**PV specialists**	
Sex	-0.072***	-0.056***	-0.057***	-0.058***	-0.032***	-0.040***	-0.051***	-0.045***	-0.040***	-0.060***
	(0.004)	(0.005)	(0.004)	(0.005)	(0.008)	(0.011)	(0.006)	(0.007)	(0.010)	(0.011)
Number of previous jumps[a]		-0.005		-0.005		-0.040***		-0.019**		-0.007
		(0.004)		(0.005)		(0.007)		(0.009)		(0.010)
Number of competitors[b]		-0.005***		-0.004***		-0.005***		-0.001		-0.003
		(0.001)		(0.001)		(0.001)		(0.002)		(0.002)
Number of fails before[c]		0.002		0.003		0.039***		0.019**		0.004
		(0.005)		(0.005)		(0.009)		(0.010)		(0.012)
Attempt FE	*No*	*Yes*	*No*	*Yes*	*No*	*Yes*	*No*	*Yes*	*No*	*Yes*
Year FEs	*No*	*Yes*	*No*	*Yes*	*No*	*Yes*	*No*	*Yes*	*No*	*Yes*
Round FEs	*No*	*Yes*	*No*	*Yes*	*No*	*Yes*	*No*	*Yes*	*No*	*Yes*
Event-type FEs	*No*	*Yes*	*No*	*Yes*	*No*	*Yes*	*No*	*Yes*	*No*	*Yes*
Specialists FEs	*No*	*Yes*	*No*	*Yes*	*No*	*Yes*	*No*	*No*	*No*	*No*
Sport FEs	*No*	*Yes*	*No*	*No*	*No*	*No*	*No*	*No*	*No*	*No*
N	21282		13709		7282		5080		4098	
Adj. R^2	0.018	0.113	0.019	0.066	0.002	0.161	0.015	0.040	0.004	0.129

*, **, and *** indicate statistical significance at the 10, 5, and 1-percent level. Dependent variable is a binary variable taking the value 1 if an athlete passes. Standard errors clustered on athlete×competition. [a] Number of jumps leading up to the decision whether to pass or not. [b] Number of competitors who are still in the competition after the bar was raised the last time. [c] Number of fails before to the decision whether to pass or not.

Figure 4 presents the estimated marginal effects for female athletes relative to male athletes for the probability to pass. The marginal effects are obtained from estimating a probit model with the full set of control variables as in the linear probability models above. For both the high jump and the pole vault, we estimate that women are less likely to pass and this difference is more pronounced for the starting heights where passes are more frequent than at greater heights.

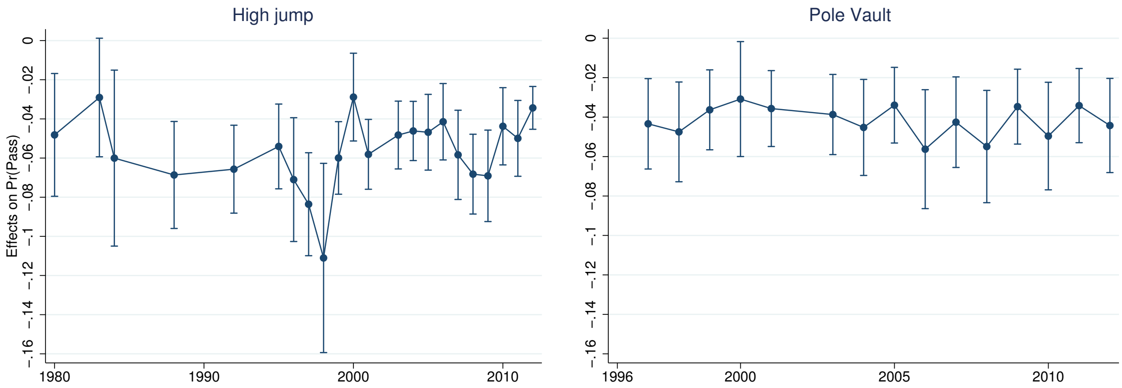
Figure 4: Estimated differences in the chances of passing, by gender.



Notes: Estimated values for the high jump are on the left and those for the pole vault are on the right. Average marginal effects calculated from probit models of passing. Dots indicate the change in the probability of passing for female relative to male athletes; the vertical lines represent the 95% confidence intervals.

We expect that differences between men and women in the competitions might decline over time as athletes (and their coaches) learn about the relative advantages of engaging in risky strategies. Figure 5 plots the estimated differences for male and female athletes between 1980 and 2012 for high jump competitions and between 1996 and 2012 for pole vault competitions. Our estimates do not indicate a convergence in the likelihood of a pass between male and female athletes over time. In contrast, the difference is remarkably stable over time.

Figure 5: Estimated differences in the chance of a pass, 1980–2012.



Notes: Average marginal effects (and their standard errors) from probit estimates of the probability of to pass, women relative to men. The left graph is based on all high jump competitions, including combined events (N=13,709). The right graph is based on pole vault competitions (N=4,098).

We estimate that women pass less often than men. To investigate this difference further, we estimate the number of passes per competition using Poisson regressions. The results from Poisson regressions are tabulated alongside results from OLS regressions in Table 2. The difference in the propensity to pass between female and male athletes results in about 0.4 fewer passes for women. This is a relatively large difference, given that the average number of passes is between 0.4 to 0.9 passes, depending on the sample.

Table 2: Estimated association between the number of passes and sex.

	All sports		**High jump**		**Pole vault**		**HJ specialists**		**PV specialists**	
	OLS	*Poisson*	*OLS*	*Poisson*	*OLS*	*Poisson*	*OLS*	*Poisson*	*OLS*	*Poisson*
Female	-0.427***	-1.037***	-0.444***	-1.521***	-0.432***	-0.553***	-0.348***	-1.407***	-0.444***	-0.627***
	(0.026)	(0.061)	(0.026)	(0.103)	(0.061)	(0.075)	(0.041)	(0.173)	(0.061)	(0.083)
Year	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Sport	*Yes*	*Yes*	*No*	*No*	*No*	*No*	*No*	*Yes*	*No*	*No*
Sport*Year	*Yes*	*Yes*	*No*	*No*	*No*	*No*	*No*	*No*	*No*	*No*
Height athlete entered	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*
Heights active	*Yes*	*No*	*Yes*	*No*	*Yes*	*No*	*Yes*	*No*	*Yes*	*No*
First height × heights active	*Yes*	*No*	*Yes*	*No*	*Yes*	*No*	*Yes*	*No*	*Yes*	*No*
Specialist[a]	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*Yes*	*No*	*No*	*No*	*No*
N	2906		1808		1098		740		645	
Adj. R^2	0.417		0.321		0.433		0.338		0.616	
Sample mean dep. variable	0.575		0.354		0.924		0.314		0.847	

Dependent variable is the each athlete's number of in-competition passes. Results from Poisson regressions are reported as coefficients. Standard errors are clustered on (athlete×competition). *, **, and *** indicate statistical significance at the 10, 5, and 1-percent level.

[a] Athletes competing in single high jump or pole vault competitions.

4 Do risky strategies pay off?

A rational athlete will weigh the benefits of a pass (preservation of energy and the lower risk of injury) against the costs (more difficult jump). This consideration will be based on the expectations of success at the next height, which is a function of the athlete's physical ability, mental strength, and the confidence of success. If athletes were too confident in their abilities, we would observe a negative relationship between passes and subsequent clears. Overconfidence will lead athletes to pass too often, resulting in advancements to heights which are too difficult to clear. In contrast, if athletes were not confident enough, we would observe a positive relationship between passes and subsequent success as athletes would only pass if they were relatively more confident to clear the next height.

Table 3 tabulates the success rates after clearing or passing the previous height, independent of the number of attempt. The success rates after passes are greater than after cleared heights, for both men and women. Women have greater success rates than men after clearing or passing the previous height. However, because this correlation is the result of selection, for example, stronger athletes may pass more often than weaker athletes, and of a causal effect of passing, for example, through the preservation of energy, we cannot infer that the athletes in our sample are "underconfident".

Table 3: **Consequences of passes.**

	cleared in t	
	Men	Women
event in $t-1$		
Clear	37.01	42.87
Pass	49.18	51.36

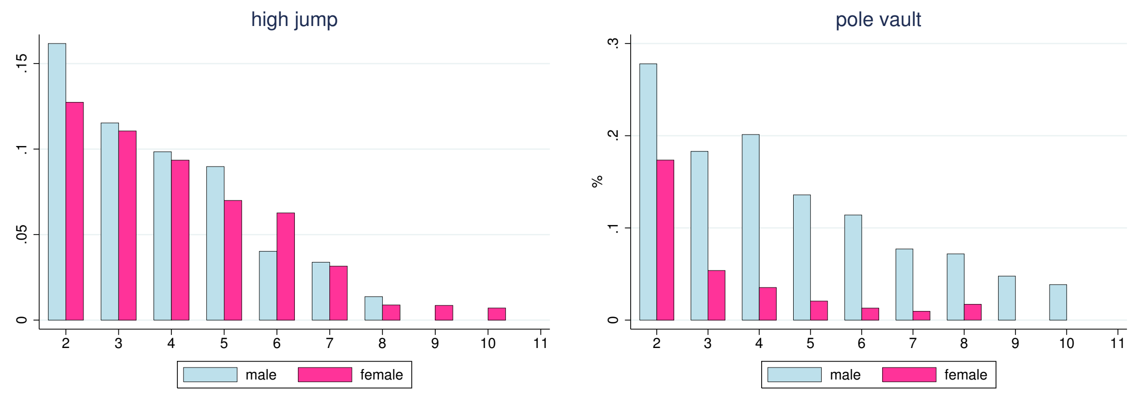
Note: The table shows the outcomes in t as percent of all attempts, by the action in $t-1$. Our sample is restricted to athletes who either cleared or passed in $t-1$ and subsequently did not pass in t, but made an successful or unsuccessful attempt. (N = 8,699)

Athletes will base their decision to pass a height on various aspects, including the individual skill level or the level of competition they face. In addition, it is likely that the athletes differ in their risk preferences. We can neither observe the talent, nor an athlete's risk preferences directly. If, for example, men and women differ systematically in their risk preferences, as suggested by our previous results, we expect to find differences in their respective returns. Because passing is an endogenous choice, possibly positively correlated with ability, we propose to estimate the returns to risk taking using an instrumental variable approach.

Our instrumental variable is the ratio of the number of athletes who are sitting out to the number of athletes who are still competing, i.e., those who are currently attempting the height and those who are sitting out.[6] It is an indicator of the degree of competition at a given height because it indicates the fraction of competitors who will have fewer attempts due to a higher individual starting height.

Figure 6 presents the average fraction of competitors who are sitting out (as a percentage of all competing athletes) by height for men and women separately, for the high jump and the pole vault.

Figure 6: Number of waiting competitors, by sex and sport.

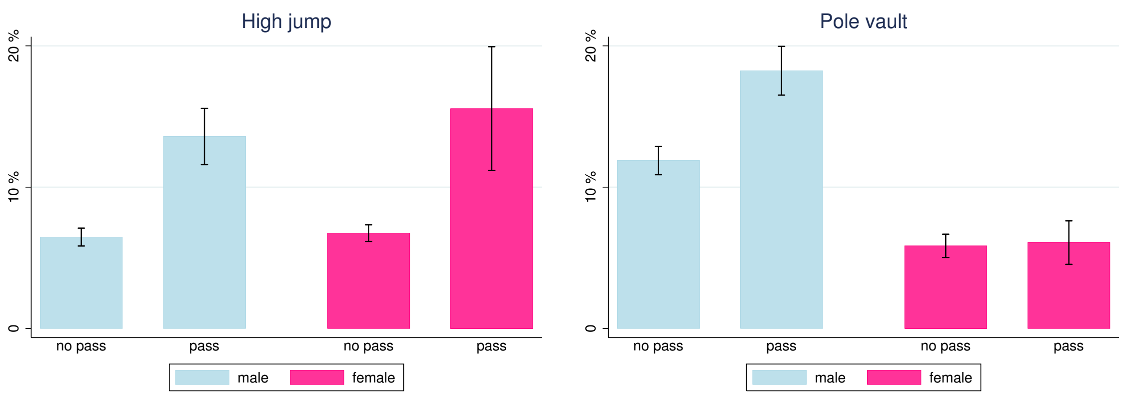


Notes: Ratio of pre-competition passes over the number of competitors still in the competition, by height increases.

[6]Athletes who are sitting out have declared an individual starting height that is above the current height. These pre-competition passes cannot be reversed and are common knowledge.

Athletes who are sitting out have a relative advantage due to fewer attempts and the possible preservation of energy. The degree of competition will influence an athlete's decision to pass a given height in order to overcome this relative disadvantage. The instrument has no direct influence on an athlete's success at the *next* height, as the instrument varies exogenously over the heights (and attempts). The instrument has thus no direct impact on the success at the next height other than through influencing the decision to pass at the current height. We expect that the greater the fraction of competitors who are sitting out, the greater the willingness to pass.

Figure 7: Correlation of the instrument with the decision to pass.



Notes: Average percentage of competitors who are sitting out, by pass, sex, and sport. Vertical lines indicate the standard deviations.

Figure 7 plots the average fraction of competitors who are sitting out (as a percentage of all competing athletes) by whether an athlete passed or not separately for men and women, distinguishing between the high jump and the pole vault. These descriptive statistics clearly indicate that passes occurred when the degree of competition, as measured by our instrument, was greater. The mean value was about twice as high for athletes who passed compared to those who made an attempt. An exception are pole vault competitions for women, where these descriptive statistics indicate the reverse relationship.

In order to estimate the returns for risky strategies, we restrict the sample to athletes who either passed or cleared a height in $t-1$ of heights 3–11. The outcome variable is the success of their attempt at height t, where we do not consider athletes who pass in t. A clear or pass in $t-1$ can either happen at the first, second or third attempt.[7] We analyze the causal effect of a pass in $t-1$ — for all attempts — on the probability to success in t, compared to the success of all who cleared the height.

In order to measure the effect of a pass on the success of the subsequent attempt, we estimate the following two-stage least squares model,

$$\text{success}_{i,t,1} = \beta_0 + \beta_1 \overline{\text{pass}}_{i,t-1,j} + \xi \cdot \mathbf{X} + \varepsilon_{it1}, \quad (2)$$
$$\text{pass}_{i,t-1,j} = \pi_0 + \pi_1 Z_{i,t-1} + \pi_2 \cdot \mathbf{X} + \nu_{itj}, ,$$

where *success* is either 1 when the first attempt $j=1$ of athlete i at height t is a clear and 0, if it is a fail. $\mathbf{X}$ is a vector of controls, including the number of previous jumps up to $t-1$ and the number of previous heights when the athlete made an attempt. It also includes competition fixed-effects and height fixed-effects.[8] We add a variable that indicates the number of attempt in $t-1$ at which the athlete declared the pass. Our instrument Z is the fraction of athletes who are sitting out of all athletes who are still competing.

Our IV estimate is a LATE estimator for the compliers in our sample, i.e., those who are induced to pass by the competitive pressure and would not have passed otherwise. A negative value for β_1 indicates that athletes pass too readily in their reaction to the competitors' behavior and are competing too much (Niederle and Vesterlund, 2009). In contrast, a positive value of β_1 is rather an indicator of "underconfidence" as athletes do not pass often enough.

[7] Figure A.1 in the Appendix sketches the selection of observations for any two heights t and $t-1$ for our estimates. Our sample selection implies that we do not consider attempts that were made after a failed attempt in the same round $t-1$. Our results are robust to the inclusion of these observations.

[8] Because we use competition and group fixed-effects, we cannot additionally control for the actual heights as they are determined by the officials for each competition separately.

Table 4 presents the estimation results for different sub-samples from estimations using OLS and IV. (We plot the estimated β_1 and their 95%-confidence intervals in Figure 8.) Our estimates suggest that both male and female athletes compete too little as there are strong positive effects of a pass. The effects are larger by an order of magnitude for female athletes. We estimate a significant and positive effect of a pass, about 25% for male and about 180% for female athletes, on the success in the subsequent attempt, when we pool our observations across the different disciplines. Overall, the OLS estimates are systematically lower than the estimated effects obtained from using the instrumental variable, supporting the view that passing is negatively correlated with the athlete's ability, resulting in downward biased OLS coefficients.

Table 4: Estimated probability of success at first attempt in t.

	All men		**All women**		**HJ men**		**HJ women**		**PV men**		**PV women**	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Passed $t-1$	0.050***	0.256***	0.006	1.844***	0.090***	0.596***	0.036	2.064***	0.052**	0.348**	0.214	0.021
	(0.016)	(0.095)	(0.030)	(0.448)	(0.023)	(0.170)	(0.039)	(0.575)	(0.023)	(0.144)	(0.598)	(0.047)
Number of jumps up to $t-1$	-0.061***	-0.070***	-0.085***	0.051	-0.073***	-0.095***	-0.087***	0.035	-0.041***	-0.053***	-0.030	-0.052***
	(0.006)	(0.008)	(0.008)	(0.034)	(0.009)	(0.012)	(0.010)	(0.036)	(0.010)	(0.012)	(0.058)	(0.013)
Number of height increases until $t-1^a$	-0.030***	-0.005	-0.017	-0.130***	-0.032**	0.019	-0.012	-0.128***	-0.036**	0.004	-0.092***	-0.086***
	(0.010)	(0.015)	(0.012)	(0.032)	(0.013)	(0.022)	(0.014)	(0.037)	(0.015)	(0.025)	(0.031)	(0.028)
$t-1$: second attempt[b]	-0.015	0.037	-0.045**	-0.120***	-0.033	0.052	-0.058**	-0.145***	0.031	0.135**	-0.010	-0.008
	(0.018)	(0.029)	(0.020)	(0.032)	(0.024)	(0.037)	(0.023)	(0.037)	(0.028)	(0.058)	(0.045)	(0.044)
third attempt[c]	-0.023	0.030	-0.032	-0.309***	-0.021	0.069	-0.035	-0.303***	0.007	0.113*	-0.090	-0.049
	(0.025)	(0.035)	(0.028)	(0.076)	(0.032)	(0.044)	(0.033)	(0.083)	(0.039)	(0.064)	(0.117)	(0.057)
Round FEs	*Yes*		*Yes*		*Yes*		*Yes*		*Yes*		*Yes*	
Competition × group FEs	*Yes*		*Yes*		*Yes*		*Yes*		*Yes*		*Yes*	
N	4841		3858		2738		3155		2103		703	
First stage coef. on instrument		0.536***		0.224***		0.491***		0.188***		0.630***		0.489**
		(0.049)		(0.039)		(0.070)		(0.038)		(0.082)		(0.241)
F-stat. on excl. I.[d]		120.152		33.415		49.371		24.264		58.621		4.136

Notes: Estimated success for height increases 3–11, conditional on having passed in the previous round. *, **, and *** indicate statistical significance at the 10, 5, and 1-percent level. Sample restricted to observations where athletes either passed or cleared the previous height $t-1$ and made an actual attempt at t. Standard errors are clustered on (athlete × competition). All specifications include competition and group fixed-effects.

[a] Number of initial height increases the athlete did not compete because of a high individual starting height.

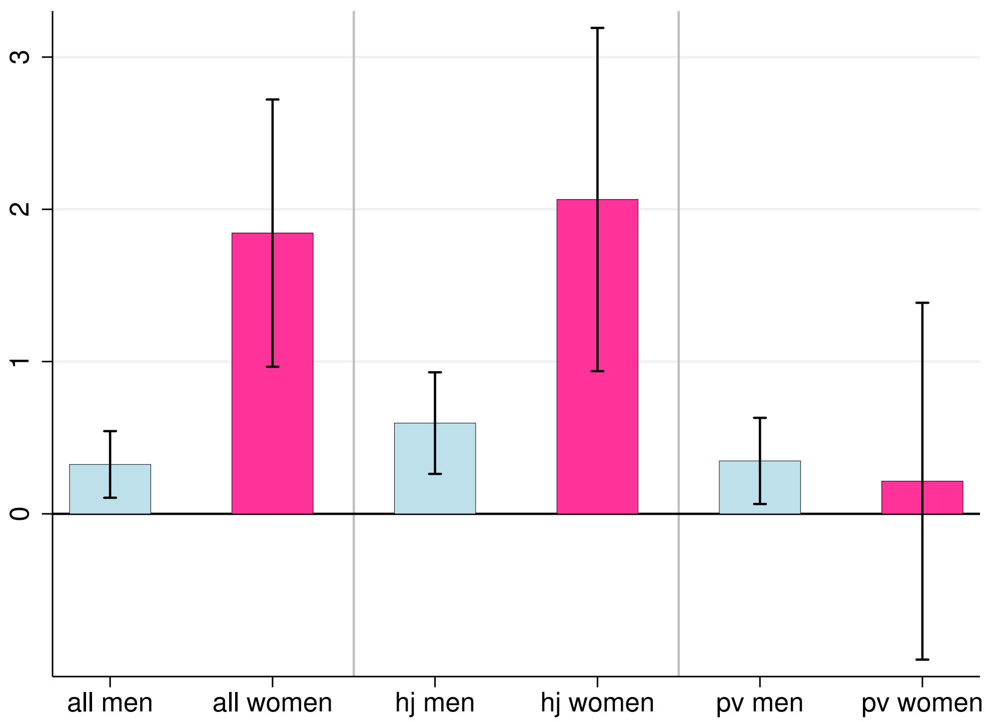
[b] Passed after 1 failed attempt at the previous height.

[c] Passed after 2 failed attempts at the previous height.

[d] Kleibergen-Paap F-statistic (Kleibergen and Paap, 2006); null-hypothesis is that the instrument is weak. All specifications include competition and group fixed-effects.

For the high jump, we estimate that a pass leads to an increase in the probability of success of about 60 percentage points for male and about 206 percentage points for female athletes. While we also estimate such a consequence of a pass for male pole vaulters, of about 35 percentage points, we cannot reject the null hypothesis of no effect for female pole vaulters. This last result might be caused by differences in the sport's history, the low number of observations or the different selection or training of female pole vaulters.

Figure 8: Estimated success at first attempt in t following a pass at $t-1$.



Notes: Estimated causal effect of a pass in $t-1$ on the probability to success at t. Vertical lines indicate the 95% confidence intervals.

Such differences are, however, already reflected in the F-statistics of the first stage regressions, where our instrument is relevant in all estimations but for female pole vaulters. The association between the instrument and a pass in the first stage regressions is positive and always greater for male than for female athletes, indicating that male athletes react stronger to competitive pressure. This corresponds to empirical findings that show that men are more competitive (Frick, 2010, 2011; Gneezy and Rustichini, 2004).

The consequences of a pass might differ by the degree of risk. A pass at the first attempt is, by definition, less risky than a pass after one or two failed attempts which will only carry over one or two attempts to the next height (as opposed to three). Table 5 shows that the majority of athletes passes at the first attempt for a height. Among male athletes, only about 7.8 percent of all in-competition passes occur after one failed attempt and about 6.51 percent after two failed attempts. Among female athletes, passes after failed attempts are considerably rarer in absolute terms, however, a combined 20 percent of all passes are observed after at least one failed attempt.

Table 5: **Distribution of in-competition passes by number of attempt.**

	Men	**Women**
first attempt	1,126 (87.63%)	254 (80.89%)
second attempt	94 (7.32%)	34 (10.83%)
third attempt	65 (5.06%)	26 (8.28%)

Notes: This table presents the absolute number (and percentages) of passes by the number of attempt, at any height from 2–11 for male and female athletes. Second (third) attempt implies one (two) previously failed attempts at a certain height.

To analyze these differences, we estimate our regressions separately for passes at the first attempt and those at the second or third attempt. Table 6 presents the estimated effects. We estimate similar positive effects of passes at the first attempt to those presented above. However, as the risk of a pass increases after one or two failed attempts, we fail to find a positive effect for male athletes, irrespective of whether we pool all sports or investigate them separately. In contrast, we estimate positive effects of all passes for female athletes, with the exception of the pole vault.

Table 6: Effect of a pass $t-1$ on the probability of success at t for all who made an attempt at t.[a]

	All men		**All women**		**HJ men**		**HJ women**		**PV men**		**PV women**	
	1	2 & 3	1	2 & 3	1	2 & 3	1	2 & 3	1	2 & 3	1	2 & 3
Passed $t-1$	0.229**	0.438	1.908***	1.761**	0.846***	0.226	2.153***	2.226**	0.438**	0.171	0.109	-1.177
	(0.112)	(0.270)	(0.575)	(0.846)	(0.263)	(0.475)	(0.747)	(0.981)	(0.204)	(0.246)	(0.615)	(11.416)
Number of jumps up to $t-1$	-0.085***	-0.042***	0.090	0.016	-0.132***	-0.044***	0.089	-0.009	-0.057***	-0.028*	-0.056	-0.102
	(0.010)	(0.011)	(0.061)	(0.037)	(0.018)	(0.014)	(0.073)	(0.027)	(0.015)	(0.016)	(0.070)	(0.691)
Number of height increases until $t-1$[b]	0.007	-0.045***	-0.149***	-0.107**	0.089**	-0.046*	-0.170**	-0.092**	0.042	-0.058***	-0.070**	-0.077
	(0.024)	(0.015)	(0.050)	(0.045)	(0.045)	(0.024)	(0.067)	(0.040)	(0.045)	(0.022)	(0.035)	(0.172)
$t-1$: second attempt[c]		0.037		0.145**		0.032		0.095*		0.039		-0.111
		(0.024)		(0.066)		(0.025)		(0.050)		(0.045)		(1.713)
Round FEs	Yes		Yes		Yes		Yes		Yes		Yes	
Competition × group FEs	Yes		Yes		Yes		Yes		Yes		Yes	
N	3230	1611	2591	1267	1807	931	2143	1012	1423	680	448	255
First stage coef. on instrument	0.531***	0.316***	0.216***	0.208***	0.411***	0.356***	0.185***	0.171***	0.560***	0.519***	0.615	0.053
	(0.057)	(0.047)	(0.046)	(0.048)	(0.088)	(0.059)	(0.046)	(0.040)	(0.104)	(0.105)	(0.334)	(.331)
F-stat. on excl. I.[d]	86.570	44.458	21.864	19.085	21.905	36.107	16.063	18.478	28.869	24.356	3.393	0.026

Notes: *, ** and *** indicate statistical significance at the 10, 5, and 1-percent level. Cluster-robust standard errors clustered for athlete × competition. All specifications include competition and group fixed-effects.

[a] Only observation where athletes either had a pass or a clear on the previous attempt at height $t-1$ and made an actual attempt in t. A pass is no possible outcome in t.

[b] Absolute number of height increases the athlete was not in the competition including starting height where consequently had no possibility to chose the strategy to pass.

[c] Passed after 1 failed attempt at the previous height.

[d] Kleibergen-Paap F-statistic (Kleibergen and Paap, 2006); null-hypothesis is that instrument is weak. All specifications include competition and group fixed-effects.

Our estimates suggest that male athletes are slightly underconfident when the risk is relatively low and we fail to find an effect of a pass for more risky situations. In contrast, female athletes exhibit consistent high levels of underconfidence irrespective of the riskiness of their pass. Male athletes appear to optimize their strategic use of passes as they do not suffer from lower chances of success in the more risky situations. In contrast, because female athletes have greater chances of success even after the most risky passes suggests that they pass not often enough. The psychological literature on performance under pressure defines "choking under pressure" as a decline in performance when the importance of performing well increases (Baumeister, 1984; Beilock and Gray, 2007). Such choking under pressure would be associated with negative returns to passing in situations associated with more risk. Our estimates do not provide evidence for this decline in the athletes' performance. This is in contrast to Dohmen (2008) who find that penalty shooters in football perform worse under pressure.

5 Discussion and Conclusion

We analyze the risk-taking of male and female athletes in jumping competitions. We show that male athletes are more likely than female athletes to use strategic risk-taking. Our results provide additional evidence that men and women differ in their risk-taking behavior. The differences are sizeable and are in line with earlier findings in the literature, e.g., Barber and Odean (2001) or Niederle and Vesterlund (2009). Our results contrast, for example, Booth and Nolen (2012) who find that girls in single-sex environments are as likely to choose risky strategies as boys from either single or mixed sex backgrounds.

We find that men react stronger to their competitors' behavior than women do, indicating that men are more likely to take risks in a more competitive environment than women. Our findings show that even within a highly selected and competitive sample, women are considerably less likely to choose the risky strategy. Niederle and Vesterlund (2009) stress that gender differences that are found in sport competitions might be lower than in non-sport settings since elite athletes typically know their competitors and their relative performance. In addition, Booth and Nolen (2012) find that girls in single-sex situations are more likely to choose risky outcomes than in mixed-sex environments. These arguments suggest that our estimates are a lower bound of gender differences in risk-taking behavior.

The returns to risk-taking are positive for both men and women in our sample, which indicates rather underconfidence than overconfidence. Overconfident athletes would pass too often, reducing the probability to clear a height. Our results confirm that men are more likely to use risky strategies, however, we do not find a negative return to these strategies as, for example, Barber and Odean (2001). The positive returns to risk-taking, however, are much greater for women than for men, indicating that women are considerably less confident than men and could improve their outcomes by choosing to pass more often.

We find that more risk leads to different consequences for men and women. For men, we find that relatively high risk decisions result in statistically different outcomes from relatively low risk decisions. While low risk decisions result in greater chances of success for men, there is no statistically significant evidence that high risk decisions have any effect on subsequent success. For females, in contrast, the riskiness of the decision does not change the positive returns to risk-taking. This implies that women, independent of the strategy's associated risk, take too few risky decisions and could improve their outcomes by incurring more risk.

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A ADDITIONAL GRAPHS AND TABLES.

Figure A.1: Structure of competitions and selection of observations.

```
-----------------------------------------------------------------
|          Height t-1                  |         Height t       |
|  Attempt 1   Attempt 2   Attempt 3   |  Attempt 1   Pass at 1 |
-----------------------------------------------------------------
|  O                                   |    Y            N      |
|  -                                   |    Y            N      |
|  X    ->     O                       |    Y            N      |
|              -                       |    Y            N      |
|              X      ->     O          |    Y            N      |
|                            -          |    Y            N      |
|                            X          |      disqualified      |
-----------------------------------------------------------------
```

Note: O indicates a clear, - indicates a pass, and X indicates a fail. We only use observations indicated by a Y in our estimations. A selected observation is either a fail or a clear at height t following a pass or a clear at height t-1, at either attempt 1, 2 or 3.