



Industrial Physical Capability Services
...DRIVEN BY DATA

The Effectiveness of the IPCS Physical Capability
Evaluation Process For Food Manufacturing
A Validation Study

By
Thomas B. Gilliam, Ph.D.

May 2009

The Effectiveness of the IPCS Physical Capability Evaluation Process For Food Manufacturing A Validation Study

Introduction

The purpose of this analysis was to demonstrate through a scientific validation method that the Industrial Physical Capability Services, Inc. (IPCS) isokinetic physical capability technology is valid as a tool to assess the necessary strength (skill) to safely perform the essential functions of the jobs requiring a physical capability evaluation (PCE) before being hired specific in the food manufacturing industry.

An Overview

Assessing the physical capability skills of a worker to determine if the worker meets the physical demands of the job is becoming more prevalent in industry particularly in physically demanding jobs. Correctly matching the physical capability of the worker to the physical demands of the job should enhance productivity and efficiency of the worker and, thus, the company, as well as minimize on-the-job injuries. This is best accomplished with a correctly matched worker, which results in fewer turnovers and less fatigue during the workday. In contrast, a worker not correctly matched will fatigue, resign or attempt to do work that he/she does not possess the physical skills to do. This results in injury, lost time and many other indirect cost factors that contribute to lost productivity and the inability to service the 'customer'.

In the food manufacturing industry, one of the critical physical capability skills needed to perform the essential functions of the job is strength. Detailed job descriptions and job task analyses in the food manufacturing industry clearly identify skills such as lifting, carrying, bending, reaching and others as critical to performing the job. A job analysis for the jobs requiring a physical capability evaluation (PCE) identifies the critical requirements to perform the jobs including physical demands. The physical demands of the jobs for the IPCS Plants

group were determined by job task analyses, which were performed independently by certified ergonomists. The JTA's are reviewed routinely and updated (most recent in 2009). The Addendum contains the matrix of the jobs analyzed and a sample of a heavy job.

The IPCS PCE evaluates the strength of the major muscle groups critical to performing the essential functions of the job as developed in the job analyses. The IPCS PCE uses isokinetic equipment to assess the strength of shoulder flexion and extension and knee flexion and extension. Inadequate strength associated with these two major muscle groups will prevent the worker from safely performing the essential functions of the job.

Validity of the IPCS Technology

There are several validation procedures that can be used to validate a process or technology. Construct validity uses a process in which a known condition exists and then a treatment is applied to determine if the known condition can be altered. If the known condition is altered, then the treatment is purported to do what it was designed to do; thus, it is validated. Criterion validity is based on a demonstrated relationship between a performance criterion (i.e., on-the-job injuries) and scored evaluations in the assessment process (i.e. the IPCS evaluation).

Since the physical capability skill of strength is critical to performing the essential functions of the job, it is safe to assume that workers who possess the critical strength perform the job better and more safely. One way to assess this is to review the company's injury history (a criterion measure) as it relates to strength. One common injury in the food manufacturing industry associated with strength is the overexertion injury. Most overexertion injuries occur because the worker lacks adequate strength to perform the essential functions. This results in injury. Thus a company that uses a validated physical capability strength test should experience an increase in productivity and efficiency because of fewer overexertion injuries and a decrease in the severity of overexertion injuries as measured by cost of injury.

Background Information

To validate the IPCS technology, injury data from 2005-2008 was collected and analyzed (the criterion) for 12 food manufacturing plants. Four plants utilize the IPCS PCE (assessment) and 8 plants do no PCE testing. All new hire applicants hired between 2005 – 2008 were tracked for injuries. The new hire applicants from the eight plants not using the PCE were labeled the No IPCS Plants and the four plants using the IPCS PCE is the treatment group labeled (IPCS Plants). Both groups were matched on length of employment.

Table 1 shows the number of associates hired between 2005 through 2008 by gender.

	No IPCS Plants	IPCS Plants
Males	7,127	9,318
Females	6,720	6,632
Total	13,847	15,950

The selection criteria for new hire applicants were the same for both groups except the IPCS Plants was administered the IPCS PCE. In addition, the data indicates that the demographics between the two groups were similar. The physical demands of the jobs for the IPCS Plants group were determined by job task analyses. The job task analyses were performed independently by certified ergonomists.

Establishing the Cut-off for Hire

To determine the appropriate cut-off score in evaluating the performance of applicants on the IPCS PCE, the Job Task Analysis completed by GMSI was compared against the United States Department of Labor for the Dictionary of Occupational Titles (DOT). Based on the frequency of lifting as defined by the DOT (i.e. never, rarely, occasional, frequent, and constant) in conjunction with the weight lifted and carried, push/pull requirements derived from the Job Task Analysis, it was possible to link the JTA for the IPCS Plants jobs to the strength definitions of Medium, Heavy and Very Heavy. Since the IPCS cut-off (see next

paragraph) is correlated to both the Job Task Analyses and the DOT, this link is critical in order for the IPCS PCE program to be effective in reducing on-the-job injuries.

Two validation studies were completed by IPCS to demonstrate the relationship between the IPCS cut-off scores for the DOL strength definitions of Medium, Heavy and Very Heavy. The attached American Airline validation studies make reference to jobs that varied between Medium and Very Heavy (i.e. Cabin Cleaner – Medium; Fleet Service Clerk – Heavy; Shop Repair Person – Very Heavy). Reviewing the data retrospectively of new hires (4,915) in terms of injury history as it related to the new IPCS program, it was determined that a Medium job should have an IPCS cut-off of 1.32, Heavy cut-off of 1.56 and Very Heavy cut-off of 2.24.

Results

Incident Rate of Injury

Table 2 shows the number of All Injuries that occurred by gender for each of the two types of plants. A Chi-square analysis of this data showed a significant difference in the observed frequency compared with the expected frequency (Chi-square = 11.598, df=1, p=.0007).

Table 2

	No IPCS Plants	IPCS Plants
Males	123	51
Females	143	29
Total	266	80

When plotting the interaction of male – female injuries versus receiving the PCE or not, the following plot shows the difference in injury reduction is greater for females than males because of the PCE.

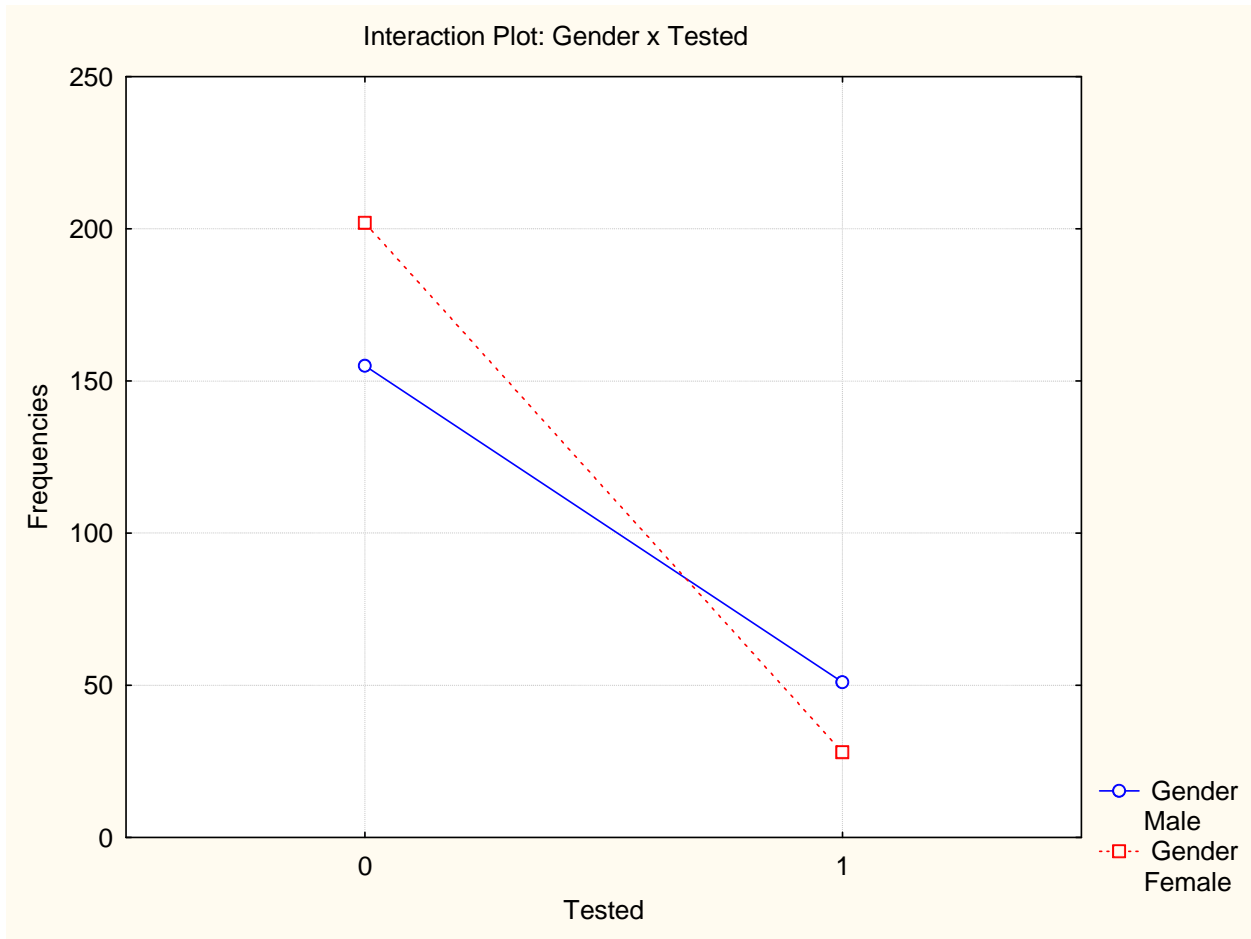


Table 3 shows the number of Strain-Sprains that occurred by gender for each of the two types of plants.

Table 3

	No IPCS Plants	IPCS Plants
Males	43	23
Females	49	14
Total	92	37

Tables 2 and 3 show that the No IPCS plants had more All Injuries and Strains-Sprains than the IPCS plants even though the No IPCS plants hired fewer workers between 2005 and 2008.

When expressing the number of new hires by gender according to plant type relative to the number of injuries for All Injury types, Chart 1 shows the incident rate of injury is substantially greater for the No IPCS Plants when compared to the IPCS plants for both genders. In fact, the male injury rate for the No IPCS Plants was 4.4 times greater for all injuries and 7.5 times greater for the female incident rate.

Chart 1

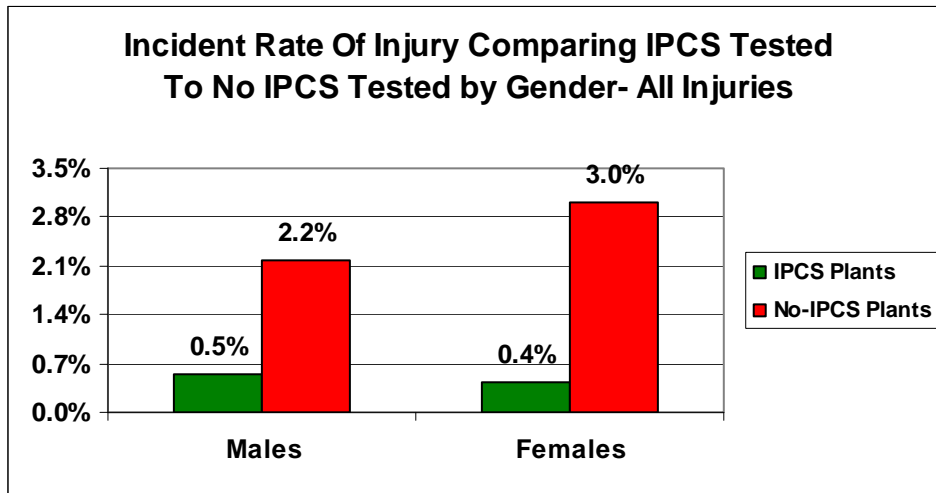
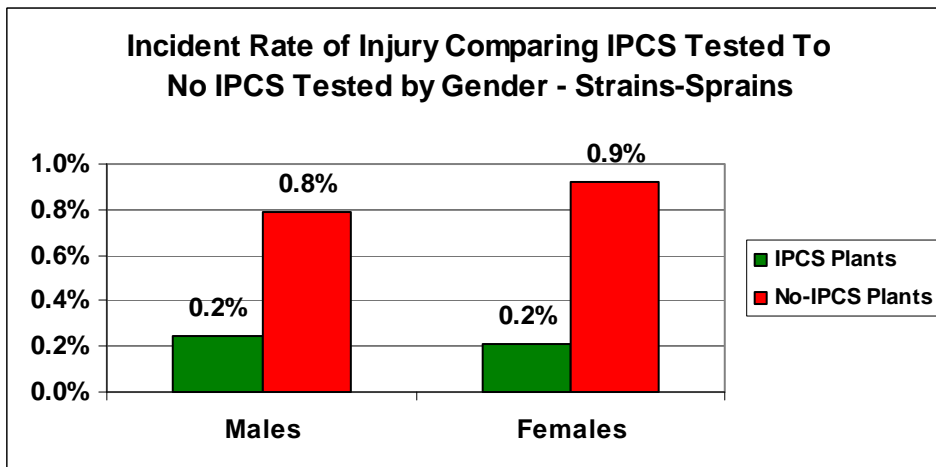


Chart 2 shows the number of Strains-Sprains that occurred by plant type according to gender. Like Chart 1, the incident rate of injury is at least 4 times less for males and females for the IPCS Plants compared with the No IPCS Plants. It should be noted that the incident rate for Strain-Sprains is identical between genders for the IPCS Plants (each at 0.2%).

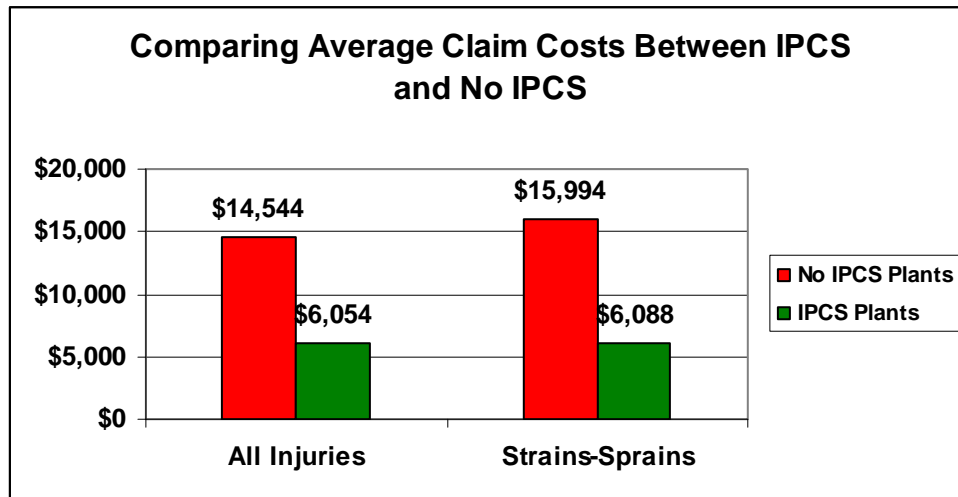
Chart 2



Average Claim Cost

Although there is debate as to the significance of using average claim cost to determine validity of a PCE, the average claim cost does provide information as to the severity of the injury. In addition to reducing the incident rate of injury, a PCE should always reduce the severity of the injury. This in turn reduces the rehab time and puts the returning injured worker less at risk for re-injury. Chart 3 clearly shows that those in the IPCS Plants had lower average claim cost than the No IPCS plants. The statistical analysis showed the difference between the No IPCS plants versus the IPCS Plants was not significant ($P < .15$) because of large variances.

Chart 3



Conclusion

The data analysis clearly shows that the performance in terms of the criterion (incident rate of injury) was substantially improved through the use of the assessment (physical capability strength test); thus, validating the technology.

Addendum

1. Sample Job Task Analysis completed used to determine IPCS PCE cut-off score.
2. Two Validation studies – one date June 5, 1999 and one dated July 2, 1998. These studies were used to establish the IPCS cut-off scores for Medium, Heavy and Very Heavy.

Injury Reduction in Airline Ramp Workers through Post-offer Physical Capability Screening

A Validation Study

Authored By:

Thomas B. Gilliam, Ph.D.

David McKenas, M.D.¹

Ken Green, M.D.

Presented To:

Annual Meeting of the American College of Sports Medicine

June 5, 1999

Seattle, WA

¹ Dr. David McKenas is Medical Director for American Airlines and Dr. Ken Green is a Regional Medical Director for American Airlines

Background Information

Historical data from various sources such as the Department of Labor's Bureau of Statistics, OSHA, NIOSH, National Insurance Institute and others have reported that soft tissue injuries caused by overexertion such as lifting has been one of the leading causes of strains and sprains occurring in industry. Although strains/sprains may only account for 20% of all injuries, they account for a disproportionate amount of the total incurred costs. For example in the state of California, 24% of the low back compensation cases were reported to account for 87% of the total workers compensation cost. Recently various reports have also shown that shoulder strain/sprains caused by overexertion are on the rise.

Industries normally involved in material handling usually are the ones with high incidence and severity rates for overexertion injuries to the low back, shoulders and knees. This kind of work is usually found in the transportation, heavy manufacturing, construction, and nursing home industries. Specifically, in the transportation industry, injury rates usually exceed the national average by up to 6 times. Most of these jobs found in the airline, trucking and distribution businesses are categorized as heavy or very heavy as defined by the Department of Labor's Dictionary of Occupational Titles. For example, heavy work is defined as exerting 50-100 pounds of force occasionally, and/or 25-50 pounds of force frequently, and/or 10-20 pounds of force constantly in order to move objects.

The overexertion injury is one that can be prevented by one of several means:

1. Use correct body mechanics,
2. Use of ergonomic aids and/or
3. Correctly match the physical capability of the worker the physical demands of the job or some combination of these.

In the airline industry for ramp workers, it is difficult to use correct body mechanics or ergonomic aids when inside the belly of an aircraft either loading or unloading it.

Purpose

The first purpose of this study was to demonstrate through a scientific validation method that the Industrial Physical Capability Services, Inc. (IPCS) isokinetic physical capability technology is valid as a tool to assess the necessary strength (skill) to safely perform the essential functions of the job category ramp worker.

The second purpose of this retrospective study was to investigate the effect of an isokinetic post-offer physical capability screening program on reducing or preventing overexertion injuries to the shoulders, low back and knees in airline ramp workers by correctly matching the physical capability of the ramp worker to the physical demands of jobs which has been identified as heavy.

Methodology

Injury data, lost time data, medical and indemnity costs, hire/termination dates and isokinetic data were obtained from several different American Airlines sources. All subjects in the study were Fleet Service Clerks who are ramp workers. The major portion of their job responsibility is to load and unload aircraft.

Two groups of individuals were analyzed – an Historical group and a Tested group. The **Historical** group consisted of all ramp workers hired between January 1994 through November 1995. They were not involved in any physical capability assessment and this group consisted of 1,401 individuals. The **Tested** group consisted of all ramp workers hired between December 1995 and March 1998. Each new hire from the Tested group went through the same new hire screening process as the Historical group except they were given an isokinetic physical capability evaluation which consisted of a flexion/extension test for shoulders, knees and trunk. Each test consisted of two sets at 60 degrees per second with 5 repetitions per set. Although trunk data was available, it was not used in the analyses presented below for the reasons stated on page 8.

The isokinetic data was analyzed for peak torque, peak torque to body weight ratio, right/left ratio score, agonist/antagonist ratio scores and a force curve rating for each joint. The data was then combined using a mathematical model to generate a single digit physical capability score.

Six thousand, four hundred and thirteen new hire applicants were tested but only 4,560 were hired. The reasons for the rejection varied from failing the physical capability evaluation, or failing the drug screen, or background check or the paper pencil test, or some combination. The physical capability test was done as part of the American Airlines medical evaluation. Following the successful completion of the medical evaluation, a job offer was made contingent on successfully passing the physical capability assessment.

Validity of the IPCS Technology

There are several validation procedures that can be used to validate a process or technology. Construct validity uses a process in which a known condition exists and then a treatment is applied to determine if the known condition can be altered. If the known condition is altered, then the treatment is purported to do what it was designed to do; thus, it is validated. Criterion validity is based on a demonstrated relationship between a performance criterion (i.e., on the job injuries) and scored evaluations in the assessment process (i.e. the IPCS evaluation).

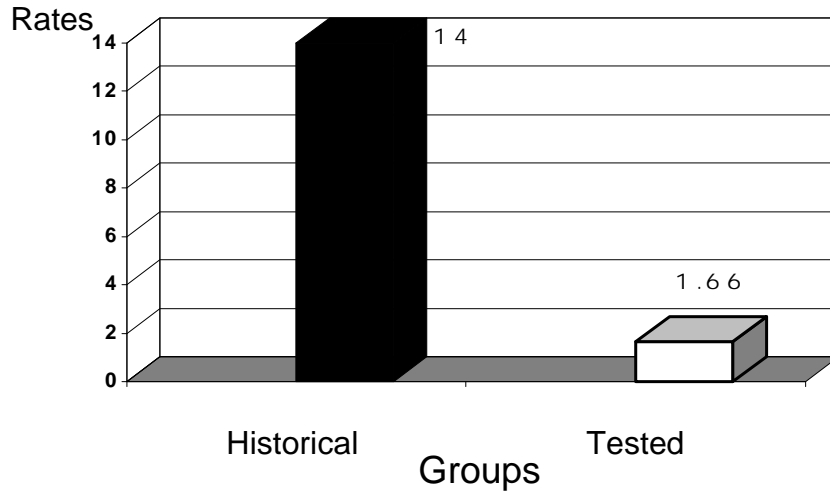
Since the physical capability skill of strength is critical to performing the essential functions of the job, it is safe to assume that workers who possess the critical strength perform the job better and more safely. One way to assess this is to review the company's injury history (a criterion measure) as it relates to strength. The most common injury associated with strength is the overexertion injury. Most overexertion injuries occur because the worker lacks adequate strength to perform the essential functions. This results in injury. Thus a company that uses a validated physical capability strength test should experience an increase in productivity and efficiency because of fewer overexertion injuries.

Results

Since the background data came from so many different sources it was difficult to make statistical comparisons between groups for such descriptive data as age, height and weight.

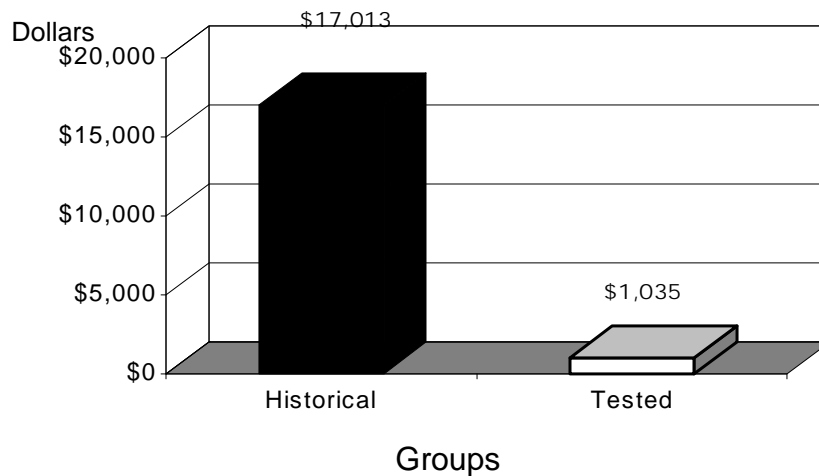
The Historical data as shown on the following graph shows that the incident rate of injury per 100 workers for overexertion injuries (criterion measure) to the shoulders, low back and knees was 14.0 in comparison to the incident rate for the Tested group, which was 1.66 per 100 workers. It should be noted that the length of time that the injury data was collected and tracked for the two groups was controlled so that each time period was equivalent to each other.

Injury Incidence Rates Per 100 Workers



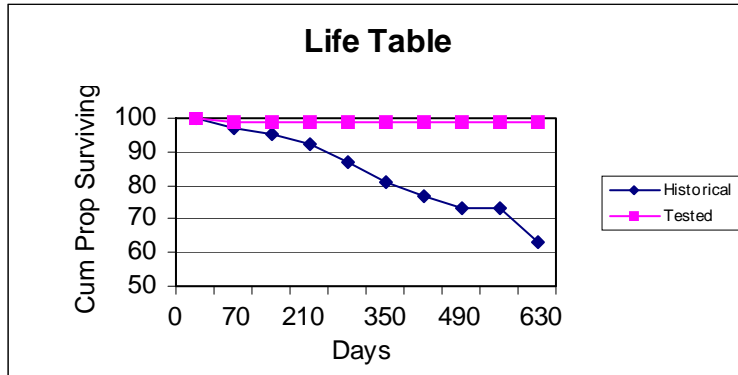
The Historical data also showed that the average workers compensation claim cost for those injured was \$17,013 in comparison to \$1,035 for the Tested group as shown on the next graph.

Average Workers' Compensation Cost per Claim



Each group's survival rate was analyzed separately using the Kaplan-Meier cumulative survival function. A Kaplan-Meier graph is a simple depiction to study "time to failure" form data of hire of an

employee. The technique monitors the employee from data of hire to the time of first injury and then that individual is no longer tracked in the study. An uninjured worker was considered a “complete” case whereas an injured worker was considered a “censored” case as the analysis looked at each time interval. The following graph shows at 700 days the survival rate for the Tested group is approximately 98% in comparison to the Historical (not tested) group at 64%.



The Historical group’s survival distribution was then compared to the Tested groups statistically using a two-sample survival comparison, which yields several statistics (mostly non-parametric). They are:

- Gehan's Generalized Wilcoxon Test
- Cox Mantel Test
- Cox F Test
- Log Rank Test
- Peto and Peto Generalized Wilcoxon Test

These tests are most reliable with sample sizes in excess of 50. The P-values for each test shows that the two survival distributions were significantly different from each other at least at the .05 level which means the observed differences between the two survival distributions are real. The Tested group had statistically significant better survival rate than the Historical group as shown in the following table.

Tests of Significance Between the Historical Group and Tested Group

(P - Values)

Gehan's Wilcoxon	Cox's F-test	Cox-Mantel Test	Log Rank Test	Peto & Peto's Wilcoxon
0.00009	0.00000	0.00011	0.00131	0.00009

Although many studies have demonstrated that physical capability new hire assessment programs have failed particularly using isokinetics, it is my belief that they failed because they focused only on the low back assessment. When focusing only on the trunk isokinetic data for this study, the results support the work of Newton, Waddel and others in that the trunk data from the new hire screening was ineffective. Physical demanding jobs, such as a ramp worker, requires the coordination and integration of the major muscles groups to safely and effectively perform the essential functions of the job. A secondary analysis showed that the trunk data's contribution to the prevention of injuries was very limited. The knee-shoulder data taken collectively was significantly more important in preventing exertion injuries to the knees, shoulders and back than the knee-shoulder-back data taken collectively. Thus, only the knee-shoulder data was used in the analyses presented in this document.

Conclusion

In conclusion the data suggest that correctly matching the physical demand of the job to the physical capability of the worker will result in a reduction in the severity and frequency of overexertion injuries to the knees, shoulders and trunk (construct validity). Furthermore, the data analysis clearly shows that the performance in terms of the criterion (injury history) was substantially improved through the use of the assessment (physical capability strength test); thus, validating the technology.

Further Validation of the NEW Technology Utilizing American Airline Isokinetic Raw Data

Presented To
Dr. David McKenas
Medical Director, American Airlines

Presented By
Thomas B. Gilliam, Ph.D.

July 2, 1998

Introduction

As a follow-up to your recent request to analyze the new hire data collected by American Airlines from July 1, 1997 through March 31, 1998, I have analyzed the American Airlines raw isokinetic data provided me. The purpose of the analysis was to compare the Gilliam's NEW isokinetic technology to American's existing vendor's technology (OLD). The following sections of this report will identify an overview, the background information pertinent to the data analysis, a statistical comparison between the two technologies, a review of the injury data relative to the two technologies, placement rates, recommendations and savings.

An Overview

The highlights of the following report are as follows:

- The NEW is a valid technology – it does what it purports to do – prevent overexertion injuries to the knees, shoulders and low trunk.
- The NEW technology would have cost American Airlines 31% less in assessment fees in comparison to American's existing vendor.
- The NEW technology would have accepted more males and females without compromising the injury prevention component of the program.
- With a higher acceptance rate, fewer assessments would have been needed which would have resulted in greater savings.

Background Information

The raw data utilized for the statistical analyses included 4,915 new-hire evaluations utilizing the Cybex 6000 and Trunk Modular Component (TMC). The data utilized was collected from July 1, 1997 through March 31, 1998. Table 1 identifies the number of new-hires by gender and job category. The raw data included whether the new hire was MMIN or Cleared according to job category. A NEW score was calculated for each new hire utilizing the isokinetic raw data.

Table 1. Number of Males and Females According to Job Category

	FC	SP	SP	AM	PU	PM	AC	SC	BC	PW	GP	CC	TA	Tot
Males	1,828	590	50	10	48	57	211	81	106	1	12	408	2	3,404
Females	479	36	2	0	0	6	582	25	74	1	0	305	1	1,511

*FC=Fleet Service Clerk, SP=Shop Repair Person, AM=Aircraft Mechanic,
 PU=Plant Maintenance Utility, PM=Plant Maintenance Mechanic, AC=Aircraft Cleaner, SC=Stock Cleaner,
 BC=Building Cleaner, PW=Parts Washer, GP=Ground Service Person, CC=Cabin Cleaner, and TA=Ticket Agent*

Statistical Comparison Between the Two Technologies

A Wilcoxon non-parametric Matched Pairs test and a Gamma Correlation analysis was computed on the new hires D.O.L. rating and recommendation for hire (Cleared) or not hire (MMIN) between the two technologies. The analysis showed that the new hire placement rate of NEW was statistically different from American’s existing vendor ($z = 9.875$, $p\text{-level} = 0.000$) and that NEW did what it was purported to do ($r = .986$) – that is to prevent overexertion injuries to the knees, shoulders and lower back. The statistical difference was due to the better placement rate of the NEW technology in comparison to the OLD.

Comparison of MMIN/Cleared Between Technologies

The purpose of the analysis was twofold:

- To mathematically demonstrate that NEW would have at least a similar acceptance rate of new-hires in comparison to the OLD.
- To mathematically demonstrate that NEW would yield at least the same injury prevention results as the OLD.

The overall analysis showed that the NEW technology placed 81% of the new hires in comparison to the OLD which placed 76% (Chart 1). On a percentage basis, the NEW technology resulted in 91% of the males being Cleared in comparison to 88% of the OLD (Chart 2). The female data showed that 58% would have been Cleared with the NEW technology in comparison to 49% for the OLD

technology. The female data represents a significant improvement in the placement rate with the NEW technology.

Injury Data

The injury data was obtained from the American Airline worker's compensation data for those who were hired during the time frame identified above. The injury data was only for the Fleet Service Clerk category. Of the 2,308 Fleet Service Clerks evaluated, 77 or 3.3% have reported worker's compensation injuries. Of these 77, sixty (60) were injuries not related to overexertion to the knee, shoulder or trunk regions. Only 17 or 0.74% of those tested reported overexertion injuries to the knee, shoulder and trunk regions. When comparing the NEW technology to the OLD, the only difference is that there would have been two less injuries with the NEW technology – one less overexertion to the knee, shoulder and trunk and one less “other” injury. This would have lowered the incidence rate to 0.69%.

Recommendation

It is recommended that American implement NEW initially at the American hubs – DFW, ORD, JFK, MIA and TUL. Use the isokinetic technology until new data can be collected on a newer and more defensible technology which will be presented to you on June 23.

Savings

Assuming 4,915 assessments were completed utilizing American personnel at their major hubs (DFW, ORD, MIA, JFK and TUL) and that American pays \$65 per assessment interpretation to their existing vendor, this would have cost American \$319,475. If NEW had completed the same assessments, it would have cost American \$221,175 (\$45 per interpretation) or a savings of \$98,300 which is equal to 31%. The savings could be greater if American agrees to prepay the interpretation fees.