The Test-Retest Reliability of the Pieterse Protocol Return to Flight Assessment for Cabin Crew

Erik Hohmann; Kevin Tetsworth; Reino Pieterse

INTRODUCTION: The purpose of this study was to assess test-retest reliability of the Pieterse return to flight duty protocol for cabin crew to return to flight duties.

METHOD: Flight attendants between 20–50 yr old were included if they underwent rehabilitation at the musculoskeletal rehabilitation unit for a musculoskeletal injury, surgical treatment for orthopedic trauma or industrial injuries, and were assessed by the treating physical therapist and aviation medical examiner to be ready for return to work. Test-retest reliability was calculated with the Fleiss kappa coefficient.

RESULTS: Included were 18 flight attendants (10 men, 34.9 ± 6.3 yr; 8 women, 34.2 ± 3.4 yr). Eight participants were rehabilitated following upper extremity injury, eight following lower extremity, and two following both upper and lower extremity injury. Perfect test-retest reliability was observed for nine items; kappa values above 0.9 were observed for three items; one item had a kappa value above 0.8 and two items had a kappa value of 0.78. The results for all 15 items were highly significant, demonstrating that the Fleiss kappa coefficients were significantly different from zero. The kappa coefficient strength of agreement was almost perfect for 13 and substantial for the remaining 3 items. Overall test-retest reliability was 0.95.

DISCUSSION: This study demonstrated almost perfect test-retest reliability for 13 items and substantial reliability for two items, with an overall test-retest reliability of 0.95 for a return to flight assessment for flight attendants. The Pieterse protocol is a reliable tool to establish return to work for cabin crew.

KEYWORDS: return to work assessment, flight attendants, occupational health, medical clearance, fitness to fly.

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Work-related musculoskeletal injuries and illnesses account for approximately 33% of lost working days for flight attendants.[9] According to the U.S. Bureau of Labor Statistics, nonfatal injuries in flight attendants in 2019 occurred at a rate of 517 per 10,000 full-time workers.[29] This is in contrast to other air personnel, who had an injury rate of 89.6 per 10,000 full-time workers.[6,29] Falls, slips, and trips accounted for 64.9 per 10,000 for full-time workers; contact with objects for 94.1 per 10,000 full-time workers; and transportation incidents for 113.3 injuries per 10,000 full-time workers.[29] Musculoskeletal disorders are common among cabin crew and 50% of female flight attendants experienced symptoms in the lower back, wrist, neck, and shoulders at least once in a 12-mo period.[23] In a later study, 82% of flight attendants reported musculoskeletal pain in at least one body region, and the most common region was the feet, followed by the neck, shoulders, and lower back.[27] Mulay et al. reported that prolonged standing and high heels were the main reasons for their symptoms.[27] These conclusions are supported by a systematic review demonstrating high-heeled shoes are not only associated with musculoskeletal pain, but also with injury.[1] Medium- to high-heeled shoes increased the risk of fractures of the foot by 100%, forearm, wrist, and tibia by 70%, and proximal humerus and pelvis by 50%.[18] In addition, turbulence further increases the risk of

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injuries and nearly 50% of the reported events in flight attendants were characterized as serious. Lower extremity injuries, especially ankle fractures, were the most common.[35]

Civil aviation authority regulations for the musculoskeletal system stipulate that a person must be fit to safely perform the duties and exercise the privileges of their license for the duration of the medical certificate.[7,8,11] General guidelines specify that any musculoskeletal abnormality must be identified and that satisfactory use of the whole musculoskeletal system is required for an applicant to be considered safe.[11] The regulations acknowledge that injury and incapacitation due to musculoskeletal injuries are common. For satisfactory return to work, a current status report, which must include the functional status and the degree of impairment as measured by strength, range of motion, pain, and medications with all side effects, is required.[8] However, despite these general guidelines, appropriate standards and specific return to work criteria for cabin crew are missing, and the current practice is instead based on rather subjective assessments.[25] In occupational medicine, several functional capacity evaluation protocols have previously been described.[4,13,21] The most commonly used assessments are the Blankenship, the Ergos Work Simulator, the Isernhagen Work System, the Ergoscience, and the Physical Work Performance Evaluation.[4,21] These protocols all include several similar lifting, gripping, carrying, pushing, and pulling tasks.[13] Kuijer et al. performed a systematic review and reported that 13 of the 18 included studies demonstrated that performance-based measures, especially a lifting test, appeared to be predictive of work participation.[21] In contrast, Gross and Battie reported that functional capacity evaluation performance was a weak predictor of return to work.[13] Unfortunately, the available functional capacity tests are rather general in nature and do not allow task-specific or more nuanced professional activity appraisals. Pieterse developed a "fitness to fly" protocol for cabin crew[31] which takes into consideration the specific tasks that are required by cabin crew preflight and in flight. The Pieterse protocol consists of 15 tasks and includes the assessment of lower extremity fitness and strength while testing occupation-specific upper limb activities required to safely provide routine service as well as assist in the case of emergency. The purpose of this study was to, therefore, evaluate the test and retest reliability and repeatability of the Pieterse protocol.

METHODS

The Pieterse protocol[31] consists of 15 items. Two items (items 1 and 2, **Table I**) assess the ability to ambulate within the airport and airplane. Item 1 can be omitted if flight attendants have sustained upper extremity injuries with no lower extremity involvement and a normal ability to ambulate. There are 10 items which assess the ability to perform general onboard duties (4–7, 9–14); 1 item (3) serves to assess the ability to lift luggage on and off conveyor belts and into the bus; and 1 item (8) serves to assess the ability to perform CPR and to be able to assist in emergencies. Table I summarizes the 15 items of the protocol and explains the rationale for testing for each item.

Subjects

Flight attendants who underwent rehabilitation following injury at the Musculoskeletal Rehabilitation Unit (MSK) of Emirates Airline were invited to participate. Participants were eligible if they were between 20–50 yr old, underwent rehabilitation at the MSK unit for a musculoskeletal injury or underwent surgical treatment for orthopedic trauma or industrial injuries, and were cleared by the treating physical therapist and aviation medical examiner for return to work. They were excluded if they did not pass the first assessment, or if they were unable to return for the subsequent test session. A total of three

Table I. Overview of the 15 Items Included in the Pieterse Protocol for Return to Flying Duties.

	TASK TO BE COMPLETED	WHY IS COMPLETION IMPORTANT
1	Walking on a treadmill in flat cabin shoes for 2 km in 25 min or less and walk 3 flights of stairs	To check for the ability to walk long distances in airports
2	Climbing and descending wooden stairs carrying a standard cabin bag of 7 kg	To check for the ability to climb stairs with hand luggage of 7 kg
3	Move a 20-kg suitcase from one surface to another	To check for the ability to lift suitcase on and off a conveyor belt and into a bus
4	Remove tray from bottom shelf or trolley	Part of onboard duty (full knee flexion, ankle dorsi-flexion, and correct lifting required)
5	Carry wine holder up and down corridor (if working in business or first class)	Part of onboard duty (to test for shoulder, elbow, wrist strength, and mobility)
6	Remove container from top shelf to work surface and back (10 times)	Part of onboard duty for security checks
7	Pull 12 kg of weight at shoulder height with pulley system and then push with 8-kg weight (2–3 repetitions)	Part of onboard duty (to demonstrate that aircraft doors can be opened and closed)
8	Perform one cycle of CPR on mannequin	Emergency procedure
9	Holding two business class trays and reach	Part of onboard duty (to test for shoulder, elbow, wrist strength and mobility)
10	Holding silver tray with weight (towels)	Part of onboard duty (to test for shoulder, elbow, wrist strength, and mobility)
11	Pouring wine and twisting bottle	Part of onboard duty (to test for shoulder, elbow, wrist strength, and mobility)
12	Pouring full tea/coffee pot	Part of onboard duty (to test for shoulder, elbow, wrist strength, and mobility)
13	Oven tray inserts (correct technique) 4 times	Part of onboard duty (to test for ability to safely operate oven; shoulder, elbow, wrist strength, and mobility)
14	Close hat rack	Part of onboard duty (to test for ability to safely operate above shoulder; elbow, wrist strength, and mobility)
15	Jamar grip strength	Grip analysis standardized tool and validated for age and sex. Overview of upper limb strength

Table II. The Pieterse Protocol for Return to Flying Duties.

	TASK TO BE COMPLETED	YES	NO	N/A
1.	Walking on treadmill in flat cabin shoes for 2 km in approximately 25 min or less or 3 flights of stairs	☐	☐	☐
2.	Climbing and descending wooden stairs carrying cabin bag	☐	☐	☐
3.	Move 20-kg suitcase from one surface to another	☐	☐	☐
4.	Remove tray from bottom shelf of trolley to top	☐	☐	☐
5.	Carry wine holder up and down corridor if working in First/Business Class	☐	☐	☐
6.	Remove container from top shelf to work surface and back	☐	☐	☐
7.	Pull 12 kg at shoulder height with pulley system and then push with 8-kg weight (2 -3 repetitions)	☐	☐	☐
8.	Perform one cycle of CPR (chest compression) on mannequin	☐	☐	☐
9.	Holding two business class trays and reach	☐	☐	☐
10.	Holding silver tray with weight (towels)	☐	☐	☐
11.	Pouring wine and twisting bottle	☐	☐	☐
12.	Pouring full tea/coffee pot	☐	☐	☐
13.	Oven inserts	☐	☐	☐
14.	Close hat rack	☐	☐	☐
15.	JAMAR grip strength Dominant hand: Right _______________ kg Left ________________ kg			

assessments were performed by the same physical therapist; a minimum of 1 wk between testing sessions was necessary. All three tests had to be completed within 4 wk of the first test. Data collection was performed between January 2018 and December 2019. The functional tests were performed in accordance with the World Medical Association declaration of Helsinki ethical principles for medical research, amended by the 64th WMA General Assembly in 2013.

All participants signed informed consent and were informed about the aims, methods, and potential risks of the project. IRB approval was not sought as these tests were part of the routine assessment process of the airline and the study was considered to be less than minimal risk. Specifically, participation with the first assessment was dictated by company policy as a compulsory component of the assessment to return to work and as such data was collected during work that all subjects would have undertaken had no experiment existed. For return-to-work fitness assessments, subjects often undergo multiple assessments until they are deemed fit or for training purposes. The two follow-up assessments were entirely voluntary and participants were able to withdraw at any time.

Statistical Analysis

A standard form (**Table II**) was completed for each test by the examiner and the items were assessed with a binary yes/no approach: participants were either able to perform the itemized test or they were not. As participants with incomplete data were excluded and a binary outcome was used, missing data and ambiguous values did not require specific consideration. Similar data cleaning, such as duplicate records, missing or out-of-range values, and inconsistencies, was not required. Data was then transferred into an Excel spreadsheet for collation. Data was de-identified and any demographic details were not carried forward to the electronic data sheet.

Descriptive analysis was applied to demographic data. For test-retest reliability, the Fleiss kappa coefficient was calculated.[20] Fleiss kappa coefficient strength of agreement was considered "almost perfect" for values between 0.81–1.00, "substantial" for values between 0.61–0.80, "moderate" for values between 0.41–0.60, "fair" for values between 0.21–0.40, and "poor" for values between 0.00–0.20.[22] Interrater reliability was established by comparing 10 random cases on 2 separate occasions with involvement of the same aviation medical examiner using Cohen's kappa for analysis. The algorithm of Landis and Koch was used to assess the rate of agreement.[22] Values above 0.80 represented excellent agreement, values between 0.62–0.79 were considered good agreement, values between 0.41–0.61 indicated moderate agreement, and values below 0.4 suggested fair to poor agreement.[22] An a priori sample-size calculation was performed for Fleiss kappa hypothesis testing and was based on the following assumptions: power 80%, two-tailed alpha 0.05, number of repetitions three, expected dropout rate 0, minimum acceptable reliability 0.81, and an expected reliability of at least 0.9. Based on these variables a minimum sample size of 16 participants was required to achieve adequate power. All analyses were conducted using STATA SE for Windows (version 12.0; StataCorp, College Station, TX, USA).

RESULTS

From January 2018 to December 2019, 18 flight attendants volunteered to participate in this study. There were 10 men ages 34.9 ± 6.3 yr and 8 women ages 34.2 ± 3.4 yr. Eight participants were rehabilitated following upper extremity injury, eight following lower extremity injury, and two following both upper and lower extremity injury.

Perfect test-retest reliability was observed for nine items (6,7, 9–15); Fleiss kappa values above 0.9 were observed for three items (1,4,8); one item had a kappa value above 0.8 (5); and two items had a kappa value of 0.78 (2,3) (**Table III**). The results for all 15 items were highly significant ($P = 0.0001$) given that the Fleiss kappa coefficients were significantly different from zero. According to Koch and Landis, the kappa coefficient strength of

Table III. Fleiss Kappa Coefficients for the Pieterse Protocol.

	FLEISS KAPPA	SE	*P*-LEVEL	z-VALUE	95% CONFIDENCE INTERVALS
1	0.955	0.136	0.0001	6.801	72.7–99.9
2	0.778	0.136	0.0001	5.519	52.4–95.9
3	0.778	0.136	0.0001	5.519	52.6–95.9
4	0.944	0.136	0.0001	6.14	72.7–99.9
5	0.889	0.136	0.0001	4.93	52.3–98.6
6	1.00	0.136	0.0001	7.348	84.7–100
7	1.00	0.136	0.0001	7.348	84.7–100
8	0.944	0.136	0.0001	5.36	72.7–99.9
9	1.00	0.136	0.0001	7.348	84.7–100
10	1.00	0.136	0.0001	7.348	84.7–100
11	1.00	0.136	0.0001	7.348	84.7–100
12	1.00	0.136	0.0001	7.348	84.7–100
13	1.00	0.136	0.0001	7.348	84.7–100
14	1.00	0.136	0.0001	7.348	8467–100
15	1.00	0.136	0.0001	7.348	84.7–100

agreement was almost perfect for 13 items (1, 4–15) and substantial for the other 2 items (2,3).[22] The overall test-retest reliability was 0.95. Interrater reliability was calculated to be 0.944 (95% CI: 0.926–0.958) and represented excellent agreement.

DISCUSSION

Civil aviation authorities clearly specify that flight attendants must be fit to safely perform their duties.[7,8,11] Fitness standards are universally applied during the hiring process and include a detailed musculoskeletal examination by a certified aviation medical practitioner.[7,8,11] Any health condition that affects the ability to lift, bend, pull, use emergency slides, open aircraft doors, use firefighting equipment, or impairs the ability to work on an aircraft automatically disqualifies an applicant.[25] Orthopedic injuries are common in aircrew, and the annual incidence for fractures range between 73–81 per 100,000 population for women and 24–100 per 100,000 population for men.[5,30] Similarly, sports injuries in young active individuals occur with a rate of 52.5 for women and 47.7 per 100 participant-years for men.[32] Evaluating fitness to work and the ability to perform tasks without being a risk to self or others is an important part of an occupational health service.[33] Outcomes of this assessment usually determine a worker to be fit, not fit, or fit with restrictions.[33] In contrast to the general population, return to light duties is not an option for cabin crew. Unfortunately, the civil aviation authority regulations do not provide specific criteria regarding how to assess return to work for flight attendants, and the responsible aviation medical examiner must judge fitness based on best practice and experience.[34] The Pieterse protocol for return to flight duty assessment was first presented in 2015 and consists of 15 items testing the most common tasks required to safely perform the duties of a flight attendant.[31] It has been routinely used by the MSK unit of Emirates Airline for the past 6 yr. Regrettably, this protocol has not previously been tested for reliability and reproducibility. The present study used 18 volunteers over a 2-yr period and demonstrated a very high rate of test-retest reliability for 13 of the 15 included items.

Repeatability and test-retest reliability studies investigate at least two measurements by the same examiner under identical conditions. A Fleiss kappa coefficient over 0.75 is acceptable and suggests at least substantial agreement.[24] However, in some cases kappa returns low values even if agreement is high.[24] This is a possible explanation for the two lower agreement values of 0.78 for items two and three. For these two items, one of the three tests was assessed as not passed in 4 of the 18 participants and, with using a weighted approach agreement for these 2 items, was 92.7%.

Muijzer et al. identified 19 factors that may be relevant for assessing aircrew capacity for return to work.[26] These factors included functional capacity; personal capacities such as age, competencies, attitude, self-efficacy, and illness perception; and environmental factors including work-related sickness absence, job availability, employer attitude, and the relationship between the employer and employee.[26] Gouttebarge et al. performed a systematic review of functional capacity methods and were critical that the test-retest reliability methods were not robust enough.[12] The current investigation performed an a priori sample size calculation and the same examiner performed all tests on three different occasions. Overall test-retest kappa values were high in a heterogeneous sample of flight attendants with a combination of upper and lower extremity injuries, indicating that both internal and external validity is acceptable.

The Pieterse protocol uses norm-referenced standards and a binary yes/no approach.[31] Cabin crew were assessed as either having passed or not having passed the items in the protocol. These tests tend to measure only one ability and generally a battery of tests are required to assess physical abilities.[17,19] An alternative to these norm-based standards, physical ability can instead be assessed through job simulations.[10,16] Typical disadvantages of using job simulations include a less controlled setting, theoretically increasing the chances of injury during the test and during return to work.[10] The Pieterse protocol combined both norm-referenced standards and job simulations with multiple tests for the assessment of similar tasks.[31] It reliably evaluates whether cabin crew are ready to return to work following injury. The binary yes/no approach does not allow ambiguity or interpretation of the test results. Cabin crew is either ready to return to work or not, in concordance with the guidelines of the regulatory bodies for the assessment of medical fitness in flight attendants.[7,8,11] The Pieterse protocol allows an objective evaluation of cabin crew readiness to return to work following injury and is the first protocol that allows reproducible assessment of task-specific musculoskeletal abilities. Cross-sectional and longitudinal relationships between musculoskeletal health and work ability have already been described, although both Boschmann et al. and Nawrocka et al. concluded that predicting future work ability by health surveillance data is rather difficult.[3,28] Serra suggested that assessment of fitness for work should be defined as the evaluation of a worker's capacity to work without risk to self and others, and that the criteria to evaluate fitness for work should use assessment tools that are specific to the workplace but also cost-effective.[33] These criteria are also fulfilled by the Pieterse protocol.[31] The test can be completed within 60 min and requires minimal equipment. This is the first study to assess the value of the Pieterse protocol. Other factors such as the discriminatory ability of the protocol and test validity have not yet been evaluated for this protocol.

The assessment of questionnaire validity is established via three methods.[14] Face validity considers how suitable the content of a test seems to be on the surface and is a more informal and subjective assessment.[2,14] On face validity, as the simplest measure of validity, the test appears to measure what it claims to measure and is suitable for assessing the ability to return to work and perform the privileges outlined in the license.[5] Construct validity is typically established by comparing the new instrument to the established standard. However, there is no currently accepted standard and, therefore, construct validity cannot be evaluated. The third method to establish validity is concurrent or criterion validity, determining whether the scores can predict future outcomes.[2,14] For the Pieterse protocol it would establish whether any unplanned or unexpected relapses would occur. Since the inception of the Pieterse protocol[31] in 2014 this has not been the case, and it could be argued that criterion validity has already been clearly established.

This study has limitations. The established criteria for return to work and reinstatement of the return to flight privileges were based on the regulations of the local regulatory body.[11] Other regulatory authorities may have different functional criteria and the results of this study cannot, therefore, be generalized. The Pieterse protocol has a specific focus on functional abilities and does not consider other factors such as psychological and demographic factors. It is theoretically possible that study participants' familiarity with the testing items influenced the participant responses. However, the binary approach used has likely mitigated the testing effect on participant response, as no quantitative measures were used. It could be argued that the Pieterse protocol does not assess the ability of cabin crew to safely perform emergency procedures such as ditching, emergency evacuation, fire extinguishing, smoke control, operation and use of emergency exits, use of crew and passenger oxygen, removal of life rafts, or donning and inflation of life vests and other flotation devices. Items 1–3 assess the ability to mobilize without limitations, and items 7–10 assess the ability to perform pulling and pushing both in the frontal and overhead planes. Item 7 has been specifically developed to assess the ability to not only open but also close aircraft doors in the most common Airbus and Boeing planes for both routine and emergency situations. It is possible that the lack of assessment for certain emergency procedures could be considered a possible limitation of the protocol. However, cabin crew returning to duties 90 d or more after their previous flight have to complete security, emergencies, and procedures (SEP) training again; this includes all of the abovementioned activities. Current regulations within the company will not allow them to participate in SEP training before being "signed fit" by the medical team. The Pieterse protocol is the first step in them resuming flying duties after prolonged absence due to injury or surgery for musculoskeletal conditions, the second regulatory step in UAE is for them to complete SEP training. Following the successful completion of SEP, they will resume normal flying duties.

The results of this study have demonstrated almost perfect test-retest reliability for 13 items and substantial reliability for 2 items, with an overall test-retest reliability of 0.95 with this return to flight assessment for flight attendants. The Pieterse protocol is a reliable tool to establish return to work for cabin crew and, therefore, suitable to replace other subjective return to work assessments.

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